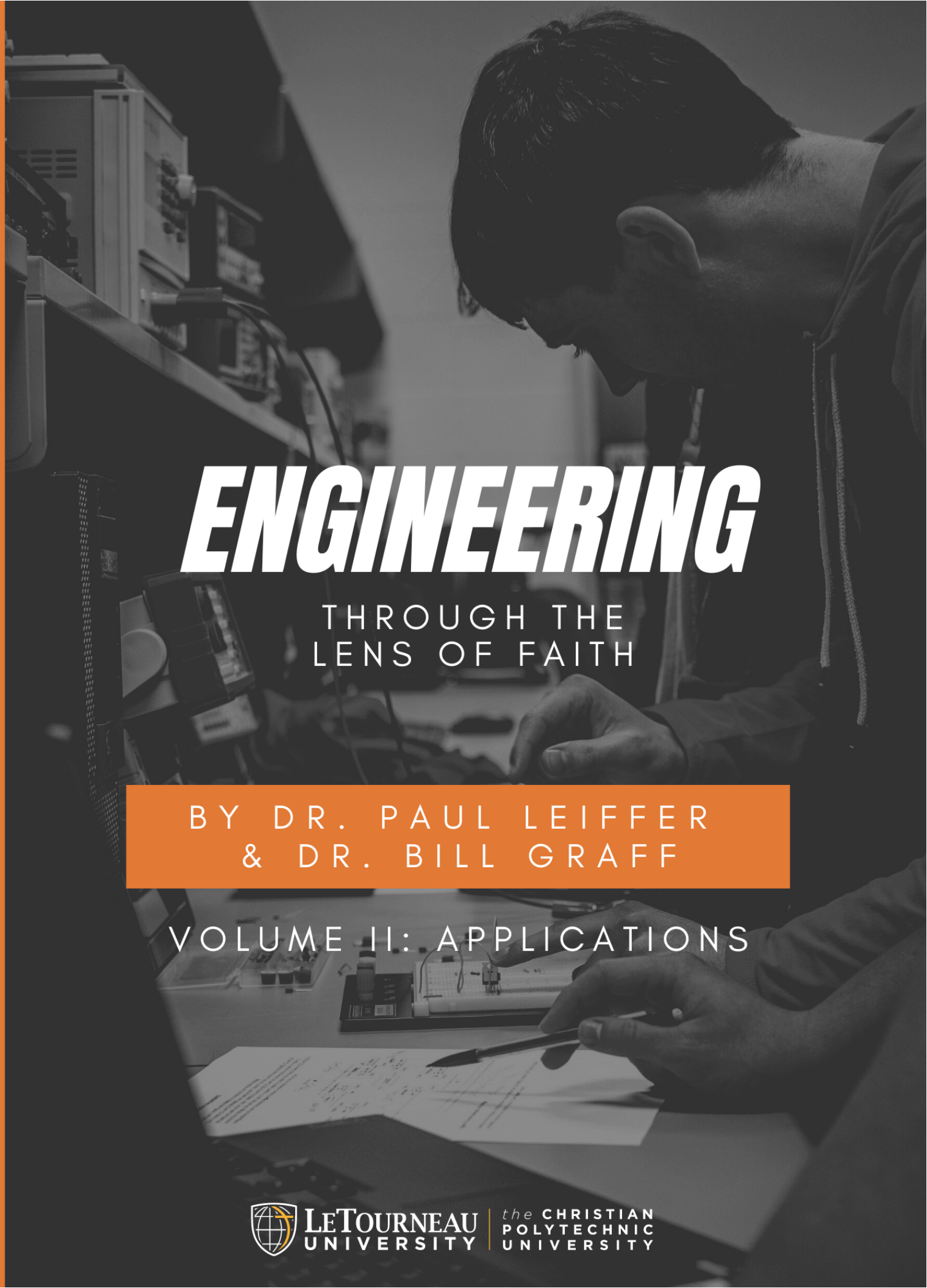

ENGINEERING

THROUGH THE LENS OF FAITH

BY DR. PAUL LEIFFER
& DR. BILL GRAFF

VOLUME II: APPLICATIONS

LETOURNEAU UNIVERSITY | the CHRISTIAN POLYTECHNIC UNIVERSITY

ENGINEERING THROUGH THE LENS OF FAITH

VOLUME 2: APPLICATIONS

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DEDICATED TO

Walter Bradley,
Lambert Van Poolen,
Bill Jordan, and
Steve VanderLeest,

Four outstanding engineering
educators who were pioneers in
describing what Christians in
engineering should look like.

OVERVIEW OF VOLUMES I & II

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PREFACE

Most of the material presented here was originally developed by the authors in the form of short papers and class devotionals. Because many of the pieces may seem familiar to former students we have differentiated these ("By Paul" or "By Bill") in the text. Some material derives from conference papers in which we were co-authors. Other material was prepared specifically for this volume. The authors are grateful to our wives for reading the manuscript, to Howard Henry, Norm Reese, and Wayne Helmer for editing and formatting help, to alumni reviewers, and to Daniel Ostendorff and Stacee Taft for spearheading publication in book form. Our hope is that this book will strengthen engineers who love Jesus and will generate ongoing discussion of the issues raised herein.

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CHAPTER 14: DESIGN

INTRODUCTION

In 1986 Michael Gilstrap related the following parable, which I have shared with students in Design classes: [1]

> *Several hundred years ago, the inhabitants of a small village in Lithuania were faced with a very difficult problem. A weird plague came into town. What was curious about the plague was its symptoms in its victims. As soon as an individual contracted the disease, he went into a deep, almost death-like coma. Most folks died within 24 hours, but occasionally one recovered. The problem the plague presented was the unafflicted had an extremely difficult time determining whether a victim was dead or not. Everyone who caught the disease looked dead, but how could, they be sure? Remember, state-of-the-art medical technology in the early 1700s was a far cry from the bits and bytes of the 1980s.*
>
> *One day a fellow by the name of Sigfried Lattourette was walking past the graveyard. This was during the height of the plague. He heard a strange sound coming from one of the fresh graves. He investigated (albeit carefully, who knows what 'kind of spook is going to pop up out of a new grave*!*) and found that one of the folks the village thought was dead, was alive.*
>
> *This new development really presented a problem for the city fathers. They called a town meeting of the whole town to decide what could be done to prevent such a situation from happening again. There was a great deal of discussion, but in the end the town divided into two groups, each with a different solution to the problem.*
>
> *The largest group decided that each "corpse" should be buried with food and water beside the body, and a hole rigged from each coffin to the surface so the "corpse" could eat, drink, and breathe until it was discovered. The second group thought that idea was too expensive. They proposed implanting a twelve-inch-long stake in every coffin lid directly over the "corpse's" heart. After the lid was finally closed, there would be no doubt as to the appropriateness of the internment. If the plague hadn't gotten the poor sap, the stake certainly would.*
>
> *Each of the two solutions was workable. I'm happy to report that the town opted for solution number one. The interesting thing to me is the road each group took in arriving at two quite different solutions. Group one asked the question, "What must we do in the event someone is buried alive?" Group two asked an entirely different question: "How do we guarantee everyone we bury is dead?"*

Each group asked different questions, looked at the problem from a different perspective, and came up with totally different solutions to the same problem.

The initial step in design must be to determine what the end-user really wants or needs. Design is an activity of engineers in which we mimic on a very small scale what God did in Creation.

The heavens declare the glory of God and the firmament shows forth his handiwork. (Psalm 19)

Engineering design (as opposed to artistic design), along with solving technical problems, is a key activity for engineers.

DESIGN DEFINITION

A hallmark of engineering and all of engineering education is the area of design. It is a specific planned action, which is based on given needs and specifications, and usually involves iteration. Design is a fundamental task of engineers, and, as such, must be a key part of any engineering curriculum, culminating in a capstone design experience.

According to ABET, Engineering design is the process of devising a system, component, or process to meet desired needs. [2]

The ABET definition goes on to say —

"It is a decision-making process (often iterative), in which the basic science and mathematics and engineering sciences are applied to convert resources optimally to meet a stated objective.

Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing, and evaluation. The engineering design component of a curriculum must include most of the following features: development of student creativity, use of open-ended problems, development and use of modern design theory and methodology, formulation of design problem statements and specification, consideration of alternative solutions, feasibility considerations, production processes, concurrent engineering design, and detailed system description.

Further it is essential to include a variety of realistic constraints, such as economic factors, safety, reliability, aesthetics, ethics and social impact." [3]

Engineering design is an ongoing process. It is required when:

- An existing system or product is no longer adequate
- An existing system or product is obsolete
- An existing system or product has failed.
- A new system or product is requested
- There is a significant market for a new product
- A new idea or discovery, if applied, could generate a new product

Like science and the scientific method engineering design is tied to a design method/process. The engineering process typically involves some or all the steps of what's been termed the "Design Cycle":

1. Identify the problem or need
2. Define the specifications (and constraints)
3. Identify (propose) candidate solutions
4. Evaluate potential solutions and select a preferred solution
5. Implement that solution (often as a trial or prototype)
6. Test to see if specifications are being met
7. Refine and complete, or cycle back to step 4

One of the key features of engineering design is that it seeks to solve "open-ended" problems. By "open-ended" we mean that there is no single, specific solution.

The alternative, which we may term "closed-ended" problems, look like this: Find the voltage necessary to produce one watt of power from a 100 ohm resistor.

We set up the relevant equation (P =V 2 /R), solve for V, and have only one value that works.

A different type of problem is this:

Develop a system (using, for example, voltage source and resistor) to produce one watt of power.

Now we have all possible combinations available. Some may not be feasible or affordable, but we have a huge range of solutions. Most design in the "real-world" involves the development of a multi-component device or a complex system.

When students first encounter open-ended problems, some are initially thrown for a loop. (How can I solve a problem that doesn't have a single "right" answer? How do I know I did it right?)

As taught to engineering students, design begins with a problem, need, or opportunity, and a blank sheet of paper. Students are often overwhelmed when they first encounter true "open -ended design" problems in contrast to textbook problems that have a single answer (two volts, seven meters per second). In most cases we seek a "best" solution within the possible range of solutions.

Not all potential designs are good solutions. We typically need to balance safety, cost, usability, power requirements, maintainability, and other variables, often optimizing for one of the variables.

Engineers typically ask five questions at the start of every design project:

1. What is required?
2. How can we do this?
3. What will it cost?
4. How long will it take?
5. How will we verify that we have met the goals?

Engineering design is deliberate, specific, and goal-oriented. In doing design, engineers are using God-given skills to imitate what God has done. Genesis suggests that God specifically planned the design of the cosmos, and, after causing the sudden and initial appearance of space and matter, carried out its development in a systematic way. (Genesis 1, 2)

DESIGN ASPECTS

Engineering design begins with a need or an opportunity and ends with a product or process. The temptation, particularly for students, is to start designing before you completely understand and define the problem.

1. Design involves constraints, limitations imposed from outside.

   Classical design constraints were: [4]
   - Safety
   - Cost
   - Aesthetics
   - Ethics
   - Reliability
   - Maintainability
   - Environment

   Today's standards call for solutions which fit within social, environmental, and political constraints:

   Students must be gain "an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability." [5]

2. Design involves context.

   Engineering design must be looked at in context. For any process, product, or project, there are:
   - Stakeholders — who care about various aspects of quality, safety, costs, and company finances
   - Physical aspects — physical principles used in design, components chosen, manufacturing plan
   - Ethical aspects — in design, use, and safety
   - Project constraints — time, costs, materials, applicable standards
   - Impacts — social, economic, environmental

   Engineering students must gain "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context." [6]

3. Design involves tradeoffs.
   Trade-offs are implicit in most engineering designs, requiring a balance between

multiple goals that each appear to be good. Yet more of the one requires less of the other. Balancing cost and quality is just one example. We trade-off weight (and indirectly safety) with high gas mileage in automobiles. We trade-off time to market with thoroughness of clinical testing for new pharmaceutical drugs. We must often prioritize the competing goods of aesthetics, performance, reliability, safety, recyclability, and more... Good designs are thus a balance of competing goods. If the balance is distorted, favoring one goal to the exclusion of all others, the resulting product is usually dysfunctional, because proper function depends on meeting multiple goals simultaneously. Not only are products the result of a trade-off, but the engineering design process itself is also a trade-off. The old saw "Better, faster, cheaper—pick any two" is a reflection of the balance between the scope, schedule, and cost of a project. Does this mean that one must always accept less of one goal in order to achieve more of another? Not necessarily. Sometimes we find a clever new way to achieve both lower cost and higher quality, e.g., by reducing waste. Sometimes we find an innovation that lets us achieve both environmental stewardship and corporate profit, e.g., by reuse and recycling. Sometimes we find a way to make a part both lighter and stronger, e.g., by using composite materials. I think such combinations are particularly excellent and praiseworthy. [7]

4. Design may be unique to the discipline.

Design, and the results of design, typically look different for different engineering disciplines: Mechanical (large scale machines and engines), Electrical (processors and controllers usually implemented with integrated circuits), Computer (hardware, software, and their interfaces), Civil (structures and waterways, heavily directed by codes and standards), and Chemical (processes and processing plants).

5.Design is typically iterative, requiring some steps in the process to be repeated.

At several steps in the process the formulated design should be checked against the requirements and specifications and corrected if it won't meet what was requested.

Engineering design requires alternating between divergent thinking (generating many possible ideas towards a solution) and convergent thinking (narrowing down to the best solution.) Engineers also adopt at least four basic thinking styles or "thinking hats" in design work. Two of these "hats" are positive and creative ("What could be done?", "How could we do it?"), and two are more negative and restrictive ("Should we do this- are there ethical problems here?", and "Is this even possible, given the finances and technology available?") [8]

6. Design should be done with people in mind.

Some devices are designed strictly for automation, but most involve humans at some point. There are several considerations to designing with people-need both concern for people and responsibility for people:

- failure [9]

- safety
- hazards (identify, prevent)
- risk and product liability
- sustainability
- product lifecycle-what happens at the end of product life?
- managing resources
- designing for the entire population

7. Several special types of design have been explored:
   - Design for Manufacturing -one key goal of the design is ease of (automated) manufacture
   - Design for Test -parts are included in the design to make testing possible during operation
   - Optimal Design -design is optimized with respect to some statistical criterion
   - Sustainable Design (Green Design)- particularly in buildings, design to reduce negative impacts to the environment and efficient use of energy
   - Design for Accessibility (universal design)- design for products that can be used by anyone
   - Frontier Design -design for a totally unfamiliar context, including outer space and extreme disabilities
   - "Design for X" -design for excellence, focusing on some particular attribute- power, cost, assembly, inspection, reliability, safety, logistics, quality, ...

HUMAN DESIGN

- Always has a goal in mind
- Human design has a specific client or end-user population.
- Is bound by certain specifications and constraints
- Is typically iterative - requires multiple "passes" before it meets the goals
- Is often based on previous designs
- May take various sidetracks

Engineering design is somewhat like the scientific method. You may propose a design to a given problem, but you won't know for sure that it works (meets the constraints) until you build it.

GOOD DESIGN

What are the aspects of good design?

1. Design with people in mind. Good design always considers the end-user (and maintainer) of a product or system. Almost everyone who has tried to work on some part of a car's cooling system or electrical system has concluded that the engineers who designed the engine must never have thought about the poor sap who had to repair it.
2. Design with a range of people in mind. People come in all different sizes and shapes. Whatever the designed artifact, it should be usable by most people.

3. Design with people with disabilities in mind. Ideally, the design is accessible, rather than frustrating or inaccessible, to people with common disabilities.
4. Design for ease of use. Good design is not overly complicated and nearly foolproof in its use.
5. Design for easy maintenance. Make it easy to keep it functioning.
6. Design for recyclability. Consider what's necessary to separate and re-use the parts at the end of the product's useful life.

Dieter Rams, a famous designer of consumer products, wrote "10 Principles of Good Design:" [10]

- Good design is innovative.
- Good design makes a produce useful.
- Good design is aesthetic.
- Good design helps us to understand a produce.
- Good design is unobtrusive.
- Good design is honest.
- Good design is durable.
- Good design is thorough down to the last detail.
- Good design is concerned with the environment.
- Good design is as little design as possible.

DESIGN FLAWS AND FAILURES

Engineers are aware of a discouraging truth: Nothing on earth lasts forever, and nothing made by humans is perfect.

After all, the technology that surrounds us is bound to fail, if only because of the fact that it's made by humans. As Petroski writes: 'All things, and especially systems in which people interact with things, fail because they are the products of human endeavor, which means that they are naturally, necessarily, and sometimes notoriously flawed.' [11]

> Collin Dickey writes —
> *The process of engineering design may be considered a succession of hypotheses that such and such an arrangement of parts will perform a desired function without fail. As each hypothetical arrangement of parts is sketched either literally or figuratively on the calculation pad or computer screen, the candidate structure must be checked by analysis. The analysis consists of a series of conditions of use after construction. These questions may be easily answered for designs that are not particularly innovative, but a computer may be required to perform all the calculations needed to analyze a bold new design. If any of the parts fails, the test of analysis then the design itself may be said to be a failure.* [12]

Design failures do happen. Some are minor, others are costly, and some wind-up costing lives.

Every year we read of plane crashes, bridge collapses, computer failures, and power outages. The key is to determine whether the failure was caused by:

- Incompetence
- Negligence
- Compromising safety
- Deliberately cutting corners
- Maliciousness
- Unusual environmental activity
- Faulty computer code
- Simple errors, or
- Mechanical/material failure.

DESIGN AND POSTMODERNISM

Postmodernism and Engineering Design

Postmodernism may be an enemy to Christian truth, ethics, and the Biblical worldview, but, according to Steve VanderLeest, it may enhance our efforts in engineering design. [13]

While postmodernism opposes fixed foundations and absolute truth, it resonates with engineering in several areas:

1. Engineers understand that open -ended design problems do not have a single "right" solution, but, rather, a set of solutions that could work (but are typically optimized for different variables.)
2. Engineering is "conceived as a discipline founded on creativity and trade-offs."
3. Engineers should apply divergent thinking to identify and select among a multiplicity of candidate solutions.
4. Engineers should hold a healthy skepticism towards some scientific results and should avoid an over-reliance on computer-based models.
5. Engineering can benefit from a diversity of viewpoints in team-based design.
6. Postmodernism would hold that design may be biased towards certain ends and that technological products are not neutral. (see discussion in Technology chapter)
7. A technological design is interpreted by the manufacturer and again by the end-user.
8. Our designs /technology affect society, and society affects our designs. [14]

Fortunately, our theories and models, while imperfect, are "close enough" to reality that our designs can work sufficiently in the physical world.

DESIGN AND GOD

God as Designer

It is clear that God is a Designer. God planned the details of the universe, scheduled the tasks,

and implemented the plan in an orderly manner (Gen. 1).

In many ways God's design (of the earth, the cell, and the human body) and engineering design are similar. Both are:

- Deliberate
- Planned
- Optimized for certain functions
- Developed in an orderly way
- Developed to specifications (at least in the mind of God)
- Carried out using physical laws and existing materials

All of our design work is a copy of what God did in Creation. There are, however, several differences. With God's design —

- There was no specific "problem" to be solved
- There was no external "client" (Creation was made by God and for God. Earth was designed for humans who would inhabit it when completed.)
- No requirements were given to God
- God had no defined schedule (other than His seven) or budget
- God had no external considerations or constraints (economics, reliability, codes and standards)
- God began with absolutely nothing present. (Some have said, "nothing-nothing.")
- Physical laws apparently came into being when God caused the universe and matter to come into being
- God knew exactly how well the outcome would work.
- God could consider all of the (essentially infinite number of) alternatives in an instant.
- God's design perfectly fit His purposes.
- There was no need for God to iterate to improve His designs.

Human design clearly differs from God's design.

1. We begin with fixed laws and given materials.
2. Everything we make is in some way a copy of something.
3. Human design involves choosing the "best" solution among alternatives. We don't know at the outset what will work best. God knows the position of every atom in the universe. He already knows every alternative approach and scenario and never attempts what might result in a "dead-end." His choice is already the optimum for His creation.

DESIGN AND CO-CREATION

Theologian Philip Hefner interprets Genesis 1-2 to suggest that, through culture and technology, humans are "co-creators" with God, that God deliberately left parts of Creation "unfinished "for us to complete:

Human beings are God's created co-creators, whose purpose is to be the agency,

acting in freedom, to birth the future that is most wholesome for the nature that has birthed us - the nature that is not only our genetic heritage, but also the entire human community and the evolutionary and ecological reality in which and to which we belong. Exercising this agency is said to be God's will for humans. [15]

It's a fascinating idea, but it's flawed. It is influenced by pantheistic thought and by Process Theology (the concept that God is somehow incomplete in knowledge or action).

It is true that God is Creator and that we also create. Certainly, God knew that over time humans would develop wheels, engines, airplanes, and computers. Certainly, we are exercising God-given creativity and changing the world as we implement design. In no sense, however, are we doing "creation" on the level of what God did. To suggest that would be hubris, if not idolatry.

Engineering design is a specific and well-developed form of design in general (which includes artistic design, clothing design, architectural design, software design, and the design of our cosmos as the ultimate design.)

RECOGNIZING DESIGN?

Design was an important aspect of apologetics in the 18th century, according to science historian Lawrence Principe [16]. William Paley's watchmaker analogy was the best known of these analogies (Just as the existence of a well-crafted watch suggests the existence of a watchmaker/designer, so the existence of the universe suggests a universe Designer.) The weakness of the argument, according to Principe, is that even if one accepts the idea of design/designer it does not guarantee only a single designer or a wise and loving designer. [17]

Believers hold that our model for all design is God's design of the universe, including design of our planet, living cells, and our bodies. Materialists counter that nature regularly exhibits "the appearance of design."

Molecular biologist Douglas Axe writes that the intuition of most people is that the appearance of complex design suggests an intelligent designer; everyone has the sense that life seems designed, but authorities steeped in naturalism talk them out of the idea.

I think the intuition by which we immediately perceive certain things to be the products of purposeful intent is close to the idea that some things are too good to be true. This expression doesn't mean that good things can't happen; it means that certain good things can't just happen. They never come out of thin air. They only happen if someone makes them happen...This hints at a universal rule for deciding what can and can't be attributed to accidental causes, which I'll state as follows: Tasks that we would need knowledge to accomplish can be accomplished only by someone who has that knowledge. [18]

Is it possible to recognize specific and deliberate occurrences of design (as opposed to random formulations or even "the appearance of design"? This was the classical argument of William Paley (1743-1805), who (argued) that the existence of a watch (in his case a pocket watch, with all of its

gears and springs) pointed unmistakably to the existence of a personal designer, a watchmaker. [19] The universe, therefore, being millions of times more complex, would point to the existence of a Divine Designer.

Could randomness and small changes over time produce complete order and conscious being?

Physicists acknowledge that there is a finite probability that every single air molecule in a room could suddenly cluster in one corner (in which case no oxygen would be available to humans and everyone in the room would die). Fortunately, it hardly ever happens (maybe once in every trillion years, and then only for an instant). Similarly, there is a finite probability that a bag of grass clippings could spill on the sidewalk and spell out the Gettysburg Address. In all such cases the probability is so small as to make the event essentially one that we would never expect to happen. Don't forget that the probability of two independent and unlikely events is the product of their probabilities.

When Richard Dawkins points to a modern automobile as an example of small changes over time [20] he fails to point out that we can document the specific and deliberate changes made by a team of designers over the car's history. Nothing blind or random here.

When we see a rock with a shape, worn by flowing water or a hill weathered by wind and storms, these usually have some very simple shape. We would be surprised to find a complex pattern or the image of a person in a rock or hill.

When we think about design, we need to decide at what level we will look: macroscopic, microscopic, or atomic. In the absence of rays or particles things are totally repeatable at the atomic level.

After working with design for several years, it seems that engineers should be able to recognize objects that are deliberately designed as opposed to objects that arise accidentally and even to design a "test" for identifying design.

ATTRIBUTES OF DESIGN

Consider some of the general concepts associated with design. A combination of several of these attributes in an artifact may suggest design:

- Order and structure
- Beauty
- Purpose
- Complexity
- Redundancy
- Information
- Functionality
- Use of repeated units
- Symmetry

- Efficiency
- Development from simple to complex
- Complex integrated subsystems
- Aesthetics
- Synchronicity (like a Rube Goldberg machine)
- Multiple subsystems
- Feedback mechanisms
- Optimization of some quantity
- Coding
- Robustness

THE SPACEMAN AND THE ROBOT (By Bill)

Imagine that you are a spaceman making the very first landing on a distant planet. As you set foot on the planet the first thing you discover is a robot. The robot appears to be autonomous and can interact with all of the planet's environment, even making structures from the parts it finds. Soon you discover that there are actually millions of robots, each unique in appearance and actions. Amazingly, the robots can reproduce themselves and can even mange basic maintenance and repair for themselves. As you leave the planet you think, as a good materialist is trained to think, "Isn't it amazing what random processes can produce?"

THE ARGUMENT FOR GOD FROM DESIGN

That the design aspects of the universe, of nature, and of our bodies imply a great Designer has been a classic and valuable argument for God's existence.

Snoke summarizes it this way:

To put the problem into focus, let me restate the argument from design in a more rigorous manner. This argument is intrinsically an inductive argument, as follows:

1. In our experience, some things are known to be designed by intelligent agents, namely us, or animals with some degree of intelligence.

2. In our experience, some other things are known to not be designed by intelligent agents.

3. In our experience, we find that all of the things which we know to be designed by intelligent agents have certain properties, and none of the things which we know are not designed have those properties.

4. Therefore, when presented with something of unknown history, if it has the properties of a designed thing, then we conclude inductively that it is designed by an intelligent agent.

As it stands, this is a perfectly legitimate inductive argument, used all the time in daily life as well as in science. For example, scientists argue inductively that since we observe that

all hydrogen has the property of absorbing light with certain exact wavelengths, and no other atoms or molecules absorb light at those exact wavelengths, therefore, if something (e.g., an interstellar gas cloud) absorbs light at those wavelengths, then we can conclude that it contains hydrogen. "Telltale" signs of the existence of one thing by their close association with something else are used in our thinking all the time.

Two objections are often made to this argument. One objection is that, in step 4, "an intelligent agent" is poorly defined. [21]

At least 12 different approaches have been developed to examine design and consider a Designer:

1. Anthropic principle (Barrow and Tipler)

In (1980) astrophysicists Barrow and Tipler put into writing the details of what has become known as the Strong Anthropic Principle –Because of its fine-tuning at even the largest dimensions, the universe seems specifically designed for life. [22]

> *The argument can be used to explain why the conditions happen to be just right for the existence of (intelligent) life on the earth at the present time. For if they were not just right, then we should not have found ourselves to be here now, but somewhere else, at some other appropriate time. This principle was used very effectively by Brandon Carter and to resolve an issue that had puzzled physicists for a good many years. The issue concerned various striking numerical relations that are observed to hold between the physical constants (the gravitational constant, he mass of the proton, the age of the universe, etc.). A puzzling aspect of this was that some of the relations hold only at the present epoch in the earth's history, so we appear, coincidentally, to be living at a very special time (give or take a few million years!). This was later explained, by Carter and Dicke, by the fact that this epoch coincided with the lifetime of what are called main-sequence stars, such as the sun. At any other epoch, so the argument ran, there would be no intelligent life around in order to measure the physical constants in question — so the coincidence had to hold, simply because there would be intelligent life around only at the particular time that the coincidence did hold!* [23]

Physicist-theologian John Polkinghorne notes that carbon is made in the stars by means of a resonance enhancement effect which exists "because the laws of physics take a specific form. If they were a little different either there'd be no resonance or it would be in the wrong place, at the wrong energy. This is a very striking example of how finely tuned the universe has to be for us to be inhabitants of it." [24]

"When you realize that the laws of nature must be incredibly finely tuned to produce the universe we see, that conspires to plant the idea that the universe did not just happen, but that there must be a purpose behind it." [25]

2. Fine tuning of the universe (Bradley, Ross)

Over (twenty) physical constants, including the speed of light, the mass of the electron, the charge of the electron, and Planck's constant are so "finely-tuned" that they do not vary out to several decimal places. Such fixedness is not only essential for our physics but absolutely essential for earth to exist and for life on earth to continue. [26] [27]

Physicist Paul Davies has noted that the initial expansion rate of the universe could not have differed by more than one part in 10**60 without affecting the conditions for life. [28]

"An accuracy of one part in 10 to the sixtieth power can be compared to firing a bullet at a one-inch target on the other side of the observable universe, twenty billion light years away, and hitting the target." [29]

When we talk about the fine-tuned universe, we should be careful not to say that "the universe seems uniquely designed for life." Actually, it doesn't. Over 99 per cent of the universe is not habitable. Instead, the universe seems uniquely designed to allow life on earth.

> *A few scientists speak as though life somewhere else in the universe is inevitable, that given enough time the galaxies will be teeming with life. The fact is, however, that we have no evidence of life developed beyond earth and instead find that the number of candidate planets for the possibility of life is increasingly small.* [30]

The fine-tuning evidence is so strong that many physicists who deny the presence of a Creator explain the uniqueness of our world by positing a "multiverse," the existence of an infinite number of parallel universes, each slightly different, in which we happen to live in the "lucky one," the one in which all parameters work for the existence of life. [31]

3. Privileged planet concept (Gonzalez and Richards)

In 2004 astronomer Guillermo Gonzalez and Discovery Institute fellow Jay Richards published *The Privileged Planet*, a book which made a strong case for Design based on earth's place in the galaxy. [32]

> *Both (mathematics and fine-tuning of constants) are prerequisites for science, yet what about the process of scientific discovery itself? What are its necessary conditions? Why is it even possible? ...Our location is much more critical to science than it is to real estate. For some reason our Earthly location is extraordinarily well suited to allow us to peer into the heavens and discover its secrets. Elsewhere, you might learn that Earth and its local environment provide a delicate, and probably exceedingly rare, cradle for complex life...Those same rare conditions that produce a habitable planet-that allow for the existence of complex observers like ourselves-also provide the best overall place for observing. What does this mean? At the least, it turns our view of the universe inside out. The universe is not "pointless" (Steven Weinberg), Earth merely "a lonely speck in the great enveloping cosmic dark," (Carl Sagan) and human existence "just a more-or-less farcical outcome of a chain of accidents" (Steven Weinberg). On the contrary, the evidence we can uncover from our Earthly home points to a universe that is designed for life and designed for discovery.* [33]

Authors Guillermo Gonzalez and Jay W. Richards suggest Earth was designed for scientific discovery. They introduce the "measurability" concept—-the idea that Earth is ideal for scientific observation. For example, the authors argue that if the Moon were slightly larger or smaller, scientists couldn't study eclipses. Or if atmospheric conditions were different, astronomers wouldn't be able to observe stars from Earth's surface. The authors then ask what the chances are that another planet could have the same specifications necessary for conducting scientific research... The book critiques the Copernican principle, which holds that Earth is not special in its ability to support life. The authors argue that Earth's measurability demonstrates the flaws in the Copernican principle and marks the theory's limitations as astrobiology dogma. [34]

4. Irreducible complexity (Behe)

Biochemist Michael Behe has developed the concept of "irreducible complexity." His argument for biological design is that certain structures and organs, such as the bacterial flagellum and the human eye, are so interconnected and complex that they could not have formed in random steps and still functioned. As an analogy, if any part of a simple spring-loaded mousetrap were not present the mousetrap would not work. [35] The eye, the ear, and most organs of the body could not have been formed randomly or partially. This "all-or-nothing" appearance points to a Designer.

> *Design may be indicated by Behe's notion of the presence of "irreducible complexity" in some living systems. A living system, such as the bacterial flagellum, is irreducibly complex if all of its constitutive parts are required for its essential function. In this case, the function (necessary for the survival of the organism) cannot be accounted for on the basis of gradual (changes)...(T)he informational content found in DNA is a clear case of specified complexity, since the information cannot be explained according to chance or natural laws alone. ...(T)he intricate and multifaceted fine-tuning of the universe as a whole similarly resists adequate explanation on the basis of chance and natural necessity because it evinces specified complexity.* [36]

> *Another certain feature of design is demonstrated when engineers foresee aspects of their project that cannot be built by increments. They respond by establishing conditions, so all information and materials are 1) available, 2) localized together, 3) at the right time, 4) capable of functioning together 5) for the intended purpose. Only intelligent agents have been observed to set conditions where all of the parts must be collected and built together or none of a specific function is obtained. Creatures have many examples of this all-or-nothing unity, but the best example is reproduction. Evolution is a dead end without operative reproductive abilities. Intelligent foresight best explains why the minimum number of parts necessary for an organism to reproduce—is the organism itself.* [37]

5. Specified complexity-filter (Dembski)

Mathematician/philosopher William Dembski developed the concept of design inference: "The design inference uncovers intelligent causes by isolating the key trademark of intelligent causes:

specified events of small probability. Just about anything that happens is highly improbable, but when a highly improbable event is also specified (i.e., conforms to an independently given pattern) undirected natural causes lose their explanatory power. Design inferences can be found in a range of scientific pursuits from forensic science to research into the origins of life to the search for extraterrestrial intelligence." [38]

The explanatory filter's steps are these:

Observation

- Is there contingency? (if no, the alternative is necessity)
- Is there complexity? (if no, the alternative is chance)
- Is there specificity? (If no, the alternative is chance)

If all three are present, this points to design. [39]

6. Six hallmarks of design (Burgess)

Engineering professor Stuart Burgess details six "hallmarks of design" that point to an Intelligent Designer: [40]

1. Irreducible mechanisms
2. Complete optimum design
3. Added beauty
4. Extreme similarity in features
5. Extreme diversity of kinds
6. Man-centered features
7. Information content (Varghese)

According to the original development by Claude Shannon, information has "surprise value." The greatest information content is associated with the lowest probability for the message content (the least predictable code.) For example, "Today is Monday" conveys very little information whereas "A giant spider is climbing city hall" would have huge information value.

Information is coded in the DNA of the cell — all of the "instructions" for cell repetition and the basic blueprint for our appearance. Information as we know it requires a conscious, deliberate source.

Roy Varghese, in his book *The Wonder of the World* [41] posits these questions —

- Why should the universe turn out to be orderly and intelligible?
- How do protons and electrons "know" what to do and how to bond, so that they do this perfectly?
- Since the DNA molecule contains the information necessary to configure the cell, where did this information come from?

Unmistakably, matter, mass/energy in this context, is the primary vehicle of information in the world. Whether it's information programmed by us, e.g. software, movies, books, or communicated by mysterious instruction manuals like DNA, or simply

inbuilt as with anything that follows the laws of nature, everything in the universe is controlled by coded information. But matter is purely a vehicle. How did it become a vehicle for codes and blueprints? We know it takes intelligence to decode the information transmitted by matter. But if decoding requires intelligence, how about the encoding? If information exists prior to matter, what is its source? [42]

Totten [43] argues that information always contains (1) Functionality, (2) Complexity, and (3) Specificity.

Totten provides the following tests for establishing design based on information:

- First, FUNCTION: We must establish that the ordered parts in a system (grouping) of things work together in coordination to perform a useful function (for example a group of letters that communicate, or a group of amino acids which comprise a properly-folding protein).
- Second, INFORMATION: We must establish that those ordered parts are complex, specified information (see above).
- Third, NO MECHANISM: We must establish that there is no law of physics, or chemistry in the mechanisms of nature which could explain the ordering of the parts found in the functioning system.
- Fourth, NO RANDOM ORDERING: We must establish that there are no random processes of chance which could explain the ordering of parts in the functioning system. [44]

7. Counterflow argument (Ratzsch)

Philosopher of science Del Ratzsch points out that "Christian theology played a significant (perhaps pivotal) role in the birth of modern science... The idea of design was crucial... things that are designed are typically intelligible, embody consistency and coherence, and generally must be empirically examined to determine what the actual structure is." [45]

Ratzsch introduces the idea of "counterflow" as any appearance in the natural world of things running contrary to what unaided natural forces operating freely would ordinarily produce. "When agents redirect, restrain or constrain nature, they leave counterflow marks. Ratzsch goes on to say that counterflow can be injected into initial states, processes, or results. Counterflow is important in identifying agent activity in a given structure." [46]

We tacitly recognize design almost non-stop in the normal course of things — in physical, conceptual, and behavioral artifacts. Design recognition is essential even in various sciences, from the social to such semi-hard sciences as anthropology, the Search for ExtraTerrestrial Intelligence (SETI), and some forensic sciences. However, the recognition process in virtually all relevant instances rests upon recognition that some aspects of the phenomenon in question exhibit counterflow—characteristics which nature unaided by agency does not, would not, or even could not produce. SETI, for instance, looks initially for signals of a type, pattern, or frequency not likely attributable to natural processes. Attempts to understand Stonehenge began with the trivial recognition that it was an artifact and not a product of natural processes. That is the basic pattern of familiar cases of design recognition—a preliminary recognition of counterflow and artifactuality...

Design recognition does not depend solely (or perhaps at all, in some cases) upon recognition of counterflow. What signals design—as opposed to just artifactuality—is that designed phenomena typically manifest some characteristic that resonates with our cognition. Even the most ordinary cases of design involve more than merely something nature would not do. Being deliberately agent-generated, they typically involve something that an agent, a mind, would do. That is the heart of the concept of design. And that characteristic in principle can be recognized independent of recognition of counterflow and can exist independent of counterflow itself. [47]

8. Reverse engineering (Halsmer)

Engineering professor Dominic Halsmer has studied the activity of reverse-engineering, typically performed by an engineer to disassemble a product into its component parts or systems in order to understand how it works. Recent publications have described efforts to reverse engineer the solar system and the human brain. Since these reverse-engineering efforts are undertaken with knowledge to understand the inner-workings of such complex natural systems, suggests Halsmer, doesn't it make sense to wonder if they weren't specifically engineered in the first place? [48] "The fact that the natural world is so readily and profitably reverse engineered suggests that the cosmos actually is an engineered system. Investigators should not hesitate to consider this perspective, since it not only seems to facilitate discovery, but may also provide a sublimely satisfying understanding of personal meaning and purpose." [49]

9. Affordances (Halsmer, Maier)

Halsmer has also developed an extensive analysis of design based on the principle of "affordances" based on the work of Jonathan Maier on affordance-based design. [50] A functional approach looks at design from the point of view of final purpose. (We need something to drive a nail.) On the contrary, affordance-based design looks at design from the point of view of an artifact that allows for certain operations.

The extent to which the affordance structure matrix is populated also indicates a measure of "designedness" of a system. A skillfully engineered system makes use of as many interactions between parts as possible to produce positive affordances, while minimizing negative affordances. A part that serves multiple purposes simultaneously represents ingenuity and an efficient use of resources. This is evident when considering the characteristics of life on Earth and the structures and mechanisms of systems biology. [51]

From a human perspective, in this (designed) world, it is possible

- To find resources to stay alive
- To find beauty in nature
- To explore, experiment, and discover
- To discover laws of nature (science)
- To find resources to establish culture

SPECIFICALLY RECOGNIZING DESIGN

In *The Design Matrix*, Mike Gene attempts to synthesize many of these ideas into a set of four criteria that can be scored and combined to quantify an indication of design or non-design for any particular system. The four criteria are these:

1. Analogy – Does the system resemble entities that we know are engineered by humans, such as machines, codes, or other devices?
2. Discontinuity – Does the system exhibit irreducible complexity, or is it possible to evolve via a series of gradual intermediate functional states?
3. Rationality – Does the system have a function that can be structurally decomposed? Does the working hypothesis of a "purpose" explain the system? How well do engineering criteria for good design map to the system?
4. Foresight – Does the system demonstrate Original Mature Design (design that has remained unchanged over long time periods and is robust in the face of disturbances? Does the present state explain something about the past? [52]

Michael Corey in his book, *The God Hypothesis: Discovering Design in our "Just Right" Goldilocks Universe* [53] asserts that the following criteria can be used to judge if any given artifact has been deliberately contrived:

1. The existence of a coherent object that is comprised of a complex concatenation of interconnected parts that all work together toward achieving some practical end.
2. A complex degree of cooperative interaction between the various internal components toward a single functional end.
3. An Aristotelian "formal cause" or intelligible design that can be laid out in a logical coherent fashion.
4. The exploitation of well-known technological and engineering principles which are utilized for a common constructive end. [54]

DESIGN AND THE HUMAN BODY

The Heart

In the upper right atrium (upper chamber) a region of excitable cells known as the sinoatrial node (natural pacemaker of the heart) beat spontaneously throughout every moment of a person's life, initiating the electrical signals which spread down and across the heart, prompting mechanical contraction and the flow of blood through the heart.

Nerves

The speed of impulses in the nervous system is about (100) meters per second. At any given second multiple channels of information are being processed. We are able to see, hear, and touch an object simultaneously in real time. The resting voltage across the cell membrane (between exterior and interior of the nerve cell) must be very close to -70 millivolts. If the ionic concentrations

of sodium and potassium in the nerve cells were slightly different, the cells wouldn't conduct. If the nerve pathways conducted at different rates we wouldn't perceive facets of objects at the same time.

Bones

Bones are sculpted for strength and minimum material. Bones employ engineering principles of the arch to achieve strength, and they reduce weight through elimination of material in places where it is not needed. The variations in cross-sections and densities make them look as if they were designed according to the latest engineering theories, but they're formed to tolerances that human engineers wouldn't dare to specify. The changes in cross-sectional areas are smooth transitions. This gradual gradient alleviates stress concentrations and crack proneness that abrupt changes and interfaces cause. These blending gradients are found all over in nature.

Bones are not designed to resist torsion, or twisting. Large and bulky cross-sections are required to get torsional strength and stiffness. Rather than take on this added weight, the skeletal mechanisms are designed to avoid any torsional loadings. Problems only arise when unnatural torsional loads are applied – like humans wringing the neck of a chicken to kill it or man attaching long levers to their feet and skiing downhill rather poorly, resulting in broken legs. The vertebrae of the chicken are very weak in torsion, as are our legs, but it takes unusual loads to apply these torsional demands. Human engineers came to the rescue, though, (at least for man) designing the modern safety bindings that release automatically in torsion. The chicken is still out of luck! By avoiding torsional loadings, there are significant bulk and weight savings in the bones. As long as they are not subjected to unnatural loads, most animals can afford to be weak in torsion. [55]

Biomimicry

An emerging field in design is the area of biomimicry, or biologically inspired design. Believers make the case that biomimicry is simply copying God's designs.

The concept behind a substantial number of common artifacts originated in nature: [56] [57] [58]

DESIGN/DEVICE	INSPIRED BY
Airplane wing	Bird wing
Fans	Leaf in the wind
Velcro	Thistle Burrs
Camera	The eye
Submarine	Fish
Sonar	Whales and dolphins
Robots	Human arms and trunk
Solar power	Plant photosynthesis
Flippers	Fish fins
Pliers	Bird beaks

Hydro dams	Beaver dams
Scents	Flowers, fruit
Helicopters	Dragonflies
DESIGN/DEVICE	INSPIRED BY
Road reflectors	Cat's eyes
Skydiving suit	Flying squirrels
Water fountains	Natural springs
Camouflage	Animals in nature
Swimming pools	Ponds and lakes
Sun-following solar panels	Flowers
Turbine blades	Whale fins
Racing swim suit	Shark skin
Office building heating/cooling	Termite den
Dust-repelling paint	Lotus flower
Bullet train	Kingfisher birds
Hypodermic needles	Snake fangs
New contact lens design	Gecko eyes
Car aerodynamic designs	Fish shapes
Dry adhesives	Gecko feet
Liquid wire	Spider silk
Honeycomb structures	Bees
Self-healing pipes	Blood platelets
Hovering microvehicle	Hummingbirds
Rescue robots	Cockroaches
Space drill	Horntail wasp
Echolocator cane for the blind	Bats
Ice tires	Polar bear feet
Advanced x-ray system	Lobster eyes

IMPERFECT DESIGN?

Certainly, all human design is sub-optimal. We can usually think of ways that any design can be improved.

It is common for scientifically minded opponents of the Biblical message to point out areas of biology or human anatomy that appear to be "poorly designed" or "imperfectly designed" (wisdom teeth, the appendix, the spine, the eye). The implication here is that "I could have done a better

job designing that" and "An all-knowing God would never have designed people this way"; hence, there must not be a Creator God. "Poor design," it is suggested, seems more consistent with blind random processes.

The assumptions being made here are that:

- God will always design something "perfect," which would last forever and never fail in its function. God is not necessarily constrained to create a "perfect" universe or body.
- Divinely designed human bodies should not wear out.
- Divinely designed human bodies should not experience pain.
- Divinely designed human bodies should be maximally efficient.
- We fully understand the function of any "faulty" parts.
- Our own redesign would actually work in a living body.

What this argument neglects, however, are these pieces —

- Our bodies coordinate and balance a number of different competing systems
- Our bodies are not designed to be pain-free and to live forever, particularly since the Fall

Critiquing the design of the body assumes we understand all that went into the design and the purpose of the design.

- Ideal, efficient design is really in the "eye" of the beholder.
- "Bad designs" are not necessarily faulty designs.
- We misunderstand the purpose for our design.
- While initial Creation was apparently perfect, everything we find on earth has been tainted by the effects of the Fall. Both our planet and our bodies are subject to decay and death since the Fall.
- Based on Scripture, we do not expect that our bodies and our lives will be "perfect."
- There will be some pain and some suffering. (Genesis 3) All of this should move us to greater dependence on God.

Typical areas that are mentioned include

- junk DNA
- wisdom teeth
- the human eye
- the appendix
- the spinal cord
- the recurrent laryngeal nerve

Studies of several of these "flawed designs" have suggested that they might not, in fact, be flawed. Let's look at some of the "poor designs"--

The Eye

At various times the argument is made that the human body could not be designed since it eventually wears out and since certain organs appear to be inefficient or "poorly designed" (hence

they must have arisen through random processes alone.) The eye, for example, includes a retina that may tear or detach and is structured so that light must pass through gelatinous fluid and a region of blood cells before reaching the cells of the optic nerve ("an inverted eye design".) Bergman describes in detail why the human eye is, in fact, a marvelous design:

> *The photoreceptors (rods and cones) must also face away from the front of the eye in order to be in close contact with the pigment epithelium on the choroid, which supplies the photoreceptors with blood. This arrangement allows a "steady stream of the vital molecule retinal" to flow to the rods and cones without which vision would be impossible. The verted design, claimed by Miller to be superior, would place the photoreceptors away from their source of nutrition, oxygen, and retinal (the choroid). This design would cause major problems because rods and cones require an enormous amount of energy for their very high metabolism required in functioning, maintenance, and repair. In addition, because of phototoxicity damage, the rods and cones must completely replace themselves approximately every seven days or so.*
>
> *The photoreceptors and retinal epithelium absorb an enormous amount of light on a continuous basis when the eyes are open. Because the light is converted largely into heat, the retina must have a very effective cooling system, again provided by the choroidal blood supply directly behind the pigment epithelium. If the pigment epithelium tissue were placed in front of the retina, sight would be seriously compromised. Reversing the retina so that it faces away from the pigment epithelium would also compromise sight to the degree that sight would be impossible because the photoreceptors must be embedded in the retinal pigment epithelium to obtain the nutrients required to function.*
>
> *Importantly, placing the retina neural components in front of the photoreceptors does not produce an optical handicap for several reasons. One reason is the neural elements are separated by less than a wavelength of light. Consequently, very little or no scattering or diffraction occurs, and the light travels through this area as if it was at near-perfect transparency. Secondly, when viewed under the microscope, most cells are largely transparent (and it is for this reason stains, such as Eosin-Y and Hematoxylin 2, are needed to better visualize the various cell parts). Consequently, the thin layer of cells in front of the retina rods and cones have a negligible light blocking effect.* [59]

The Spine

Why do many individuals experience back pain? Is it because of an "improper" curvature of the spine?

The idea that humans or their ancestors originally walked on all for limbs is not a solution to back problems and may, in fact, cause enormous harm. [60]

> *Williams asserts that mankind, in forcing the body 'to stand erect, severely deforms'*

the spine, 'redistributing body weight to the back edges of the intervertebral discs in both the low back and neck …. The fifth lumbar disk (and sometimes the fourth lumbar disc as well), ruptures,' and the nuclear material 'ruptures into the spinal canal causing pressure on the spinal nerves.' As mentioned previously, the solution Williams recommended was primarily to 'always sit, stand, walk, and lie in a way that reduces the hollow [or curved lordosis] of the low back to a minimum' (emphasis mine). [61]

It now is recognized that the curvature of the lumbar vertebrae is critically important for back health, and the problems do not result from too much curvature as Williams' theory states, but from too little curvature. The lordosis helps to prevent disk rupture by subjecting the disk to pressure to keep it in place. This is done by placing the body load directly over the central weight bearing axis through the hip joints, thus minimizing oblique or vertical shearing loads on lumbar disks, but still allowing movement of the spine. [62]

The Knee-Burgess

Engineering professor Stuart Burgess has done extensive study of the human knee and marvels at the assembly of the parts. Because of the arrangements of the ligaments and the shape of the bones the knee acts as a four-bar linkage. Some have argued that the design is inefficient and that parts of the knee are unnecessary.

It is important to note that the complete knee contains an extremely efficient and elegant design with many complex parts. These include a bone at the front of the knee called the patella (kneecap) and a fibrous capsule containing several ligaments, which encloses and supports the joint. There is also a soft cartilage to reduce shock loads between the bones and an elaborate arrangement of muscle fibers connected to the front and back of the leg to enable the movement of the joint to be finely controlled. There is even a lubricating fluid, called synovial fluid, inside the knee that makes the joint rotate smoothly and last a long time. [63]

The basic principle of the knee joint is unique whether it is the knee joint of an animal or human being. However, there is yet a further problem for the evolutionist in that the human knee is distinctly different from animal knees. In the case of humans, the knee is designed to lock easily in extension (straight leg) so that maintaining straight legs and a vertical posture is easy. This design feature is one reason why man is a biped (two-legged) and is able to walk and run upright in a completely natural way. Apes' knees cannot lock and must be continually loaded in flexion (bent leg) … In contrast, an able-bodied and fit human being can run many miles without great difficulty! [64]

The fact that things in nature, including our bodies, look to be designed and yet are not perfect may suggest to some a less-than -perfect Designer or a flaw in the design process. At this point reality lines up with the Bible's explanation: The world was created ideally, yet has been marred, but not destroyed, by the Fall.

HUMANS WERE DESIGNED

Design is done for a purpose, and God's design of human beings suggests our purpose. What were we, as humans, designed for? We are actually told in scripture. We were not designed for constant pleasure, personal fulfillment, or freedom from all pain and suffering. Scripture makes it clear that we (our minds and bodies) were designed to give glory to God.

Humans were not designed to maximize pleasure, to live forever, or to "survive." According to the Bible we were designed primarily to image God and to glorify God. In addition, we were designed to "have dominion over the earth," to populate the earth, and to relate to others. The believer is also designed to reflect the light of Christ and to let his or her body be the temple of the Holy Spirit.

The human body has these capabilities:

- To walk uprightly, to see the world in an upright position and, figuratively, to walk upright before the Lord
- To see the world in three dimensions and color, to appreciate the beauty of creation
- To hear spoken communication and to respond to the words of those we relate to and to God's scripture
- To produce musical tones with our voices, to sing in worship
- To control our limbs – to kneel, to stand, to bow, to raise our hands in worship; to travel short distances on foot; to carry out manual labor

A person who is unable to speak, to hear, or to move is still able to glorify God simply by showing God's design.

Simply by being human, with all that is unique to humanity (abstract thinking and communication, moral choices, complex volition, creativity and design) we show our stamping with the image of God.

Glorifying God, on the other hand, seems to involve deliberate action. (I Cor. 10:31)

- Our eyes see the beauty of nature.
- Our mouths and vocal cords sing praise.
- Our ears hear the words of Scripture.
- Our hands may be raised in worship or extended in service to others.
- Our legs and feet allow localized travel to places of service or worship.

An old hymn, *Take my Life and Let It Be*, by Frances Havergal expresses the idea this way: [65]

Take my life and let it be consecrated, Lord, to thee.

Take my moments and my days; let them flow in endless praise.

Take my hands and let them move at the impulse of thy love.

Take my feet and let them be swift and beautiful for thee.

Take my voice and let me sing always, only, for my King.

Take my lips and let them be filled with messages from thee.

Take my love; my Lord, I pour at thy feet its treasure store.

Take myself, and I will be ever, only, all for thee.

Our bodies were not designed to maximize our pleasure but to be a part of our role in imaging God and in worshipping God.

REAL AND APPARENT DESIGN

Matt Young, a strong opponent of divine design musters this argument: [66]

> *The classical design argument should fail for this reason: If we see a bulldozer on an island or even on a planet, we expect that humans have been there precisely because we recognize a human-made artifact (something we've seen before), or something like it. We can assume (human) design from experience. Period.*

The issue, however, is this —

What does it mean when we encounter an artifact far greater and more complex than any human has made or knows how to make (planets, living animals, and humans)?

We have no experience with the human design of anything alive in nature. Should we assume that multiple random processes gave rise to these items, or could we postulate that something greater than ourselves must have been involved? Some in science have reported examples of local self-organizing matter, but there is no basis to think that it could spontaneously build into complex whole systems, let alone living beings.

> *That answer ought to catch attention and keep discussion on the main question: "What is the best explanation of nature's design?" The Bible says in Romans 1:18-23 that the Lord's witness to His reality is "clearly seen" from the "creation" by the things He has "made." He used the language of design construction, not biology. Everyone can see nature's design and conclude it was designed-by a cause bigger than nature. Thus, Romans details how everyone's accountability to acknowledge God has always been based on the very clear design-designer*(i.e., created creator) connection, demonstrated by all human cultures, and not on detailed biological insight.
>
> *So, the biological question "how do organisms adapt to environments?" is not the root issue, which is founded on basic question corresponding to problem-solving activities of intelligent engineers: Are features of design evident when the innate programming of organisms actively solves problems (or exploits opportunities) presented by environments?* [67]

While the universe may point to a Designer, scripture is clear that our natural tendency is to

"suppress the truth in unrighteousness." (Rom. 1:18) To the believer, ultimately everything is designed, since the universe from galaxies down to the sub-atomic particles all have a divine origin. To the non-believer, ultimately nothing is designed, since neither the universe nor the atom has any divine origin.

The Fatal Flaw in Naturalism

A fatal flaw in naturalism has been expounded by philosopher Alvin Plantinga: If our brains are only the results of random physical actions maintained by purely chemical processes why should we expect that any of our thoughts are true? How can I trust the ideas in my brain? Who would trust the output of a computer that was assembled randomly? [68]

John Lennox summarizes the case:

> *If we take the atheist view, then rationality dissolves, as distinguished philosopher Alvin Plantinga of Notre Dame neatly puts it:*
>
> *"If (Richard) Dawkins is right that we are the product of mindless unguided natural processes, then he has given us strong reason to doubt the reliability of human cognitive faculties and therefore inevitably to doubt the validity of any belief that they produce - including Dawkins' own science and his atheism. His biology and his belief in naturalism would therefore appear to be at war with each other in a conflict that has nothing at all to do with God."* [69]

CONCLUSIONS

God is the ultimate Designer, and all of our design work simply copies his. The argument from the 18th Century remains valid today: The world around us suggests design, and design suggests a Designer.

> *We recognize immediately that nature requires an explanation beyond itself, that the things in nature are designed, that design requires personal agency. In short, we recognize immediately that we are created by the one true God.* [70]

Design is strongly related to the concept of purpose.

> *Design is obvious not just in our bodies but across the whole range of human powers and capacities. The function of fear is to warn; of minds, to deliberate and know; of anger, to prepare for the protection of endangered goods. Everything in us has a purpose; everything is for something. A power is well-used when it is used for that purpose and according to that design. Thus the virtue of courage is not being fearless, but fearing rightly: For the right reasons, in the right way, and to the right degree, neither more nor differently.* [71]

Recognizing design prompts more questions.

> *Philosopher William A. Dembski observes that "Design" is a better name for a research*

program than for a theory. Once we realize that something is designed-whether us or another thing--our questions have only begun. What are the components of the design? What is the function of each one? What degree of disturbance allows it to go on functioning? Once it has been disturbed, how can the original function be recovered? What are the constraints within which it functions well, but outside of which it breaks? What were the designer's intentions? [72]

Consider that the simultaneous presence of a number of high-level design evidences could point to deliberate design rather than accidental development:

- Apparent purpose
- Fine-tuning
- Irreducible complexity
- Information content
- Affordances
- Unlikely occurrences

What does "God's grand story" mean specifically for engineering design?

Creation —

- Nature is valuable.
- Humans are valuable.
- All designs must be done with humans in mind (even if the design is not specifically for humans.)

Fall —

- A fallen world can be "repaired" in part.
- All designs must recognize that humans may misuse what we design.

Redemption/Restoration —

- Christ has purchased us and given us new life.
- All design must be done as servants of Christ and to His glory.

Biblical principles

- We are our brother's keeper
- We are to protect others
- God has special concern for the injured and oppressed
- Our designs should be usable by all -Usage-centered frontier design (Matthew Green)

Design for the real-world

We must avoid the danger of perfectionism. The designs we create are never the best they can

possibly be, and they won't last forever. They must function well and be safe and affordable. They should be the best they can be within the constraints that we're given. We are always limited by budget (costs), time, and availability of resources.

References

1. Gilstrap, M., "The Right Answer?" *Geneva Review*, Aug. 1986.
2. ABET, definition of design.
3. Ibid.
4. ABET, *Criteria for Accrediting Engineering Programs*, 1985.
5. ABET, *Criteria for Accrediting Engineering Programs*, 2018 - 2019.
6. ABET, *Criteria for Accrediting Engineering Programs*, 2020 - 2021.
7. Vander Leest, S., Deus Ex Machina, "Broken Christmas Toys," Dec. 12, 2012
8. Graff, R.W., Leiffer, P., Batts, M., and Leiffer, M., "What Fuzzies Might Learn from Techies," ASEE Annual Conference, 2010.
9. Petroski, H., *To Engineer is Human*, Vintage, 1985.
10. Detweiler, C., *IGods: How Technology Shapes Our Spiritual and Social Lives*, Brazos, 2013.
11. Dickey, C., A fault in our design, http://aeon.co/magazine/technology/is-technology-making-us-vulnerable/
12. Petroski, H., op. cit., p. 44.
13. VanderLeest, S., "Deconstructing Engineering Design," ASEE Annual Conference 2005.
14. Ibid.
15. Hefner, P., *The Human Factor*, Augsburg Fortress, 1993, p.27.
16. Principe, L., *Science and Religion*, The Great Courses, The Learning Company, 2006.
17. Ibid.
18. Axe, D., *Undeniable*, Harper One, 2016, p.20.
19. Paley, W., *Natural Theology*, John Morgan, 1802.
20. Dawkins, R., *Climbing Mount Improbable*, Norton, 1996.
21. Snoke, D., "Defining Undesign in a Designed World," https://www.christianscientific.org/wp-content/uploads/2012/06/undesign.pdf
22. Barrow, J., and Tipler, F., *The Anthropic Cosmological Principle*, Oxford University Press, 1988.
23. Penrose, R., *The Emperor's New Mind*, Harvard University Press, 1989.
24. Polkinghorne, J. ,Transcript of Interview, https://www.yumpu.com/en/document/read/38556158/transcript-of-interview-with-revd-dr-john-polkinghorne-kbe-frs
25. Polkinghorne, J., "Science Finds God," *Newsweek*, 20 July, 1998
26. Bradley, W., "The Fine-Tuning of the Universe: Evidence for the Existence of God?" *Persp*.

Sci. Chr. Faith 70 (3) (2018):147-160.

27. Ross, H., "Fine Tuning of Universe," (video) https://www.youtube.com/watch?v=ffDXc4akhGo
28. Davies, P., *The Accidental Universe*, Cambridge University Press, 1982, p. 90-92
29. Collins, R. The Fine-Tuning Design Argument, https://rintintin.colorado.edu/~vancecd/phil201/Collins.pdf
30. Ross, H., Improbable Planet, Baker Books, 2017.
31. Friedrich, S., "A New Fine-Tuning Argument for the Multiverse," *Found. Physics*, 49:1011-1021, 2019.
32. Gonzalez, G., and Richards, J., The Privileged Planet, Regnery Publishers, 2004.
33. https://privilegedplanet.com/synopsis/
34. Privileged Planet, earlier version of website.
35. Behe, M., *Darwin's Black Box*, Free Press, 1996.
36. Beckwith, F., Law, Darwinism, and Public Education, Rowman and Littlefield Publishers, 2003, reviewed by Douglas Groothuis, http://www.arn.org/docs/groothuis/dg_beckwithpc.htm
37. Guliuzza, R., "Evaluating Real vs. Apparent Design," Acts & Facts. 40 (1): 10-11, 2011.
38. Dembski, W., *The Design Inference*, Cambridge University Press, 1998.
39. Dembski, summarized by Sean McDowell.
40. Burgess, S., *Hallmarks of Design*, Day One Publications, 2005.
41. Varghese, R., *The Wonder of the World*, Tyr Publishing, 2003.
42. Ibid., p. 422-423.
43. Totten, R., "The Intelligent Design of the Cosmos: A Mathematical Proof," www.geocities.com/worldview_3/mathpsfcosmos.html
44. Ibid.
45. Ratzsch, D., *Nature, Design, and Science*, SUNY Press, 2001.
46. Luskin, C., "Dembski responds to Anti-ID article by SETI Astronomer," https://evolutionnews.org/2005/12/dembski_responds_to_antiid_art/
47. Ratzsch,D., "Design: What Scientific Difference Could It Make?" *Perspectives*, 56 (1), March 2004, p.14 ff.
48. Halsmer, D., Halsmer, N., Johnson, R., and Wanjiku, J. , "The Applicability Of Engineering Design Principles In Formulating A Coherent Cosmology And Worldview" ASEE Annual Conference, 2008.
49. Halsmer, D., Roman, N., and Todd, T. , "Integrating Affordances Into Function Based Reverse Engineering With Application To Complex Natural Systems," ASEE Annual Conference, 2009.
50. Maier, J., and Fadel, G., "Affordance-Based Methods for Design," *Proceedings of the*

ASME Design Theory and Methodology Conference, 2003.

51. Halsmer, D., Weed, K., and McDonough, S., "Affordance-based Reverse Engineering of Natural Systems with Possible Corruption," CEEC Proceedings, 2011.
52. Gene, M., *The Design Matrix*, Arbor Vitae Press, 2007.
53. Corey, M., *The God Hypothesis*, Rowan and Littlefield, 2001.
54. Halsmer et al, 2008, op. cit.
55. Dovich, L., "Our Creator-The Master Designer," http://ict.aiias.edu/vol_30/30cc_035-054.htm
56. Gunther, S., "8 Amazing Examples of Biomimicry," https://www.treehugger.com/amazing-examples-of-biomimicry-4869336
57. Benyus, J., Biomimicry: Innovation Inspired by Nature,William Morrow, 1997.
58. Biomimicry Institute, www.biomimicry.org
59. Bergman, J., "Is the Backwards Human Retina Evidence of Poor Design?" https://www.icr.org/article/backwards-human-retina-evidence-poor-design/
60. Bergman, J., "Back problems: how Darwinism misled researchers," http://creation.com/back-problems-how-darwinism-misled
61. Ibid.
62. Ibid.
63. Burgess, S., "Critical Characteristics and the Irreducible Knee Joint," *Creation ex Nihilo*, 13:2, 1999.
64. Ibid.
65. Havergal, F., "Take my life and let it be," 1874 hymn, public domain.
66. Young, M. and Edis, T., *Why Intelligent Design Fails*, Rutgers University Press, 2004, p. 194.
67. Guliuzza, R. 2011. Evaluating Real vs. Apparent Design. *Acts & Facts*. 40 (1): 10-11.
68. Beilby, J., *Naturalism Defeated? Essays on Plantinga's Evolutionary Argument against Naturalism*, Cornell University Press, 2002.
69. Lennox, J., "Can Faith and Science Co-Exist: Response," http://blogs.scientificamerican.com/cross-check/can-faith-and-science-coexist-mathematician-and-christian-john-lennox-responds/
70. Budziszewski, J. *What We Can't Not Know: A Guide*. Ignatius, 2011. p.84.
71. Budziszewski, p. 87.
72. Budziszewski, p. 85.

CHAPTER 15: ETHICS

INTRODUCTION [1]

Fritz Sander was an exceptional engineer. He had risen to an important position with the Topf works, a specialist in thermal sciences who devoted himself to designing and creating high-capacity heating devices.

One day he found himself being interrogated as to why he had designed the things he had. The following are quotes from that interrogation, in March 1946, in Eufurt, Germany: [2]

> *Question: Although you knew about the mass liquidation of innocent human beings in crematoriums, you devoted yourself to designing and creating higher capacity incineration furnaces for crematoriums-and on your own initiative•*
>
> *Answer: I was a German engineer and key member of the Topf works, and I saw it as my duty to apply my specialist knowledge in this way in order to help Germany win the war. Just as an aircraft construction engineer builds airplanes in wartime, which are also connected with the destruction of human beings.*

The account disturbs us at several points. Sander was an engineer in a highly educated society; he used his engineering skills to destroy civilians in the Holocaust. Primarily, Sander saw his actions as good.

How can an event as horrendous as the Holocaust be supported by "civilized" people? What does "civilized" mean? Is there some absolute standard for right and wrong? What about the millions of people killed in the USSR and Communist China? Were they products of a few deranged people, a "sick" system, or typical of the logical conclusions of a certain worldview? Can we learn from history?

The case of Fritz Sander is an example of large scale breakdown of ethics in society. While we may never see events this terrible, all ethical failures potentially give rise to personal loss or injury.

While interest in ethics has increased significantly at the university level, the actual outworking of those ethics into society at large has not taken place. John Haas writes:

"It is heard so frequently today that it is taken virtually as a truism: the development of our moral systems has not been able to keep pace with technological and medical developments, leaving us prey, individually and societally, to a host of dangers." [3]

Sooner or later every practicing engineer will face some kind of ethical issue.

If there is one area of engineering where believers should have significant input, it is the area of engineering ethics.

- How do you know what's the right thing to do?
- How do you get young engineers to have the behavior you desire (i.e., act ethically)? A big stick doesn't always work.

Responsibility always accompanies privilege. Engineers have a three-fold responsibility to others: [4]

(1) A professional responsibility to the public as professionals

(2) A moral responsibility, as developer/producer of goods and services for the public, which must be safe, useful, and reliable

(3) A legal responsibility, in that engineering firms can be held liable for injuries and damages should their designs fail.

ETHICAL CLIMATE

"Everyone knows that stealing, lying, and harming others is wrong." Possibly, although Americans are becoming less Biblically literate all the time. Knowing that certain actions are wrong does not, in a crunch, ensure that we will avoid doing them and "do the right thing." In a startling report titled *The Day America Told the Truth* [5], the authors interviewed a number of people and posed highly illegal or unethical situations (Would you murder a relative? Would you steal funds from your company? Would you sleep with a stranger?) Most respondents, of course, said "no." Then the questions were rephrased -Would you do any of these things if you could absolutely get away with them, and I paid you ten million dollars? Suddenly morality went out the window.

> *It is now estimated that the annual financial impact of global corruption exceeds a half a trillion dollars, and concern is being raised for the engineers who make their living in the construction industry... We have a hint of what happens when professionals lack commitment to public safety in the recent scandal of Tokyo Architect Hidetsugu Aneha, who testified that since 1998 developer-pressure caused him to reduce the steel below requirements, cover up structural defects in buildings and fake earthquake safety data. Authorities feared that at least 71 structures could collapse in a moderate tremor.* [6]

Ethics Should Now Be the Top Priority for Science, Technology, and Engineering (STE)

Green makes these points: [7]

- STE empowers us for new actions, good and evil.
  - STE should now be the top priority for ethics, simply because it has qualitatively changed human power and therefore our ability to flourish or fail.
  - Ethics must also now be the top priority for STE, because only STE professionals can

best understand the implications of their work

- Technical skill is vital, but control of that skill for good ends is even more vital. Skills are means to an end, and we can no longer assume that public "health, safety, and welfare" will automatically be protected no matter what is done.
- If technology is an experiment conducted on the public, then we need to develop the idea of societal informed consent.
- Those with this power or who create this power for others have the responsibility to use it well and see to it that others also use it well.

For several years we used a video called Incident at Morales to introduce ethical discussions. In the story dozens of bad decisions that led to a lethal disaster in a chemical plant. None of the decisions actually broke any laws but the combination of all the compromises was an ethical mess.

DEFINITIONS

Morals vs Ethics

According to Hinman [8], morality involves "first order beliefs" about good and evil to guide behavior, while ethics involves "second order reflective consideration" of beliefs and practice.

Morality refers to general concepts of right and wrong, while Ethics involves specific applications of moral principles. Further, we may distinguish between descriptive and prescriptive ethics: Descriptive ethics is a study of people's beliefs about values, rightness, and virtues. It is mostly theoretical Normative (prescriptive) ethics deals with how people ought to act.

Assumptions Concerning Ethics [9]

1. Ethics is a process.

   How a problem is finally resolved is a key element.

2. Human behavior is caused.

   People have reasons (motives, whether good or bad) for what they do.

3. Actions have consequences.

   Moral (or non-moral) actions cause a rippling of waves moving in all directions.

4. What is perceived as ethical depends on the viewpoint of the constituents.

   Persons impacted by a decision perceive what is ethical from different personal perspectives. (Note: This does not make ethical decisions themselves relativistic.)

5. The need for good ethics rests on our mutual vulnerability.

Whether end-user of a product or company employee, most people are, at various times, somehow "at the mercy of" someone else's decisions.

We find at least four categories of ethics:

- Philosophical ethics – a discussion what is "good"
- Personal ethics – based on beliefs, values, moral standards
- Social ethics – a study of what is best for society
- Professional ethics – ethics for specific professions, with some aspects unique to the profession

Professional ethics requires

- Awareness of ethical issues
- Some kind of "measuring stick": what constitutes right/moral behavior?
- Motivation to do the right thing
- Response consideration- Not only determine whether an action is right/legal/morally acceptable, but how to respond if it isn't.

Professions, however, are not always held in respect. We have seen, in our generation, the degeneration of various professions. The medical profession was once the purveyor of the Hippocratic oath. Doctors could be trusted to preserve and foster life and fight disease and injury, no matter what the cause. Now abortion is rampant, euthanasia is a possibility, and in some countries (Holland, for example), doctors cannot be trusted, because they may kill a person without his/her consent. The recent proliferation of "lawyer jokes" shows that society has cast doubt on the ethics of that profession, also.

Engineering Ethics

Engineering ethics is a particular branch of professional ethics dealing with right behavior in engineering practice. Modern engineering education requires that graduates have "an understanding of professional and ethical responsibility." [10] A series of technical disasters in the 1980's- early 2000's (the Space shuttle explosion, Hyatt Regency walkway collapse, various oil spills) have made the public aware of the dangers of engineering failure.

Aspects of engineering ethics may include values, dealing with people, dealing with clients, safety and protection of user or public, company responsibility, legality, and impacts on society.

Types of Ethical issues:

- Moral issues
- Legal issues
- Professional issues
- Corporate issues

Engineering ethics touches on

- Public safety
- Worker safety
- Company integrity
- Trade secrets
- Gifts and bribery

- Conflicts of interest
- Accountability to clients

Engineering ethics subdivides into a number of topics:

1. Protecting the public
2. Integrity at work
3. Ethical business practice
4. Impacts of designs on community, environment, poverty, peace
5. Technology development issues- Should we even make this?

Business ethics, medical ethics, and engineering ethics emphasize-

- The dignity and safety of others (medical, engineering)
- Honest dealings (business, engineering)
- Honestly representing our service or product (business, engineering)

Engineering ethics seems to fit between business ethics and medical ethics.

Why does engineering ethics often seem so broad and so fuzzy compared to other areas of professional ethics (legal, medical, business)?

1. Engineering activity encompasses a large range of fields, including electrical mechanical, civil, chemical, industrial, and biomedical, with unique application challenges in each area.
2. Medical personnel typically deal with one patient at any given moment. Engineers develop projects and products that may impact, or be used by, dozens or even hundreds of individuals at a time (bridges, buildings, automobiles, power tools,...) Engineering has potential for great good as well as great harm.
3. No single professional society represents all engineers. Separate, but similar, codes of ethics exist for members of IEEE, ASME, ASCE, AIChE, ...
4. Engineers may interface with employers, clients, regulatory bodies, and the public.

In addition, philosopher John Ladd notes that

1. Unlike medicine and law whose services are directed to the needs of individual persons, the services provided by engineers relate to things (machines, buildings, equipment, products, etc.) [11]
2. Unlike professionals in medicine and law, engineers seldom engage in solo practice but are part of a company or agency. [12]

Education for Ethics

All accredited engineering programs must include engineering ethics (in some form). Some require a specific course or module in ethics. Others include it throughout the curriculum.

Most courses in engineering ethics include [13]

- Classical Ethical Theories (duties, virtues, consequences)

- Ethical Dilemmas
- Codified professional ethics (understanding and using Ethical Codes)
- Case studies: Engineering Disasters (ethical failures)

At a meeting of professors dealing with courses in engineering ethics the following conversation took place:

"Two students were caught cheating in the class. I suggested to one of them that he should take the university's course in ethics. The student laughed and said that he had already taken the course. What do we do when courses in ethics actually make students less ethical?

Remember that our job is not to create ethical behavior but to promote ethical awareness."

We would suggest that our goal is more than awareness. Students should have some moral guidelines and motivation for ethical behavior.

Ethical Dilemmas

The classical dilemma discussed in many engineering courses is the Heinz dilemma, first introduced by philosopher Lawrence Kohlberg. The story goes like this: Heinz is a poor European laborer whose wife is dying of a rare form of cancer. The local pharmacist has actually developed a cure, but charges far more than the drug is worth and far more than Heinz can pay. Should Heinz steal the drug?

This is a phony situation from several standpoints. Most ethical dilemmas are carefully crafted stories which don't arise from real-life. The dilemma suggests that there are only two possible options to Heinz: Steal the drug (a crime) or let his wife die (morally unacceptable).

In fact, there are several other possibilities:

- Heinz could look into cures in other cities.
- He could pray for his wife's healing.
- He could try to borrow the money from a bank or from relatives.
- He could pray for the necessary money.

In engineering we want to generate as many alternatives as possible to any problem. Ethical dilemmas may generate some interesting insights but may actually discourage brainstorming for solutions. [14]

Dilemmas

Engineers will seldom encounter a pure dilemma (only two choices) but will often encounter a messy situation in which power, politics, money, or ego enter. The "right" response may be clear but you supervisor may oppose it. It may conflict with some agency regulation that doesn't make sense, or someone may be getting a payoff for taking a certain position. Be prepared to make a case based on integrity and the welfare of the public.

Typical ethical issues in the workplace are more like these: [15]

- Rigging the bidding
- "Only a little poison"
- Make the test results work
- others

The most common and serious issues in 1991 included: [16]

- Technical incompetence
- Conflicts of interest
- Discrimination, favoritism, harassment
- Misuse of company or client resources
- Failure to protect public safety and welfare
- Improper relations with clients and contractors
- Improper political or community involvement
- Mishandling sensitive information
- Failure to reconcile employee concerns
- Alcohol or drug abuse

These are some of the most prominent current ethical issues in industry, according to a leading engineering ethicist [17]:

1. False reporting – Reporting results far beyond what was accomplished.
2. Signing off – Signing off on the plans prepared by an inexperienced engineer without a detailed review.
3. False accounting – Using funds allocated for a different purpose when project funds are running low.
4. Bribery – Providing payment or services to gain an advantage or to induce an official to "look the other way."
5. Padding accounts – Including inflated costs or nonexistent expenditures in an expense account.
6. Padded bids – Estimating significantly high to have extra funds in a contract.
7. Deliberately low bid – Submitting a low bid to win a contract while expecting to make up the difference later through costly change orders.

Two interesting observations: (1) Most of the ethical issues involve money. (2) Only the signing off on plans is directly addressed in the Code of Ethics. Most of the other issues involve basic honesty.

In the book of Daniel, we read that Daniel "purposed in his heart" not to eat the king's somehow defiled food. We see the importance of deciding beforehand how we'll handle a certain situation.

- We will tell the truth.
- We will insist on safety.
- We won't take a bribe.

A COMPLETE ETHICAL SYSTEM

Some things are clearly black and white (Shall we lie about the costs? Steal plans? Allow users to get hurt?)

Other issues are really gray. (Shall we try a new process that has a 10% probability of failure? Shall we build a plant in a depressed region of the state? Shall we hire union workers? Shall we use robotic assembly? Shall we buy intermediate parts from China? Is it helpful to disclose every problem we ran into?) Here we may rely on multiple inputs, tradeoffs, risk analyses, and optimization.

It seems that there are two areas of ethics, much like the two areas of engineering design:

1. Ethical decisions where some guidance exists (laws, commandments, codes) -The engineer must not falsify project documents.
2. "Open-ended" issues (like open-ended design problems) in which there are no clear guidelines- Should we use a less expensive but usually reliable component?

Area 1 calls for knowledge and motivation, while area 2 calls for wisdom, guidance, and creativity.

Standard ethics typically does not address these questions:

- What is the source of ethics and morals?
- What is the foundation of ethics?
- Who or what defines what is good?
- What is the motivation for ethical action?

To be complete, Engineering ethics should encompass at least four areas:

- General morality
- Codified professional ethics
- Approaches to non-covered issues
- Ethical motivation

General Morality

General morality fits with Biblical morality: a handful of actions are "absolutes," or universally applicable. Many people will agree that is morally wrong to steal, to lie, to be sexually immoral, or to deliberately kill or injure another. Not only are these forbidden in Scripture (as sins), but such behaviors by employees will also poison a company.

Sandbox Morals

Everyone should have learned some basic principles ("Share your toys", "Don't take what's not yours", "Admit it if you broke it") in the sandbox or in kindergarten or at the supper table. Unfortunately, this is not always the case today. Many young people simply have never had moral lessons at the supper table.

General morality is an area that is crucial to professional behavior but doesn't get a lot of discussion. It is expected behavior and consistent with Biblical teaching.

- Absolute honesty regarding property.
- Absolute honesty in statements made.
- Avoiding any action that could injure another person.
- Avoiding all forms of immorality.

We must avoid the position of moral relativism. Some principles must be universal and non-negotiable.

Moral relativism is the position that argues that there are no universal moral principles...Another version of this argument, called cultural relativism, takes the position that while some moral standards may exist, they exist only within a particular culture... Are we willing to excuse heinous practices around the world under the guise of "when in Rome, do as the Romans do?" [18]

"If there is no absolute beyond man's ideas, then there is no final appeal to judge between individuals and groups whose moral judgments conflict. We are merely left with conflicting opinions." [19]

ENGINEERING CODES OF ETHICS

Background

As a profession, engineering includes a code of ethics, spelling out what is acceptable practice for members of the profession. Codes typically provide some specific guidance on relating to employers, clients, society, and other engineers. While each of the major engineering societies (ASME, ASCE, IEEE,) has published a code, the National Society of Professional Engineers (NSPE) developed a more generalized code that has become a standard of conduct for most engineers.

Purpose

Why do we need codes of ethics?

"In order to serve the public effectively, engineers must maintain a high level of technical competence. However, a high level of technical expertise without adherence to ethical guidelines is as much a threat to public welfare as professional incompetence. Therefore, engineers must also be guided by ethical principles." [20]

"It is generally conceded that an individual acting on his or her own cannot be counted on to always act in a proper and moral manner. Creeds, statutes, rules, and codes all attempt to complete the guidance needed for an engineer to do '...the correct thing.'" [21]

In terms of our Biblical framework:

(1) Creation - Opened great potential for good; creativity and opportunities exist.

(2) Fall - Introduced sin and impacted all of life; Engineers do not always do the right thing or know the right thing to do.

(3) Redemption - Based on God's principles we establish codes. Engineers should operate within or build beyond the laws and the codes of ethics.

For the Christian, laws and codes may be seen as foundational, on which we build, or as boundary conditions, within which we work.

We are informed by NSPE that "(t)he services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct." [22]

This Code of Ethics, says Vesilind, "is intended to be a set of rules which define the 'correct' path leading to the correct decision {in an ethical issue} as dictated by the collective wisdom of a professional society."[23]

Ethics codes play fundamental roles with respect to other mechanisms such as support or enforcement procedures of professional societies or licensing agencies. They may also be brought into play in lawsuits. Even where no formal processes are involved, a provision of an ethics code can sometimes be pointed to by an engineer to help justify a decision to colleagues or managers when there are countervailing pressures to meet a deadline, cut costs, cover up a blunder, make a sale, and so on. There is thus a sense in which a formally stated rule can provide an "excuse" for ethical behavior.

A secondary value of a good ethics code is to indicate to others a concern within the profession that its members practice in a responsible manner. [24]

Why not just the Bible?

Students sometimes ask — Why do we need a Code of Ethics when we have God's perfect standards in the Bible?

I would suggest 3 reasons:

1. Not all people believe the Bible.
2. The Bible does not cover specifics of the engineering profession, like stamping drawings.
3. The Code is in agreement with Scriptural principles in many places.

Code Statements (Canons)

The NSPE Code of Ethics summarizes its content in six "Fundamental Canons" of practice: [25] Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
2. Perform services only in areas of their competence.
3. Issue public statements only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.

6. Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Each of these is explained in greater detail in the Code.

Value of the Code

1. The Code of Ethics does make it clear that certain actions within the profession are ruled out:
   - Signing off on drawings they didn't oversee
   - Failing to act as a "faithful agent" for employers and clients
   - Involvement in any conflicts of interest
   - Slandering of other engineers

2. The Code places a higher standard for engineers than simply corporate profits:

   Engineers, whose primary obligation is to the public, frequently work for corporations whose priority is to shareholder profit; potentially placing them "in tension with managers, marketing directors, and salespeople." The codes give engineers a response to directives from employers to perform technically legal tasks that are financially beneficial to the company or clients; but which might put the public at risk. Without the paramount language in the codes, there would be little refuge for engineers caught between their employer's desires and their concern for the public. [26]

Obligations of the Code

The Code of Ethics may be seen as spelling out a series of obligations placed upon the practicing engineer [27]

Obligations to society in general:

- Guardian of public health and safety
- Designs conform to accepted standards
- Inform client or employer of safety risks
- Submit truthful reports
- Not involved in fraudulent practices
- Inform State Board of violations

Obligations to employers and clients

- Accept assignments only if qualified
- Don't sign off on unsupervised work
- Protect client's projects and data
- Receive only contracted payment

- Avoid conflicts of interest

Obligations to other professional engineers

- Honestly represent their background and qualifications
- Compete only on the basis of qualifications and cost (no gifts, considerations, or bribes)
- Not slander or attempt to injure the reputation of another engineer

Assumptions of the Code

The Engineering Code of Ethics is an excellent professional code, but it is strictly a code for professional behavior. It assumes up front that we desire an ethical life and are not involved in illegal or immoral activity. It is significant by what it does not address.

Areas the Code does not address directly:

- Personal honesty. It is assumed that the engineer is not embezzling funds from the company.
- Personal performance. It is assumed that the engineer's ability is not impaired by illicit drugs.
- Personal behavior. It is assumed that the engineer won't deliberately injure a co-worker or seduce the boss's wife.
- Work ethic. It is assumed that the engineer will perform an "honest day's work" for the company.
- Choice of projects. What the company or the engineer specifically works on is outside the venue of the Code.
- Insider trading. It is assumed that the engineer is not violating any regulations of the SEC.

We really need additional parts to our ethics system:

(1) A clear description of our professional obligations (the Engineering Code of Ethics), and

(2)A moral framework and foundation that undergirds our life, motivates our behavior, and gives us direction in making moral decisions.

Limitations of the Code

1. Motivation

   It is possible to know the right thing to do and to give assent to it and yet not carry it out. Motivation to act properly requires internal commitment. Codes can't motivate ethical behavior.

2. Actions not covered by the Code

   The Ethics Code contains a few very specific directives, yet many ethical decisions are not directly addressed by the Code.

3. Codes confuse ethics and law

... John Ladd has argued that codes of ethics serve no good purpose whatever. Ladd argues that ethics should be open-ended and reflective, and that relying on a code

of ethics is to confuse ethics with law. He further asserts that it is mistaken to assume that there is a special ethics for professionals which is separate from the ethics of ordinary human beings within a moral society. Professionals, he suggests, have no special rights or duties separate from their rights and duties as moral persons, and therefore codes of ethics are pointless and possibly pernicious. [28]

4. Codes don't actually guide many ethical decisions

   He [Heinz Luegenbiehl] believes that ultimately codes of ethics create moral problems rather than helping to resolve them. Luegenbiehl notes that practicing professionals rarely turn to their codes of ethics for guidance, and that the guidelines within the codes sometimes seem internally inconsistent. He also voices a concern similar to Ladd's -- namely, that implementation of a code of ethics may be in conflict with the moral autonomy we expect of individuals. [29]

5. Codes can change over time.

   Jordan notes that the NSPE Code was changed in 1978 in the area of competitive bidding.

   The society [NSPE] was forced by a federal court order to change their code and no longer call the practice of submitting competitive bids an unethical act. However, it is clear that the society has not really changed its opinion. While it cannot officially call competitive bidding for engineering services unethical, it still clearly urges engineers to not practice it. The code appears to be trying to do two things at the same time. There is a behavior that it cannot call unethical, but it still urges engineers not to do it. They completely ignore the issue of how can something be ethical (as determined by the court) but still bad to do (as determined by the society). This section clearly shows the fallibility of the codes of conduct. They do change (sometimes voluntarily and sometimes by force). As this example makes clear, even when the words do change, sometimes the basic attitudes do not change. [30]

In addition —

- Codes can be vague and general.
- Codes don't cover every situation.
- Codes can't resolve ethical conflicts directly.
- Many people are unaware of the Codes.
- Most employers and managers are unfamiliar with engineering ethics.
- There is no way to enforce the Codes (other than removing the license of a professional engineer who is involved in fraudulent practice.)

Biblical Fit with the Code

Each of the canons in the Code is consistent with Biblical principles. We do value human life. We are responsible for the safety of others. We are commanded to communicate truthfully and to work honestly. Notice a number of assumptions in the Code, all of which are fully consistent with a

Christian worldview:

1. It is assumed that the public (a collection of individual people) has great value, since their safety and health are held most important.

   God's precepts," states Chewning, "assert that 'when you build a new house you shall make a parapet for your roof, that you may not bring bloodguilt upon your house if anyone falls from it' (Deut. 22:8). From that statement and similar ones, we can rightly conclude that health and safety are equated with blood guiltiness in the mind of God and should therefore be extremely important to us. [31]

   Deuteronomy 22:8 above is case law, expanding on the responsibilities of Genesis 9:6 and the Decalogue, explicitly demanding that a property owner deliberately safeguard the welfare of all those exposed to even latent hazards on his property. We find similar case law treating open wells. We should reasonably infer that those employed by the property owner who design and construct his parapet share this responsibility. The Mosaic statute stands therefore not as relic, but as an insightful case law revealing a civic duty transcending culture and architecture and perpetuated by building codes today. [32]

2. It is assumed that truth exists, independent of the observer, since we are to issue statements in an objective and truthful manner.
3. It is assumed that engineers will act as faithful stewards of the property and activities of employers or clients.

   "It is required of stewards that they be found faithful." (1 Cor. 4:2)

The expansion of the Code states – "Engineers shall not offer, give, solicit, or receive, either directly or indirectly, any contribution to influence the award of a contract by public authority, or which may be reasonably construed by the public as having the effect or intent of influencing the awarding of a contract." [33]

"Avoid the very appearance of wrongdoing." (1 Thess. 5:22)

The ten statements in Exodus 20, commonly known as the 10 Commandments, form the basis of many moral codes. The commandments are part of the Law given to Israel but apply on a much broader scale. Most are detailed with examples in later chapters of Exodus, along with Leviticus and Deuteronomy (case law). The first four of the commands pertain directly to God, and four are foundational to human society:

- You shall not kill (murder). (God cares about human life.)
- You shall not steal. (God cares about human property.)
- You shall not commit adultery. (God cares about the marriage relationship and the family.)
- You shall not bear false witness. (God cares about truth.)

The commandments are a basis for defining sin (Romans 1 – 3). The New Testament, however, goes far beyond the Law and emphasizes both motive and action.

Without the first principle (God cares about human life), there is no motivation to act on the others.

This is also related to being kind to, and respecting, others; sexual purity, and faithfulness in marriage and business. It therefore covers canons 1, 2, 4, and 6 of the code.

This also includes keeping one's word, avoidance of self-misrepresentation, and faithfulness in marriage. It covers canons 2, 3, 5, and 6.

This means rewarding employees fairly, giving a full day's work for a full day's pay, and not stealing, covering canons 1, 2, 4, and 6.

One can further reduce these four principles to two, since the first is covered in the first four of The Ten Commandments, and the others, which are constituted by the last six, are simply The Golden Rule. The basis of the Engineering Code of Ethics is the moral code presented in the Bible. [34]

> *All ten say, essentially, 'do not steal.'" Do not steal recognition, honor, or worship from God. Do not steal the day of rest from God. Do not steal respect from your parents. Do not steal someone's life. Do not steal your neighbor's wife. Do not steal, in general. Do not steal the truth from your neighbor, by bearing false witness against him. And in fact, do not covet — which means, 'don't even think about stealing*!' [35]

If we lose these basic principles, we are in danger of losing engineering ethics altogether.

In 2011 Keith Elder presented a Master's Thesis at Reformed Theological Seminary developing the idea that the first clause in the Engineering Code of Ethics ("engineers shall hold paramount…") is both justified and Biblical. [36] Elder finds no epistemological justification for protecting the public's safety, health, and welfare anywhere in the Code or in society at large, but does find it in Scripture:

> *"You shall love your neighbor as yourself." (Lev. 19:18)*
>
> *"Do not withhold good from those to whom it's due, when it is in your power to do it." (Prov. 3: 27-29)*

Further, safety, health, and welfare all fit within the translation and expanded concept of the Hebrew shalom. [37]

Several statements in the code of ethics follow directly from biblical teaching. Jordan notes these: [38]

1. Engineers shall hold paramount the safety, health, and welfare of the public.

> *"'As we have opportunity, let us do good to all people.' (Gal.6:9-10)… We have an obligation to all people, not just the immediate client who hired us."*

In each major case of ethical failure someone placed something (money, power, reputation,) ahead of the safety and welfare of the public.

2. Engineers shall avoid deceptive acts.

   "We need to tell the truth at all times. (Prov. 16:14) ...We need to realize that this portion of the Code does more than mandate truthfulness. It also forbids deceit." [39]

3. Engineers shall endeavor to extend public knowledge and appreciation of engineering and its achievements.

"Being pleased in what we do is certainly legitimate. If we are doing what God wants us to be doing, then we ought to be satisfied. The writer of Proverbs writes in 13:4: 'The sluggard craves and gets nothing, but the desires of the diligent are fully satisfied.'" [40]

Motivation to Act Ethically

It is not enough to know the right thing to do. We also need to be motivated to carry out the ethical action, particularly if it's hard. The profession needs to promote ethical behavior and understand what motivates individuals to be ethical.

Psychologists distinguish between "external" and "internal" motivation, based on forces outside ourselves vs. generated from within.

External

External motivations often involve rewards and punishments (Desire to feel good about oneself, fear of getting caught). The lowest level of thinking would be, "What do I have to do? What can I get away with?"

> *There are a number of reasons a person should act ethically. External reasons consist of fear of being caught and all of the ramifications that entails, such as being punished by the law, resulting social stigma, etc. Internal reasons might just consist of not wanting to feel guilty, without questioning the reason behind the guilt. There might be philosophical reasons such as put forth by Kant and the "categorical imperative," which simply says that if everyone did what you did and it would be bad for society, you should not do it. However, one of the most persuasive reasons, if not THE greatest to increase cognitive dissidence is one's religious commitments.* [41]

> *People have many different reasons for making appropriate ethical choices. Those motivations are often directly or indirectly related to their own self-interests. They might choose to follow ethical rules because if they do not there will be unpleasant consequences. Breaking the law may result in fines or jail-time. Violating one of the specifications of a professional code of ethics may result in being barred from practicing that profession. Discovery of dishonest behavior may result in shame and loss of credibility in the eyes of family and society. More positively, people often desire the respect and admiration of others and might therefore be motivated to behave in ways that would benefit others. Some might even imagine a celestial being keeping*

a tally of the good and evil they have done. They mighty therefore make sacrificial choices in the short term to gain a long-term reward or escape eventual punishment. Some people also behave morally out of a sense of altruism. They exhibit a desire to help others, although this can also be a thinly veiled form of self-interest. The presumption is that if an individual behaves ethically, the world will be a better place, and all individuals will be better off. [42]

Internal

Many internal motives are based on an engineer's basic moral sense. An engineer making decisions that are based on internal convictions rather than external rewards or punishment is more likely to be able to make good decisions in difficult situations.

The higher-level position involves:

1. Integrity- No partitioned life (a desire for truth and ethical behavior in all parts of life)
2. Importance of ethical commitment
3. Genuine love for others
4. Ideally, a desire to please God by our actions

Ultimately Christians are motivated to behave ethically out of gratitude to God for his love and salvation. Those who are saved are called to serve God and others. This is accomplished by obeying God's laws, or in a less negative sense, trying to achieve God's ideals. Christians try to become the type of persons God wishes them to be and to act in the way God has directed them to act. [43]

General Religious Motivation

Given that many college students are thoroughly steeped in a postmodern culture, how do engineering faculty encourage ethical behavior when relativistic moral values hold sway?

Bradley [44] has noted that for most professionals some religious framework provides the motivation for ethical behavior. For the Christian it is very specific and includes love for God and neighbor.

Bradley suggests the following:

1. Discuss the legal costs of unethical behavior, including potential loss of an engineering license.
2. Appeal to altruism. Most engineering students sincerely want to benefit mankind.
3. Connect to their religious belief system. Help students connect ethical teaching to their beliefs.

Beginning with God who exists as personal Creator and who communicates with the human race in a rational way, recognize that such revelation from God is better able to give us guidance for moral decision-making than reason and experience alone. Religious connection to ethics has

multiple benefits: a motivation for altruism and positive actions, a motivation for integrity, and a motivation for the courage to put societal needs above self. [45]

Helweg has observed that:

> *We, in academia, have, in a lemming-like race, been caught up in a fear of promoting any kind of religious basis for ethical behavior. Not only is this a practical mistake, but it is philosophically flawed. One reason for this is that a major, if not the main problem in unethical behavior is not one of knowledge, but one of character. This is, the problem is not knowing what to do, but doing what we know.* [46]

NON-SPECIFIC ETHICAL AREAS

How do we handle ethical situations for which laws and codes give no guidance?

What about the dozens of ethical issues that are not addressed by the Code?

Consider issues where there is no guiding principle from Scripture, law, or code:

- Should we build a new dam on the Arkansas River?
- Should we introduce a product that may render DVD's obsolete?
- Should we purchase component parts from China?

If your company buys a particular piece of automation equipment it will almost certainly eliminate twenty jobs over the next year. You may say, "People matter. Don't buy it." That's reasonable and compassionate. What if you found out that those twenty jobs were very dangerous jobs that no one wanted to do? Additional information can often change the response to an issue.

At least 16 approaches have been proposed to real-world ethical problems:

Approaches

1. Classical ethical theories

A popular approach to ethical problems involves the application of classical ethical theories. Philosophers define two major approaches to ethics:

(1) Normative (something is right or wrong before the fact)

(2) Consequentialist (the rightness or wrongness of an action isn't known until after the fact)

Four major classical theories exist:

1. Utilitarianism (John Stuart Mill, Jeremy Bentham)
   A form of consequentialist ethics
   Actions are good when they produce "the greatest good for the greatest number."

2. Duty ethics (expounded by Immanuel Kant)
   Rule-based ethics, doing the right thing, regardless of consequences

3. Rights ethics (expounded by John Locke)

   Actions are good when they respect the rights of others. These are often "natural rights": life, freedom, property ownership.

4. Virtue ethics (emphasized by Aristotle)

   Actions are good when they are tied to virtues.

   Plato- wisdom, courage, temperance, justice

   Seven cardinal virtues of the medieval church: prudence, temperance, justice, fortitude, faith, hope, love

   Today: honesty, respect, loyalty, kindness

After reviewing a number of philosophical approaches to ethics (utilitarianism, rights, duty, virtue) Jordan has concluded that Virtue Ethics best provides an approach to ethical issues outside the Code while being most consistent with Christian ethics. [47]

2. Plural (Combination) approach (Starrett and Bertha)

In a recent book of engineering case studies Starrett et.al. [48] recommend the application of the Engineering Code of Ethics along with a combination of three classical philosophical approaches (duty/principle-based ethics, virtue/character-based ethics, and consequentialist/consequence-based ethics). They term the approach "moral pluralism" (which differs from truth or worldview pluralism).

> *An absolutist would be committed to choosing one-and only one- moral theory to guide all moral choices... The position (is) that all three moral theories previously explored are right-in their own context. And none is perfectly and absolutely right 100% of the time. This middle ground is called "moral pluralism," which is a position that accepts that it is possible for moral questions to have more than one right answer but that accepting that there may be more than one right answer does not entail that there are no wrong answers.* [49]

Design approach (Whitbeck, Kallenberg)

Various authors [50] [51] [52] have suggested approaching ethical problems in much the same way as we approach design problems. Real engineering design involves fuzzy problems, problem definition, problem specifications, and evaluation of alternative solutions.

Whitbeck writes:

> *Although for interesting or substantive engineering design problems there is rarely, if ever, a unique correct solution, two solutions may each have advantages of different sorts, so it is not necessarily true that, for any two candidate solutions, one must be incontrovertibly better than the other...Although no unique correct solution may exist, nonetheless, some possible responses are clearly unacceptable—there are wrong answers even if there is not a unique right answer—and some solutions are better than others* [53]

Her approach includes these considerations:

- Unknowns and uncertainties must be considered.
- Additional information may be required and should be sought
- No solution is perfect, but some solutions are better than others.
- "Synthetic reasoning" should be employed -an attempt to generate solutions that satisfy as many demands (constraints) as possible.
- The engineer may need to pursue multiple possible solutions simultaneously.

In his book *By Design*, philosopher Brad Kallenberg looks ta approaching ethical problems through the lens of "design reasoning." He concludes: [54]

- The world is not ideal. Real engineering problems are "messy".
- Real-world ethical problems are "open-ended", like real design problems. There is no single, correct, design solution to a real design problem. Instead, there is a range of solutions that can be evaluated for a satisfactory outcome.
- Real-world design is seldom straight-line. It often involves multiple loops and re-starts.
- In doing design we often employ rules of thumb, or heuristics. A typical heuristic would be "Balance safety and cost."
- Communication is essential to design.
- Design involves practice. It may be useful to consider the question, "What would an experienced practitioner do?"
- Creativity-an ability to "think outside the box"- can be valuable in design. Creativity is enhanced by "cross-domain transfer", the use of concepts or principles from other disciplines.

In *Moral Choices*, Scott Rae provides a design-like model for making ethical decisions, which he applies to several case studies to show how it works. He lists, explains, and applies seven elements in his model: [55]

1. Gather the Facts.
2. Determine the Ethical Issues.
3. Determine What Virtues/Principles Have a Bearing on the Case.
4. List the Alternatives.
5. Compare the Alternatives with the Virtues/Principles.
6. Consider the Consequences.
7. Make a Decision.

Based on the "ethics as design" concept, two faculty members at Georgia Tech have offered a combined design and ethics course for engineers (Design Ethics) in which ethics is studied/ discussed at every decision point in an actual design project. They conclude that the resulting ethical awareness was superior to simply learning ethical theories. [56]

3. Multiple-input workplace ethics (Alenskis)

Brian Alenskis, in teaching ethics with case studies, has proposed evaluation of workplace

ethical cases using a multi-factor worksheet considering stakeholders, values, duties, and company policies, as well as Codes. [57] Engineers are encouraged to identify key concepts involved and relationships noted.

A good ethical decision, says Alenskis, [58]

- Implements an ethical point of view without violating interests and well-being of others
- Compromises ethical principles as little as reasonably and ethically justifiable
- Achieves personal goals as well as interests of others

Values (principles):

- Equal consideration of interests /equitable treatment of others
- Honesty/no deception
- No maleficence/ no harm or damage
- Fidelity/faithfulness to employer
- Autonomy/acting free of coercion
- Confidentiality/control of information
- Lawfulness/obeying all laws

Duties (rights)

- Knowing/duty to inform
- Privacy/personal information
- Free expression/without penalty
- Due process/appeal decisions
- Safe workplace/reasonable precautions
- Property ownership/personal control
- Profit earning/ company's right
- Future generations/sustainable environment
- Self-interest/caring for oneself

4. Focal engineering (Moriarty)

Following Borgmann [59], engineering professor Gene Moriarty defines the practice of "focal engineering," emphasizing products and services that really benefit others.

> *The focal engineer aims to engineer products that contribute to enlivening, engaging, and resonant life events or focal practices... To shift into a focal engineering perspective, an engineer needs to inquire about the nature of this something. What is the device for, the device in which the chip will be embedded? How does it add beauty, peace, life, love, joy to the world? In what way does it enhance human life-events or focal practices? Why should it be brought into the world? Why does it or why does it not support a sense of the good life in a convivial society? And replies to these questions will inevitably be debatable and open up other questions and other discourses.* [60]

Moriarty discusses four dimensions of a profession: knowledge, autonomy, obligation, and commitment.

Moriarty in *The Engineering Project* and a series of articles suggests the need for "three kinds of ethics" "to match three aspects of engineering". [61]

Kind of ethics	Virtue ethics	Conceptual ethics	Material ethics
Area involved	The person	The process	The product
Aspects	Care, honesty, fairness	Justice, health, safety	Engagement, enlivenment, resonance
Source	Being with others	Code of ethics	Product interactions in the real world
Level	Personal	Professional	Social

Ideally, suggests Moriarty, we can combine the aspects of all three kinds of ethics and find a point of balance. The goal is balance between old and new, local and global concerns, actuality and possibility, abstract and concrete. Ideal designs (focal products) not only "do no harm" but actually "do good," improving lives in a desirable way.

While some of the ideas are inspiring, the overall approach is overly philosophical and often fuzzy. [62]

5. Ethics based on Love (Catalano and Baillie)

This is an intriguing approach and seems to be one that Christians could embrace from the title.

> *We would like to offer a new paradigm for engineering based upon a new ethic, linked to our capacity to love. Using such a paradigm, each and every being matters, groups are disaggregated into individuals and equal respect exists for each individual. Such an ethic calls upon us to transcend our own particular situations and imagine a global society which is based upon equality, to honor individual dissent and to develop our own individual narrative of moral imagination, that is, to develop the ability to be in another's shoes, to cultivate our inner eye of seeing and knowing and to overcome the blindness that we have all become far too accustomed.* [63]

Their arguments are these:

1. Traditional engineering based on profit-making gives little consideration to peace, social justice, environmental justice, or wealth distribution.
2. Traditional engineering ethics based on Codes and ethical theories rely heavily on concepts of justice and rationality.
3. Interconnectedness with others and with the Earth should be foundational to our ethics.
4. Six qualities (elements) can be evaluated in every design:
    - *Kindness: the act or the state of charitable behavior to other people.*
    - *Sensitivity: the quality or condition of being sensitive, that is, the capacity to respond to stimulation.*
    - *Tenderness: the quality or state of being considerate or protective*
    - *Compassion: the human feeling of pity over another's sorrows, along with the desire to help others in their situations.*
    - *Creativity: the ability to see something in a new way, to see and solve problems no one else may know exists, and to engage in mental and physical experiences that are new, unique, or different.*
    - *Intelligence: a property of mind that encompasses many related mental abilities, such as the capacities to reason, plan, solve problems, think abstractly, comprehend ideas and language, and learn.*

Catalano and Baillie propose a "recasting" of the first Canon of the ethics Code:

> *Engineers, in the fulfillment of their professional duties, shall promote through love the overall well-being of the communion of subjects which make up the Earth, its diversity of species and ecosystems as well as the powerful and powerless members of society.* [64]

Christians have had some difficulty with their paper in a few ways:

1. Situational ethics is suggested as a balanced approach to ethical difficulties, but situational ethics often overrules divine commandments in the name of "love."
2. Some of the approach feels very pantheistic rather than theistic. ("When we practice our profession of engineering, it is important that we view humanity and the ecosystem as part of an undividable whole.")
3. The suggestion of wealth distribution (or re-distribution) verges on a socialistic solution (rather than a person-enabling solution) to poverty.
4. There is no clear definition of love. (I Cor. 13 is a powerful summary). Only humans are loved in the fullest sense of agape. The environment is protected and stewarded, but not loved. Animals are protected and cared for, but we are not called upon to lay down our lives for our pets.

Catalano and Baillie are correct that our engineering must be built on more than profits. We

define engineering as being "to the benefit of mankind." Some human, or Bible-based values should also drive our designs.

Their approach to ethics ties in the environment and economics (which are actually more in the area of stewardship than the area of love).

6. Ethics tied to Emotions (Roeser)

> *Engineers who are trained in using their empathy and sympathy can imagine themselves in different roles, for example in the role of victims of risky technologies. This enables them to realize that they should go beyond their formally defined role, and to be motivated accordingly. This means that*
>
> *We need to include emotional-ethical reflection and deliberation in the design process of risky technologies, and 2, we have to revise our curricula for engineering education, by including courses that enhance the emotional and imaginative capacities of future engineers.*
>
> *This will enable engineers to live up to the moral responsibilities that are inherent to their work.* [65]

While emotions can be motivators for action and a feeling of compassion can prompt us to care for the needy, emotions cannot be relied upon as a determination of what is right and wrong. The Bible is clear that emotions can't be in charge of our decisions:

> *"The heart is deceitful above all things and desperately wicked. Who can understand it?" (Jer. 17:9)*
>
> *"There is a way that seems right to a man, but its end is the way of death." (Prov. 14:12)*

7. Preventive Ethics (Harris)

Based on their study of various engineering disasters over recent years, Charles Harris and others advocate "preventive engineering," an approach which tries to anticipate and prevent similar occurrences in the future. Most disasters, says Harris, involved these common features: (1) a failure, in either engineering, management, or ethics, and (2) impropriety a contributing cause of the incident. [66]

- The failure could be in engineering, in management, or in ethics.
- Impropriety is often a contributing cause of the disaster
- We must inform people of potential dangers upfront.

8. Aspirational Ethics (Bowen)

Richard Bowen laments the disconnect between the technology as designed and the human user or human impacted by the technology. [67] Too often, he suggests, the focus is on the technology and not on the person. We must go beyond mere responsibility to the public to a genuine concern

and care for the public. Bowen uses the Biblical parable of the Good Samaritan (Luke 10) to illustrate this concern, relating it to Martin Buber's "I-Thou" relationship. As Cain asked "Am I my brother's keeper?" (Answer: absolutely, yes), so the Law-expert asked "Who is my neighbor?" (Answer: The person close to you; the person in need.)

Jesus commanded us to "love your neighbor as yourself." This love is sacrificial and proactive. We know from scripture that its source is God Himself and is "shed abroad in our hearts" (Rom. 5:5) as part of the fruit of the Holy Spirit (Gal.6). Not only must we "do no harm," but specifically and deliberately look to bless people and improve their lives by our technical output.

9. Social Ethics (Devon)

Richard Devon has proposed an approach to engineering ethics based on the concept of social ethics. [68] Because technology is socially contrived and since ethical decisions affect society, a group should be involved in any ethical decision, not just a single individual.

- The emphasis is on the process, not the final product.
- Ethical decision- making should take place simultaneously with design decision -making.
- The goal is to improve the social arrangement for decision-making.
- Project management, corporate behavior, and public policy may be involved.

> *Studying only individual behavior in ethics raises a one-shoe problem. It is valuable to lay out the issues and case studies and to explore the ethical roles of the participants. However, what we also need to study are the ethics involved in how people collectively make decisions about technology. A collective decision has to be made with participants who have different roles, knowledge, power, personalities, and, of course, values and ethical perspectives. This is the other shoe. How do they resolve their differences and, or, combine their resources and wisdom? And insofar as engineering ethics only focuses on engineers and not on the many other participants in decision-making in technology, it exacerbates the problem.* [69]

These values are emphasized:

- Creativity (multiple alternatives)
- Openness
- Democratic information flow
- Diversity of viewpoints
- Listening to stakeholders
- Assessment of tradeoffs
- Inclusiveness
- Possibility of revising decisions

10. Ethics based on the Golden Rule (Maxwell)

Leadership expert John Maxwell, in *There's No Such Thing as Business Ethics*, makes a case that there is one primary guideline for all ethical decision-making in business: the Golden Rule. [70] We

ask ourselves how we would want to be treated. We want to be

- valued
- appreciated
- trusted
- respected
- understood and
- not taken advantage of. (p.38)

To engender trust, for example, we should

- maintain integrity
- openly communicate views and values
- show respect
- focus on shared goals
- do the right thing regardless of personal results
- listen with an open mind
- demonstrate compassion and
- maintain confidences. (p.42)

While there are some valuable insights in this approach others argue that it is insufficient for professional ethics. [71]

11. Macro vs. Micro Ethics (Ladd, Herkert)

John Herkert writes:

> *A number of authors have suggested that engineering ethics encompasses multiple domains. The ethicist John Ladd subdivides engineering ethics into `microethics' or `macroethics' depending on whether the focus is on relationships between individual engineers and their clients, colleagues and employers, or on the collective social responsibility of the profession. In each case Ladd seems to be concerned with what might be called `professional ethics,' with microethics focusing on issues for the most part internal to the profession and macroethics referring to professional responsibility in a broader, societal context.*
>
> *McLean, an engineer, utilizes three categories in discussing engineering ethics: technical ethics, dealing with technical decisions by engineers; professional ethics, dealing with interactions among managers, engineers and employers; and social ethics, dealing with sociopolitical decisions concerning technology.* [72]

12. Ethics and professional Autonomy (Luegenbiehl)

Luegenbiehl [73] looks at professional autonomy as a goal tied to engineering ethics. Autonomy is defined here as independence of judgment based on adequate information, rational deliberation, and freedom from coercion.

Implications of professional autonomy:

- Engineers must assume responsibility for their actions.
- Engineers must be able to meet their professional responsibilities to clients, employers, customers, and the public.
- Engineers cannot simply follow the orders of their institutional superiors.
- Engineers must think independently about the consequences of engineering decisions and (be able to) act on their decisions.

13. Ethics of care (Gilligan)

Carol Gilligan, a feminist philosopher, has expressed concern that traditional ethics, based on law and justice seems like "male" ethics and needs a balancing "female ethics." Gilligan defines an "ethics of care" as:

> *An ethic grounded in voice and relationships, in the importance of everyone having a voice, being listened to carefully (in their own right and on their own terms) and heard with respect. An ethics of care directs our attention to the need for responsiveness in relationships (paying attention, listening, responding) and to the costs of losing connection with oneself or with others. Its logic is inductive, contextual, psychological, rather than deductive or mathematical.*
>
> *Morality is grounded in a psychological logic, reflecting the ways in which we experience ourselves in relation to others and that the origins of morality lie in human relationships as they give rise to concerns about injustice and carelessness. Studying development, I realized that concerns about oppression and concerns about abandonment are built into the human life cycle, given the differential power between children and adults and the fact that care is essential for human survival. An ethics of care speaks to these concerns.* [74]

14. Social justice ethics (Riley)

Engineering professor Donna Riley proposes that social justice (or correction of social injustice) needs to be a foundation of engineering ethics. Riley looks at every issue in terms of power struggles:

- Who wins?
- Who loses?
- Who decides?
- Who acts and reacts?
- Who gets to participate?

The result is an ethical system that focuses on poverty, environmentalism, and opposing military action. Riley's principles are these: [75]

- Engineers' primary goal is to help people in need and to address social problems
- Engineers challenge social injustice

- Engineers practice cultural and epistemic humility
- Engineers respect the dignity and worth of each person
- Engineers recognize the central importance of human relationships
- Engineers seek to live in peace with their individual selves, others, and the planet.

15. Normative Ethics (Ermer)

Based on the concepts outlined by Monsma in the book *Responsible Technology* [76], Gayle Ermer has proposed an approach to ethics using a decision matrix based on specific Biblical perspectives, or norms. Project decisions are weighted based upon these factors: [77]

- Cultural appropriateness
- Transparency
- Stewardship (including renewability, reliability)
- Harmony
- Justice
- Caring
- Trust

WORLDVIEWS AND ETHICS

Three major worldviews are naturalism, pantheism, and theism. Certainly a person who holds any one of these worldviews can be ethical and can hold an ethical position, but they may not necessarily be logical and they may not have a motivation for ethical behavior. People may create ethical guidelines and chose to live by them, but good and evil don't come with the worldview.

Naturalism

Can an atheist be ethical? Certainly, and many are very ethical in their engineering work. Their ethical work, however, has no logical foundation in their worldview. Naturalism presupposes that all is only matter. Naturalism, fact, is devoid of a moral code.

Naturalists cannot produce a consistent and universal moral system. They will have difficulty making a case why someone else should act ethically. At best, moral actions are god for society. Naturalists often slide into "situation ethics" (the idea that moral decision- making depends totally on the specific circumstances or context) and cannot produce a strong motivation for ethical practice.

Naturalism attempts to find ethical direction from these sources:

- The individual (pragmatic) — What works to promote personal well-being or to promote species survival?
- Science
- Nature

- Culture – what concepts have developed in a given culture?

1. The individual cannot produce meaningful morality, since the individual has no extrinsic meaning.

A purely naturalistic ethic recognizes that we are meaningless organisms…We are not beings created to love and care for each other with responsibilities, duties, and moral expectations. We are merely animals, and the fittest will survive. This makes for an easy solution to many ethical problems… If there is nothing but the natural world around us, then we don't matter. We can do whatever we like to each other because there is no sin. [78]

2. In a naturalist system science degrades to "scientism" as attempts are made to ground every question in science. Science can measure and describe but cannot tell us what is right or wrong or even why we should pursue the good.
3. Nature cannot provide guidance for ethical decisions. There is nothing in nature that would teach us that killing, or stealing is wrong (let alone involvement in conflicts of interest). Animals have no moral compunction against killing other animals.

If we are simply animals, why refrain from raping or practicing infanticide when this is "natural" or "widespread" in nature? It seems that those who vehemently resist such practices are smuggling in metaphysical capital from another worldview that clearly demarcates valuable, responsible moral agents from environment-bound, instinct-guided animals. [79]

4. Cultural values not only differ between cultures but have no means of comparison.

In naturalism there is no transcendent, objective moral truth. Instead, cultures merely embrace the values and moral principles that "work" for them and have resulted in the flourishing of their particular people group. If this is the case, one group of evolved humans has no business trying to tell another evolved group what is truly right or wrong from a moral perspective. After all, each group has successfully arrived at their particular level of development by embracing their own accepted moral standards. [80]

Paul Copan writes:

There is a background or contextual problem for the naturalist who believes in objective moral values: How do we move from a universe that originates from no prior matter into a universe of valueless matter and energy, eventually arriving at moral values, including human rights, human dignity, and moral obligation? It is hard to see how the naturalist could bridge this chasm. Matter just does not have moral properties, let alone mental ones. [81]

Schlossberg adds:

A system of ethics that says human beings ought to base their behavior on nature

> *therefore justifies any behavior, because nature knows no ethic. If naturalism rules, it means there is no bar to adultery, which is all right with many naturalists, but it also means there is no bar to murder.* [82]

Moreland concludes:

> *Many naturalists agree with atheist Kai Nielsen, who acknowledges that there is no answer to the question of why we should be moral. For Nielsen, the choice between adopting the moral point of view vs. living a life of pure selfishness in total disregard for morality and virtue is an arbitrary, non-rational choice.[6] But any view that reduces the difference in worth between the overall lifestyle of a greedy, hateful racist vs. the life of St. Benedict to being nothing more than an arbitrary choice like the one between being a fast-food lover vs. learning to play the tuba is deeply flawed. It is no wonder that moral chaos has resulted from the hegemony of naturalism among our cultural elites.* [83]

Pantheism

In pantheism reality is identical with divinity. For this reason, many pantheists claim to be very moral/ethical. Since they find the sacred within every living thing, they should have great concern for both nature and people. The difficulty, however, is that when "all becomes one" there are no longer any categories or hierarchies. Why are should humans be more valuable than leeches or cypress trees? Individual pantheists can act morally, but they have no consistent ethical norms to guide them. There are no external guidelines for good and evil. There is no way to address sin. People lose their dignity and individuality. All actions are equally valid, and the tendency is to leave things exactly as they are.

> *The Pantheist says, "If the universe is divine, then everything is sacred." Sacred to whom? If there is nothing else but one thing, who is there to hold it sacred? If it is merely the universe that holds itself sacred, what does "sacred" even mean? What else is there besides sacred? What standard can there be to say that treating the universe one way is treating it sacredly and treating it another way is somehow sacrilegious? How is one particular action or frame of mind "recognizing the universe as sacred" and another not? If the universe holds itself sacred, then all my thoughts are automatically sacred, for they are part of that one universal essence. There can be no distinctions.* [84]

People may be treated as valuable in some pantheistic cultures, but that value arises in contradiction to the underlying worldview rather than emerging naturally from it.

Professor John Warwick Montgomery pointed out:

"Pantheism … is neither true nor false; it is something much worse, viz., entirely trivial. We had little doubt that the universe was here anyway; by giving it a new name ("God") we explain nothing. We actually commit the venerable intellectual sin of Word Magic, wherein the naming of something

is supposed to give added power either to the thing named or to the semantic magician himself." [85]

> *The traditional pantheistic view and its corollary, the New Age Movement, presents quite a different view of ethics and morality from either naturalism or Christian theism. If all is one, as they assert, then there can be no clear distinction between good and evil. Some pantheists hold that evil is part of God and will be eventually reabsorbed into the oneness of god. Others believe that evil is an illusion.*
>
> *When it comes to moral guidelines, Shirley MacLaine and her followers are of little help. She argues that, until mankind realizes that there is no good or evil, there will be no peace. All is one. The consequences of this view are predictable. She tells us that a revelation from her "higher self" advises us to throw off all morality.*
>
> *Instead of being concerned about morality, pantheism would have us focus on avoiding bad karma. Karma is not to be confused with the concept of sin. Bad karma is built up when we perform actions that show a lack of understanding or knowledge, that move us away from becoming one with the impersonal force of the universe. Sin, on the other hand, is disobedience to a personal creator. The issue for pantheists is education, not repentance.* [86]

A medical worker in Cambodia recently related that those who are physically suffering in certain villages receive no help from the local populace since their suffering is seen as linked to "bad karma," some failure in a "previous life," and to assist them would be to interfere with the spiritual outworking needed in their lives. [87]

Theism

The only worldview category which can give rise to a universal and consistent set of ethics is theism, since the principles arise from outside of man. A universal and consistent ethical system deals with universal principles, applicable in all cultures at all times. A law for all times requires an eternal Lawgiver. If all that exists is only matter (naturalistic worldview), it really doesn't make sense to talk about universal and transcendent ethics.

Orr writes: "Completeness and consistency are no small matters when considering the scope of human behavior. For the ethics of the Bible to be considered complete, they must touch upon every conceivable aspect of human behavior. And if they are to be thought consistent, no part of them may contradict another part." Orr is satisfied that the ethics of the Bible are, in fact, both complete and non-contradictory. [88]

The basis of the Engineering Code of Ethics is the moral code presented in the Bible. Ertas and Jones express this in their chapter on engineering ethics:

> *In the United States, Judeo/Christian beliefs are held by most people, and ethical value systems are largely based on writings in the Bible. The Old Testament includes a significant amount of text concerning the way a person should live. The most notable text in this regard is the Ten Commandments, Exodus 20:3-17. The New Testament*

> *also has much to say about value systems and ethics. Possibly the most widely quoted verse from this portion of the Bible is the statement of Jesus in Matthew 7:12 which is paraphrased as the Golden Rule: 'Therefore all things whatsoever ye would that men should do unto you, do ye even so to them. (Bible, KJV)' Page 14.1184.16 It can be seen from the above that the principal difference in secular and Judeo/Christian ethics is that secular ethics are defined by man and as such, are subject to change and interpretation, depending on the interpreter and the time in which he or she lives, whereas Judeo/Christian ethics are based on God's word, the Bible, which does not change but is subject to interpretation.* [89]

In an ASEE presentation, Niewoehner made the case that a Christian foundation for engineering ethics is compatible with protection of the environment and professional duties to the public:

> *How might a Christian articulation of engineering ethics contribute to the broader cause of progress in engineering ethics scholarship and practice?" Prima facie, a Christian view of does not offer profoundly different conclusions with respect to our duties to protect life and to protect the environment. It does offer a substantially different foundation for such conclusions, as well as substantially different motivations for adherents. Furthermore, it offers an avenue for future discussion and development as Christians interact with our broader pluralistic society on the meaning, significance and purpose for technology.* [90]

The fundamental principles in this system are love for God, followed by love for humans, and, finally, respect and care for the environment as a creation of God. Theism is not only compatible with engineering ethics but provided the social context out of which the ethical system arose.

Theists who believe the Bible, on the other hand, begin with (1) a God who cares about their actions, (2) a high value of persons, (3) a requirement to love one's neighbor, and (4) specific commandments against falsehood, killing, and theft. Biblical Christianity is the only worldview that actually requires truth-telling and care for others.

> *Morality is rooted in His nature and His commands. He, therefore, upholds justice and bestows mercy. I can love God and my neighbor, not because everything is one and there is no distinct God or neighbor to love, but rather because I am not God or my neighbor and can therefore humbly put both before myself. In a pantheistic world, morality cannot exist. Love and mercy are impossible. Justice is an illusion at best. Only on the Christian worldview is there an adequate foundation for all of these things.* [91]

A Christian would say that we need legal boundaries and codes of ethics because of the Fall. Our knowledge is limited, and we may be easily tempted to shade the truth or to seek our own advantage.

Gayle Ermer [92] writes that we need both Biblical morality and engineering ethics based on Codes of Ethics. Based on the terminology of Stephen Jay Gould, she suggests that these are "overlapping magisteria." The Bible doesn't cover professional specifics or a problem-solving

approach to ethical problems, and a code doesn't cover personal morality and intrinsic motivation.

Professional ethics should not be reduced to the logical aspect, which engineering ethics tends to do. We can acknowledge the contributions of secular theories of ethics to the discussion of ethical problems, but we should retain a healthy skepticism toward the claim of any particular ethical theory of providing definitive answers. The secular theories and processes upon which the domain of engineering ethics is founded can contribute many good ideas, but ultimately, they may need to be modified and combined to fit the more robust picture of what is good for society provided by a Christian worldview. Neither can the ethical aspect be reduced to the faith aspect, as Christian values tend to do. We ought not to assume that anyone with a Christian commitment will make the right choices with respect to technological design, since the ethical and economic aspects have distinctive explanatory theories. An engineer needs to have specific information related to expectations of the profession and the character of modern technical society in order to correctly assess the ethical implications of his or her work. [93]

Can we be good without God?

This question is often raised in discussions of ethics, primarily by those who reject a Theistic worldview.

Non-Christians can certainly act in moral ways and can have a deep interest in ethics. The problem is that they can't have a universal and consistent moral base without God.

In the end most societies which reject a Biblical foundation will gravitate towards either a Marxist or a Fascist (Nazi-like) system. In the limit, in the extreme, the far-far-right and the far-far-left don't look very different. The result is tyranny, oppression, betrayal, spying on citizens, prison camps, and executions.

Unfortunately, the media have helped to move our culture from one which fosters absolute standards of morality and ethics to a system of relative (which is equivalent to no) standards. This has been done by presenting adultery and fornication (which seem highly desirable to young adults) in a good and acceptable light, glorifying violence and murder, and by painting those who are wealthy, whether that wealth has been acquired by hard work or otherwise, as "evil capitalists".

CHRISTIANS AND ETHICS

Stephan has suggested the need for Christian scholars to have input to issues of engineering ethics:

> *The diverse community of engineers presents both a challenge and an opportunity for Christian scholars. The challenge lies in the fact that modern science-based engineering education often has an undesirable side effect: it trains engineers to disregard the non-quantifiable as irrelevant to the practice of engineering. Fortunately, the profession itself is beginning to understand that this type of training produces people who can be unhealthily narrow in their interpretation of what an*

> *engineer should take responsibility for. The recent heightened interest in engineering ethics education stimulated by changes in accreditation requirements presents a new opportunity for Christian scholars to address questions and issues of interest to engineers and technologists. Some examples that come to mind are genetic engineering, the Internet and its implications for global changes in communications and commerce, environmental problems on local and global levels, and the future of threatened cultures in the increasingly technological world we will live in as we begin the third millennium after Christ.* [94]

There is a clear theological basis for ethics –

- God has given us standards
- We are created as moral beings
- God despises our worship if we don't love one another (Isa. 1, Isa. 58)

Pennington [95] suggests three key areas pertaining to life that line up with key areas of Scripture (and approaches to ethics):

1. Law / actual state laws, plus codes, standards
2. Wisdom literature, especially Proverbs/ developing character, virtue ethics
3. Prophetic and apocalyptic literature/ consideration of future consequences

Realize that we can't simply pull verses out of context to apply to ethical issues, particularly from the OT law. We need to understand what God commands and what He forbids. All forms of theft, lying, and immorality are forbidden in Scripture, and we must never try to justify them.

Christian ethics doesn't rely on commandments alone. Not every decision is covered in the Bible. Loving one's neighbor fulfills the law (Rom. 13).

Like Christian guidance, Christian ethics is built on a combination approach, not a single technique.

Most ethical issues involve more than a statement in a code or a few Biblical verses. In fact, a large number of resources are available to assist with engineering ethics decision making:

- General morality
- Appropriate laws
- Codes of ethics
- Company or agency policies
- Case studies (precedents)
- Ethical theories
- Values and virtues
- Advice of others

In addition, these resources are available to believers–

1. God's commands and principles

Note particularly the case laws in Exodus and Deuteronomy. When is an individual responsible for damage or injury?

- When he or she is the actual person who caused the incident
- When the danger was known to the owner who did nothing about it (ox that gored)

2. Values and character, shaped by God's Spirit and daily obedience
3. Praying for wisdom
4. Thinking based on Bible truth
5. Guidance from the Holy Spirit
6. Input from other believers

In summary, Christian engineers will value God's commands as well as human life and safety. They will work with engineering codes and ethical theories where they apply. They will approach ethical problems humbly, seeking wisdom from God and guidance from fellow engineers.

CONCLUSIONS

Sooner or later every practicing engineer will face an ethical issue of some kind, if only as small as accepting gifts from vendors. (Company policy manuals often address this with a given acceptable value amount. Obviously, a pen set with the vendor's name is in a different category from a trip to the Bahamas.) Clearly, engineers who follow Christ as Lord should act in an ethical manner.

There appears to be three actual approaches to ethics in practice:

1. Pragmatic - (possibly the most used approach): What's desirable is what works, what's good for completing the task or making a point.
2. Strictly rule based - a few professionals would rather not think deeply about things. (Give me a rule for everything, even if it makes no sense.)
3. Struggle to find the right response - What is actually going on? How do we make sense of the issue in the light of Biblical truth, the codes, and human needs? In some cases, what is the best approach, since these there is no clear or perfect approach.

The best approach would be a combination of several (approaches)

Seven considerations —

- Integrity (personal)
- Values (personal, external)
- Obligations (professional)
- Morals (personal, external)
- Codes (professional)
- Accountability (personal, professional)
- Safety (external)

Areas of Consideration — a Checklist

- Safety

Have I taken all reasonable steps to ensure the safety of my product?

- Honesty

Are all statements truthful and all dealings open?

- Confidentiality

What information is truly proprietary and should not be shared?

- Competence

Are all employees competent to carry out engineering design work for the public?

- Company loyalty

How do we build company loyalty, and at what point is it trumped by issues of health and safety?

- Conflict of interest

What constitutes conflict of interest? (code statement)

- Competition

What is reasonable and healthy competition, and what is unfair and savage?

Suggested approach — the funnel

A design-based funnel or multiple filter approach would cover most situations. A method promoted by my colleagues and I involve the following steps:

1. Define the problem - What is the key issue?
2. Determine the key stakeholders in the decision.
3. Define the boundary conditions of the problem.
4. Is it a moral problem? What Biblical commands or moral principles apply?
5. Is it a legal issue? What laws would apply?
6. Does the Code of Ethics address this?
7. Is it an issue of company policy? What is the source of the policy?
8. Do the moral, legal, ethical thing.

Ethics is often presented as if the individual engineer will always have to decide and act alone. In the long run, a final decision may be up to a given person, but many aspects of design involve teamwork. If at all possible, involve others in your ethical decision making.

Realize that handling an ethical issue doesn't end when you've decided on rightness or wrongness of an issue or concluded the best option. Now what will you do? How will you carry out the decision? How can you make things right? How will you explain your action?

Observations —

- Ethics is a way of showing love to our neighbor.
- Values are more important than feelings in decision making.
- Engineering ethics is partly rule-based and partly philosophical.
- Engineers are very good at following procedures, but not always good at "ad libbing."
- What we need is a set of responses to given situations that are essentially automatic:

Cover up an unsafe product? Never!

Lie about project expenses? Never!

- For the believer, we recognize that "opportunities" to steal or to represent facts falsely are simply temptations to sin and should be dealt with as such.
- We also need a process for reasoning through situations we've never seen before.
- One's worldview plays a large part in one's ethics.
- Becoming an ethical professional may involve a change from within. Christianity deals with heart change.

Suggestions —

- Don't make every issue black and white - code interpretations and company policies are not absolutes.
- Don't make every issue gray - issues involving harm, theft, or deceit have only one correct response.
- Differentiate between a product that could possibly be made safer and a product that is known to be unsafe. You have a definite ethical obligation in the latter case.
- Gain some basic sense of basic business practice and business ethics, since many company issues involve business choices.

REFERENCES

1. Graff, R.W., Leiffer, P. R., and Helmer, W. A., "The Importance of Worldviews in the Teaching of Engineering and Ethics", ASEE 1994.
2. Fleming, G., "Engineers of Death", The New York Times OP-ED, Sunday, July 18, 1993.
3. Haas, J., "Thinking Ethically about Technology", *The Intercollegiate Review*, Fall 1992.
4. Graff, R., Leiffer, P., and Helmer, W., "A Survey of What a Course in Ethics Might Entail,"Proceedings, Annual Conference, American Society for Engineering Education, 1993.
5. Patterson, J., and Kim, P., *The Day America Told the Truth: What People Really Believe about Everything that Really Matters*, Prentice Hall, 1991.
6. Elder, K., *An Epistemological Justification for the "Hold Paramount" Language in Professional Engineering Codes of Ethics*, thesis, Reformed Theological Seminary, 2011.
7. Green, B., "Are Science, Technology, and Engineering Now the Most Important Subjects for Ethics?" *2014 IEEE International Symposium on Ethics in Science, Technology and Engineering* (pp. 1-7). https://doi.org/10.1109/ETHICS.2014.6893408
8. Hinman, quoted in G. Baura, *Engineering Ethics*, Academic Press, 2008.
9. Cotham, P., *The Heart and Soul of Business*, Providence House, 1998, p. 100.
10. Outcomes, Criteria for Accrediting Engineering Programs, ABET.
11. Ladd, J., "Collective and Individual Moral Responsibility in Engineering", *IEEE Tech. Soc. Magazine*, June 1982, p.3-10.
12. Ibid.
13. Graff, et. al. 1993, op. cit.
14. Whitbeck, C., "The Trouble with Dilemmas," *Prof. Ethics* 1(1/2) (1992):119-142.
15. From a series of cases published in *Chemical Engineering* magazine in the 1990s.
16. Graff, et. al. 1993, op. cit.
17. Bertha, C., Ethics Seminar at LeTourneau University, September 6, 2019
18. Starrett, S., Lara, A., and Bertha, C., *Engineering Ethics: Real World Case Studies*, ASCE, 2017, p. 14
19. Schaeffer, F., *He is There and He is not Silent*, Tyndale House, 1972.
20. FE Supplied- Reference Manual, NCEES, 2011.
21. Lindeburg, M., "Ethics," *FE Review Manual*, Professional Publications, Inc., 2000.
22. National Society of Professional Engineers (NSPE) Code of Ethics.
23. Vesalind, P., and Gunn, A., *Hold Paramount*, Cengage, 2016.
24. Unger, S., *Controlling Technology*, Saunders College Publishing, 1995, p. 32.
25. National Society of Professional Engineers, op. cit.
26. Elder, op. cit.
27. FE review book op. cit.

28. IIT, "Why Ethics Codes?" *http://ethics.iit.edu/ecodes/introduction*
29. Ibid.
30. Jordan, W., Elmore, B., and Napper, S., "A Biblical Perspective on Engineering Ethics," Christian Engineering Conference, 2002.
31. Chewning, R., "Doing Justice to Employees," Biblical Principles: The Practice (1990). *http://www.worklife.org/articles*
32. Niewenhoner, R., "Must Engineering Ethics Presume a Secular Foundation?" Proceedings, Annual Conference, American Society for Engineering Education (2008).
33. National Society of Professional Engineers, op. cit.
34. Orr, J., "Engineering ethics and the Ten Commandments," *Machine Design*, July 25, 2002.
35. Ibid.
36. Elder, op. cit.
37. Ibid.
38. Jordan et. al, ,op. cit.
39. Ibid.
40. Ibid.
41. Helweg O., "Teaching Values in Engineering Ethics," Christian Engineering Conference, 2002.
42. Ermer, G., "A Normative Approach to Ethical Engineering Design," Christian Engineering Conference, 2002.
43. Ibid.
44. Bradley, W., "The challenge of teaching engineering ethics in a postmodern culture," ASEE Gulf-Southwest Conference plenary, 1999.
45. Ibid.
46. Helweg, op. cit.
47. Jordan, W., "A Virtue Ethics Approach to Engineering Ethics," Proceedings, Annual Conference, American Society for Engineering Education, 2006.
48. Starrett, et.al., op. cit.
49. Ibid.
50. Whitbeck, C., *Ethics in Engineering Practice and Research*, Cambridge Univ. Press, 1998.
51. Kallenberg, B., *By Design*, Cascade Books, 2013.
52. Bero, B., and Kuhlman, A. 2011. "Teaching Ethics to Engineers: Ethical Decision Making Parallels the Engineering Design Process." *Sci. Engin. Ethics* 17 (3):597-605, 2011.
53. Whitbeck, 1998, op. cit., p. 58-59.
54. Kallenberg, op. cit.
55. Rae, S., quoted in Dockery, D., *Faith and Learning*, B&H Academic, 2012, p.65.
56. Kirkman, R., Fu, K., and Lee, B., "Teaching Ethics as Design," *Adv. Engin. Educ*. Fall 2017.

57. Alenskis, B., "Integrating Ethics into an Engineering Technology Course," Proceedings, Annual Conference, American Society for Engineering Education, 1997.
58. Ibid.
59. Borgmann, A., "Technology and the Character of Contemporary Life," *https://religioustech.org/wp-content/uploads/2019/09/Borgmann-Albert-Focal-Practices.pdf*
60. Moriarty, G., *The Engineering Project*, Penn State University Press, 2008.
61. Ibid.
62. Review of Moriarty, *The Engineering Project* by Henry Petroski, *Techn. and Culture* 51 (2) April 2010:540-542.
63. Catalano, G. and Baillie, C., "Engineering Based on Love," Proceedings, Annual Conference, American Society for Engineering Education, 2009.
64. Ibid.
65. Roeser,S., "Emotional Engineers: Toward Morally Responsible Design," *Sci. Eng. Ethics* (2012) 18:103–115.
66. Harris, C., *Explaining Disasters - The Case for Preventive Ethics*, Routledge, 2005.
67. Bowen, R., *Engineering Ethics - Outline of an Aspirational Approach*, Springer, 2008.
68. Devon, R., "Towards a Social Ethics of Technology", Techne Vol. 8(1) Fall 2004, p. 99-115
69. Ibid.
70. Maxwell, J., *There's No Such Thing as Business Ethics*, Center Street, 2003.
71. Review of Maxwell, *There's No Such Thing as Business Ethics* by David Gill, Books and Culture, March-April 2004. *https://static1.squarespace.com/static/57b0be1c579fb3136382b62d/t/57c8e74d37c5815308cb028c/1472784205877/Maxwell-J.-Theres-No-Such-Thing-As-Business-Ethics.pdf*
72. Herkert, J., " Professional Societies, Microethics, and Macroethics: Product Liability as an Ethical Issue in Engineering Design," *Int. J. Eng. Ed.* 19(1) (2003): 163-167.
73. Luegenbiehl, H., "Ethical Autonomy as a Student Outcome" (PPT), Rose-Hulman Institute of Technology, 2001.
74. Gilligan, C., "The Ethics of Care" *https://ethicsofcare.org/carol-gilligan/*
75. Riley, D. and Lambrinidou,"Canons against Cannons? Social Justice and the Engineering Ethics Imaginary" Proceedings, Annual Conference, American Society for Engineering Education, 2015.
76. Monsma,S., et.al., *Responsible Technology*, Eerdmans, 1986.
77. Ermer, op. cit.
78. Birkett, K., "Naturalism in a Biblical Worldview," *https://www.christoncampuscci.org/naturalism-full-article/*
79. Copan, P., God, "Naturalism, and the Foundations of Morality," in Stewart, R. (ed.), *The Foundations of Atheism*, Fortress Press, 2008.

80. Wallace, J. W., "Three M's That Naturalism Can't Provide," 2017, *https://coldcasechristianity.com/writings/three-ms-that-naturalism-cant-provide/*
81. Copan, op. cit.
82. Schlossberg, H. *Idols for Destruction*, Crossway, 1993, p. 171.
83. Moreland, J. P., "The Ethical Inadequacy of Naturalism," *Promise*, May-June1996, p. 36-39.
84. Wayne, L., The Ethical Incoherence of Pantheism, CARM, *https://carm.org/the-ethical-incoherence-of-pantheism*
85. Montgomery, J.W., *The Suicide of Christian Theology*, Bethany, , p. 252, 1975, quoted by J. Safarti, *http://creation.com/morality-and-pantheism*
86. Closson, D., The Nature of Man, *http://www.leaderu.com/orgs/probe/docs/naturman.html*
87. Copeland, K., Report given at Hope Fellowship, Longview, Texas, May 2017.
88. Orr, op. cit.
89. Ertas, A., and Jones, J. C., *The Engineering Design Process*, John Wiley & Sons, 1993, p. 381.
90. Niewoehner, op. cit.
91. "The Ethical Incoherence of Pantheism", *https://carm.org/hinduism/the-ethical-incoherence-of-pantheism/*
92. Ermer, G., "Professional Engineering Ethics and Christian Values: Overlapping Magisteria," *Persp.Sci.Chr.Faith* 60(1):26-34, 2008.
93. Ibid.
94. K. Stephan, K.,"Christianity and Engineering Ethics," Presented to the "Christian Scholarship Conference," Ohio State University October 22, 1999.
95. Pennington, J., *The Sermon on the Mount and Human Flourishing*, Baker, 2017.

CHAPTER 16: ETHICS POVERTY

ENGINEERS, SOCIAL JUSTICE, AND POVERTY

INTRODUCTION

As engineers working in a complex world, we will need to think through an approach (hopefully a Biblical approach) to key issues in society. Three areas consistently come to our attention–

1. Poverty – What part should engineers play in reducing poverty?
2. Warfare – What is our position on warfare? Should engineers be involved in weapons development?
3. Environment – What is a proper and reasonable approach to maintaining our environment?

These three areas have been framed as ethical issues and issues of social justice, requiring a response by engineers. In this chapter we will look at the concept of justice and the issue of poverty. In subsequent chapters we will examine war/peace and the environment.

APPLIED ETHICS AND SOCIAL JUSTICE

Peace and justice are Biblical concepts, strongly tied to the Old Testament prophets. We are to seek the Kingdom of God– where God Himself rules, where God's ways dominate, where all the effects of the fall are reversed –all separation, all destruction, all chaos, and all injustice.

When Morgan and Claypool Publishers began releasing a series of short books ("synthesis lectures") in the area of Engineering and Social Justice, believers could clearly identify with the call to meet the needs of the world's poor and marginalized people wherever possible. We owe these authors some thanks for bringing these issues to light. Unfortunately, in this arena, while we may agree on the needs, we will often disagree on the methods.

In the publisher's summary of a key volume in the series engineers are portrayed as largely responsible, not for the world's improved health and standard of living, but for the world's problems:

> *The profession of engineering in the United States has historically served the status quo, feeding an ever-expanding materialistic and militaristic culture, remaining relatively unresponsive to public concerns, and without significant pressure for change from within. This book calls upon engineers to cultivate a passion for social justice and peace and to develop the skill and knowledge set needed to take practical action for change within the profession. Because many engineers do not receive education and training that support the kinds of critical thinking, reflective decision-making, and effective action necessary to achieve social change, engineers concerned with social justice can feel powerless and isolated as they remain complicit. Utilizing techniques*

from radical pedagogies of liberation and other movements for social justice, this book presents a roadmap for engineers to become empowered and engage one another in a process of learning and action for social justice and peace. [1]

In the book *Engineering and Social Justice*, we find that engineers, as problem-solvers, need to address issues of social justice, but that "it is difficult to define the term social justice. The problem is that the term resists a concise and permanent definition. Its mutability and multiplicity are, in fact, key characteristics of social justice... Social justice is not so much a thing to be achieved, as it is a continuing process and an ongoing struggle." [2]

Social justice appears to be a response to real or perceived injustice in society. Historically, it has encompassed issues pertaining to environmental justice, economic justice, housing, immigration, gender, animal rights, policing, prison reform, peace movements, and labor. Some of the goals are those that anyone could embrace: "Social justice means moving toward a society where all hungry are fed, all sick are cared for, the environment is treasured, and we treat each other with love and compassion." [3]

If Christians believe in justice and know that God cares particularly for the downtrodden, why are believers reluctant to support social justice activities?

- Social justice is typically political.
- Social justice advocates typically reserve it to themselves to define the issues and the solutions.
- Social justice issues are usually defined by "oppression" of some sort.
- Social justice action often involves protest marches, sit-ins, and other acts of civil disobedience.
- Social justice advocates usually are strongly pro-abortion, against traditional marriage, and unwilling to consider Biblical or "conservative" solutions.
- Social justice solutions often involve pantheistic and Marxist thinking. [4]

The book *Engineering and Social Justice* contains these ideas:

Economic inequality and the problem of poverty have been at the heart of social justice struggles...Marx and Engels were able to contribute an understanding of the social transformations taking place during the industrial revolution that give us great insight into struggles for economic justice and economic equality. Industrialization's new technological developments created social conditions that highlighted the need and capacity for workers to unite to demand better working conditions.

Marx and Engels [shown in photo of their statue in Berlin] introduced the idea of class struggle as a critical lens for interpreting historical and current events, emphasizing the importance of understanding forms of oppression. Their work considers two main classes-the bourgeoisie who are owners of capital and do not work themselves but profit from the work of others (or through trade, real estate, or financial investment) and the proletariat who do not own any resources other than their ability to work, and thus must seek employment from a member of the bourgeoisie, entering into a

> *relationship that is inherently exploitative... Marx and Engels established the role of power in such exchanges-the laborer is often not free to demand a higher wage because he or she may not have other options. They focused on society as being centered around production and noted that under industrial capitalism workers experience alienation-from the products of their labor, from themselves, from others, and from nature. This system that exploits and alienates labor sets up inevitable class struggle...*
>
> *Beyond his contributions to economic justice issues, Marx has contributed to social justice both in a philosophical and a practical sense. This has had an enormous influence on movements for social justice including struggles for worker's rights, human rights, anti-globalization movements, ...* [5]

How soon we forget history. This is nothing less than the lead-in to Communism. The culmination of the Marx-Engels writings was a Manifesto calling for a complete overthrow of the system, and the later creation of a new system, a system that resulted in the death or exiling of millions in the former Soviet bloc. Freedom of speech, assembly, and religion were curtailed. Few would trade life in the United States for the "people's paradise" of China, Cuba, or Venezuela.

(Actually, the exploitation of poor workers by the rich was clearly condemned in James 5, with the promise that the Lord Himself will avenge their cause.)

JUSTICE

When the American Society for Engineering Education was tasked with drafting a statement on justice (2010 -2011), the task force members discovered that they had differing views of justice:

> *To some the term social justice has political implications and implies governmental intervention in many economic areas. To more conservative people (such as this author) social justice means equality of opportunity (not equality of result) ... Part of this issue is that some see justice as a top-down issue which can be implemented largely by governmental action. Others see justice as a bottom-up issue best addressed by helping individual poor people to better their lives.* [6]

Tim Keller writes, "Doing justice means giving people their due. On the one hand that means restraining and punishing wrongdoers. On the other hand, it means giving people what we owe them as beings in the image of God." [7]

The Law recognizes four types of justice:

1. Retributive punishment in accordance with crime or injury ("an eye for an eye")
2. Distributive- fair distribution of resources
3. Procedural- insuring that people are treated fairly
4. Restorative- restoring a "righteous" condition, aiding victims of crime

Justice in practice involves at least five concepts -

1. Equality before the law
2. No unfair treatment of any citizen
3. Righting wrongs against persons
4. Honest weights and measures
5. Concern for the poor and suffering

Biblical Justice

Along with holiness and love, justice is a key attribute of God.

> *"He is the Rock. His works are perfect, for all His ways are just. He is a God of faithfulness with no injustice. Righteous and upright is He." (Deut. 32:4)*
> *"The Lord upholds the just cause of the poor, justice for the needy." (Ps. 140:12)*
> *"What does the Lord require of you? To do justly and to love mercy, and to walk humbly with your God." (Micah 6:8)*

Biblical justice seems to have eight aspects –

1. Reward all good and punish all evil, through judges who must decide cases impartially.
2. Protect the basic rights (life, daily necessities, property) of all people.
3. Provide honest weights and measures in all transactions.
4. Compensate for injury caused to people, property, or farm animals due to injury, damage, or theft.
5. Do not exploit the poor. Provide ways for them to feed themselves.
6. Protect the orphans, widows, and disabled in the community.
7. Set the captives free.
8. Allow no partiality or escape from responsibility.

> *Throughout the Scriptures justice and righteousness go hand in hand. Justice is right action–doing the right thing. Righteousness speaks to the condition of our hearts and the attribute of being pure (or "right") before God.* [8]

The French revolution tied justice to "liberty, equality, and fraternity" (brotherhood).

Amy Sherman suggests that in a fallen world, through Christ, we need to provide rescue, equity, and restored relationships. [9]

Justice and Mercy

Mercy, Justice, and Judgment are linked. They are, in fact, not opposites. Justice is giving someone what they deserve, whether reward or punishment. Mercy is withholding punishment and is linked to grace, providing good that isn't even deserved. The opposite of justice is injustice (deliberate, wickedly unfair treatment). The opposite of mercy is indifference or cruelty.

Koessler writes:

> *God's judgment and mercy, both important themes in the Minor Prophets, seem incompatible. Yet they are both characteristics of God's dealings with sinful humanity. The God of the Bible hates sin, and He executes judgment. He is also a God who is patient with sinners and shows mercy. Divine judgment is never executed without cause and is always preceded by mercy…*
>
> *Yet how is it possible for God's judgment and mercy to coexist? The answer is found in Jesus Christ. Jesus Christ is the ultimate manifestation of God's judgment, just as He is the ultimate manifestation of God's mercy. The fact that Christ suffered vividly reminds us that sin must be punished. God's justice will not allow the guilty to go free. The fact that Christ suffered for us demonstrates His mercy. God's heart is still to redeem people to Himself.* [10]
>
> *In the Beatitudes, Jesus proclaims, "Blessed are the merciful, for they will be shown mercy" (Matthew 5:7). James gives the converse of that statement in James 2:13, saying, in essence, "Cursed are the unmerciful, for they will be shown no mercy." A Christian is not under God's curse. One of the qualities of the Christian is that he shows mercy and compassion toward others.* [11]

Meeting social needs is not the Gospel, but it is clearly Biblical and part of our response to a hurting world. God calls for a compassionate response to downtrodden people:

- The sick
- The poor
- Widows
- Orphans
- Outcasts
- Prisoners
- Refugees
- Strangers/aliens

Social Justice

It should be noted that the term "social justice" originated in the church but has been changed and embraced by thinkers towards the left:

> *The term "social justice" emerges out of Scripture and was originally coined by the church: a Jesuit monk based the phrase on the teachings of Thomas Aquinas. Contrary to some misconceptions, "social justice" is a concept deeply rooted in the historic, Biblically orthodox traditions of the Christian faith.*
>
> *When we talk about "social justice" in a Reformed context, we are referring to God's original intention for human society: a world where basic needs are provided for in love, where people flourish, and where shalom reigns in the Kingdom of God. This vision of shalom is a vision of "the way things ought to be," or the way God created*

the world to be before sin. As Cornelius Plantinga writes, "In the Bible, shalom means universal flourishing, wholeness, and delight... the webbing-together of God, humans, and all creation in justice, fulfillment, and delight." [12]

What does Biblical justice look like in business?

Chewning et. al. set forth the following principles for Biblical justice in a business enterprise: [13]

Produce goods and services that enhance quality of life

- Provide for the basic needs of the poor
- Allow for individual differences; fairness and equity in resolving conflicts among individuals
- Reward and encourage initiative and hard work
- Provide opportunities for meaningful work for all; work is meaningful when it contributes to the welfare of society
- Use resources efficiently and carefully
- Respect other nations and future generations
- Share or distribute power equitably among groups
- Distribute fairly both costs and benefits of the system
- Protect human rights
- Value persons for their own sake, by providing opportunities for personal growth and development

THE POVERTY ISSUE

Poverty

Poverty is the condition of having little or no money or personal property and insufficient or no means of support to obtain them. The poor are always at a disadvantage in society, and, in cases of extreme poverty, may not survive from one day to the next.

A given segment of nearly every population on earth lives in desperate economic conditions, unable to provide for their basic needs. Such existence is far removed from the shalom/flourishing that was intended for mankind.

It is generally accepted that up to two billion people . . . are now poor. The World Bank describes the one billion of these people as "individuals who subsist on incomes of less than $75 a year in an environment of squalor, hunger and hopelessness. They are the absolute poor, living in situations so deprived as to be below any rational definition of human decency...It is a life at the margin of existence." For the other billion who are living slightly above this absolute poverty level, life is nearly as joyless and has improved little, if at all, through decades of "development" efforts. [14]

Nearly a third of Americans briefly slip below the poverty level at some point. Catalano writes:

We are confronted daily with growing evidence of the deteriorating health of the

Earth's ecosystem. Unfortunately, such evidence of environmental deterioration is only the tip of a much more dangerous problem: the growing inequities in wealth and income between countries and within countries, inequities that will generate enormous social unrest and pressure for change. Moreover, who would deny the reality of starving people in Somalia, India, or other countries which are desperately trying to cope with millions of homeless, landless people? According to the most recent estimates, six billion people now exist and seven billion are expected by the year 2006, nearly eleven billion by 2045.

Over 79 percent of humankind lives in the immense and poor southern hemisphere; one billion people live in the state of absolute poverty; over three billion do not have enough to eat, sixty million die of hunger every year; and fourteen million young people die each year as a result of hunger-caused diseases. There is practically no consensus view on how to deal with the poverty issue. The United Nations has challenged the world's wealthy countries to earmark 0.7 percent of each nation's Gross National Product (GNP) for aid to the needy countries. Tragically, the richest country, the United States, devotes less than 0.15 percent of its GNP.

It would be easy to dismiss the problem of poverty to those not fortunate to be born in the United States. In fact, in the United States fully 12.7 percent of the population (i.e. nearly 40 million people) – the highest percentage in the developed world – lives in poverty. Each year since 2001 the number in the U.S. that lives in poverty has grown.

Since January 2004, an additional 5.4 million have slipped below the poverty line. Poverty in the U.S. is a far different and more complicated phenomenon than our traditional understanding affords us. Most people who live below the poverty line have jobs. In fact, many families have members with two jobs. In the U.S. today, countless families, even those with two working parents, frequently fall below the poverty line for both short and long periods of time. The minimum wage of $5.15 an hour has not risen since 1997 and, adjusted for inflation, is at its lowest since 1956. There is a growing gap between those members of society who count themselves among the 'haves' and those who are part of the 'have-nots.' In 2004, 45.8 million Americans lacked any health insurance. Also in 2004, the top 20 percent of earners took home over half the national income while the bottom 20 percent earned approximately 3.4 percent of the national income.

While there are 39 million Americans living below the poverty line, the United States has 269 billionaires, the highest number in the world. Almost a quarter of all black Americans live below the poverty line; 22 percent of Hispanics fall below it while for whites the figure is 8.6 percent. There are 82,000 homeless people in Los Angeles alone...

The United States has more people below the defined poverty line than 26 other advanced countries; however, the measures used to establish a poverty line are controversial and may not always be comparable among countries. What is clear,

however, is that the United States has the widest rich-poor gap of any high-income nation today, and that gap continues to grow. The ten percent of Americans with the highest incomes earn 15 times more than the bottom ten percent. [15]

From the book *Engineering, Poverty, and the Earth* we find:

While engineering is a profession with a strong ethical dimension, and while we have explicitly stated in our various codes of conduct that we must hold paramount the public safety, there has been until very recently no reference to addressing two of the most important issues of our times – poverty and underdevelopment and environmental degradation. It is as if engineering as a profession is somehow excused from such deliberations or that if we serve our employers faithfully and professionally, it will somehow all work out in the end. I do not believe it will somehow work out in the end but rather believe that we, as engineers, need to change the way we envisage our profession. [16]

I would suggest that the solutions proposed in the paper and the book quoted above do involve engineers but fail to address the deeper issues of poverty. The authors' proposals include:

- Address poverty and social justice throughout the engineering curriculum.
- Understand the link between environmental issues and poverty.
- Rethink the Code of ethics and the accreditation criteria.
- Reword the code of ethics to "hold paramount the safety, health and welfare of the identified integral community."
- Support the work of humanitarian engineering groups like Engineers without Borders.
- Work towards a better distribution of wealth.

In response to these proposals, consider these ideas:

1. Christian engineers would agree that our designs must be just in every aspect, not simply in areas deemed "social justice."
2. Evidence for the link between poverty and the environment was the failure of the levees in New Orleans during Hurricane Katrina. Those in the poorest neighborhoods were the most devastated. Sadly, those in poverty often suffer the most in any crisis or natural disaster. The levee failure was only partly an engineering issue. It also involved politics, negligence, and graft.
3. Engineers are reluctant to modify the Code of ethics, since some aspect will be diminished in the process. All users of engineered products, regardless of income level, need assurances that products are safe and reliable.
4. The author of the poverty book is primarily concerned with American poverty, but Engineers without Borders works almost exclusively overseas.
5. It is not so much the size of the income gap that matters but whether a family can afford basic necessities.

Is there anything in the ethics code or creed that would make engineers responsible for solving the problem of poverty? No. Engineers are responsible for "holding paramount the safety, health,

and welfare of the public" and performing their duties faithfully to clients and employers.

As members of the human race, however, we cannot be satisfied with any human suffering that we might alleviate. For Christian believers, we have a particular duty to the poor and disadvantaged. The solution, however, does not involve a massive redistribution of wealth.

Myths about Poverty

1. All poor are equal and living in similar situations

The conditions of the poor in India may be very different from the conditions of the poor in America, yet their mindset and sense of desperation may be similar. In order to alleviate poverty, it may be important to distinguish among various causes of poverty. The poor are always marginalized, but the poor are not always righteous, not always oppressed, not always victims. While some poverty results from oppression, not all poverty is the result of deliberate exploitation.

2. Inequality is the major problem

It is important to distinguish between absolute poverty and relative poverty.

Absolute poverty refers to a situation in which a person cannot survive without help. It is linked to starvation, disease, lack of water and sanitation in the poorest regions in the world. A person cannot possibly earn enough to stay alive.

Relative property is more of a statistical definition. In comparison to others in society a person is living below a given level and cannot afford decent housing, education, and health care.

Distinguish between absolute poverty, in which an individual may not survive, and relative poverty, in which a person is poor compared to others in the society, living at an income below a certain figure or below a given percentage of the population.

Both situations need a remedy, but the first is actually a desperate situation.

3. The rich are God's enemies

James 5:1-6 is a pronouncement against the rich but does not imply that all those who have earned wealth are God's enemies. "Woe to the rich who oppress the poor." Like the parable of the rich fool and the parable of the rich man and Lazarus these are the traits of the rich who stand condemned:

- They have stored up treasure only for themselves.
- They have withheld the pay due their laborers.
- They have lived a life of wanton pleasure.
- They have no concern for God or others. [17]

4. Profits are evil

Often among college students one encounters a mindset that running a business or making

money is inherently evil, that profit is a dirty thing that should be avoided at all costs. This is a Marxist concept, rather than a Biblical idea. Various parables in the New Testament involve hired workers and landowners.

At various times we encounter business owners who have exploited their employees or placed them in unsafe working conditions, but such actions are always contrary to God's standards. A company simply cannot stay afloat without making a profit. Profits are a good thing if

- Employees are treated well and receive a decent wage.
- Goods and services are reasonably priced.
- The company acts openly and ethically.
- The company beats the competition on the basis of quality and productivity, rather than taking steps to destroy the competition.

5. CEOs are evil

Industrial companies and their CEOs often come under attack by socialist thinkers. In fact, it is not wrong

- To make an expensive product,
- To hire a limited workforce, or
- To make a profit.

What the Bible condemns is "unjust gain."

It is unjust

- To make a necessary product that the poor cannot afford
- To produce a shoddy or unsafe product
- To pay workers less than a "living wage."
- To mistreat workers
- To withhold pay from workers (James 5:4)
- To destroy all competition.

6. Many are poor because Americans are rich

Is the rest of the world poor specifically because many Americans are rich and depleting their resources? This is a common view, an "economics of scarcity" approach related to the idea that "The pie has only so many pieces." The complete causal link is not necessarily there. Many Americans, particularly believers, are among the most generous people in the world.

On the other hand, are Americans often self-centered, wasteful, and failing to share with those in need? That part is evident.

The problem with capitalism is not the free-market economy but the fact that humans can be greedy. Love of money instead of love for people results in all sorts of evil.

7. Political solutions are the answer

Contrary to the desires of many politicians, it is neither reasonable nor possible to make

everything equal in life. It is possible to meet the needs of many.

Political solutions to poverty bring their own problems:

- They may incentivize not working.
- They may incentivize not marrying.
- They may incentivize having children for the sake of receiving more money.
- They may foster an overall mindset of dependency.

8. There are Deserving and undeserving poor.

There are no "undeserving poor." There are only poor. All of us are undeserving when it comes to God's grace.

9. Poverty is somehow spiritual.

St. Francis of Assisi suggested that physical poverty is spiritual.

> *In chapter ten [of Spirit of the Disciplines], Dallas [Willard] discusses poverty and the prevailing myth that poverty is somehow more spiritual than being rich. He completely destroys that myth and reminds us that the Scriptures never tell us that we are supposed to eliminate poverty from the world. Yes, we are to care for the needy and poor, and he is all for that. But the point is, you can't help the poor if you are poor. So intentional poverty is no more spiritual than possessing a lot.* [18]

We are to be "poor in spirit," acknowledging that we need the Lord for everything in life, while acknowledging that our income is not simply ours to spend totally on ourselves.

Causes of Poverty

The typical liberal view is that the poor are always victims of oppression.

The typical conservative view is that the poor are always lazy, or that, somehow, their poverty is their own fault. Neither position is true and complete.

The Bible suggests multiple causes for poverty, which require multiple different solutions. Among the causes are famine, drought, war, refugee status, natural disasters, social collapse, sickness, disability, theft, exploitation, lack of skills, wasteful living, and sloth.

External factors

- Hurricanes or other natural disasters
- Widespread plagues or famine
- Medical emergency
- Major economic downturns
- Runaway inflation
- Disability, debilitating injury, or chronic illness
- Mental illness

- Loss of employment and subsequent foreclosure
- Divorce
- Domestic violence

Injustice to individuals

- Substandard living conditions
- Minimum access to education
- Refusing to hire minorities
- Unjust wages
- Unjust prices (especially in the ghettos)
- Unjust interest on quick loans
- Prejudice in criminal justice system
- Unaffordable transportation
- Slavery and human trafficking
- War and refugee status
- Graft, corruption, gangs, and dictatorships

Personal failings:

- Addictions
- Gambling
- Overspending and debt traps
- Refusal to learn skills or a trade
- Criminal behavior and imprisonment
- Poor spending choices (mostly pleasure)
- Sloth (laziness)
- Irrational or unhealthy beliefs
- Rejecting God

Engineering solutions would approach the root cause of each of these.

We can come up with various excuses for not helping the poor–

- "The poor you will always have with you." (Matt. 26:11) This is a stated fact, not an excuse for inaction.
- "I don't know any poor people."
- "It's not my fault they're poor."
- "They want to be poor."
- "Nothing will help."

It is clear from Scripture that we need to help the poor. The question is: What is the best way to help them?

Mindset of Poverty

The mindset of those who have lived in poverty for years is often one of resignation, fatalism, and helplessness:

- There is no hope for the future.
- I will never escape from this condition.
- Nothing is permanent.
- I am unable to plan for the future. I think only short-term.
- I will not defer basic pleasures, since I have no guarantee of tomorrow.
- If I receive a check, I will typically spend it in one or two days.
- I am not part of the broader society.
- I have little sense of history or knowledge of the world outside of my own.

Wes Stafford of Compassion International has stressed that false messages mar identity and create a sense of disempowerment:

> *At its very core poverty is a mindset that goes far beyond the tragic circumstances. It is the cruel destructive message that gets whispered into the ears of millions by the enemy Satan himself- "Give up! You don't matter. Nobody cares about you. Look around you: Things are terrible. Always have been, always will be. Think back. Your grandfather was a failure. Your parents couldn't protect or take care of you. Now it's your turn. You, too, will fail. So just give up!"* [19]

Part of helping people out of poverty needs to be restoring a sense of hope and building new habits.

THEOLOGY OF POVERTY

God's special concern

Many Bible passages address poverty, even indicating that God has a special concern for the poor.

God made all people and desires a relationship with them. In addition, God cares for the poor and disadvantaged, partly because of His mercy, partly because they have no one but God to cry out to.

The Lord protects foreigners; He defends the fatherless and the widow, but the ways of the wicked He frustrates. (Ps. 146:9)

Whoever has mercy on the poor lends to the Lord. (Prov. 19:17)

Those who oppress the poor revile their maker. (Prov. 14:31)

Poverty and Sin

Bryant Myers in Walking with the Poor examines the conditions of poverty around the world and expresses them as four separations: [20]

- Separation from God
- Separation from Oneself
- Separation from Others
- Separation from the earth

Leading to:

- Separation from opportunities

This terminology sounds remarkably like the results of the Fall (recall chapter 4). Poverty is clearly part of the fallout from the Fall, and any hope of significantly alleviating poverty must acknowledge this.

> *"Poverty consists of broken relationships that each person has with God, self, others, and the rest of creation," manifest at both individual and community levels...Poverty alleviation consists of working (at both the individual and community level) to reconcile these relationships."* [21]

It should not be a stretch to say that all poverty can be traced, in some way, to sin.

- Someone is being exploited or mistreated; or -
- Someone is suffering the ravages of war; or -
- Someone is living recklessly; or -
- Someone is suffering from a natural disaster (in a fallen world); or -
- Someone is too physically or mentally damaged to work productively.

All of these are linked to the Fall.

Sin is at the root of four causes of poverty: [22]

- Oppression by others
- External calamities
- Moral failure and foolishness
- Living in a fallen world

Approaches will include relational, asset-based, participatory, and articulating the Gospel. "Christ is the only One who can alleviate poverty in the fullest sense." [23]

Biblical solutions for the poor -

1. Meet the needs of the desperate, with compassion

> *Throughout Scripture, God indicates His special concern for the most vulnerable in society: the widow, the orphan, the lame, the blind, the alien/stranger.*
> *As I have analyzed the message of the Old Testament prophets, I have concluded that there are three main sins that offend God. The first is idolatry; the second, adultery; the third, failure to care for orphans and widows. It seems to me that God puts them all on the same level...*

> *"So, the people asked Him, 'What shall we do then?" His answer was simple. He said to them," He who has two tunics, let him give to him who has none, and he who has food, let him do likewise." (Luke 3:10-11) Not complicated, not theology -just be concerned about the people who need you.* [24]

Borgmann adds:

> *It is not that the affluent are uninformed of the bitterness of brute poverty, nor is it the cause that the rich, though informed, are economically unable to help. Rather we must assume that they are suffering from an incapacity to be moved by misery. And that incapacity, I want to urge, is a feature of advanced poverty. Thus, brute poverty points us to advanced poverty in two ways. First, the religious inconclusiveness of brute poverty and its normal supersession by advanced poverty suggest that if there is today a decisive setting for the advent of the Gospel's good news, it must be advanced poverty. And second, if there is to be any hope for a vigorous and imminent attack on brute poverty, it hinges on our ability to open up in advanced poverty a sense of compassion and readiness to share.* [25]

In the Old Testament the orphan and the widow were supported in part by the tithe that was collected every third year and distributed by the Levites. (Deut. 14: 28-29).

In the New Testament the church in a given region (Antioch) raised funds to provide relief for another church (Judea) (Acts 11:29). The earliest deacons provided food to the widows of Jerusalem.

Notice that we are not instructed to eliminate all poverty, but rather to help the poor, to meet the needs of people.

2. Provide opportunities to provide for families- gleaning

In Leviticus 19 we are given a Biblical model for dealing with the poor. The ancient Hebrews were told to leave the edges of their fields unharvested so that the poor people in their region could gather the remaining grain and feed their families. We see a detailed picture of this practice in the book of Ruth. Gleaning meant that everyone with a field contributed a small amount, and that some effort was expended by poor families to harvest the remains. [26]

3. Discipleship - Help many to get on their feet

Dennis Peacocke writes, "The Biblical response to poverty ...is to call the poor into the kingdom, disciple them to adopt the mental and moral attitudes of good stewards under God, and train them with the skills to begin to create wealth themselves." [27]

> *One author claims that the best way local churches can alleviate poverty is to keep the gospel at the center of their preaching and teaching, believing that men and women who begin to look more like Jesus will seek out and restore the brokenness around them. A transformed believer will no longer oppress the men and women in his or her employ but will instead pay a fair wage because they recognize all of their employees are made in God's image. A transformed believer will actively seek to meet the needs of his poor brothers and sisters. A transformed believer will*

end harmful addictions and sinful behaviors that create and amplify poverty and will instead accept the charge to work "as unto the Lord" and to cherish the responsibility to work and provide for his or her family. [28]

4. Combine justice and mercy

Tim Keller writes that both aspects of God's character should be present when we help the poor –

Two aspects to a Biblical approach to alleviating poverty: [29]

1. Mercy – There are many who are injured, elderly, or sick, who are simply unable to provide for themselves. For these, compassion is the proper response. It is right and essential that we provide help to them.
2. Justice – If a person is able to work but refuses to, he may (temporarily) be refused meals and help. (2 Thess. 3:10). If a person is able to work it is right that she should be expected to earn a living.

Keller rightly notes that poverty has two categories of causes: those due to injustice and those due to personal failings. A Biblical approach to helping the poor must address both external injustice and internal patterns of sin and failure.

External injustice would instruct us to

- Provide for the poorest of the poor.
- Ensure that jobs exist.
- Insure that people aren't locked out of jobs.
- Ensure that wages are reasonable.

Internal failings include

- Learn to show up for work.
- Learn to postpone some pleasures.
- Learn to save some money.
- Learn to do quality work.

Rich people can certainly be treated unjustly, but philosopher Nicholas Wolterstorff says it is a simple fact that the lower classes are "not only disproportionately vulnerable to injustice, but usually disproportionately actual victims of injustice. Injustice is not equally distributed." It stands to reason that injustice is easier to perform against people without the money or social status to defend themselves. The poor cannot afford the best legal counsel, as my friend Heather knew very well. The poor arc more often the victims of robbery, one of the most common forms of injustice. [30]

If God's character includes a zeal for justice that leads him to have the tenderest love and closest involvement with the socially weak, then what should God's people be like? They must be people who are likewise passionately concerned for the weak

and vulnerable. God injected his concern for justice into the very heart of Israel's worship and community life with these texts. [31]

Another cause of poverty, according to the Bible, is what we could call "personal moral failures," such as indolence (Proverbs 6:6- 7), and other problems with self-discipline (Proverbs 23:21). The book of Proverbs is particularly forceful in its insistence that hard work can lead to economic prosperity (Proverbs 12:11; 14:23; 20:13), though there are exceptions (Proverbs 13:23). Poverty, therefore, is seen in the Bible as a very complex phenomenon. Several factors are usually intertwined.40 Poverty cannot be eliminated simply by I personal initiative or by merely changing the tax structure. Multiple factors are usually interactively present in the life of a poor family. [32]

By contrast, the causes of poverty as put forth in the Bible are remarkably balanced. The Bible gives us a matrix of causes. One factor is oppression, which includes a judicial system weighted in favor of the powerful (Leviticus 19:15), or loans with excessive interest (Exodus 22:25- 27), or unjustly low wages (Jeremiah 22:13; James 5:1-6). Ultimately, however, the prophets blame the rich when extremes of wealth and poverty in society appear (Amos 5:11- 12; Ezekiel 22:29; Micah 2:2; Isaiah 5:8). [33]

5. Stewardship involves both investment and charity

Anne Bradley writes:

We often look at the parable of the talents to guide our thinking about stewardship.

As I read through the passage more recently, I was reminded of something striking about the master's attitude toward his servants upon his return.

Rather than praising each of them for saving the coins he gave them, his praise mirrored the return each received from the original investment.

We must be careful not to confuse this investment with charity. Charity is given without expectation of return, while an investment necessitates accountability and proof that the investment was a wise one.

The master praises those who make the best of his gifts to them. This distinction underlies the discussion about education. [34]

Guidelines for Helping with Poverty

According to Corbett and Fikkert [35], how we see the primary cause of poverty will affect how we try to alleviate poverty –

If we think the cause is...	we will try to...
Lack of knowledge	Educate the poor
Oppression by the powerful	Strive for social justice
Personal sins of the poor	Evangelize and disciple

Lack of material resources Provide resources to the poor [36]

We often miss the actual cause and try to apply a remedy that doesn't match the situation.

Biblical guidelines for helping the poor include these:

1. Have compassion for the needy.
2. Never oppress the needy.
3. Meet the needs of the destitute without question. (James 2)
4. Help people get onto their feet. Don't provide for those who refuse to work. (2 Thess. 3)
5. Provide an opportunity for the poor to "glean". (Lev. 19)

Poverty alleviation solutions, whether here or abroad- very similar to successful development projects –

- Must involve the entire community
- Must offer hope
- Must have long-term sustainability
- Must fit the culture

An approach to poverty in a developed nation may be very similar to the approach used in developing nations:

Ensure that basic social needs are met

- Insure access to health care
- Insure access to nutritional food
- Insure access to clean water

Develop earning potential

- Develop local skills
- Develop local industry
- Emphasize entrepreneurship
- Ensure access to needed energy

Avoid paternalism

Do not do things for people that they can do for themselves.

Not a welfare solution

A disabled person feels much better about himself/herself if given some skills and the opportunity to achieve to their maximum potential, at whatever level that may be.

CNN's Hero of the Year for 2016 is Jeison Aristizabel, born in Colombia with cerebral palsy. Jeison began helping disabled children from his garage 15 years ago and now runs a large foundation providing wheelchairs, therapy and training without a fee.

"Today I realize God chose me to help children with disabilities and their families and

build a chain of dreams. I am about to graduate as a lawyer, and I want to do more to change my country's laws."

"Sometimes when we see a big problem, we feel like we can't do something," he said. "But starting with the little things, helping fix the little things, we can transform many lives." [37]

Around the world, when families have a kid with a disability, they think that child won't be capable of much. We have to change that idea completely. We have to tell these families that their child may have a disability, but that doesn't mean that person doesn't have talents that will enable them to succeed in life.

Sometimes families are the first ones to get in the way of their kid's progress. So, we work with them and strive for them to be the main engine to move their kids forward. We educate these families through psychologists and through each of our own personal stories. We've changed the way of thinking here.

Fifteen years ago, in Aguablanca, disabled children were kept hidden because their families didn't know how to care for them. Today, they go outside, they study, they are becoming independent. [38]

A person living in poverty is in a similar situation. Becoming independent should be a goal. Being given absolutely everything can destroy self-worth.

ENGINEERS AND POVERTY

Engineers have significantly aided the poor, although primarily in overseas settings.

Internationally, engineers have undertaken important steps to provide help to people in poverty, primarily at the community level. Adequate water for irrigation and even minimal electrical power can help a community rise above subsistence living. Many projects involving micro-finance have kick-started small craft and village manufacturing projects. Organizations such as Engineers Without Borders and Engineers Against Poverty have been at the forefront of several of these efforts. [39]

The origins of poverty in developing countries are tied to lack of access to clean water, sanitation, health care, nutrition, education, employment, transportation, and electrical power. [40] Many of these gaps may be partly alleviated by engineering solutions, provided that the local community is involved, local materials are used wherever possible, and anything developed fits with the local culture. Wherever possible, lessons learned overseas should be transferred to our country.

In addition to providing direct help through agencies such as the Salvation Army and help for the developing world, engineers might best help the poor in our nation by developing robust and affordable products, lower cost (no-frills) versions of appliances, heaters, air conditioners and vehicles. We have become experts in designing high-end equipment with glitzy displays, remote controls, and embedded controllers, but a real need exists for some very simple yet functional equivalents. Ideally, such production would also provide much-needed jobs.

As private citizens and through our churches we can help the poor, including providing a way for the poor to "glean." [41] How might the gleaning principle translate to engineering?

- Make discarded but still functioning phones and computers available to poor families (probably through a community agency).
- Make discarded and obsolete prototypes available to those who could use them.
- Make previous years' designs and plans available to any charitable group who might use them to develop products.

Just as law firms dedicate a given amount of time for volunteer or "pro bono" work on behalf of those who can't afford their services, various engineering firms arrange days of volunteer service for the community or for charitable organizations. Some engineers have mentored students from low-income schools.

Engineers need to be aware that our designs can negatively impact the poor, if, for example,

- We make them unaffordable
- We deplete necessary resources
- We remove jobs
- We make junk that needs to be replaced after a short lifetime
- We create or market an artificial need

Widespread Poverty Reduction

The book The *Poverty of Nations* by Grudem and Asmus [42] examines the wider question of poverty from a Biblical perspective and contains 78 steps for addressing poverty.

> *Poverty remediation requires simultaneous transformation in three spheres: cultural (social), political, and economic... The three spheres are interrelated domains of human existence, culture being the most fundamental of the three... the authors are unapologetically committed to free market economics. Research overwhelmingly confirms the effectiveness of the free market model, as opposed to various redistributive schemes in favor with international developmentalists like Jeffrey Sachs of Columbia University.* [43]

Grudem and Asmus list the following as key foundations/beliefs for a nation to transform itself: [44]

- Believes that God approves of several character traits related to work and productivity.
- Respects private ownership of property.
- Highly values individual freedom.
- Believes that economic development is a good thing and shows the excellence of earth.
- Believes the earth is a place of opportunity.
- Believes that time is linear and therefore there is hope for improvement in the lives of human beings and nations.
- Manifests a widespread desire to improve on life, to do better, to innovate, and to become more productive.

- Gives honor to economically productive people, companies, inventions, and careers.
- Believes that mutual gains come from voluntary exchanges, and therefore a business deal is "good" if it brings benefits to both buyer and seller.
- Counts family, friends, joy in life, spiritual well-being, and a relationship with God as more important than material wealth.

CONCLUSIONS

There is a strong case, based on the Gospel itself, for helping the poor.

The issue of poverty is deep and complex in our culture, and we have often failed in our attempts to alleviate it.

Because the "social gospel" distorted the proclamation of the Gospel message, essentially making acts of kindness equal to the gospel, many evangelicals have (wrongly) shied away from helping the poor. If we aid the poor only to reach them for salvation we are manipulating them and failing to glorify God. [45]

> *Christian responses to the overwhelming problem of poverty are often out of balance in one direction or the other. Many ministries become so intent on poverty alleviation that evangelistic zeal is lost, others mistake "holistic" for comprehensive and fragment themselves by trying to run too many different kinds of programs, yet others become crass extensions of prosperity teaching while others see the poor as "in need of values" and descend into almost Victorian moralizing. All these approaches are either ineffective in the long term and do little to help the poor or advance the Kingdom of God. Balance is urgently needed.* [46]

Poverty is associated with a lack of skills, a lack of things, and a flawed culture. Christians with some resources are in a position to address each of these.

The real causes of poverty, according to Bryant Myers: [47]

- Physical – including housing
- Social – including schooling issues
- Mental – including nutritional impairment
- Spiritual – including relational

Starting point –

- NOT looking to see if some have more than others
- Looking to see if basic needs are met-food, clothing, shelter

These factors were present in the lives of the few individuals I've known who emerged from situations of real poverty:

- Getting some education and skills
- Taking a basic job and working diligently
- Getting free from drugs or alcohol dependence

- Building a disciplined lifestyle
- Getting married and aiming for a stable family

In many cases we aren't acquainted with the desperately poor and don't know how best to help them. We might work through organizations who know how to help: the Salvation Army, the local rescue Mission.

What individuals can do:

- We must provide emergency help to all those who cannot survive without help.
- Befriend and assist a family in financial crisis.
- We must treat all people with dignity.
- We must preserve self-respect.
- Create products, create jobs.
- Our goal should be to help people escape from poverty. Offer education, living skills, and hope.
- Contribute to or volunteer with organizations skilled in poverty relief, like the Salvation Army.
- Live more simply.

What churches can do:

- Address the problem at every level.
- Provide help to those who need help.
- Provide food, medicine and clean water to the poorest people.
- Evangelize and disciple all people within reach. Teach stable living habits.
- Partner with organizations skilled in poverty relief, like the Salvation Army.
- End obstacles to economic advancement - Dictatorships/racism/oppression/injustice.
- End the culture of poverty.

Our goal should be sustainable, long-term solutions.

REFERENCES

1. Morgan and Claypool, Engineering and Social Justice, *https://www.morganclaypool.com/doi/abs/10.2200/S00117ED1V01Y200805ETS007*
2. Riley, D., *Engineering and Social Justice*, Morgan and Claypool, 2008, p.1.
3. Medea Benjamin, quoted in Riley, p. 4.
4. Wolfe, W., "Social Justice vs. Biblical Justice," *https://www.standingforfreedom.com/2021/07/24/social-justice-vs-biblical-justice-an-incompatible-difference/*
5. Riley, op. cit., p. 5-7.
6. Jordan, W., "Engineering and Justice", ASEE Conference, 2011.
7. Tim Keller interview- Generous Justice *https://www.thegospelcoalition.org/blogs/kevin-deyoung/interview-with-tim-keller-on-generous- justice/*
8. Cannon, E., *Social Justice Handbook*, IVP, 2009.
9. Sherman, A., *Kingdom Calling*, IVP, 2011.
10. Koessler, J., "God of Judgment, God of Mercy," *https://www.todayintheword.org/issues/2010/9/theology-matters/*
11. "Mercy Triumphs Over Judgment," *https://www.gotquestions.org/mercy-triumphs-over-judgment.html*
12. Christian Reformed Church, Office of Social Justice *http://www2.crcna.org/pages/osj_faqs.cfm*
13. Chewning, R., Roels, S., and Eby, J., *Business through the Eyes of Faith*, Harper One, 1990.
14. Harvie Conn, quoted in M. Goheen, "Gratitude and Groaning", PPT
15. Catalano, G., "Engineering and the Other America," ASEE Conference, 2007.
16. Catalano, G., *Engineering, Poverty, and the Earth*, Morgan and Claypool, 2007.
17. Alister Begg, "Truth for Life" radio, Feb. 23, 2016.
18. Review, *The Spirit of the Disciplines* by Dallas Willard, *https://musicman6724.wordpress.com/2016/09/03/the-spirit-of-the-disciplines-by-dallas-willard/*
19. Stafford, W., quoted by Scott Todd in "Poverty is a Lie," *Mission Frontiers*, July-Aug. 2011, p. 17.
20. Myers, B., Walking with the Poor, Orbis, 1999.
21. Corbett, S., and Fikkert, B., When Helping Hurts, Moody, 2014.
22. Kotter, D., "Remember the Poor" in Bradley, A., and Lindsley, A., For the Least of These, Zondervan, 2014, p. 70.
23. Corbett and Fikkert, op. cit
24. Prince, D., "Orphans, Widows, the Poor, and Oppressed," Intercessors for America report.
25. Borgmann, A., Power Failure: Christianity in the Culture of Technology, Brazos, 2003, p.105.

26. Grant, G., Bringing in the Sheaves, American Vision, 1995.
27. Dennis Peacocke, quoted in Miller, D., Discipling Nations, YWAM Publishing, 2011, p.159.
28. Dickens, A. Book Review: For the Least of These, *https://www.thegospelcoalition.org/reviews/least-biblical-answer-poverty/*
29. Keller, T., Generous Justice: How God's Grace Makes Us Just, Dutton, Penguin Group USA, 2010.
30. Keller, p.7.
31. Keller, p.8.
32. Keller, p. 34.
33. Keller, p. 33.
34. Bradley, A., "Stewardship and Education," *https://tifwe.org/stewardship-and-education/*
35. Corbett and Fikkert, op. cit.
36. Ibid.
37. http://www.cnn.com/2016/12/11/world/cnn-hero-of-the-year-jeison-aristizbal/
38. http://www.cnn.com/2016/06/23/health/cnn-heroes-jeison-aristizabal/
39. "Engineering and Social Justice Bibliography," *www.onlineethics.org/Resources/Bibliographies/SocialJustice.aspx*
40. Singleton, D., "Poverty Alleviation-The Role of the Engineer", *http://www.arup.com/Publications/Poverty_alleviation_the_role_of_the_engineer.aspx*
41. Grant, op. cit.
42. Grudem, W., and Asmus, B., The Poverty of Nations, Crossway, 2013.
43. Osburn, R., "Hope for the Nations -A review of Wayne Grudem and Barry Asmus' The Poverty of Nations: A Sustainable Solution," Mission Frontiers, Mar-Apr 2014.
44. Grudem and Asmus, op. cit.
45. Suggested by Tim Keller.
46. "A Biblical Perspective on Prosperity and Poverty," *http://www.aibi.ph/tmk/tmk10_prosperity_and_poverty.htm*
47. Myers, op. cit.

CHAPTER 17: WAR AND PEACE

INTRODUCTION

The same design process that can produce devices for amazing, good can also produce devices for devastating death and destruction. Since the 19th century engineers have been principal players in the development of weapons and technology for warfare.

> *Before World War II began, we were around the sixteenth or seventeenth largest military in the world (about the size of Portugal or Romania). Because of World War II, we created the Pentagon, the CIA, and the nuclear weapons program.* [1]

Individual soldiers often exhibit courage and heroism, but there is nothing beautiful or glorious about war. John McCain, who served in the Navy and spent 5 ½ years as a POW in Viet Nam said this: "All wars are awful… Nothing, not the valor with which it is fought nor the nobility of the cause it serves, can glorify war. Whatever gains are secured by war, it is the loss the veteran remembers most keenly. Only a fool or a fraud sentimentalizes the cruel and merciless reality of war." [2]

The results of war are always ugly:

- Destruction of human life, including leaving behind widows and orphans
- Destruction of the countryside
- Residual unexploded bombs and landmines
- Destruction of cities
- Destruction of innocent non-combatants
- Birth defects from toxic chemicals (agent orange)
- Disease and starvation after cities are bombed or besieged
- Destruction of the economy
- Refugees, displaced and uprooted people
- Psychological results: fear, depression, PTSD

Warfare has always been difficult and ugly but has become even more so in recent years. Originally the soldier was clearly identified by a uniform, and soldiers fought only against other soldiers, often in open settings. Today we have

- Guerrilla warfare
- Urban warfare
- Civilian "shields"
- Civilian soldiers
- Heavy civilian casualties ("collateral damage")
- Terrorism
- "Weapons of mass destruction," including nerve gas and nuclear missiles

Of all human actions, warfare is most clearly linked to the Fall. All human conflict arises from our sinful nature.

"As Samuel Shoemaker has said, 'You do not wait for a war to look at the problem of evil, war is simply the problem of evil writ large.'" [3]

"Where do wars and fights come from among you? Don't they come from your desires for pleasure that war in your members? You lust and you do not have. You murder and covet and cannot obtain. You fight and war. Yet you do not have because you do not ask." (James 4:1-2) James is writing to a church about quarrels and fights that arise internally, but the reason given is the root cause of all conflicts: self-driven cravings, whether for property, power, conquest, or destruction.

Some wars have been justified based on protecting the innocent. Many wars, however, can never be justified:

- Wars of conquest
- Wars of religion
- Wars of "ethnic cleansing"
- Wars of revenge/retaliation

The ethics of warfare is a complex issue. When we look at the problem of warfare we find not only that engineers are divided in their response, but that Christ's followers are divided in their response to this issue.

ENGINEERS AND WAR

Along with poverty and the environment, warfare is a key element in the writings of the faculty associated with "Engineering and social justice." *Engineers and War* by Blue et. al. [4] details the deep involvement of engineers in the activities of warfare, focusing on the earliest military engineering and the growth of the "military-industrial-complex" from the Cold War.

> *The term "engineer" dates from the 14th century and explicitly ties engineering to warfare: Engineer (origin): Middle English (denoting a designer and constructor of fortifications and weapons; formerly also as ingineer)... Insofar as one understands "engineering" to entail the design and making of technology, it can be connected to military purposes even earlier. Egyptian, Mayan, Greek, Roman, Aztec, and other ancient civilizations were built, in no small part, upon technologies of fortification and weaponry. Surely, the history of technologies of warfare is even older, likely dating from the very beginnings of civilization, or at least from the time human or even pre-human species began to make and use tools of any sort.* [5]

> *The profession of engineering has long been closely tied to military endeavors...The origin of the word engineering is based on military technology, hence the distinction of civil engineering as nonmilitary or civilian in nature. The first engineering school in the United States was founded at West Point, and similarly the European polytechnics have their roots in military academies.* [6]

The largest employers of engineers have typically been government contractors, particularly Lockheed Martin, Boeing, Northrup Grumman, General Dynamics, and Raytheon.

> *As of 1984, approximately 20% of all engineering jobs were sponsored by the DoD [Department of Defense]. Also, 60% of Aerospace engineers, over 40% of systems engineers, and nearly 30% of electrical and computer engineers held DoD-sponsored positions.* [7]

> *Given the intertwined nature of engineering and militarism, it can be difficult for engineers who have a clear commitment against participating in war-related activities to manage their careers in a way that honors their values. For others who have no particular commitment against engineering for warfare, considerable incentives exist to pull them in that direction.* [8]

> *(Engineering professor/philosopher Aarne) Vesilind noted that engineering from its inception has been intimately associated with waging war. The earliest engineers were military engineers who worked at the behest of leaders who either were leading conquering armies or defending their conquered lands from invasion... Vesilind concludes with a description of the dichotomy that he claims captures the essence of engineering today. "The engineer is sophisticated in creating technology, but unsophisticated in understanding how this technology is to be used. As a result, engineers have historically been employed as hired guns, doing the bidding of both political rulers and wealthy corporations."* [9]

Blue adds the following:

> *While the number of engineers—in total and in military-related work—grew rapidly in the U.S. post-World War II, military perspectives have informed engineering since its creation and have influenced engineering practices far beyond the character of employment patterns. Among the work practices that define engineering and distinguish it from other professional groups are its comfortable integration within hierarchical organizations, its heavy reliance on command-and-control problem solving, a high degree of division of labor and expertise within the field, and its notably masculinist culture. As Noble's (1979) history of engineering shows, these attributes are not coincidental, nor are they shaped exclusively by postwar employment patterns, but instead they were designed into the field from its beginning and as it evolved alongside the growth of corporate capitalism.* [10]

Engineering professor Dean Nieusma, part of the engineers for social justice group, describes the history of war in our country:

> *The United States, for example, has waged numerous wars, both literal and metaphorical. From its inception as a settler colonial society, certainly, but also in its more recent wars on concepts and abstract nouns. Domestically, it has seen wars on crime in the 1930s and again in the 1970s, a war on drugs, a war on poverty, and now a war on terror. Overseas, it has seen wars (or police actions) in the Philippines, Cuba, Haiti, Mexico and throughout Latin America, two wars in Europe, and two more*

in East Asia. Beginning with World War II and persisting through the Cold War, military spending was the literal foundation of the US economy. Military Keynesianism drove everything from road-building programs to factory openings, sanctioned by a bargain among the federal government, large corporations, and the politically centrist unions that garnered stable, high-wage jobs for their members, thereby ensuring that US-dominated capitalism prevailed over Soviet communism and other economies across the third world. All of this required massive building, massive spending, and massive engineering, which was directed by states and governments, but also by private corporations—and the best work was done when their interests aligned, as in World War II and the Cold War. [11]

To summarize the position of the social justice authors:

- Our country is under the economic thumb of the military-industrial-complex.
- Far too many engineers-particularly EE's and ME's- are employed in military work.
- Engineers are blinded by the high salaries paid for military work.
- Engineers wind up as "hired guns" for the defense contractors.
- Far too much of our national budget is spent on the military.
- Money spent on the military should be spent on social needs.
- We have a militaristic mindset and a proliferation of weapons, which pushes us towards war.
- Far too many faculty are involved in military-funded research.
- Engineering education grew out of a military mindset and continues to contain a militaristic flavor (exemplified by rigid expectations and report formats)
- Engineering faculty should teach applications to world needs, not applications used by the military.

The alternative, suggests the authors, is the formation of organizations of engineers with a peace initiative ("Scientists, Technologists, and Engineers for Peace and Justice"), an emphasis on the common humanity of all persons, including "the enemy," and a focus on humanitarian engineering.

George Catalano has suggested that the engineering accreditation criteria be modified to include the following outcomes:

- Promote peace through the development of an individual plan for the lifelong cultivation of an awareness of the interdependence of all and the qualities of compassion, caution, and reflection.
- Promote peace through an improved understanding of other cultures.
- Promote peace through employing the principles of peaceful conflict resolution. [12]

The notion of humanitarian engineering is appealing and should be pursued. Knowledge of other cultures and conflict resolution can be valuable. Some of the other arguments from the social justice authors are flawed:

1. Several of the writings in the "engineering and social justice" series express a concern that engineers have often used their talents to help the military. It is important here to distinguish

between the legitimate place of a standing military for national defense and the concept of "militarism," the idea that military might and conquest is what makes us great or gives us identity. Scripture gives us an alternative mindset: "Some trust in horses, and some trust in chariots, but we trust in the Lord our God." (Ps. 20:7)

2. A significant portion of our national budget is spent on defense, but protecting the nation is one legitimate purpose of national government (Article 1, section 8 of our Constitution: Taxes are levied "to provide for the common defense"). Like most areas of the government, the Defense Department has often run into waste, patronage, cost overruns, and duplication of programs. Those problems need to be addressed, rather than gutting the Defense Department.
3. The era of the Military-Industrial Complex is winding down, as many former defense companies shift to civilian products. [13] The number of defense firms went from 107 down to five by 1990, although many were simply bought up by the larger companies. [14]

   The federal budget only claims 22% of the economy, and defense in turn represents a mere one in every seven federal dollars (14% of the federal budget). Do the math, and it turns out that all that money Washington spends on the military only amounts to about 3% of the economy.

   Furthermore, most of the defense budget is not spent on weapons, it is spent on items like military pay and benefits, training, maintenance and the like. The amount of money set aside for developing and procuring military equipment in the budget agreement Congress reached last week is $197 billion -- a third of the $593 billion defense budget, and barely 1% of GDP (which stands at $19 trillion).

   Granted, this may represent close to a tenth of all U.S. manufacturing, given the way so many industries have fled the U.S. for Mexico and Asia. But how much of a problem can the "military-industrial complex" be when it only represents 1% of the economy? Healthcare is 17%, but nobody refers the "healthcare-industrial complex." [15]

4. Critics are divided on the impact of the defense economy:

   While Cold War defense spending did reshape the American economy; it was mostly in a good way. Military outlays supported industries, such as aerospace, that altered the economic landscape of entire regions. By one estimate, over $50 billion in defense dollars flowed into California alone during the 1950s; the rise of Orange County and other areas around Los Angeles was a byproduct of the Cold War. Federal funding allowed private firms to push the frontiers of innovation: In 1959, nearly 85 percent of American research and development in electronics was funded by the government. [16]

5. The concept that money will be spent either on defense or on civilian needs has been termed the "guns or butter" argument. Regardless of the size of the military budget, however, politicians seem to be able to spend more each year on "civilian" programs.

6. The mission of the military is not to kill as many people as possible, but to defend the nation and to win a war if attacked. It is important to consider that a military action against an aggressor does not necessarily mean an invasion with thousands of soldiers or launching nuclear missiles. There are a large range of responses possible, including retaliatory strikes against missile sites and military transportation lines. I have never met an active-duty officer or a retired officer who actually desired war, particularly if they had ever engaged in combat. Most believed in the notion of "peace through strength."
7. The rigor of engineering education is essential, not for a military mindset, but for preparing engineers for work in every industry that does things a certain way and for developing safe products for the public.

PACIFISM (ANTI-WAR POSITION)

Pacifism is the position that violence can never be justified under any circumstances. Under Eastern Pacifism not only is it wrong to kill a human, it is wrong to end the life of any animal.

The extreme "peace" position, or anti-war position, sees the military and all weapons as the problem:

- The military must be inherently evil. No one should support the military in any way.
- Military leaders teach hate, not love.
- Military leaders want a war.
- The military is racist, since most wars are against foreigners.
- Military leaders don't care about suffering people.
- If we disarm completely there will be peace.

This is the position of many in the "peace movement." We might call it "humanistic pacifism." The argument is made that all people are basically good and, deep-down, really want peace. If we simply show kindness to the enemy and lay down our arms, they will put aside their weapons and we all be one loving family.

Unfortunately, neither history nor the Bible bear this out. Conquerors, destroyers, predators, and terrorists have taken lives and property in almost every generation since life began. Our loving actions alone will not change evil hearts.

The problem is: We're really not good at heart. The idea is blind Pollyanna thinking. Our nation (and most others) has enemies who will not abandon their aggression.

Much of the "peace movement" of the Vietnam era was anything but pure in its pacifism. It opposed the American military in every way while many were simultaneously celebrating Soviet military power, North Vietnam's Marxist leaders, and dictatorships in Central America.

If pure hawks will get us into a war by goading and aggression, pure doves will get us into a war by appeasement and disarmament.

CHRISTIAN PACIFISM

Christians historically have fallen into one of two camps on the issue of involvement in warfare:

1. Christian Pacifism
2. "Just War"

There are, in fact, two ways to deal with an enemy:

- Kill him.
- Make him my brother.

We know that God has "no pleasure in the death of the wicked" (Ezek. 33:11), nor should we.

Unlike humanistic pacifism, Christian pacifism acknowledges that people are sinful, but urges us to respond with nonviolence anyway, following the example of Jesus and acting in the strength of God's Spirit.

Christian Pacifism holds that a believer should not engage in military warfare in any way, since it is incompatible with the Bible's instructions and with the Christian life. The position is based on the teachings of Jesus and the examples of many early believers. If all humans are valuable to God, and God loves the world, we cannot justify ending human lives in war.

Certain denominations, including Mennonites, Quakers, Moravians, and Brethren, incorporate pacifism into their denominational theology.

Many verses in Scripture are consistent with pacifism:

"You shall not kill." (Exodus 20:13)

"But the meek shall inherit the earth and shall delight themselves in the abundance of peace." (Ps. 37:11)

"When a man's ways please the Lord, He makes even his enemies to be at peace with him." (Prov. 16:7)

Biblical pacifists base most of their position on the Sermon on the Mount:

"Blessed are the peacemakers, for they shall be called the children of God." (Mt.5:9)

"You have heard that it was said, 'Eye for eye, and tooth for tooth.' But I tell you, do not resist an evil person. If someone strikes you on the right cheek, turn to him the other also. And if someone wants to sue you and take your tunic, let him have your cloak as well." (Matthew 5:38-41)

"But I say to you, love your enemies. Pray for those who persecute you." (Mt. 5:44)

And later —

"He who lives by the sword shall die by the sword." (Mt. 26:52)

"My kingdom is not of this world. If my kingdom were of this world, then my servants would fight." (Jn. 18:36)

"Do not repay anyone evil for evil." (Rom. 12:17)

"If possible, so far as it depends on you, live in peace with all men." (Rom. 12:18)

"Never avenge yourselves..." (Rom. 12:19-21)

When God rules over the nations He promises that "men shall beat their swords into plowshares and their spears into pruning-hooks. Nation shall not lift up sword against nation, nor shall they train for war anymore." (Isa. 2:4)

> *...Jesus practiced what he preached. He exemplified his call to non-resistance. For he resisted neither betrayal nor arrest, neither trial nor sentence, neither torture nor crucifixion. When he was insulted he did not retaliate, He was the innocent, suffering, Servant of the Lord...(Isa. 53:7) He loved those who despised and rejected him. He even prayed for the forgiveness of those who nailed him to the cross...For this is the way of the cross, and Jesus calls us to take up our cross and follow him.* [17]

Ted Grimsrud sees a four-fold Biblical basis for Christian pacifism: [18]

1. The love command provides the central building block for Christian pacifism – both in the positive sense of establishing love as the highest ethical standard that can never be secondary to some other possibly violence-justifying ethical value and in the negative sense of providing the basis for rejecting the participation in or support for lethal violence as a morally acceptable choice.
2. Jesus rejected power politics and created a community independent of nation states insofar as they depend upon the sword.
3. When Jesus called his followers to make kindness and love, even for enemies, the kind of priority that can never be overridden by some other value (that is, when Jesus established the basis for pacifism), he expected that this indeed would be possible.
4. Jesus' cross serves as a model for his followers. At the heart of his teaching stands the often repeated saying, "Take up your cross and follow me." He insisted that just as he was persecuted for his way of life, so will his followers be as well.

Besides the Scripture, the strongest arguments for Christian Pacifism are these:

1. Missionaries living in dangerous cultures don't carry weapons to defend themselves. All believers are missionaries to some culture.
2. To enter into war with soldiers who are non-believers and to end their lives in battle is to remove any possibility of their receiving Christ and being with Him forever.
3. It is impossible to "witness" to someone while they're shelling, bombing, or directly attacking you (or vice versa). It is possible to witness to them (often very effectively) when they're a POW or in a refugee camp.

4. It is very difficult to take a human life initially unless a person is extremely threatened or extremely filled with hatred for the enemy.
5. One cannot imagine Jesus taking up arms to destroy others.
6. The early church was primarily pacifist.

The early Christian church was largely pacifist, but all this changed when Constantine came to power. Thus the church had to somehow narrate how Christian service in the military was not only acceptable but laudable. [19]

In reality, however, the Scriptural position on pacifism is not totally simple.

"You shall not kill." (Exodus 20:13) literally forbids murder, rather than killing. Several crimes in the Old Testament Law were punishable by death.

"Turning the other cheek" (Mt.5) is a non-retaliatory response to a personal insult. We are not told, "If someone cuts off your right arm, offer to him your left arm as well."

The Sermon on the Mount applies to individual believers, not to governments.

In Luke 3:14 John the Baptist's direction to soldiers was simply, "Don't take anything by force, don't falsely accuse anyone, and be content with your pay."

Jesus healed a Roman soldier's ear (Luke 22:51) and praised a Roman Centurion's faith (Mt. 8:10).

Jesus submitted to torture and crucifixion because that was His specific purpose, His primary mission on earth.

"(Biblical) pacifism," suggests Brown, "is based on an unfounded assumption that because Jesus did not directly support the use of force, he must have condemned it." [20]

Contrary to opposing it at every point, the Bible contains several significant statements about warfare.

1. God is described as a warrior who fights on behalf of His people Israel. He is named several times as Yahweh Tsabaot, the Lord of Hosts. The concept suggests that God is the leader of an army of angels (2 Kings 6:17).

   "The Lord is a Warrior... Your right hand, O Lord, shatters the enemy... You overthrow those who rise up against you." (Ex. 15: 3, 6, 7)

   "Blessed be the Lord, my Rock, who trains my hands for war and my fingers for battle." (Ps. 144:1)

2. Abraham went to battle against the kings who raided his camp and kidnapped his nephew Lot. After the victory Abraham delivered a tithe of the recovered monies to Melchizidek. (Genesis 14)

3. Joshua was commanded to attack Jericho, Ai, and other Canaanite cities, to capture the land for Israel. (Josh. 6:2-5, 8:1)

4. The admonition "Be sure your sins will find you out" (Num. 32:23) was actually spoken to a tribe who apparently was refusing to go to war along with the other tribes. [21]

5. David's victory over the giant soldier Goliath is celebrated as one of the high points of the Old Testament. (1 Sam. 17)

6. Israel was commanded to form an army of armed soldiers. (Deut. 20)

7. King Uzziah prepared for war in order to avert war. (2 Chron. 26:6) [22]

8. The Christian life involves spiritual battles. Ephesians 6 describes the "armor of God," modeled on the equipment of a first century Roman soldier.

According to the Bible, our true enemies are not other human beings. We have a spiritual enemy, and we engage in a spiritual warfare.

A case can be made for a national military, based on Biblical truth:

1. We live in a fallen world, where violence and war are not unexpected.

The harsh reality is that all humans are fallen, and war will exist until Christ returns. "The Bible takes evil and the reality of war seriously. It recognizes that if men will war with God they will certainly war with other men." [23]

2. Force is justified to protect the defenseless.

   "You are to defend the defenseless." (Ps. 82:3)

   If we were to encounter an adult about to beat a child to death, we would be justified in stopping that person by force. In fact, we would be doing wrong not to protect the innocent child.

   "If you know the right thing to do and fail to do it, you commit sin." (James 4:17)

3. The Bible allows for self-defense.

   "The king allowed the Jews to gather to defend their lives …against any people or province that might attack them." (Esther 8:11)

   "Do not be afraid of them. Remember the Lord who is great and awesome, and fight for your brothers, your sons, your daughters, your wives, and your homes." (Neh. 4:14)

4. God ordains human government, which is charged with protecting its citizens.

   "Let each person be in subjection to the governing authorities. For there is no authority except from God, and those which exist are established by God… For the one in authority is God's servant for your good. But if you do wrong, be afraid, for the ruler does not bear the sword in vain. He is God's servant, an agent of wrath to bring punishment on the wrongdoer." (Rom. 13: 1, 4)

   "Those who are in a position of authority do have the right, even duty, to use force to defend the common good." [24]

Under certain circumstances the individual is given the authority to defend himself,

and if need be, kill an intruder (Exodus 22:2). If an individual, who is not given the authority to wield the sword in a civil capacity, can protect himself, then we must conclude that the civil magistrate who does have authority to wield the sword can defend the nation. [25]

The Apostle Paul was protected form a murderous religious mob by the Roman troops of Jerusalem. (Acts 23:16-24)

5. The government may order its citizens to fight against an enemy.

   "Render to Caesar what is Caesar's and to God what is God's." (Mt. 22:21)

6. There seems to be a difference between personal response to an individual who acts as my enemy and a national response to a nation's enemy.

The goal of war is not to kill as many of the enemy as possible. The goal of war is to defeat the enemy

- By destroying his weapons, if possible.
- By cutting off his supplies, if possible.
- By crippling his cities, if necessary.
- By defeating his armies, if necessary.

We might consider that in order for the church to express God's full character and God's love for the oppressed, some of His wrath against oppressors needs to be manifest as well. [26]

Under God's command and God's direction and for His own purposes, to punish sinners, wicked nations, wicked people, God wielded a mighty sword of death. He wielded it against nations that threatened Israel. He wielded it against nations that threatened peace, against nations that threatened other nations. He wielded not only as a sword of punishment but a sword of protection. God wielded His sword against aggressive, evil, destructive enemies who desired to destroy others. [27]

There was no possible way to stop that awful terror that was occurring in Hitler's Germany except by the use of force. There was no way. As far as I'm concerned, this is the necessary outworking of Christian love. The world is an abnormal world, because of the Fall it is not the way God meant it to be. There are lots of things in this world which grieve us, and yet we must face them...

Unilateral disarmament in this fallen world, and with the [nation's enemy's] materialistic, anti-God base, would be totally Utopian and romantic and lead, as utopianisms always do in a fallen world, to disaster. [28]

A number of World War Two veterans were interviewed about their service and asked what part they thought Jesus would have played in that war. No one could picture Jesus with a machine gun or dropping bombs. He would be offering His Gospel to both sides... At the same time, all of the veterans were convinced that they were obeying God when they went to war and that Hitler's slaughters absolutely had to come to an end. This is the dilemma of war. [29]

The early church was largely pacifist, partly because of Jesus' commands, but also because being a soldier in the Roman Empire meant absolute allegiance to the Emperor, often including worshipping the Emperor.

Was Jesus perfectly pacifist?

Jesus did act with force at one instance in the Gospels, when he overturned the tables of the moneychangers and cleansed the temple with a whip made of cords. (John 2:15)

In Revelation we see that Jesus will return with an army to destroy all remaining enemies:

> *And I saw heaven opened, and I beheld a white horse. The One that sat upon him was called Faithful and True. In righteousness He judges and wages war. His eyes were like a flame of fire, and on His head were many crowns. He had a name written on Him that no man knew, but He himself. He was clothed with a robe dipped in blood, and His name is called "The Word of God." The armies which were in heaven followed Him upon white horses, clothed in fine linen, white and clean. Out of His mouth came a sharp sword, that with it He should strike the nations. He will rule them with a rod of iron, and he treads the winepress of the fury and wrath of Almighty God. He has on His robe and on His thigh a name written, "King of Kings, and Lord of Lords." (Rev. 19:11-16)*

While we might expect missionaries to be anti-military because killing eliminates any opportunity for evangelism, we usually don't find this to be the case. Many missionaries have been grateful to national or American troops for keeping their families and the local community safe during times of conflict or danger. A number of former military personnel later returned to the field as missionaries, some to the same regions where they were originally deployed.

In summary, we find that while we are commanded to live as people of peace, there may be reasons for war to occur.

Just War Theory

Not every possible reason justifies war or conduct in warfare. The Just War position holds that a nation and its believing citizens are justified in going to war if certain specific conditions push them into this situation. Just War is based on Biblical patterns of warfare and the need to defend the defenseless.

War can be justified under certain conditions (we are attacked; we defend our family and country; it is a last resort; the decision is made by a proper authority; we count the cost of the action).

JUST WAR IN SCRIPTURE

> *Several conditions for just war are given in the Bible. First, it must be declared by one's government (Rom. 13:4). Second, it must be in defense of the innocent and/or*

> *against an evil aggressor (e.g., Gen. 14). Third, it must be fought by just means (Deut. 20:19).* [30]

Israel fought several wars but did not engage in "holy war" or genocide. Israel did not go to war with every pagan nation. God directed the wars in Canaan and, in fact, linked them to His judgment on ungodly cultures.

> *In every case the baneful infection of degenerate idolatry and moral depravity had to be removed before Israel could safely settle down in these regions and set up a monotheistic, law-governed commonwealth as a testimony for the one true God. Much as we regret the terrible loss of life, we must remember that far greater mischief would have resulted if they had been permitted to live on in the midst of the Hebrew nation. These incorrigible degenerates of the Canaanite civilization were a sinister threat to the spiritual survival of Abraham's race.* [31]

In addition, as a nation, Israel defended itself numerous times from external attacks.

The concept of "just war" in Christian thought began with Augustine:

> *Augustine wondered why, if rejection of military force was so crucial to one's faith in God, men such as David, the Centurion of the Gospels (Luke 7), Cornelius (Acts 10), and the soldiers who came to John the Baptist (Luke 3) were not told to renounce their occupation, and in several cases were even held out as examples of faith. Augustine saw that Christianity was not incompatible with war but was to influence it toward the proper methods and ends: "Peace should be the object of your desire; war should be waged only as a necessity." Violence may be necessary in our fallen world to protect the innocent and to fulfill the command to love one's neighbor.* [32]

Jus ad bellum (Justness of War):

(1) *Competent authority*: A war must be declared by politically responsible authorities and not by private individuals.

(2) *Probability of success*: A war should not be undertaken if there is no obvious hope for success.

(3) *Last Resort*: A war must be a last resort after sincere efforts have been made to resolve the controversy peacefully.

(4) *Just Intent*: The object of a war must be peace and reconciliation and not the unlimited destruction of the enemy state.

(5) *Just Cause*: The war must be an act of defense in response to armed aggression.

Jus in bello (Justice in war):

(6) Proportionality: The good brought about by a war should outweigh its evils in cost and destruction to both sides and the means used should be proportional to the harm caused.

(7) Discriminate means: Military actions should not be waged that directly intend to take the lives of noncombatants (i.e., civilians or innocents). [33]

There are several types of military actions:

Category 1 *(more readily defensible)*

- Conflict prevention
- Peacemaking
- Peacekeeping
- Monitoring
- Defense against air attack
- Defense against invasion
- Rescue of hostages
- Defensive operations during combat
- Counterterrorism
- Pre-emptive strike

Category 2 (expectations of war)

- Strategic area capture
- Bombardment before ground assault
- Air support
- Targeted air attack
- Blockade or siege

Category 3 (indefensible)

- Taking specific revenge for an enemy action
- "Show 'em who's boss"
- "Nuke 'em all"

Just war supports patriotism without giving rise to nationalism (an idolatrous position that basically worships the state). Nationalism would say, "My country, right or wrong." An unjust war should not be supported.

The Powell Doctrine

The Powell Doctrine, developed by General Colin Powell to flesh out the just war concept, states that a list of questions all have to be answered affirmatively before military action is taken by the United States:

- Is a vital national security interest threatened?
- Do we have a clear attainable objective?
- Have the risks and costs been fully and frankly analyzed?
- Have all other non-violent policy means been fully exhausted?
- Is there a plausible exit strategy to avoid endless entanglement?
- Have the consequences of our action been fully considered?

- Is the action supported by the American people?
- Do we have genuine broad international support?

If all possible means for negotiation and reconciliation (political, economic and diplomatic means) have been exhausted and the conditions above have been met, then Gen. Powell encouraged responding to the enemy with overwhelming force to end the conflict quickly: "Every resource and tool should be used to achieve decisive force against the enemy, minimizing casualties and ending the conflict quickly by forcing the weaker force to capitulate." [34]

Problems with Just War

Very seldom are all the conditions for Just War fully met. Mark Clark explains some of the difficulties:

> *There are several problems with the "Just War" doctrine that are not as easily susceptible to resolution, but nonetheless deserve some attention... Implementing the "Just War" doctrine as it now stands requires superhuman wisdom. No Christian will ever have enough facts, or time, to know all the evidence regarding a country's decision to go to war. At the highest levels, decisions to go to war are shrouded in ambiguity and much more will that be the case in the society at large...Nothing man can do is fully just, but rather under sin (even the study of theology)...*
>
> *Of the principles of jus ad bellum, several are problematic from a scriptural standpoint. The one most supported by scriptures is that the war must be declared and conducted by competent authority... Exactly how authority is established and maintained is not discussed and seems, therefore, to be left to individuals in the nation to work out for themselves. The principle of competent authority would rule out Christians serving as mercenaries, and make problematic the fighting of revolutionary wars...*
>
> *The idea of probability of success seems more an idea of prudence than one of "justness." Now, it is claimed by "Just War" theorists that there is a close association since, without prudence, one can involve a nation in a war that leads to excessive misery for its citizens if it cannot be won...*
>
> *War as a last resort is ideal in a perfect world, but would be difficult to determine in some cases. For example, at the outset of the 1967 Arab-Israeli war, the dawn preemptive strike by the Israeli Air Force on Egypt may not have appeared to citizens as a choice of last resort, but intelligence analysis provided strong evidence that an Arab surprise attack was to be launched just a few hours later. How much more suffering, indeed loss, would the Israelis have sustained had their leadership not authorized a preemptive strike?...*
>
> *We draw a line between the war itself, for which soldiers are not responsible, and the conduct of the war, for which they are responsible, at least within their own sphere of activity...*

Pursuing limited war, using discriminate means, and avoiding unjust acts all conform to the biblical view of war. The only time Israel ever pursued wars of extermination occurred during its theocracy and, according to prophecy, will occur again during the Second Coming. But at no other time were wars of extermination encouraged or advocated. And when it was (and will be) used, it was under God's personal direction. [35]

Warfare itself is usually complicated:

A particular war as a whole may be considered just or unjust; however, a war is composed of many discrete acts, each of which may be either just, unjust, or some shade in between. As such, service members fighting in an unjust war may do so in a just fashion. Likewise, service members fighting in a just war may do so in an unjust fashion. [36]

1. For Western nations, wars are now undertaken more from choice than from the pressing necessity of territorial defense. For example, there are no current strategic threats to the UK. This increases the need for careful justification of military engagement.

2. War has a protean nature: it readily takes on various shapes or forms. The just war doctrine is primarily directed at war between nation states. However, war now often involves non-state entities such as terrorist and insurgent groups.

It should also be noted that many commercial organizations have a strong financial interest in promoting conflict, including those 'private military companies' (mercenary organizations) that engage directly in hostilities, and manufacturers of weapons and supporting systems. [37]

R. C. Sproul summarizes:

Just War theory tells us the government is not supreme. We cannot defend our participation in an unjust war simply by saying, "I was only doing my duty to the government." We are never allowed to say, "My country, right or wrong, my country." Yet when the cause is just, we must obey our authorities. Consider who has more authority in your life, God or the state. Ask the Lord to help you discern how to obey Scripture in the matter of armed conflicts. [38]

SPECTRUM OF CHRISTIAN POSITIONS

At the outbreak of recent wars American young people responded in a variety of ways:

- Some were already in the military, and wondered what the future held
- Some immediately enlisted
- Some were drafted
- Some enrolled in college or seminary to alter their draft status

- Some took jobs in defense-related companies
- Some became conscientious objectors
- Some became war-protesters
- Some left the country

Biblically, we have seen that the situation with war for believers is mixed —

- Christians are called to love and forgiveness
- Christians are called to love our enemies
- Warfare arises from our fallen nature
- Warfare arises from wanting what we shouldn't have (James 4)
- Self-defense was permitted in the Jewish law
- Warfare exists, and God often supported the armies of Israel

We can define at least four legitimate positions Christians have taken on warfare:

1. Absolute Christian Pacifism

   Some believers, based on Scripture, are unwilling to serve in the military in any capacity or ever to touch a weapon. This is neither cowardice nor rebellion, but a position of conscience that the government has recognized (draft classification "1-O"). Those who support a just war also usually allow for this exception:

   But what of the tradition of conscientious objection to military service?...I believe it is important to allow for such a possibility, not simply on humanitarian grounds. Comparing the law of liberty (I Cor. 6:12; 10:23; and James 1:25) with the law of love (Rom. 14:1-13), one can reasonably allow for some to not serve in armed combat if such persons' conscience cannot allow them to do so. [39]

2. Limited Pacifism

   There is another position, a Christian form of limited pacifism, which holds that the taking of life should be avoided at all costs, cannot be commanded (by a military leader), but may be a last resort if one's family or other innocent people are about to be destroyed. The primary reason for refusing combat would be that every foreign enemy killed would at that point in time almost certainly have lost their last opportunity of hearing and responding to the Gospel.

3. Limited military involvement

   This is a position which hasn't received much publicity. During the years of a military draft, when those drafted for any specialty were classified as "1-A," those with a reservation against killing were classified as "1-A-O." There are many Christians who decided to be limited conscientious objectors, which means they would participate in war for the good of the country (as combat medics) but not kill anyone. This may be the best balance between pacifism and service. (The enemy would look on them as "shooting ducks in a barrel.")

The movie *Hacksaw Ridge* is the true story of Desmond Doss, a man who decided to serve his country in World War II but not to kill anyone, because the Bible says, "You shall not kill." In the midst of some of the most intense fighting between the Americans and the Japanese at Okinawa he even ministered as a medic to Japanese soldiers who wanted to shoot him. He saved 75 men without firing a shot.

4. Full military Service (typically holding to a Just War position)

   A Christian soldier is prepared both to fight and to die for his nation.

   "I am a United States fighting man...I am prepared to give my life..." [40]

   "Greater love has no man than this-that a man will lay down his life for his friends." (John 15:13)

Not everyone is cut out to be a soldier. Those believers who pursue a career in the military must be convinced that it is God's calling and that they are serving strictly for the defense of the nation. If they serve honorably, their service should definitely be honored.

ENGINEERS AND THE DEFENSE INDUSTRY

Next to the military combatants and the leaders who decide on their actions, engineers play a major role in modern warfare.

Since the Civil War

The fifty years from the Civil War to the World War I horses, rifles, and cannons were replaced with tanks, transport trucks, machine guns, and airplanes for reconnaissance. The fighting in France took place largely in trenches, with soldiers trying to avoid mustard gas, barbed wire, and land mines. The twenty years from World War I to World War II saw the introduction of battleships, aircraft carriers, and bombers.

> *The biggest change was in airplanes, to the extent that some commanders claimed (correctly) that control of the airspace was of supreme importance. Planes were now metal-skinned with internal bracing, flying much faster with much longer ranges, and carrying war to the heartland and civilians. They could carry a load of bombs, each of which exceeded the payload of a WWI plane. They carried defensive armament, and the B-17 was called the "flying fortress."* [41]

The last four years of World War II, the war in the Pacific, has sometimes been called "the engineer's war," since rapid construction of bases, airstrips, and roads on many of the islands turned the course of the war and made allied victories possible. Engineers were involved in the development of radio communication, bomb delivery, submarines, landing craft, runways, carriers, radar, codes, and the construction of the A-bomb.

The Cold War

The period from 1947 to 1991 marked a time of intense rivalry and geopolitical tension between the United States and the Soviet Union. While there was no large-scale fighting it was a time of espionage, propaganda, and a major arms race. Defense work during the Cold War was geared not so much to develop the greatest weapon but to match what the enemy had, show greater strength than the enemy, and to be able to respond to any strike.

During the Cold War with the Soviet Union the U.S. developed a 3-pronged deterrence force:

- Air Force bombers
- Land-based missiles in silos
- Sub-launched missiles [42]

By 1993 the Cold War had ended, but by 2001 a new War on Terror began as the Twin Towers in New York were destroyed by hijacked commercial jets.

Work in weapons design has involved both scientists and engineers. "The work of the engineer is closer to the final outcome than that of the applied scientist, and it is of a different kind." [43]

Even those who basically oppose weapons research (WR) have admitted that Britain was right to respond to the Nazi bombings or civilian neighborhoods:

> *There have been times in the past when the case for doing WR has been so strong as to resemble a positive duty; for instance, in the last war when Britain stood alone in 1940, it could be said that scientists and engineers had a duty to conduct research into radar, code-breaking machines, and so forth, in order to prevent harm to their fellow citizens.* [44]

A huge number of engineers have been employed by such major military contractors as General Dynamics, Lockheed Martin, Northrup Grumman, Rockwell Collins, and Raytheon. The defense industry relies heavily on engineers, since the bulk of advanced warfare is technological by nature:

- Satellite surveillance
- Threat detection
- Airborne radar systems
- Fighter aircraft controls and displays
- Countermeasures and counter-counter measures
- Missile launch and guidance systems
- Combat communications systems

Much of modern technology grew out of Defense programs.

> *We invented fast, small, light, inexpensive microchips,...new sensors, and the semiconductor laser. And we did virtually all of this through the Defense Advanced Research Projects Agency (DARPA) and NASA, in conjunction with the great corporate*

laboratories…CMOS chip technology came about because the Pentagon wanted fighter pilots to have a weather forecasting module in their cockpit… [45]

DARPA, in fact, was the "father" of many key technologies: [46]

- Supercomputing
- VHSIC –very high speed integrated circuits
- High powered lasers
- Natural language processing
- Virtual reality mapping
- Global Positioning System (GPS)
- Cloud computing –MULTICS as precursor
- The Internet (note original DARPANET)

Many items developed for the military have produced valuable "spinoffs"- commercial civilian applications – including

- Microwave ovens, from the microwave generators used in radar
- Teflon pans, using a microwave dielectric material
- Cell-phone frequency hopping, from spread spectrum techniques used in sonobuoys
- Servomechanisms for steering control, based on techniques developed for artillery

What's the attraction for engineers to be involved in weapons design?

1. Defense contractors offer some of the highest paying jobs.
2. Defense projects are typically high-tech, high-budget projects with an associated "coolness factor." The fastest jets and most sensitive sensors are developed for the defense sector, making this an appealing area for young engineers.
3. Some feel it is a patriotic duty to support weapons development.
4. A few engineers like the idea of destroying our nation's enemies.
5. Most engineers are convinced that some form of national defense is a necessity.

The case may be made that weapons developed are a form of "insurance" for the nation, where the thinking goes like this:

- We buy catastrophic health insurance for our dependents, but hope we'll never have to use it.
- Our cities purchase fire trucks with every possible attachment, but hope they'll never need to be used.
- We develop emergency plans in the event of a tornado or hurricane and hope it will never be necessary to implement them.
- Similarly, a homeowner purchases a handgun, or the defense department purchases a bomber, hoping that the attack will never come and the weapons will never be required.

Is defense work a violation of the First Canon of the Engineering Code of Ethics ("Engineers shall hold paramount the health, safety, and welfare of the public.")?

It might seem so, in that war is devastating to a population.

On the other hand, the military and defense workers are specifically protecting the safety and welfare of the public in a nation being attacked.

What is meant by "the public"? Is it the company that designs the weapons? Is it the managers that pay the salary? Is it the community that has decided to deploy the weapons? Is it the foot soldier of the enemy nation who will be injured or killed? (This question has never been resolved.) [47]

One difficulty with engineering work is that we often don't know the ultimate purpose of our designs.

> *Because the Department of Defense funds large research programs at both public and private universities, and contracts out the construction of weapons to corporations, many engineers work as military engineers without realizing the purpose of their work...My belief...is that we do owe moral consideration to those we serve.* [48]

Engineers, argues Vesilind, are not hired guns doing the bidding of their employers without asking questions about the morality of their work. [49] It is important for an engineer to know as much as possible about the goal of their work and whether their conscience can allow them to proceed.

Not all defense work is weapons related:

Increased intelligence can produce limited countermeasures.

> *Military forces depend upon strategic and tactical intelligence for two basic services: (1) collection of information on the capabilities, intentions, and activities of foreign powers, organizations, and persons, and (2) counterintelligence support, or the gathering of information and conduct of activities to protect against espionage, sabotage, assassinations, and international terrorist activities.*
>
> *There are three kinds of situations in which low-intensity conflict forces need support from these capabilities. First, they need strategic intelligence monitoring, prior to US military involvement, of situations which might require their deployment. Secondly, during their involvement in security assistance missions, they need support from all US and host country resources capable of assessing and countering threats. Finally, during crises or combat, they need support which draws battlefield and threat-relevant information from all sources and focuses specifically on the needs of operational forces – combat commanders.* [50]

Today highly trained special operations teams directed air strikes, or targeted drone strikes can carry out a small mission without the need for a major battle.

Significant research has been done on weapons designed to destroy weapons.

- The Patriot missile system uses ground-based radar to detect and counter incoming ballistic missiles and cruise missiles.
- The Army has developed lasers to destroy enemy artillery.
- Work is progressing on high-energy electromagnetic fields to damage or destroy enemy launch electronics.
- The Pentagon is working on a Standard Missile 3-IIA missile capable of intercepting and destroying incoming ICBMs.

The U.S. Army's Rapid Equipping Force is fast-tracking new technology to war that can track, jam, and destroy attacking enemy drones as a way to respond to an explosive amount of new combat threats.

The systems, called "Drone Busters," use Electronic Warfare (EW) to interfere with the GPS signal or Command and Control technology of enemy drones, disabling them or throwing them off course. [51]

For the Christian working in a defense industry the considerations are very similar to those of a Christian in the military:

- Their first allegiance must be to Christ
- They must be serving for the right reasons
- They must hold to a "just war" position
- They must realize that the end result of their effort may end lives
- They must believe that more lives will be spared than ended by their actions
- They must desire the salvation of non-believers
- They must not desire the death of thousands

Like the range of positions regarding warfare, a multiplicity of positions exist regarding participation in defense work:

- Willingness to work on any weapons system
- Unwilling to work with nuclear arms or "weapons of mass destruction"
- Willing to work on conventional weapons only
- Unwilling to work on conventional weapons
- Willing to work on defensive systems only (radar, navigation, anti-missile systems, communication)
- Willing to work on military support materials only (protective armor, vests, barriers,...)
- Unwilling to work in any sector of the defense industry or military support

Engineers and the concept of Just War

How might the principles of Just War apply to engineers working in the defense industry?

Although the principles of just means in war were largely designed with military forces

in mind, they nonetheless may be translated into a unique set of moral considerations for engineers in the workplace...

Despite their shared ultimate goals, not all weapons are the same, morally speaking... Some weapons are not accidentally immoral, but are intrinsically so and engineers have a moral obligation to avoid working on them. Such weapons could never be used in a fashion that coheres with the principles of Jus in bello. Several types of weapons that would qualify as such are:

1. *Weapons that are inherently cruel.*
2. *Weapons that are inherently indiscriminate.*
3. *Weapons that are inherently unchivalrous.*

Development of each of these types of weapons is a clear violation of the principles of jus in bello, and the engineer involved in such projects is morally blameworthy as are those in the military chain of command who deploy them. [52]

Weapons that would fall into this category, according to the author, include

- Biological weapons
- Chemical weapons
- Landmines
- Nuclear weapons [53]

Engineers and Social Responsibility

As engineers, our legacies will be the technology we create and the effect that it has on the world. It would be presumptuous to say that some technologies are never necessary, or that some are inherently bad. However, as no one can ever predict completely what a technology will be used for or whose hands it will fall into. This necessitates engineers to consider the potential implications of the technology they make, and consider the ethical implications. This will be different for each person, and each person may come to a different conclusion. As more and more has become possible, we must ask ourselves, not what can I make, but rather, what should I make. Engineers need to be clear on what kind of work they morally agree with, and what work they do not, so they can choose projects based on it. Though greater consideration, Engineers will be able to do the least harm and most good for the world. Instead of blindly making weapons that someone else gets to control, we can make technology that leaves the world a better place than when we started. [54]

The most important point, then, is to insist that any decision regarding defense work is an ethical decision. Working for Raytheon must not be seen simply as an "employment opportunity," but as a decision having profound moral implications. Students should realize that there are limits in the use of weapons in terms of their effects on the innocent and the proportionality between the means used and the ends achieved... [55]

An additional difficulty with defense engineering is that the end-user is occasionally not the United States military. Some contractors will sell overseas. Some weapons may be seized when a nation is overthrown. Many American-made weapons wind up in the hands of dictators, terrorists, and enemy nations.

> *Surely everyone who accepts a job in a war-related industry should seriously consider his or her motives in doing so. Prudential self-interest is not sufficient to guarantee responsible participation in what must be regarded as mankind's most crucial engineering experiment. Only those who have arrived at morally autonomous, well-reasoned positions for either engaging in or abstaining from weapons work can be counted on to carefully monitor the experiment and try not to let it run a wild course.* [56]

For engineers working in the defense industry —

- They must conclude that their work is an act of patriotism, a way of serving their country.
- They must sincerely desire an outcome of peace, not war.
- They should desire to develop devices that will produce maximum effectiveness in insuring victory coupled with minimum loss of human life.
- They must draw a line at what projects they will or will not work on.

If a project is unjust (e.g., a weapon targeted at civilians), they should be prepared

- To turn down a project.
- To turn down a promotion.
- To risk losing their job by refusing.
- To walk away from a company that will not accommodate their conscience.

ALTERNATIVES

Positive Peace

> *Defining peace as the absence of war is too easy because this is a negative definition: defining what it is not. We might call this "negative peace"...*
>
> *If there is negative peace, then there must also be "positive peace," which would be more than an absence of war, but this would be a proactive effort to establish social justice through equal opportunity, a fair distribution of power and resources, and equal protection and impartial enforcement of the law... Positive peace would establish social equality and justice, economic equity, and ecological balance, protecting citizens from attack, and meeting basic human needs.* [57]

"Engineers," says Richard Bowen," have the practical skills to remove many of the causes of conflict and hence promote sustainable peace." For nations or groups facing shortages of food or water or lacking basic infrastructure, engineers can certainly help. [58]

Non-lethal weapons

Charles Adams, a Christian engineering professor wrote:

> *The human race, in dealing with conflict, is using its advanced technological know-how more in a return to the barbaric past than in efforts to seek peace and justice. Instead of using our knowledge of creation- ore cultural mandate- to develop humanitarian instruments for the securing of peace, we develop increasingly more sophisticated and barbaric means of violent destruction...* [59]

> *In an advanced technological society such as ours, there is no reason why, for example, we could not develop a system that immobilizes people without doing them bodily injury. Aggressors might then be stopped, their weapons confiscated, and the leaders removed to some prison supervised by the United Nations, this may sound like science fiction, but, I assure you, it is not technologically impossible. The chief difficulty is that we have a bias toward violent means of defense.* [60]

The Department of Defense is, in fact, exploring the use of non-lethal weapons:

> *Marine Col. Wendell Leimbach, Joint Intermediate Force Capabilities Office director, stressed innovation in his brief on intermediate force capabilities (IFC): strategic risk mitigation investments that provide warfighters tools to seize initiative while competing below the level of armed conflict. Examples of IFCs are dazzling lasers and acoustic hailing devices, active denial systems, and counter unmanned aerial systems. Airports already employ a minor version of IFC technology in airport terminal safety screenings. Teams were asked to incorporate IFCs into their final concepts.*
>
> *"We have to think differently about war because the nature of war has moved on. Our traditional deterrent effect is no longer effective," said Leimbach. "IFCs enable you to push back. It's a minor investment that can enable our entire force. This technology is a safe, effective way to deter."*
>
> *"IFCs enable the warfighter to compete across the competition continuum without losing in the information space," continued Leimbach. "The goal is to avoid unnecessary destruction that initiates or prolongs expensive hostilities."* [61]

CONCLUSIONS

In a world plagued by wars and violent oppression, Christians are called to be peacemakers (Mt.5). The Biblical/Hebrew concept of peace, shalom, is far more than the absence of conflict. Shalom includes the idea of health and flourishing. We are personally commanded to "love our enemies" and to "turn the other cheek," commands that make no sense apart from the love of Christ. Many believers are convinced that it is possible to protect and defend those we love without aggression and without hating an enemy.

> *To affirm that one is a member of the kingdom of Christ now means that loyalty to Christ and his kingdom transcends every other loyalty. This stance goes beyond*

nationalism and calls us to identify first of all with our fellow disciples, of whatever nation, as we serve Christ together. This is not a position which can be expected of the world nor asked of the government as such. The Christian respects rulers as God ordained them, to "protect the innocent and punish the evildoer." The Christian can only encourage the government to be the government and to let the church be the church. We ask the government to be secular and to let the church be free to do its work in society. The church enriches society by the many things it brings to it, and in its respect for government it does not subordinate itself to any particular social order but is in allegiance to its one Lord. [62]

"As an engineer and as a representative of the Lord Jesus Christ," wrote Charles Adams, "I can tell you with some authority that there will be no assault weapons in the New Jerusalem. Let us, with the apostle John, pray that the Lord does indeed come quickly." [63]

Here is the bottom line:

As Christ's followers we must be peacemakers wherever possible. We cannot love or desire war. And at the same time, we must acknowledge the need for a standing military. Each person must determine, with wisdom and prayer, the extent to which he or she will be involved with the military and defense work.

1. The Christian is specifically called by God to peace and peacemaking.
2. Because of the broken world we live in we may find ourselves facing violence and war. Until Christ returns there will be a need for national armies.
3. Each believer must decide where on the spectrum he or she will be involved.
4. We can never desire war, love weapons of mass destruction, hate a set of people, or desire the annihilation of any population.

"If peace can only rule in the hearts of Christians, then good intentions will not avert war." [64]

Only Christ can truly establish peace on the earth. The one positive action Christians can take toward world peace is to advance the Gospel. In 1863 (the middle of the Civil War) the New Hampshire Baptists wrote:

"It is the duty of Christians to seek peace with all men on principles of righteousness. In accordance with the spirit and teachings of Christ they should do all in their power to put an end to war. The true remedy for the war spirit is the Gospel of our Lord." [65]

REFERENCES

1. Ted Grimsrud-Interview- Justice, Mercy, and God's Love https://peacetheology.net/2015/06/17/an-interview-on-justice-mercy-and-gods-love/
2. McCain, J., quoted by Mark Shields in "McCain the Patriot", Creators Syndicate, July 27, 2017.
3. Augsburger, M., "Christian Pacifism," https://intervarsity.org/news/christian-pacifism
4. Blue, E., Levine, M., and Nieusma, D., *Engineering and War*, Morgan and Claypool, 2013.
5. Blue, op. cit., p.3.
6. Riley, D., *Engineering and Social Justice*, Morgan and Claypool, 2008.
7. Ibid.
8. Blue, op. cit., p.2.
9. Catalano et.al., "Engineering, Peace, Justice, and the Earth: Developing Course Modules," ASEE Annual Conference, 2008.
10. Blue, op. cit., p.8.
11. Nieusma, D., and Blue, E., "Engineering and War," International Journal of Engineering Social Justice and Peace, 1(1):50-62, 2012.
12. Catalano, G., "Promoting Peace in Engineering Education: Modifying the ABET Criteria," *Sci. Engin. Ethics*, 12(2), 2006, p. 399-406.
13. Lynn III, William (2017). "The End of the Military-Industrial Complex". *Foreign Affairs*. 93: 104–110.
14. Ibid.
15. Thompson, L., "Eisenhower's 'Military-Industrial Complex' Shrinks To 1% Of Economy" https://www.forbes.com/sites/lorenthompson/2017/05/08/eisenhowers-military-industrial-complex-shrinks-to-1-of-economy/?sh=5aacf11fbed1
16. Brands, H., "Trump, Ike, and the Myth of the Military-Industrial Complex," https://www.aei.org/op-eds/trump-ike-and-the-myth-of-the-military-industrial-complex/
17. Stott, J., *Issues Facing Christians Today*, Zondervan, 1999, p. 86.
18. Grimsrud, T., "Some Biblical Bases for Pacifism," https://thinkingpacifism.net/2017/11/04/some-biblical-bases-for-pacifism/
19. Stirm, J., "Moral Injury: Narrating Life after War," *Christian Scholar's Review*, Winter 2017, p. 179 (summarizing Meagher).
20. Brown, D., *The Sword, the Cross, and the Eagle*, Rowman & Littlefield, 2008, p. 20.
21. Noted by John Eidsmoe in *God and Caesar*, Wipf and Stock, 1997)
22. De Mar, G., *God and Government* vol. 3, American Vision, 1986, p. 108.
23. De Mar, p. 109.
24. Brown, op. cit., p. 23.

25. De Mar, op. cit., p. 108.
26. Suggested by Aaron Conrad, LeTourneau University, 2014.
27. MacArthur, J., "A Biblical Perspective on War," https://www.gty.org/library/sermons-library/80-241/a-biblical-perspective-on-war
28. Schaeffer, F., "The Biblical Perspectives on Military Preparedness," a speech at the Mayflower Hotel Washington, D.C. June 22, 1982.
29. Jones, P., "The Cross and the Man in Combat," *Breakpoint*, March 2007, 29-34.
30. Geisler, N., "Does the Bible Support a Just War?", in *The Apologetics Study Bible*, p. 995.
31. Clark, M., "The paradox of war and pacifism," *Persp. Sci. Chr. Faith* 47:220-230, 1995.
32. Ibid.
33. Ibid.
34. "Colin Powell Talks Rachel Maddow - https://www.nbcnews.com/id/wbna30002070
    Archived - https://web.archive.org/web/20191112202846/http:/www.nbcnews.com/id/30002070/ 2019-11-12 at the Wayback Machine", MSNBC, 1 April 2009.
35. Clark, op.cit.
36. Stirm, op. cit., p. 185.
37. Bowen, W. R., *Engineering Ethics*, Springer, 2014.
38. Sproul, R.C., "When to War," https://www.ligonier.org/learn/devotionals/when-war
39. Clark, op. cit.
40. U.S. Code of Conduct
41. Delagrange, A., "Engineering Aspects of War Part II," *The Bent of Tau Beta Pi*, Spring 2010, p.29-33.
42. Tobias, S., et.al., The People's Guide to National Defense, Quill, 1984, p.157.
43. Vesilind, P. A., *Peace Engineering*, Lakeshore Press, 2005, p. 25.
44. Vesilind, p. 30.
45. Goldman, D. P., "How to meet the strategic challenge posed by China," *Hillsdale Imprimis*, March 2018.
46. McCallion, J., "10 Amazing DARPA Inventions," https://www.itpro.com/technology/34730/10-amazing-darpa-inventions
47. Vesilind, A., *Engineering Peace and Justice*, Springer, 2010, p. 13.
48. Ibid.
49. Ibid.
50. Oseth, J., "Intelligence and Low-Intensity Conflict," *Naval War College Review* , November - December 1984, Vol. 37, No. 6 (November - December 1984), pp. 19-36. https://www.jstor.org/stable/44637928
51. Osborn, K., "Army fast tracks drone-destroying weapon," https://www.foxnews.com/tech/army-fast-tracks-enemy-drone-destroying-weapon

52. Fichtelberg, A., "Applying the Rules of Just War to Engineers in the Arms Industry," *Sci. Engin. Ethics*, 12(4): pp, 2006.
53. Davis, M., "Ethical Issues in the Global Arms Race," *Ethical Dilemmas in the Global Defense Industry Conference*, April, 2015.
54. Freake, J., "An Engineer's Conscience," http://www.northeastern.edu/nuwriting/an-engineers-conscience/
55. Wilcox, J., "Engineering Ethics: Challenge and Opportunity for the Christian Ethicist," *Ann. Soc. Christian Ethics*, v.5, 203-215, 1985.
56. Martin and Schinzinger, *Engineering Ethics*, McGraw-Hill, 1988.
57. Vesilind, 2010, p.125.
58. Bowen, op.cit., p.99.
59. Adams, C., "Developing Our Perspective," *Exercising our Worldview*, Dordt College Press, 2014, p. 43.
60. Adams, op. cit., p. 42.
61. "NSWC IHD Wargaming Event Ushers In a New Phase of Warfighting," https://www.navsea.navy.mil/Media/News/SavedNewsModule/Article/2737370/nswc-ihd-wargaming-event-ushers-in-a-new-phase-of-warfighting/
62. Augsburger, op. cit.
63. Adams, op. cit., p. 280.
64. DeMar, op. cit., p. 109.
65. New Hampshire Baptist Confession (1863) Article 16- Peace and War

CHAPTER 18: ENGINEERS AND THE ENVIRONMENT

INTRODUCTION

We've been entrusted by God with a remarkable planet. We marvel at the beauty of mountains and oceans, and we are dependent upon the air, water, and land for our daily survival. No one, anywhere, would choose to live in an ugly cesspool.

Humans, however, have often treated the earth poorly. Neglect of the environment in the first half of the 20th Century led to large areas of destruction: pollution of water, air, and soil, destruction of forests, and, in some case, destruction of entire species.

Christian authors Moo and White state:

Some of the earth's resources we have in fact already used up or destroyed, so they will never again be available to those who follow us. We have, knowingly or not, annihilated thousands of living species and continue to do so at a shocking rate. We are polluting the land, sea, and air, with little understanding of what might be the long-term consequences. [1]

Air

Air quality problems...exist on regional and local scales. Polluted air affects our lives in many ways. It can cause adverse health effects, and in some cases, death. The greatest effect of air pollution is on the respiratory system, especially the lungs. Air pollution can also cause great harm to our natural environment as evidenced by acid rain in the Adirondacks in upstate New York. [2]

Water

Seventy percent of the earth's surface is covered by water, but water is a finite resource.

Water pollution (involves) the release of substances into subsurface groundwater or into lakes, streams, rivers, estuaries, and oceans to the point where the substances interfere with beneficial use of the water or with the natural functioning of ecosystems. In addition to the release of substances, such as chemicals or microorganisms, water pollution may also include the release of energy, in the form of radioactivity or heat, into bodies of water. [3]

Organic wastes, pesticides, toxic chemical, sediments, and petroleum products can destroy a body of water. Impacts include excessive algae, dangerous growth of bacteria, and depletion of dissolved oxygen, resulting in unsafe drinking water, unsafe swimming, and damage to aquatic life. Lake Erie, the shallowest and most fish-filled of the Great Lakes, was in serious trouble in the late 1960's because of the pollution from heavy industry along its shores. Lake Erie basically launched the environmental water movement.

Forests

Each year a tropical forest the size of Scotland is destroyed on planet Earth. India alone has lost 85 percent of her original forests. Nearly one-half of all forests in developing countries have been cut down in this century...Due to deforestation as many a one million species of plants and animals could become extinct by the end of this century. [4]

While air quality, water quality, and land quality (avoiding soil contamination with toxic chemicals and hazardous wastes) were the primary focal points of environmentalism in the past, today discussions of ecology and the environment include

- Preserving all plant and animal species
- Reducing energy use and diminishing the use of fossil fuels
- Halting global warming
- Limiting population growth (of humans)

What responsibilities do Christians have towards our planet? What steps can engineers take towards reducing and reversing the damage being done?

Engineers vs. the Environment

Have engineers done more harm than good to our planet? Some, primarily in the "social justice" movement, would suggest so:

> *Why as engineers do we assist in the destruction of the earth? We are, by and large, good men and women who strive through our work to maximize the good and minimize the harm. Our profession has a recognized ethical dimension with codes of acceptable behavior...Not withstanding all these activities, the deterioration of the natural world continues.* [5]

> *The world is in the midst of a period of unprecedented and disruptive change. It is particularly evident when examining the health of the world's ecological systems. A host of human forces impinge upon coral reefs, tropical rain forests, and other critical natural systems located around the world. Half the planet's wetlands are gone. Total carbon emissions and atmospheric concentrations of carbon dioxide are both accelerating and 2004 was the fourth warmest year ever recorded.* [6]

> *Dominant current culture is the result of a long history of the narrative that natural and human resources exist for exploitation, commodification and control, and to fuel economic growth. This story is underpinned by values of competition, privatization, consumption, anthropocentrism, and dominance of Eurocentric techno-scientific epistemology. These values and narratives have been perpetuated and enacted by the global elite (economic, political, social) to concentrate power and wealth, which necessarily requires oppression of the masses and the marginalized. Entire groups of people are deliberately framed as having less worth by and to the benefit of those with power, embodied in a litany of genocides, enslavement, and systematic*

oppression. Imperial and colonial practices continue to exploit land and people for material gain. Theft and privatization of commonly shared resources allows for exploitation and oppression of populations who can no longer afford to access that which has been commodified. [7]

To summarize their view,

- Industry owners are greedy and consequently exploit workers both workers and poorer citizens.
- Their exploitation includes the earth itself.
- Engineers, as employees or industry, are complicit in the destruction of the earth.

The solutions suggested by the social justice authors include:

- Include ecology and social justice concepts in engineering education. [8]
- Understand and teach chaos theory and non-equilibrium dynamics as the models for nature. [9]
- See and appreciate the interconnectedness of all things. [10]
- Rethink our approaches to design and ethics. [11]

As in previous chapters, we will find ourselves agreeing with some of the goals while rejecting parts of the analysis and many of the solutions.

RETHINKING ETHICS AND THE ENVIRONMENT

Because of the threat to the ecological system, modern engineers have come to recognize the importance of including environmental considerations in engineering decisions. Such additions as sustainability and consideration of environmental impacts are worthwhile; however, to place the emphasis on such considerations may override the focus of the basic ethics statement. A series of recent publications, including two books, [12, 13] has urged a move toward broad environmental thinking as the core foundation for engineering ethics.

In terms of ethics a new environmental ethic was proposed as follows:

"A thing is right when it tends to allow the natural world and all the entities thereof, to thrive in richness and diversity, and to experience change. It is wrong when it tends otherwise." [14]

Instead of the first canon of the Code of Ethics stating that "Engineers shall hold paramount the health, safety, and welfare of the public," a proposal was put forth to alter the canon to read instead, "Engineers, in the fulfillment of their professional duties, shall hold paramount the safety, health and welfare of the identified integral community." [15]

When first considered, these changes may seem to be a good idea. Any modifications of the basic ethical concepts previously established, however, including the Engineering Code of Ethics, should be examined carefully.

The solution proposed by some to the destruction of our environment (a solution which attempts

to link peace, justice, ending poverty, and protecting the environment) is a move toward a new ethical foundation for engineering, a foundation that is specifically rooted in the environment. The proposed new ethical system has been termed "morally deep ethics" since it is based on the concept of "deep ecology." "Deep ecology" is an approach to ecology based upon the complete considerations of the large environment and upon the assumption that all living creatures, plants and organisms, are treated as equals.

This approach is considered "biocentric," or nature centered. In contrast, "shallow ecology," which is an ecology based primarily on human interaction with the environment, is termed "anthropocentric" (or human centered.) It is based upon the assumption that human beings are the most important environmental entities, and that everything should be done to meet their needs and desires above all others.

> *The belief that humanity is the moral center of the universe has had lasting endurance... In our actions regarding the nonhuman world, we have only been concerned with human values. Our goals, our technologies, have focused on how to best utilize the natural world to benefit humans. Various religious and secular reasons have been given for our pre-eminent moral standing. Humans, unlike lower animals, are said to have souls or to be morally superior because of their rationality...[As a result,] Engineers should care about nature if at all only of it serves the interests of humankind. Nature has no intrinsic value, only instrumental value. Nature needs to be managed, controlled, and manipulated to serve us.* [16]

The new ethics centers on the environment and the nonhuman world. Such an environmentally based ethic has four major pitfalls, as follows:

1. It proves detrimental to the meaning of engineering.
2. It provides an inadequate base for an ethical system.
3. It requires a major shift in worldview, and
4. It could produce a situation that is actually harmful to human lives.

Serious concern for the environment over the last five decades produced both (1) a scientific examination of the issues at stake and (2) various philosophical or socio-political movements rooted in ecological concerns. The latter set includes such widely varying approaches as ecofeminism, socialist ecology, deep ecology, and animal liberation. De Laplante summarizes the issues this way: "The central themes of environmental philosophy, as the discipline is currently understood and practiced, revolve around two related but distinct sets of questions:

(1) Do human beings have moral obligations to protect or preserve the natural environment? If so, what are they, and to whom, or what, are they owed? How are such obligations justified?

(2) What are the root causes of contemporary attitudes and practices with respect to the natural environment, and how can we change them?" [17]

De Laplante places the movements into historical context:

> *The 1960s saw the rapid growth of information concerning a diverse array of environmental threats, including overpopulation and its relation to poverty and famine, the depletion of non-renewable resources, and the harmful effects to human and nonhuman welfare caused by chemical pollutants. The result was the birth of modern environmentalism, a socio-political movement predicated on the belief that current attitudes and practices toward the environment are at best imprudent, and at worst, gravely immoral, to other human beings and perhaps to nature itself. 'Environmental philosophy' as an academic discipline arose in the early 1970s in response to a perceived need for intellectual support and defense of the ethical and political commitments of environmentalism.* [18]

In the extreme, radical environmentalism would oppose any alteration to the environment, even for the improvement of human lives.

> *It is an improvement in his environment when man builds bridges, digs canals, opens mines, clears land, constructs factories and houses, or does anything that represents an improvement in the external, material, conditions of his life...all of them represent the rearrangement of nature's elements in a way that makes them stand in a more useful relationship to human life and well-being...*
>
> *What the environmentalists are actually afraid of is not that the planet or its ability to support human life will be destroyed but that the increase in its ability to support human life will destroy its still extensively existing wilderness.* [19]
>
> *Founder of Friends of the Earth and former director of the Sierra Club David Brower suggests that while the death of young men in war is unfortunate it is no more serious than the touching of mountains and wilderness areas of mankind. Says Earth First co-founder and former Wilderness Society lobbyist David Foreman: "We are a cancer on nature."* [20]

St. Francis of Assisi is often held up as the first ecology theologian. The claim is made that he was basically a pantheist, holding that humans were one with all the animals.

Richard Neuhaus debunks this idea: Francis celebrated nature because nature was created by God: "What was so impressive in Francis is the unremitting focus on the glory of the Creator. Francis' line of accountability drove straight to the Father and not to Mother Nature. Francis was accountable for nature but to God." [21]

We simply cannot have human progress without affecting the environment in some way, hopefully having minimum negative impact. "All of man's productive activities fundamentally consist in the rearrangement of nature-given chemical elements for the purpose of making them stand in a more useful relationship to himself-that is, for the purpose of improving his environment." [22]

Did a perfect pristine environment ever exist? Only before the Fall. Even North America, known as the New World, as encountered by the earliest European explorers, had been harvested, built upon, and, in some cases, burned, by the tribes then inhabiting it.

Part of the irony of environmentalism is the unforeseen consequences of publicizing the wilderness. After Robert Redford showcased the serenity of the Blackfoot River in Montana in his classic film *A River Runs Through It*, hundreds of movie-goers wanted to visit or move there. [23]

In fact, much advancement has been made in the area where engineering and the environment intersect: a new emphasis on sustainability, a requirement for sustainability in the ASCE Code of Ethics, the inclusion of the environment in design constraints and impacts in the ABET Criteria. The current NSPE Code of Ethics includes the following statement under Professional Obligations: "The engineer shall at all times strive to serve the public interest... Engineers are encouraged to adhere to the principles of sustainable development in order to protect the environment for future generations." [24]

Environmental considerations should be included in engineering design decisions where appropriate. Not all engineering designs involve the environment. The selection of filter standards for software-defined radio, the modeling of knee ligaments, and areas of software engineering are a few examples. Courses or course modules in Environmental Engineering or Alternate Energy Systems are desirable for all engineering students. Electrical engineers should be familiar with such topics as lead solder replacements, PCB's, antenna and cell tower construction issues, Environmental Impact Statements in manufacturing, and the recycling of electronic appliances. Some progress has been made at including such considerations in engineering, but much more can be done. We are responsible for the earth, and we can and must protect it, without the necessity of altering our ethical codes or worldviews.

WORLDVIEWS AND THE ENVIRONMENT

Does one's worldview affect one's concept of the environment?

> *To quote (Lynn White): "What people do about their ecology depends on what they think about themselves in relation to things around them. Human ecology is deeply conditioned by beliefs about our nature and our destiny—that is, by religion." Here I believe he is completely right. Men do what they think. Whatever their worldview is, this is the thing which will spill over into the external world. This is true in every area, in sociology, in psychology, in science and technology, as well as in the area of ecology.* [25]

Naturalism

For the pure naturalist there is no inherent reason to value the earth, since everything that exists is merely matter.

> *Nature is simply there. One of the characteristics of a materialist's world view is that the existence of nature, with all of its resources, is taken for granted...If energy [as well as matter] is uncreated, then there is no Creator, and hence no divine imperative to use it in a particular way.* [26]

Pantheism

For the pantheist, the earth is valued because it is part of the life-system. In fact, the earth may become an object of worship. In the extreme, all is one, and humans are also one with nature.

> *Nature is a living organism. Not only is nature a manifestation of God, but it is alive. The soul or life force that permeates it is one great living organism...*
>
> *God is manifest in nature with great diversity. Each living species is a manifestation of God. Hence it is necessary to preserve the multiplicity of species that exist.* [27]

A pantheistic approach to the environment has led to these kinds of ideas:

- Both the plants and the earth itself are conscious and feel pain when we chop or dig. This is akin to the animism of primitive peoples.
- We need to develop an "empathy," even for the plants. Vesilind writes: "our empathy toward the nonhuman world cannot be based solely on sentience. Something else is going on. When a person does not want to cut down a tree because of caring for the tree, this certainly some form of empathy..." [28]
- Human improvement of the environment (by clearing brush land, building homes, or constructing dams) is consistently viewed as destruction of the environment.
- Nature is good, but humans are evil

> *Radical environmentalism implies a perception of man as the systematic destroyer of the good, and thus the systematic doer of evil. Just as man perceives coyotes, wolves, and rattlesnakes as evil because they regularly destroy the cattle and sheep he values as sources of food and clothing, so, on the premise of nature's intrinsic value, the environmentalists view man as evil because, in the pursuit of his well-being, man systematically destroys the wildlife, jungles, and rock formations that the environmentalists hold to be intrinsically valuable.* [29]

Theism

Fortunately, theism provides a point of balance, a way to properly treat the earth without worshipping it.

> *Too many Christians build their understanding from a negation of wrong. The opposite of a wrong is not always right. For instance, the opposite of naturalism (nature is ultimately only physical) is animism (reality is ultimately only spiritual). Both are wrong. We need to build our case from a biblical worldview, a unified field of knowledge and reality as God has made it.* [30]

THEOLOGY OF THE ENVIRONMENT

The Ecologic Crisis

Much of the philosophical controversy surrounding the environment stems from a 1967 article in

Science magazine by historian Lynn White, Jr. entitled "The Historical Roots of Our Ecologic Crisis." [31] In this article White placed the bulk of the blame for environmental problems squarely on the western Christian Church, which, he suggested, had taken the command to "subdue the earth and have dominion over it" (Bible, Genesis 1:28) as license to pillage and destroy the earth. Because Christians believed in dominion over nature, argued White, their mindset was to exploit nature (with God's permission).

As a result of this critique, new philosophical approaches to the environment were encouraged. White's thinking also prompted an entirely new worldview and approach to the earth. White wrote, "... somewhat over a century ago science and technology—hitherto quite separate activities--joined to give mankind powers which, to judge by many of the ecologic effects, are out of control. If so, Christianity bears a huge burden of guilt." [32] "Since the roots of our trouble are so largely religious," he wrote, "the remedy must also be essentially religious, whether we call it that or not." [33] In other words, a pantheistic approach was superior.

The British historian Arnold Toynbee also weighed in on humans' relationship to nature. He was disturbed by the Genesis account, which he saw as "a license and incentive for mechanization and pollution." [34] "Because he thought that belief in nature spirits led to respect for natural places, Toynbee, like White, saw the displacement of pantheism by monotheism a disaster for the environment." [35]

This is what Toynbee wrote:

> *The damaging effects of the Industrial Revolution are discussed with particular reference to man's improvidence leading to the waste of irreplaceable natural resources and to the pollution of the environment...It is claimed that monotheistic religions have removed the constraints on man's greed and have overthrown the traditional balance between man and nature. The present environmental crisis is ascribed to the rise of monotheism. The remedy may consist in reverting to pantheism and the religions of the East.* [36]

Theologians point out that the original thesis of Lynn White's seminal paper ("The Historical Roots of Our Ecologic Crisis") was flawed: "All the article's erroneous statements seem to stem from White's heretical concept that there is a 'Christian axiom that nature has no reason for existence save to serve man.'" [37] Christian theology was not, in fact, the root cause of the ecological crisis, but rather human greed, ignorance, irresponsibility, and a twisted application of the dominion of the earth concept. The Christianity he describes is not the Biblical version that is true to the teachings of Christ but a perverted one, in which the environment is seen as something to be used for man's purposes. Jesus taught in the "Sermon on the Mount" (Bible, Matthew 5:8) that God even cares for sparrows. In addition, the Jewish dietary and cleanliness laws as well as the Sabbath and Jubilee rules acted to preserve the environment. Geisler [38] divides these laws into several categories: good stewardship, Sabbath rest (for animals as well as humans), rest for the land, Jubilee laws, harvesting rules, sanitation rules, rules for ecology and warfare, and rules against greed for land.

> *The basic Christian position has often been represented as misogynic, giving license to ownership and beating of slaves, and ecologically ravaging the world. If the*

Christian Scriptures are carefully examined, however, they lead to a very different conclusion: that man is to exercise "dominion without tyranny." [39]

We must include environmental considerations in all engineering designs, but we must not make the environment sacred or central to all of life. Humans are always more valuable than the environment.

CLASSICAL THEOLOGY OF THE ENVIRONMENT

The classical Christian position deals with the environment in this way:

1. All creation was made by God and was originally declared "good."

   "God saw all that He had made, and it was very good." (Genesis 1:31)

2. All human beings have enormous value, by virtue of being made "in the image of God." "So, God created mankind in His own image, in the image of God He created them; male and female He created them." (Genesis 1:27)

3. God rejoices in His creation.

   "May the glory of the Lord endure forever; may the Lord rejoice in his works." (Ps. 104:31) "Do you give the horse its strength or clothe its neck with a flowing mane?

   Do you make it leap like a locust, striking terror with its proud snorting?" (Job 39:19-20)

4. Nature itself worships God -by being "itself" and showing God's beauty in creation and sustaining power.

   "All the earth worships you and sings praises to you; they sing praises to your name." (Ps. 66:4)

   "The pastures of the wilderness overflow, the hills gird themselves with joy, the meadows clothe themselves with flocks, the valleys deck themselves with grain, they shout and sing together for joy." (Ps. 65: 12-13)

   "Praise the Lord from the earth, you great sea creatures and all deeps, fire and hail, snow and mist, stormy wind fulfilling his word! Mountains and all hills, fruit trees and all cedars! Beasts and all livestock, creeping things, and flying birds!" (Ps. 148:7-10)

This understanding should move us beyond a mere attribution of "instrumental" value to nature. (Nature is valuable because of what it provides for us: Forests provide wood for furniture and a pleasant site for recreation.) [40]

Christians must go beyond this and realize that nonhuman creatures also have an intrinsic value. Nonhuman creatures are God's good creations and may well be invested with values of which we are ignorant. Accordingly, each of them should be valued very highly for its own sake. [41]

5. God cares for every creature, including ravens and sparrows.

   "Are not five sparrows sold for two pennies? Yet not one of them is forgotten before God." (Luke 12:6)

"He gives food to the wild beasts and to the young ravens that cry." Ps. 147:9

"Look at the birds of the air; they do not sow or reap or store away in barns, and yet your heavenly Father feeds them..." (Matt. 6:26)

6. A distinction is made between the worth of humans and the worth of animals.

   "...You are of more value than sparrows," says Jesus. (Matthew 6:26)

If the issue comes down to survival of humans or survival of nature, of rights of humans versus "rights" of an animal species, humans are clearly more important.

7. God created the earth for humans and gave "dominion" of the earth to humans.

   "And God blessed them, and God said unto them, 'Be fruitful, and multiply, and replenish the earth, and subdue it: and have dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moves upon the earth.'" (Gen. 1:28)

   This dominion implies responsibility, ruling under God's direction.

   God placed minerals, plants, and animals in and on the earth for His pleasure, to reveal His glory and elicit man's praise, and to serve human needs through godly use (Genesis 2:5-16; 4:22; Numbers 31:21-23; Job 38-41; Psalm 19:1-6; Psalm 104). One way of exercising godly dominion is by transforming raw materials into resources and using them to meet human needs. [42]

8. The first assigned duty of man was to cultivate a garden. Mankind's dominion over nature did not include spoiling nature, but rather promoting nature to flourish for our benefit.

   "Then the Lord God took the man and put him in the Garden of Eden to tend and keep it." (Gen. 2:15)

   Humans have a responsibility to care for the earth as responsible agents. The concept is "stewardship of the earth." God gave a two-fold command regarding the Garden: Gen. 2:15

Timmer [43] has pointed out that Genesis 2:15 details two aspects for the role of man in the garden: the words can be translated as to tend (or till) and to keep (or guard). In no sense are we free to exploit or to destroy what God has given.

The verbs here may be translated as "cultivate and care" or "till and protect" or "use and guard." In other words, Adam was given a two-fold command- a privilege to use the resources of the earth and, simultaneously, a responsibility to protect the earth.

In practice we see two (supposedly Biblical) extremes regarding the environment:

One, Biological Romanticism (Don't touch creation) vs. Two, Unbridled greed (The earth is mine to dig, drill, and polute).

Gen. 2:15 puts things into perspective: We are allowed to use the earth within reason, but we must protect it.

9. In the Law, God placed limits on what humans could do to the environment.

   God's design for creation, even after the Fall, included divinely imposed limits on what man may do to God's creation and those other creatures with whom God has entered into covenant. Throughout the Pentateuch we find divinely mandated limitations concerning what man may do with and to the rest of God's creation:

   - Fields are not to be reaped to the border (Lev. 19:9).
   - The grower may harvest only from trees five years old (Lev. 19:25).
   - The land is to be idle regularly (Lev. 25:1-12).
   - Fruit trees may not be used for siege works (Deut. 20:19).
   - A mother bird is not to be taken with her young (Deut. 22:6).
   - An ox is not to be muzzled when treading corn (Deut. 25:4).

   God continues as the landlord of His creation, with human beings His stewards and leaseholders who will give an account of their stewardship of His creation. [44]

10. The Sabbath, the Sabbath year, and the Jubilee concept (every 50 years) allowed the land to "rest."

    The resulting movement arising from this approach combines theology with ecology, including such concepts as "Earthkeeping" and "CreationCare."

11. The Biblical position regarding time, money, resources, and the environment is that we are designated managers ("stewards") rather than owners.

    The Bible's teaching on the natural world should keep us from two common modern errors. The first error is to treat the earth as if it belongs to us, as though we can use it however, we like. Tied in with this is the idea that the earth only exists to provide things for human beings. Phil Gaglardi, the former Highways Minister in British Columbia, Canada, is reputed to have once said. "God wouldn't have put all those trees there if he didn't intend for us to cut them down."

    The other error is to treat the natural world as if it were some self-contained, pristine things that should always be left alone, never to be interfered with by human beings. The modern world has a lot of romanticism about nature and often portrays nature as perfect in itself – its only problems coming from human interference. [45]

    We are the stewards of all things – including time, energy, health, organization, family life, work styles, buildings – everything that exists in human life.

    Second, to steward all these things is to treat them in the way that God calls us to treat them. This means carefully attending to all the ways in which we can express love – through beauty, through preservation, and through proper use. To be a steward of something is to be aware of its proper place in God's creation, to be sensitive to the ways it can be misused, to recognize the ways it can bring benefits to others, and to preserve it and cause it to be "fruitful" – caring for it so that what is good is conserved and using it so that it brings blessing. [46]

12. On several occasions God's judgment of Israel involved lack of rain, crop failure, polluted land, and famine. (Not all famine is a result of judgment.)

    "The anger of the Lord will be kindled against you [because of idolatry], and He will shut up the heavens so that there will be no rain and the ground will not yield its fruit; and you will perish quickly from the good land which the Lord is giving you." (Deut. 11:17)

    "When the heavens are shut up and there is no rain, because they have sinned against You..." (Deut. 8:35)

13. At times, human disobedience caused the land to be destroyed.

    "...The Lord has a charge to bring against you who live in the land: "There is no faithfulness, no love, no acknowledgment of God in the land...bloodshed follows bloodshed.

    Because of this the land dries up, and all who live in it waste away; the beasts of the field, the birds in the sky and the fish in the sea are swept away." (Hosea 4:1-3)

14. Damage to creation is a result of ignorance or sin.

    "They have all gone out of the way, they have together become unprofitable; there is no one that does good, no, not one." (Rom. 3:12)

Much of the literature in philosophical ecology places blame for environmental problems as well as interpersonal problems on some particular group of people: industrialists, capitalists, landowners, loggers, engineers, and others. Such an approach misses the idea that we are all at fault. None of us have always protected the resources of nature. None of us consistently treat our fellow humans with care.

Gary DeMar, quoting R.V. Young, writes:

> *Sin leads to abuse and sin is lawlessness (1 John 3:4). If companies were held responsible for chemical spills and were made to pay restitution, then such "crimes" would indeed be scarce (c.f. Exodus 22:6) The "ecological crisis" that we experience today is really only one aspect of the pervasive moral and cultural crisis of our time, and the cause of this crisis is pride. For too long we have believed that no bounds need be placed on human ambition and desire, but now it has been discovered that even scientific technology, the instrument of modern man's intended self-deification, must bow to the finitude of reality.* [47]

Hahne writes: "Other human sins throughout history also harm nature. For example, habits of selfish and unbridled consumption directly and indirectly harm the environment and diminish the finite resources of the planet God entrusted to the care of humanity. Nature continues to groan because of the short sighted and selfish acts of the human race." [48]

Frair et. al. summarizes the environmental problem:

> *Our present ecological crisis is due to several possible causes-ignorance, inertia and irresponsibility:*
>
> *1. People were, and in some cases still are, unaware that their exploitation practices would be on a large scale and in the long run detrimental.*

2. As a result of former procedures, instituted at a time when a future tragedy would not have been expected, it now is too late or the inertia of the program has become so great that there appears to be little opportunity to reverse a trend.

3. Some people have acted with irresponsibility, preferring to ignore or disregard the balance of nature, the welfare of a species, and the interest of their fellow man for selfish reasons. As a result of modern technological advance, selfish men have had greater opportunity to exploit resources at the expense of others. [49]

15. Creation "groans" until Christ returns.

"We know that the whole creation has been groaning as in the pains of childbirth right up to the present time." (Romans 8:22)

Nature/creation itself has suffered from the sin of humans and from the curse of Genesis 3. Everything in nature ages and wears, and every living thing eventually dies. Just as we should be eagerly awaiting the return of Christ, so creation itself seems to yearn for renewal, in what is described as being like labor pains.

Romans 8 is a chapter about hope through the work of the Holy Spirit. The Fall created a rift between mankind and God, between mankind and others, and between mankind and the creation. The Holy Spirit convicts us of sin and creates faith in us, restoring us to our Heavenly Father. "The Spirit also empowers us to restore our relationship with God's creation. The same Spirit who changes our hearts and adjusts our attitude toward other people also changes our attitude toward the land, water, plants, animals, etc. We have a new attitude toward creation." [50]

The result should be a new respect and appreciation for what God has made, a repentance from our greed and wastefulness, and a restored desire to steward the earth as entrusted to us.

16. Part of our future hope is a new heaven and a new earth.

"The creation itself will be liberated from its bondage to decay and brought into the freedom and glory of the children of God." (Romans 8:21)

"Then I saw a new heaven and a new earth, for the first heaven and the first earth had passed away, and there was no longer any sea." (Rev. 21:1)

The Christmas carol by Isaac Watts expresses the hope in these words:

Joy to the world! *The Savior reigns: Let us our songs employ;*

While fields and floods, rocks, hills, and plains repeat the sounding joy.

No more let sins and sorrows grow, nor thorns infest the ground;

He comes to make his blessings flow far as the curse is found. [51]

The expectation is that, as He renewed the body of Christ in the resurrection, and as He will give us new bodies when Christ returns, God will completely renew creation.

In this Edenic vision [Rev.21], with its tree of life, we are reminded again of Genesis, as we were already by the mention of a heaven and earth. Here in the new heaven

and new earth, the entire creation reaches the goal that God always intended for it…There is a fundamental continuity between this creation and the new creation, a continuity that gives us hope for this world in God's future and challenges us to anticipate His kingdom even in how we live and care for the earth now. [52]

THEOLOGIANS ON THE ENVIRONMENT

In 1970 theologian-apologist Francis Schaeffer published *Pollution and the Death of Man* [53], the first prominent evangelical book concerning the environment. Schaeffer was concerned about the destruction of the environment and also pointed out the value of nature and the importance of distinctions.

Schaeffer wrote:

The man who believes things are there only by chance cannot give things a real intrinsic value. But for the Christian, there is an intrinsic value. The value of a thing is not in itself autonomously, but because God made it. It deserves this respect as something which was created by God, as man himself has been created by God.

If God treats the tree like a tree, the machine like a machine, the man like a man, shouldn't I as a fellow-creature, do the same - treating each thing in integrity in its own order? And for the highest reason: because I love God - I love the One who has made it! Loving the Lover who has made it, I have respect for the thing He has made. [54]

Summarizing Schaeffer:

Schaeffer believed that nature was important, more than just for purely pragmatic human reasons, and should be respected because God made it. This was sufficient grounds. It wasn't because, according to pantheistic belief, the value of a thing such as a tree or stream was somehow autonomous or have some sort of divine existence in itself; rather a Christian attitude of care must flow from a respect and integrity for something which God, through the sphere of creating, saw as good and fit for human entrustment. It's a simple construct, but one that alarmingly seems foreign to so many Christians. According to Schaeffer, "Christians, of all people, should not be the destroyers. We should treat nature with an overwhelming respect" and "each thing in its own order, each thing the way He made it . . . the tree like a tree, the machine like a machine, the man like a man . . ." This to me seems to be the correct Christian approach. [55]

How to Rescue the Earth without Worshipping Nature was a work by sociologist-theologian Tony Campolo (1992). [56] He also showed the value of a perspective based on God's Creation.

"…We are to take what God has provided, nurture it, care for it, and enable it to produce more than might be otherwise expected. Irrational abuse of nature is not permitted. Ignoring our responsibility to protect nature and failing to nurture nature

to abundance are clearly sins. According to the Scriptures, as interpreted by the followers of Calvin, we are not only to preserve nature, but we are to make it even more beautiful and fruitful than it was when we received it from God.

It is that kind of joyful, satisfying, caring relationship that God wills for each of us to have with His creation. God, according to Calvin's thinking, wants us to become partners with Him in making His creation beautiful and fruitful. [57]

A world without God is not viewed with a sense of awe. A universe in which His presence is not felt is doomed to abuse. Such a world is primarily the creation of science. The theologians did not produce the chemicals that we have pumped into the air. Priests and rabbis did not create the plastics that clog our rivers and choke the dolphins. It was science---or more specifically, a particular kind of science. [58]

I am suggesting that, just as the first Adam's sin permeated nature and fostered violence and death, so the righteous 'shalom' of the second Adam, as expressed through those who are willing to be channels of it, can permeate nature, bring healing to it, and restore something of its former glory. [59]

Theologian John Stott adds:

Our unique dominion over the earth is due to our unique relation with God...We are able to think, choose, create, love, pray, and exercise dominion...We combine dependence on God with our dominion over the earth...

Generally speaking, human beings have obeyed God's command to fil the earth and subdue it...Human beings may not have known it, or humbly acknowledged it, but in all their research and resourcefulness, far from usurping God's prerogatives or power, they have been exercising the dominion God gave them...We must also humble ourselves to acknowledge that our dominion over nature would be entirely fruitless if God had not made the earth fruitful, and if He did not continue to "give the increase."... [60]

In consequence, we learn to think and act ecologically. We repent of extravagance, pollution, and wanton destruction...We should strenuously avoid all wastefulness, not only out of solidarity with the poor but also out of respect for the living environment. [61]

Biblical Norms

What do Biblical norms have to do with our handling of energy? Consider the principles of (1) being caretakers of the earth, (2) doing justice, and (3) showing love for others:

The norm associated with our being caretakers means that we treat the creation in a conserving and efficient manner...

Doing justice in our use of energy means that we seek to give every person and every

creature the opportunity to be the person or creature that God calls them to be…

The norm of love means that in our energy use we have a genuine and heartfelt concern for our fellow image bearers and for the creation.

We ought to be outraged and saddened when we see the land stripped bare for the sake of mining coal, when the sunset is obscured by the haze of air pollution, or when the nightly news brings oil-drenched waterfowl into our living rooms during their last tortuous moments of life. And our love for our fellow human beings ought to move us to compassion when we consider the plight of many in this world, some even here in the United States, who do not have available or cannot afford the energy needed to cook a meal or drive away the winter chill. [62]

A few have advanced arguments against stewardship of the earth: [63]

1. "God gave us dominion over everything."
2. "Everything will be renewed after the rapture."
3. "Ignorance is bliss. I don't have time to worry about the world's problems."
4. "I'll be dead before the oceans play out or the forests are all down."
5. "Science will find a solution."
6. "God lives in Heaven. Why should we care so much about plants and animals?"

But — God retains ownership (Ps. 24:1-2) and expects us to be responsible as we exercise dominion.

ENGINEERS AND THE ENVIRONMENT

Rather than being the cause of the problem, engineers have been at the forefront of environmental progress. Contrary to the claims of critics, it was largely not engineers who decided to dump wastes into the rivers.

Much has been turned around in the past 50 years. Lake Erie had lost fish species, which have returned. Many cities had unacceptable air quality, which has been significantly improved.

The Clean Air Act of 1970 set standards for the reduction of air pollution at industrial facilities. Maximum allowable concentrations of ozone, carbon monoxide, nitrogen dioxides, sulfur dioxide, and particulate matter were set. Engineers designed separators, scrubbers, and stack filters.

The Clean Water Act of 1972 was put into place "to restore and maintain the chemical, physical, and biological integrity of the nation's waters. It regulates quality standards for water, limiting the discharge of pollutants, particularly from factories and treatment plants, into United States waters. Water is treated by filtering through activated carbon, sedimentation, and adding chemical disinfectants (primarily chlorine, for drinking water).

The Resource Conservation and Recovery Act (RCRA) of 1976 regulates hazardous wastes.

Most new projects require the filing of an Environmental Impact Statement.

Many disciplines of engineering specifically contribute to a cleaner environment.

1. Environmental engineers

Environmental engineering grew out of civil engineering (and is sometimes a subset of civil engineering). The emphasis here is on engineering solutions to environmental problems, particularly air and water pollution.

2. Civil engineers

Civil engineers have historically been designers in two major areas that are key to environmental concerns:

- Water supply
- Water treatment and sewage (treatment)

3. Chemical engineers

Chemical engineers continue work on new production techniques to reduce the environmental footprint of the chemical, pharmaceutical, semiconductor, pulp-and-paper, petroleum-refining, and electric-power-generation industries. [64]

Chemical engineers have always been at the forefront of environmental protection by designing complex solutions to our vexing environmental challenges. One success is the conversion of the sulfur oxides in power plant gases into gypsum for use in wallboard another one is the removal of trace contaminants from drinking water by reverse osmosis. [65]

4. Mechanical engineers

Mechanical engineers have contributed to

- Eco-friendly public transportation systems
- Alternative fuels
- Engine and appliance efficiency

5. Electrical engineers

Temperature sensors and controls were previously more expensive than energy costs, particularly as air streams were mixed and air was heated and cooled twice. Today's controls are very inexpensive and effective.

"Green Design"

Green design has been an approach to engineering design characterized by these emphases:

- Waste reduction
- Materials management
- Pollution prevention

- Product enhancement

Green Design concepts:

- Prevention is better than treatment
- Minimize diversity of materials
- Think "sustainability"
- Utilize life-cycle thinking
- Consider design tasks in parallel

LEED design

Heating, cooling, and lighting of buildings is an enormous use of energy. Leadership in Energy and Environmental Design (LEED) provides a rating system for design, construction, operation, and maintenance of "green" buildings, scoring energy use/efficiency, indoor air quality, and water use.

LEED certification (via the U.S. Green Building Council) does not appear to be as prevalent today as it was about ten years ago.

A third party had to document and certify the buildings, adding significant costs to the design. Many companies will design to LEED standards without seeking certification ("the plaque on the wall.")

LEED was market-driven. It was successful in driving upgrades and efficiency without government requirements.

ASCE ON SUSTAINABILITY

The American Society of Civil Engineers has put forth a concept of sustainability: "the triple bottom line," where any product or project simultaneously has long-term stability, not only for the environment, but for (1) the environment and (2) the economy (affordable and realistic cost) and (3) society (the public will accept it). Biodegradable canteens might be great for the environment, but if they are priced out of range or aesthetically unappealing, they will not be purchased and used.

> *The society defines sustainability as "a set of economic, environmental, and social conditions (aka "The Triple Bottom Line") in which all of society has the capacity and opportunity to maintain and improve its quality of life indefinitely without degrading the quantity, quality or the availability of economic, environmental and social resources." They further define sustainable development as "the application of these resources to enhance the safety, welfare, and quality of life for all of society."*
>
> *ASCE offers many recommendations for implementing sustainable infrastructure practices. The Code of Ethics starts with an emphasis on sustainable infrastructure. Canon 1. Hold Safety Paramount states "Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties."* [66]

The major difficulties associated with regulation of air and water quality are these:

- We simply don't know what values to set as the target.
- Some regulations are open-ended in terms of the amounts that will be spent. [67]
- Increasing the quality standard by 0.1% could cost companies millions of dollars without significant health or species results.

CONCLUSIONS

There are several faulty reasons to care for the environment —

- "We are one with all of nature." This is pure pantheism and not the Biblical worldview.
- "Plants and animals have rights, too. Plants and animals deserve justice." I expect that someday we'll see lawyers in court representing plants and animals. They may deserve care, but justice is a conscious concept.
- "Plants and animals are worth as much as humans." No, humans are the crown jewel of God's creation.
- "We should love all living creatures." We should care for all living creatures, but actual love involves communication, sacrifice, generosity, and forgiveness.

The Bible gives us reasons to care for the environment-

- God made the world and called it good.
- God takes pleasure in His creation. (particularly visible in the Psalms)
- God's care for nature (common grace) is similar to God's care for us.
- God entrusts some care of nature to us.

We need to avoid:

- Idolatry- worshipping the earth
- Pantheism- seeing all as one, without differentiation
- Falsifying environmental data
- Creating fear and panic

Just because neo-pagans are speaking out about environmental issues doesn't mean we become anti-environment. We are to be concerned for economics and the environment because God made the universe good, and he wants us to do something good with it. Christians should be providing leadership in the realm of stewardship: progress and conservation of creation. [68]

An unmistakable challenge is presented to the world-wide Christian church to take on the God-given responsibility of caring for the environment. It provides an unprecedented mission opportunity for Christians to take a lead and demonstrate love for God the world's creator and redeemer, and love for our neighbors wherever they may be - remembering the words of Jesus, 'From everyone who has been given much, much will be demanded' (Luke 12: 48). [69]

Godly dominion is a responsibility for everyone at all times, regardless of eschatological perspective. Our obligation to love our neighbors requires godly dominion, whether the earth is to remain and be transformed, or be annihilated and replaced, and whether Christ's second coming and the final judgment are moments away or thousands of years ahead. [70]

REFERENCES

1. Moo, J., and White, R., Let *Creation Rejoice*, IVP, 2014, p. 23.
2. Catalano, G., "Developing an Environmentally-friendly Engineering Ethics," *J. Engin. Educ.* 82: 27-33, 1993.
3. "Water Pollution," Britannica Online, https://www.britannica.com/science/water-pollution
4. Geisler, N., "Ecology," in *Christian Ethics: Options and Issues*, Baker, 1991.
5. Catalano, G., "An Ecological Approach to Engineering Education," American Society for Engineering Education Annual Conference, 1993.
6. Catalano, G., *Engineering Ethics: Peace, Justice, and the Earth*, Morgan Claypool, 2014, p. 24.
7. Solomonian, L., and Di Ruggiero, E., "The critical intersection of environmental and social justice: a commentary," https://globalizationandhealth.biomedcentral.com/track/pdf/10.1186/s12992-021-00686-4.pdf
8. Catalano, G., 1993.
9. Catalano, G., "Chaos and a new environmental ethic," ASEE Annual Conference, 1994.
10. Catalano, G., "Engineering in a Morally Deep World," ASEE Annual Conference, 2006.
11. Catalano, G., "Engineering, Social Justice, and Peace, ASEE Annual Conference, 2006.
12. Catalano, Morally Deep World, 2006.
13. Catalano, G., *Engineering, Poverty, and the Earth*, Morgan and Claypool, 2007.
14. Catalano, G., 1994.
15. Catalano, *Engineering, Poverty and the Earth*, p. 52.
16. Catalano, G., Morally Deep World, 2006.
17. De Laplante, K., "Can You teach Environmental Philosophy Without Being an Environmentalist?" in *World Views: Environment, Culture, and Religion* 8:198-212, 2004.
18. Catalano, *Engineering, Poverty and the Earth*, p. 52.
19. Reisman, G., "The Toxicity of Environmentalism," *The Freeman*, Sept. 1992, p. 336-350.
20. Asmus, B., "Building an Unlimited Future," *Imprimus*, Hillsdale College, January 1992.
21. Neuhaus, R., *In Defense of People*, MacMillan, 1971.
22. Reisman, op. cit.
23. Heide, G., *This is my Father's World*, Joy Publishing, 1998, p. 42
24. National Society of Professional Engineers, http://www.nspe.org/Ethics/CodeofEthics/index.html
25. Schaeffer, F., *Pollution and the Death of Man*, Tyndale House, 1970, p.13.
26. Geisler, op.cit.
27. Ibid.
28. Vesilind, A., *Engineering Peace and Justice*, Springer, 2010, p. 106.

29. Reisman, op.cit.
30. Miller, D., "Francis Schaeffer and a Christian View of the Environment," http://darrowmillerandfriends.com/2010/09/20/francis-schaeffer-and-a-christian-view-of-the-environment/
31. White, L., "The Historical Roots of Our Ecological Crisis", *Science* 155:1203, 1967.
32. Ibid.
33. Ibid.
34. Toynbee, A., "The religious background of the present environmental crisis," *International Journal of Environmental Studies* 3:141-146, 1972.
35. Loevinger, N., "(Mis)reading Genesis, response to environmental critiques of Judaism," in Bernstein, E., *Ecology and the Jewish Spirit*, Jewish Lights Publishing, 1998.
36. Toynbee, op. cit.
37. Frair, W., Feenstra, E.S., and Munro, D.W., "Comments on the Historical Roots of Our Ecological Crisis," *Journal of the American Scientific Affiliation* 21: 42-47, June 1969.
38. Geisler, op. cit
39. Schaeffer, op. cit., p. 29.
40. Finger, T., *Evangelicals, Eschatology, and the Environment*, Evangelical Environmental Network, 1998.
41. Ibid.
42. Beisner, E. C., "Foundational Principles of Earth Stewardship," https://cornwallalliance.org/landmark-documents/foundational-principles-of-biblical-earth-stewardship/
43. Timmer, T., "Putting the 'And' back into Genesis 2:15," *ProRege* June 2013, p.27-34.
44. Land, R., "A theology of Creation and the Environment," https://juicyecumenism.com/2008/11/14/a-theology-of-creation-and-the-environment/
45. Marshall, P., *Heaven is not my Home*, W Pub Gray, 1999, p. 126.
46. Marshall, p. 132.
47. DeMar, G., *God and Government* Vol. 2, American Vision, 1986, p.67.
48. Hahne, H., "The Whole Creation has been Groaning," https://www.baylor.edu/content/services/document.php/106707.pdf
49. Frair, W., Feenstra, E.S., and Munro, D.W., "Comments on the Historical Roots of Our Ecological Crisis," *Journal of the American Scientific Affiliation* 21: 42-47, June 1969.
50. Heide, p. 157.
51. Watts, I, "Joy to the World," public domain hymn.
52. Moo and White, p. 158.
53. Schaeffer, op. cit.
54. Schaeffer, chapter 4.

55. "A Christian Perspective on Environmental Stewardship by Francis Schaeffer," http://conservefewell.wordpress.com/2013/08/28/a-christian-perspective-on-environmental-stewardship-by-francis-schaeffer/
56. Campolo, T., *How to Rescue the Earth without Worshipping Nature*, Thomas Nelson, 1992.
57. Campolo, p. 24.
58. Campolo, p. 31.
59. Campolo, p. 81.
60. Stott, J., *Issues Facing Christians Today*, Zondervan, 2006, p.118-119.
61. Stott, p.126-127.
62. Adams, C., *Exercising Our Worldview*, Dordt College Press, 2014, p. 286.
63. Sleeth, M., *Serve God, Save the Planet*, Zondervan, 2007.
64. AICHE, "Frontiers in Environmental Protection," https://www.aiche.org/community/students/career-resources-k-12-students-parents/what-do-chemical-engineers-do/saving-environment/frontiers
65. Annab, R., "Chemical engineers role in environment," https://www.linkedin.com/pulse/chemical-engineers-role-environment-eng-ruba-annab/?articleId=6451517474365014018
66. ASCE Richmond, "Sustainability Initiatives," http//ascerichmond.org/2018/08/20/asce-sustainability-initiatives/
67. "Engineers and the Environment," http://ethics.tamu.edu/wp-content/uploads/sites/7/2017/04/ethics.tamu_.edu_ethics_essays_environm.pdf
68. Miller, D., "Francis Schaeffer and a Christian View of the Environment," http://darrowmillerandfriends.com/2010/09/20/francis-schaeffer-and-a-christian-view-of-the-environment/
69. Houghton, J., "Why Care for the Environment?" Faraday Paper Number 5, Faraday Institute, 2007.
70. Beisner, op. cit.

CHAPTER 19: TECHNOLOGY

INTRODUCTION

Technology impacts nearly everything that we do as 21st Century humans. It is so much a part of our lives and produces so many positive results that we seldom consider its possible negative impacts.

Technology is totally intertwined with engineering. Engineers develop technology and are primary users of technology.

Technology has meant different things to the public over different eras. In the 1800's "technology" meant steam engines and machinery. At the outset of the Industrial Revolution only manufacturing technology existed. By the mid-Twentieth century "technology" was associated with factories and assembly lines. Today our concept of "technology" is most often tied to computing, the Internet, and mobile devices.

Let's consider some definitions:

1. (Technology is) what we create/develop out of natural things. Results from engineering work. The wider definition includes the techniques, methods, and processes involved with man-made things. [1]
2. Technology refers to that subset of the world that is man-made, typically with tools. Sometimes the emphasis is on the tools (early factories employing steam technology); at other times the emphasis is on the resulting product (computers, cell phones as technology). We use tools to extend our natural abilities. [2]
3. (Technology) refers to the intelligent organization and manipulation of materials for useful purposes. [3]
4. "Technology is best understood as an earth system—that is, a complex, constantly changing and adapting system in which human, built and natural systems interact." [4]
5. "Technology is (properly) understood as a social system...a philosophy of life that sees all things as objects, including people. Instead of defining technology as disparate tools unconnected to each other, philosophers have suggested a more comprehensive definition that says technology does not mean neutral objects ready for use at our convenience, but a way of life that informs and controls everything we do." [5]
6. Technology refers to "the entire body of methods and material used in combining science and art to produce items and concepts to satisfy industrial, commercial, and social objectives." [6]
7. "(Technology is) a distinct cultural activity in which human beings exercise freedom and

responsibility in response to God by forming and transforming the natural creation, with the aid of tools and procedures, for practical ends or purposes." [7]

In practice, we use "technology" in two different senses: as the individual objects and products themselves, and in the broader sense of technical advance, with all that this entails.

As we discuss technology we need to realize that there are several different categories of technology, each with different processes and materials: computer and information technology (including laptops and the internet); communication technology (including cell phones and blackberries); vehicle and transportation technology (including engine computers and GPS); medical technology (including automated blood chemistry and artificial organs); appliance technology (including food-sensing microwaves and water-saving washers); military technology (including smart bombs and satellite surveillance); and manufacturing technology (including CNC machines and robotics).

My observation is that most writers lump all technologies into one when critiquing "technology." Often what is implied is only pertinent to computer-information technology or communication technology.

We need to differentiate between technology as a specific entity or defining category and specific types of technology:

- Communication technology
- Consumer technology
- Computer technology
- Transportation technology
- Appliance technology
- Military technology
- Assistive technology
- Medical technology
- Manufacturing technology
- Information technology

BRIEF OVERVIEW OF TECHNOLOGY

If technology simply means making and using tools, then technology has been with us from the beginning of human history. From the earliest tools used in tilling the soil to modern computers, technology has been tied to how we live.

Francis Bacon (1561-1626), who advanced the Scientific Method, was essentially the first proponent of technology as the key to progress.

> *Though it is hard to pinpoint the birth of an idea, for all intents and purposes the modern idea of technological "progress" (in the sense of a steady, cumulative, historical advance in applied scientific knowledge) began with Bacon's The Advancement of Learning and became fully articulated in his later works. Knowledge is power, and*

when embodied in the form of new technical inventions and mechanical discoveries it is the force that drives history – this was Bacon's key insight. [8]

Historians of technology speak of three ages in human culture: [9]

1. Agrarian (pre-industrial, tied to the land)
2. Industrial (the machine age, tied to the clock and later to the machine)
3. Post-industrial (the information society, tied to data)

Highlights in the history of technology include:

- Animal-powered mechanisms
- Clocks
- Printing press
- Steam engine – start of the "Industrial Revolution"
- Steam locomotive
- Telegraph
- Automobile
- Telephone
- Airplane
- Radio
- Television
- Transistor
- Integrated Circuit
- Computer
- Internet

We might consider three quantum leaps associated with technology:

- steam power
- electric power
- digital/computer innovations

All three had broad applications.

History after the Industrial Revolution has been considered "The age of the machine." In the First Machine Age machines replaced muscle power. In the Second Machine Age computing machines replaced cognitive power. [10] While early technology required only manual skills, modern technology is strongly based on science: semiconductor theory, polymer processing, new materials, and scientific manufacturing.

OBSERVATIONS REGARDING TECHNOLOGY

1. Technology is ubiquitous

Gayle Ermer writes:

> *There is no question that modern life in the industrialized world is reliant on technological systems which we typically take for granted. We depend on technology to transport people and goods from place to place safely, to provide sanitary living conditions, to protect people from extremes of the physical environment, and to allow communication with people both near and far. Technology has contributed, in ways too numerous to count to the flourishing of many individuals and cultures.* [11]

Aycock adds:

> *We are so totally surrounded by technological developments that it is difficult to organize a list of commonplace objects or service delivery systems which were in existence before, or have remained unchanged during, the 1900's. Technology affects us broadly through our transportation and information systems, financial institutions, et cetera, and intimately through the clothes we wear, the deodorants we use, and the contact lenses which some are using to read this page. The use of the computer, technology's most heralded recent achievement, is illustrative of the widespread utilization of scientific achievements. Computers touch the lives of almost every American whether through a direct access by the individual (e.g,, automated bank tellers, microwave ovens) or through indirect avenues (e.g., bank transactions, airline ticketing). Technology has a firm grasp on our lives. Christians are not immune (nor would most wish to be) from these applications of science. Schwarz maintains: "We cannot turn the wheel of history back, aborting our technological advancements. Our civilization is much too completely and we are much too removed from "a natural way of life" to be able to do without technology.* [12]

> *Technology includes, in one form or another, all those things that do not naturally occur, all those things that we shape and reshape. Technology infuses art as much as physics, families as much as engineering. To talk about technique and technology is to talk in one particular way about all of human life, as all of human life as some technical aspect. Responsible technical skill is both a gift and a calling. It is the human task of reshaping the materials of God's world in new ways. It is imagination and skill in the service of usefulness.* [13]

2. Technology Changes How We Live

Humans create technology to adapt their environment to themselves, but technology also changes the way humans live, think, multiply, and die. In this sense, we say that humanity and technology live in symbiosis, as to a large extent one creates the other. Indeed, while it is useful to think about technology as a means to solve problems, sometimes the introduction of the tool precedes the problem to be solved! *Did the*

introduction of the firearm solve the civil war problem in Japan? The invention of the telephone also did not solve a particular problem, as humans were communicating in other ways before its invention. But it did enable faster communication.

Seeing technology as a means to solve problems, while correct, is not the whole story. Tools enable us to both cope and change our environment, but as the environment changes so do our needs and ourselves, leading us to use the same and new tools in unforeseen ways, in an endless loop of social-technological interaction. [14]

Consider the changes brought about by common technology:

- Automobiles -growth of suburbs, commuting to work, carpools, soccer moms.
- Air conditioning – people moved indoors, less interaction with their neighbors on front or back porches.
- Television – passive watching with little talking thinking, fewer family games and deep discussions.
- Microwave ovens – warm up a meal at any time; fewer families eat dinner together every evening.
- Television, stereos, and mp3 players -Ken Myers has noted that few families today buy pianos and sing together in the living rooms. [15]
- Computers – shopping without going to a store; planning trips without travel agents; communicating worldwide, but with simpler messages.

3. New technology (if successful) eventually replaces earlier technology.

If we look at the technology of the 1950's:

- Wall telephones
- Manual typewriters
- Flash cameras, Polaroid cameras
- Movie cameras
- Black and white television
- Adding machines, slide rules
- Tape recorders
- Record players

Each one of these has been rendered obsolete by the computer and the microprocessor chip.

4. Technology becomes "transparent."

Often the impacts of technology are so deeply embedded in a culture that we don't even consider them. Balabanian [16] mentions the automobile specifically. In most American cities it is not possible to walk to the grocery store, to school, or even to work. It is simply assumed that everyone has access to a car.

"Transparent technology" is that class of technology which has been with us so long and is

familiar that we don't even think about it (until we visit a less-developed country or region that does without it). Examples include:

- electric lights
- clocks and watches
- telephones
- running water
- indoor plumbing
- gas or electric stoves
- refrigeration

5. Technology is always accompanied by unintended consequences, sometimes beneficial, sometimes detrimental. [17]

Had we been aware at the outset of the negative consequences of the automobile (accidents, huge highways, noise, smog, pollution, traffic jams, parking lots ...) would we still have proceeded to develop, manufacture, and purchase cars? My guess is, yes, but with a much more balanced view of them.

TECHNOLOGY	ANTICIPATED ADVANTAGE	UNINTENDED CONSEQUENCES
Steam engine	Power for ships and trains	Boiler explosions
Railroad	Inter-city travel	Noise, smoke, railroad yards
Telegraph	Communication across the country	Western Union telegrams
Radio	Continual news and music	Top 40 stations, talk radio
Automobile	Personal travel	Accidents, smog, development of suburbs
Electric power	Lights and power in homes	Power lines, power poles, electrocutions

Telephone	In-home communication	Telemarketing, solicitations, surveys
Airplane	International travel	Plane crashes, cancellations, TSA
Television	International news, cultural broadcasts	Decreased family conversation, inane programming, "couch potatoes"

Kitchen appliances	Work reduction, efficiency	Removed need for kitchen maids; costly repairs and replacement
Highway system	Inter-city connections	Thousands of intersections, Traffic jams, billboards
Stereo/CD player/ music streaming	Recorded music available	Less singing in the home
Air conditioning	Pleasant indoor environment	Increased electric bills
Computer	Rapid computation and file manipulation	Hard drive crashes, obsolete software, continual upgrades
Factory assembly line	Rapid assembly, efficiency	Monotonous, mind-numbing work
Indoor lights at night	Read and visit after sunset	Staying up later, getting less sleep
Internet and computer networking	Access to millions of web pages, email communication	Spam, hacking, porn

Smart phones	Hand-held access to information	Distraction, texting while driving
Medical technology	Better and precise health care	Medical accidents caused by failures
Robotic assembly	Replace unsafe and repetitive jobs	Displacing human workers
Copy machines	Rapid duplication of documents	Thousands of unnecessary copies

Facts about Technological Change: [18]

1. All technological change is a trade-off.
2. The advantages and disadvantages of new technologies are never distributed evenly among the population.
3. Embedded in every technology there is at least one powerful idea.
4. Technological change is not additive; it is ecological. A new medium does not add something; it changes everything.
5. Media tend to become mythic.

PICTURES OF TECHNOLOGY

In the literature we find at least five "pictures" of technology:

1. Technology as utopia

Thomas More first postulated a "utopia": in his 1516 book by that name. [19] A utopia is an ideal society, characterized by peace, prosperity and wealth. Technology has often been evoked as the lead-in to utopia.

2. Technology as Babel

In Genesis 11 we have the account of a tower being built to heaven, which God destroys, along with confusing the builders' language. Some have suggested that this shows God's displeasure with human technology. In fact, Babel is actually God's judgment on human pride and rejection of His plans.

3. Technology as Prometheus

Greek mythology tells the story of the Titan Prometheus who created human civilization and then stole fire (technology) from the gods to advance humanity. The result was daily suffering

for Prometheus. While technology advances us, unbridled technology (like unconstrained nuclear energy) can destroy us. Robert Wauzzinski calls his book about approaches to technology *Discerning Prometheus*. [20]

In *Prometheus Wired* philosopher Darin Barney expands the idea: Prometheus was punished because he "deprived human beings of their humility and critical reason and replaced these with blind, irrational hope," the kind of hope we currently have in our technology. [21]

4. Technology as Frankenstein

The actual subject of Mary Shelly's novel is Dr. Victor Frankenstein, the scientist who brings the creature (monster) to life, made of human parts. "While engineers and computer scientists don't design and build live, walking, talking monsters, they do create devices that have the qualities of living beings...What then can engineers do to reduce, if not eliminate the chances of unwittingly creating a Frankenstein monster?" [22]

5. Technology as HAL

In the classic 1968 science fiction film 2001 *A Space Odyssey*, HAL (note: one letter off from IBM) was the total-control computer running the space ship, which seemed to have a mind of its own. In the story, HAL somehow goes rogue and begins killing the crew.

APPROACHES TO TECHNOLOGY

A number of early Christian writers specifically saw technology as a gift from God.

The followers of the monastic Bernard of Clairvaux (1019-1153) used waterwheels to produce paper for copying Scripture. They believed that "technological advance is an expression of God's love for His children", that technology is actually "part of God's compassion for mankind." [23]

The medieval monk Hugh of St. Victor (1096-1141), author of The Didascalicon, elevated technology (which he called "mechanical philosophy") to a status equal to that of theoretical and practical philosophy. He wrote that technology, carpentry, agriculture, and medicine are valuable since they assist people and remove drudgery from the common worker (particularly waterwheels and looms). As a result, medieval "monasteries became centers of technological innovation."[24] Dessauer goes so far as to say that "God as it were continues the creation by means of technology." [25]

Technology amplifies human efforts and accelerates human activities. Because we live in a fallen world there will always be problems in the use of technology- faulty decisions, sinful decisions, deception, improper use, deliberate misuse, unintended consequences, and eventual failure.

We have seen that every individual technology has its own set of drawbacks. [26] The same automobiles and airplanes which give us great mobility generate pollution and are involved in

deadly accidents. The same computer networks which give us access to the world's information also give us access to degrading pornography and debilitating viruses.

As a result, two opposing views of technology have developed:

(1) Unbridled optimism (Technophilia)
(2) Pessimism or rejection (Technophobia)

1. Technological optimists

An optimistic view of technology is held by those who fully embrace technology and believe it promises a better life and hope for this world and the human race. Those who subscribe to this view cannot deny that technology results in problems and undesired effects, but they believe that any problems brought about by technology can be solved. [27]

Lewis Strauss, former director of the Atomic Energy Commission wrote:

It is not too much to expect that our children will enjoy in their homes electrical energy too cheap to meter, will know of great periodic regional famines in the world only as matters of history, will travel effortlessly over the seas and under them and through the air with a minimum of danger and at great speeds, and will experience a lifespan far longer than ours as disease yields and man comes to understand what causes him to age. [28]

Technological optimists include Samuel Florman, George Gilder, and Ray Kurzweil. To these Balabanian adds Simon Ramo, Melvin Kranzberg, and Peter Drucker. [29]

General advantages of technology include expanded choices, ability, freedom, changes, and free time. [30]

Positive contributions of modern technology include:

- Distant travel
- Ease of communication
- Information at our fingertips
- Rapid production of goods
- Creation of new jobs
- Better medical diagnostics
- Some common ideas and language

Technology often acts as a "multiplier":

- Timesaving
- Transportation
- Communication

- Information
- Health care
- Multiplied strength

Colin Dickey writes:

> *Having eradicated smallpox, we are on the verge of consigning polio and guinea worm disease to the same fate. Each new generation of engineering brings lighter, stronger, safer materials, resulting in more durable, safer automobiles, planes and infrastructure. The new Highway W35 bridge in Minneapolis, completed in 2008 to replace the one that collapsed in 2007, has 323 fibre-optic sensors built in that provide real-time data to engineers regarding stress, corrosion and movement of the bridge.* [31]

2. Technological pessimists

> *Those who hold a pessimistic view of technology reject technology, and feel a hopeless despair that it will bring only pain and destruction to this world and the human race. Those who subscribe to this view cannot deny that technology has often been used to humanitarian ends, but the holder of such a pessimistic view believes that technology creates more problems than it solves.* [32]

Technological pessimists include Martin Heidegger, Jacques Ellul, Lewis Mumford, Langdon Winner, and Neil Postman.

Classical technological criticism focused on three areas:

- Dehumanization of people (automation, assembly lines); people treated as numbers
- Technology as master, not servant
- Specialized knowledge (how the machine works) replaces broad knowledge

THE LUDDITES AND THE AMISH

Luddites

The Luddites were a movement of British textile workers in 1811 who organized to destroy cotton mill machinery that threatened their jobs. They were apparently named for the mythical Ned Ludd. Today "Luddite" refers to anyone who vigorously opposes new technology.

The Amish

The common perception is that Amish people are strongly opposed to the use of technology as modern and a violation of the simple life. That's not entirely the case. There is some technology in use in the Amish community, although primarily pulleys, gears, and hydraulic powered devices. Most are opposed to the use of electricity and electronic devices. Most do not own cars. The actual reasons for the separation from recent technology is that technology separated the community. The

individual who owns a car is "better" than his neighbors who don't. The use of electricity makes the community dependent on strangers (primarily on the power company).

The Amish are often cited as a group opposed to technology. In fact, the Amish use a fair amount of hand-crafted technology but most refuse to use electricity, telephones, or automobiles, not because they are modern but because they separate people. Dependence on the electrical grid removes dependence on neighbors, and owning cars and electronics separates those who have from those who have not.

The actual concern of the Amish is not that modern technology is Satanic, but that technology separates people and divides the community. Automobile ownership can generate pride and jealousy. Tying to the electrical grid produces a dependence on strangers rather than reliance on the community.

IS TECHNOLOGY NEUTRAL?

When people ask this question, they are really asking whether a given technology is actually good or bad. Clearly, technology is inert. It has no power in itself but must be used by a human operator. At the same time, all technology is designed for a purpose, and that purpose may be specifically beneficial or destructive.

If a technology can be misused, humans will find a way to misuse it, whether foolishly or maliciously.

Is technology neutral or value-laden?

By itself, any item of technology is inert, unable to act on its own, and strictly a tool of human users. On the other hand, certain items of technology were developed for a clearly destructive purpose.

As a result, two opposing views of technology have developed:

(1) Instrumentalism – Technology is absolutely neutral

(2)Value-laden technology suggests that technology is always infused with value and that certain technologies are created only for an evil purpose.

1. Instrumentalism

In the sense that technology is not living and has no conscious direction, technology is neutral. It requires a human user in order to be employed for good or for harm. (This position is known as Instrumentalism.)

The "instrumentalist" position holds that technology is absolutely neutral, strictly a tool with respect to its ends, and that only the user determines whether good or bad results from it.

Balabanian summarizes the instrumentalist position:

- *That technology is just a passive tool whose consequences depend on the uses to which it is put;*

- *That if technology is used harmfully, "man" is to blame.*
- *That there are no values embodied in technology.*
- *That technology plays an entirely passive role with respect to issues of power and control.*
- *That prime reasons for introducing innovations in production processes are increased efficiency and productivity.*
- *That the prime reason for introducing innovations in products is to satisfy a human need, "to satisfy it more safely, reliably, and at a lower cost to the user."* [33]

An engineer may develop a microcomputer chip or a fastener that could conceivably be used in any device- a toy, an automobile, a heart monitor, a missile guidance system. At this component level, technology certainly seems neutral.

In general, developers of technology often seem to regard technology as neutral since they focus only on the particular piece of technology they are working on and thus define technology as the collection of technological objects. Those who examine technology from a larger scope and define it as an entire system more often see it as non-neutral. [34]

In the article "Are Engineers Instrumentalists?" [35] Byron Newberry develops the idea that engineers treat familiar technology as neutral but may see unfamiliar technologies as potential problems. Newberry suggests that most engineers are subject to a "proximate instrumentalism," since they see little connection between the commodity items they produce and the noble goal of designing "for the benefit of humanity." "Engineers, in other words, are consumers as well as producers of technologies...{Because they understand and feel that they can control them,} they have an instrumental attitude about technologies they are close to. " [36]

Charles Adams adds:

> *When I read the Bible, I learn of a Creator who brought into being all things and who originally delighted in all things (Genesis 1). I learn that the purpose of all things is to serve the Creator (Ps. 119:89-91). I learn that humankind was created in the image of the Creator and called to serve in a particular way: to care for and enable the rest of creation (Psalm 8). I learn that despite humankind's rebellion and the curse wrought upon the whole of creation as a consequence of that rebellion, the Creator has promised to redeem the whole of creation (Col. 1:20). All this suggests that technology is one of many kinds of human activities, all of which are characterized as "service to the Creator" and all of which can be performed in a multiplicity of obedient and disobedient ways. Hence technology cannot be characterized as good or evil in itself (inherently) because it does not exist "in itself."*
>
> *Technology is just one way in which we as the Creator's image bearers, along with the nonhuman creation, relate to the Creator... As such, engaging in technology is no more or less a "spiritual" activity than is attending a church service. For one biblical affirmation of that claim, read the account of Bezalel and Oholiab in Exod. 35:30-36:5. To engage in technology obediently we need, like Bezalel and Oholiab, to be filled with the Spirit of God.* [37]

2. Non-neutrality

In the sense that every technological object is designed for a specific use and that some intended uses are destructive (such as a guillotine), then technology is not neutral.

Is Technology neutral?

(1) No, says John Dyer

Technology is not completely neutral, according to technical theologian John Dyer:
One half of the story is that we can use technology as we choose. The "other half" most of us miss about technology is that tools transform us regardless of whether we use them for good or for evil. Whether I use my shovel to build that orphanage or go on an axe-murdering spree, I'll end up with blisters on my hands from the shovel. And just as physical tools reshape our bodies, digital tools transform our minds. I can use Twitter to follow Christian pastors like John Piper and Rick Warren or mindless celebrities like Kim Kardashian and Snoop Dogg, but regardless of the goodness or badness of the content they tweet, my mind will be transformed such that it gains the skill of consuming enormous numbers of short sentences, but loses the ability to read a book for more than a 10 or 15 minutes without feeling distracted. [38]

(2) No, says Lawrence Terlizzese-

Technology is clearly non-neutral says Christian philosopher Lawrence Terlizzese [39] since technology (the spirit of technology) is much more than the objects we use. Following Heidegger and Ellul he writes:

"Technology is a philosophy of life that sees all things as objects, including people...Everything becomes stuff ready for usefulness. Technology really means an interconnected system rather than a neutral tool...Everything is understood as a machine and should function as a machine, including the government, the school, the church, and you."

Conclusion: "We should develop technologies that reflect our values of freedom, equality, and democracy."' [40]

(3) No, says Jerry Mander

"As stated earlier, the idea that technology is neutral is itself not neutral, since its blinds us to the ultimate direction in which we are heading and directly serves the promoters of the centralized technological pathway." [41]

(4) No, says Paul Marshall

The structure of modern technology shows that technologies are never "neutral" - they are not just tools that happen to be lying around, which we can use at will for either good or evil purposes. They become part of the structure of the world in which we live, part of the pattern of our lives. Technologies always embody, promote, and reproduce human commitments, beliefs, and activities; they can free us or trap us by

what we have already done; they can reduce our actions and our futures to mere extrapolations, extensions of our past. Technologies are both cages and doors. [42]

(5) No, says Willem Vanderberg

We are endlessly told that technology is neutral and that its influence on human life, society, and the biosphere is the result of its use, as opposed to its structure and its intermingling with other phenomena...Such a position is untenable. Science, technology, and the economic growth achieved with them are hardly neutral and certainly not objective. [43]

The reasons for this non-neutrality and the accompanying problems in advanced societies, says Vanderberg, are several: [44]

- Ever narrower disciplines
- Division of labor
- Emphasis on efficiency in all areas
- Organization of everything in mechanistic or informational terms
- Separation from experience and culture

(6) No, says Norman Balabanian

• *Technology is not a neutral, passive tool devoid of values; it takes the shape of and, in turn, helps to shape, the embedding social system.*

• *The ideologically promoted, neutral-tool, use-abuse model of technology conceals issues of economic and political power relationships among different groups in society. In this way, it serves the instrumental function of legitimating the dominant ideology.*

• *Far from increasing freedom, contemporary technology limits individual autonomy and imposes a style of living concerning which individuals have little choice.* [45]

(7) No, says Robert Whelchel

Technology cannot be neutral, suggests Whelchel, since there are values associated with it, values such as cost-saving, quantification, systemization, and efficiency. [46]

(8) No, says Jack Swearingen

Technology is decidedly non-neutral, according to Christian writer and engineer Jack Swearengen:

Among human endeavors only technology has the capability to extend human life and make it less laborious but at the same time to extinguish species (including humans), decrease self-reliance, destabilize the planet's life support systems, and invade our privacy and security without our consent. [47]

(9) No, says Steven VanderLeest

The technology we develop reflects the values and desires of the human creators, even when the designers intended to be objective. Technology is always a means to an end. The problems we choose to solve and the tools we develop as solutions have biases-at the very least towards the goals we had explicitly in mind, but additional biases also sneak in without our conscious intent. [48]

Category Approach

I would suggest an alternative approach, which would be to categorize man-made objects into four categories.

I Intended for good, used for good	II Intended for good, used for evil
III Intended for evil, used for good	IV Intended for evil, used for evil

Quadrant I includes most information and transportation technology, and, particularly, medical technology.

Quadrant II consists of tools used as weapons or such actions as using an airplane to destroy a building.

Quadrant IV includes gas chambers, guillotines, and IED's.

Quadrant III is the most difficult to fill. Trans World Radio in Monte Carlo is currently broadcasting the message of God's love from shortwave facilities designed for airing Nazi propaganda (war, conquest, anti-Semitism) during the Second World War. The clearest example in this category is the cross, used by men to kill the innocent Son of God, but used by God through the sacrificial death of Christ to destroy sin and death.

Myth: The greater the potential of a given technology for good, the greater is its potential for evil use. Cardiac pacemakers and blood glucose monitors have had great positive benefit in the medical field. We will be hard-pressed to think of an evil use for these.

As an example of a technology designed for good and used for ethically questionable purposes, I would suggest looking at fMRI, functional magnetic resonance imaging. This device uses the interaction between magnetic fields, radio frequency energy, and the spin of protons to provide high-resolution real-time images of the brain. By emphasizing areas of high neuronal activity

and blood flow, researchers have been able to better understand the workings of the brain in normal and diseased states. fMRIs are a valuable tool in diagnosis of brain abnormalities and in the study of brain physiology. Since active areas of the brain seem to "light up" in the image, the same technology has been used to predict the effectiveness of different advertisements shown to subjects under test. [49] Is it ethical to use highly sophisticated equipment designed for medical studies to evaluate brain response to various advertising images?

TECHNOLOGICAL DETERMINISM

Technological determinism holds that technology is not neutral and is specifically moving society in a given direction. Following philosopher Jacques Ellul, it suggests that a society's technology drives its societal development and social values. [50] Technology drives history, rather than human decisions.

John Staudenmaier writes:

> *Most critics of technology, especially the ones who write for a popular audience, rely on a theory that is no longer supported by most historians. That theory, commonly known as "technological determinism," posits that technologies have a kind of one-way, deterministic "impact" on any society that adopts them. The stronger forms of this theory also hold that technological innovations advance according to an internal logic that makes technological progression inevitable and unstoppable.*
>
> *Although technological determinism was the dominant historical theory for the first half of the 20th century, most current historians consider it to be only half right. Technologies most certainly change the societies that adopt them, but those changes are rarely, if ever, deterministic. Instead, detailed historical cases show that consumers play very active roles in shaping our understanding of what a new device is and is good for. In some cases, they also instigate a physical or functional reshaping of the new device as they seek to make it fit better into their lives (for example, the Kosher mobile phone).* [51]
>
> *Technological determinism continues to exert powerful influence on public debate. Pervasive popular rhetoric, in such varied contexts as Disney's immensely popular EPCOT Center, advertisements using hi-tech iconography, and Congressional testimony on competitiveness or weapons research, portrays a race toward the future driven by extant technologies which resist critique from any individual person, place, politics or social vision. Deterministic "Technology," inexorably moving forward, intimidating even as it promises abundance, remains the dominant underlying structure of popular attitudes...*
>
> *Technology with its restless innovative energies, operates in public consciousness as an omnipotent force, sometimes benevolent, sometimes nefarious, god-like in power and devilish in whim. When, by contrast, technological decisions are seen as part of an unending and necessary debate about allocating resources toward competing*

goals, in short, as politics in the original meaning of the word, technological practice is situated in a hopeful context of chosen human purposes. From this perspective, retrieving the old tradition of civic virtue, achieved through public action and debate, appears to be a primary national agenda. [52]

David Stearns adds:

This scholarship, which started in earnest in the 1980s, challenges two commonly held assumptions: first, that technologies "impact" society in a sort of one-way, deterministic relationship; and second, that technology advances independently of society according to its own internal, relentless, and unstoppable logic. This sort of view, which is commonly referred to as "technological determinism," was fairly prevalent among early critics of technology, and is still quite common today among journalists, and dare I say it, popular Christian writers as well. The trouble with technological determinism is that it just doesn't square with what we see in detailed historical case studies. New technologies most certainly shape the societies that adopt them, but instead of being mere passive recipients of new technologies, early adopters often play very active roles in shaping our understanding of what a new device or system actually is, as well as what it is good for.

Most innovations seem to have a certain degree of "interpretive flexibility." The meanings we now associate with things like bicycles, telephones, synthesizers, or payment cards (to give just a few examples) were actually worked out in a dynamic interplay between designers, manufacturers, marketers, and consumers. In some cases, early adopters have also helped to physically and functionally reshape these new devices so that they better fit with their social values... But the deeper problem with technological determinism is that it leaves us with a rather bleak choice regarding new devices that we find problematic: adopt it and suffer the inevitable consequences; or entirely reject it. When we use this sort of logic, we think about technology in the same way an addict thinks about his drugs, and it leaves us feeling just as powerless, and just as hopeless. [53]

Florman responds to the notion that technology is out of control:

The first anti-technological dogma to be confronted is the treatment of technology as something that has escaped from human control. It is understandable that sometimes anxiety and frustration can make us feel this way. But sober thought reveals that technology is not an independent force, much less a thing, but merely one of the types of activities in which people engage. Furthermore, it is an activity in which people engage because they choose to do so. The choice may sometimes be foolish or unconsidered. The choice may be forced upon some members of society by others. But this is very different from the concept of technology itself misleading or enslaving the populace. [54]

DANGERS OF TECHNOLOGY

The direction new technology takes often surprises us. Henry Ford said, "If I had asked people what they wanted, they would have said 'a faster horse.' "Fifty years ago, who would have predicted laptops? Smart phones? Amazon? Facebook? Google? Dropbox?

When we look at the critiques of technology over the past century, we need to keep in mind that the earlier writers were primarily focusing on machinery and automation, while current writers are usually focusing on computer technology and smart phones.

Technology has made life easier and contributed to human progress, yet technology is not without potential dangers. Various writers have developed in detail the dangers and drawbacks of technology:

Technology can dehumanize people as people take on repetitive industrial jobs.

Jacques Ellul felt that technology was dehumanizing us and described his concern in detail.

> *In his work The Technological Society... Ellul gives a phenomenology of technology and its role in society, shifting from one aspect to the all- encompassing paradigm. He argues that the modern mindset after the industrial, political, scientific, technological revolutions of the 15th-19th centuries shifted from one in which technical knowledge was one among many types of knowledge and technology was descriptive of tools or machines, to the contemporary notion that every aspect of life is technical, can be measured, made more efficient, commodified and in extension to his work marketed. For Ellul, the machine has us, because we have become the machine.* [55]

Technology can push society in an undesirable direction.

Langdon Winner expanded on Ellul's thoughts in warning of 'technological determinism," arguing that "changes in technology are the single most important cause of change in society," primarily because of the unpredictable social consequences that accompany technology. [56] The disturbing motto of the 1933 Chicago World's Fair was "Science finds - Industry applies - Man conforms." [57] In the myth of human progress, technology is the engine that moves mankind forward.

The end result of society conforming to technology is a state that Neil Postman called "technopoly." Technopoly, in Postman's formulation, involves "the submission of all forms of cultural life to the sovereignty of technique and technology." [58]

> *Technopoly is a state of culture. It is also a state of mind. It consists in the deificaiton of technology, which means that the culture seeks its authorization in technology, finds its satisfactions in technology, and takes its orders from technology. This requires the development of a new kind of social order, and of necessity leads to the rapid dissolution of much that is associated with traditional beliefs.* [59]

Technology can separate us from nature.

It is not some mystical oneness with nature that we need, but rather a deep appreciation for the world God made. It is essential that our children realize that our wood and our wool, our sandwich meat and our milk, initially come from the natural world and not from the store. It is important for our inner health that we "escape" on a regular basis from our concrete and steel buildings to be refreshed by a forest or a waterfall. (The irony of modern life is to watch a televised nature show instead of going outdoors or to drive ten miles to find a place to hike for a mile.) When we are sufficiently separated from the natural world, we may be very willing to exploit nature for the sake of increased technology.

> *From morning to night, we walk through a world that is totally manufactured, a creation of human invention. We are surrounded by pavement, machinery, gigantic concrete structures. Automobiles, airplanes, computers, appliances, television, electric lights, artificial air have become the physical universe with which our senses interact. They are what we touch, observe, and react to. They are themselves "information," in that they shape how we think and, in the absence of an alternate reality (i.e. nature), what we think about and know.* [60]

> *There is a paradox, however. Because technology is now everywhere apparent, pervasive, and obnoxious, we lose awareness of its presence. While we walk on pavement, or drive on a freeway, or sit in a shopping mall, we are unaware that we are enveloped by a technological and commercial reality, or that we are moving at technological speed. We live our lives in reconstructed, human-created environments; we are inside manufactured goods.* [61]

Technology can separate us from other people.

A familiar sight in our age of instant communication is a couple at dinner, each messaging on a phone rather than talking with each other, or students waking with earphones or handheld games, oblivious to the world around them. Facebook can be ideal for re-connecting with old friends, but many teens have hundreds of Facebook friends and few real friends. The Amish oppose technology largely because it separates people.

> *Truthfully, I cannot think of anything that distracts us so fully and completely and consistently as technology. For too many of us, technology is a master and not a servant. It is our owner, not our possession. We let it run and rule our lives. We allow technology to determine the course of our lives, taking us where it leads. We determine our schedules with TV Guide in one hand, a Blackberry calendar in the other. We invest countless hours in online friendships, many of which are shallow and insignificant, while ignoring people in our local churches and communities. Perhaps while ignoring even our own families.* [62]

Nicholas Carr has recently modified Maslow's hierarchy of need into a hierarchy of technology. [63] At the lowest level is Technologies of Survival (food, clothing, shelter), followed by Technologies of Social Organization (agriculture and basic defense), Technologies of Prosperity (industry),

Technologies of Leisure (entertainment and mass media), and capped with Technologies of the Self (self-expression, identity management, vanity). It appears that our culture has now entered the highest level, which is actually the most selfish and least beneficial level.

Technology can separate us from God.

Borgmann, in his study appropriately titled *Power Failure*, emphasized that increasing technology leads to decreased spirituality. [64]

Living and working indoors, in a nearly-completely man-made environment, surrounded by artificial lighting, computer screens, and television monitors, makes it easy to miss all of nature and the wonders of the night sky. There is little to remind us of the awesome grandeur of God.

If C.S. Lewis were writing today, one could imagine his Screwtape advising apprentice tempter Wormwood on how to exploit technology to keep people from God:

> *Technology can, of course, be a powerful tool for the Enemy in getting His message out worldwide, but we can easily use it for our advantage. Keep them full of sound and entertainment. Let them think of every gathering with music as simply a religious version of "American Idol." Don't let them think deeply. Keep things too noisy for them to pray. Make sure they're wired 24/7 and tire them out with their technology.*
>
> *Keep them distracted and never fully attentive. Encourage them to keep up with their e-mail in church while they are supposedly following the Bible readings on their phone. Insist that they be obsessed with having the very latest products in every area. Keep them from thinking deep thoughts by tying them up in trivia.*

Derek Schuurman suggests that technology moves people to replace the Dominion Mandate of Gen. 1:28 with a "technical mandate" in which pursuing technology directs our lives, replacing a need for God with a need for, a worship of, and a dependence upon, modern technology (techno-idolatry). [65]

> *We are at the end of the religious era in human history. Technology has brought to a climax the process which now renders God quite unnecessary and brings man to a type of maturity in which he will no longer accept a position of dependence. The consequence of this...is that all those concepts by which we speak about God are either meaningless or appear as the relics of a religious era. Thus, those who are living most fully and freely in a technological age are simply uninterested in the question.* [66]

Technology carries the risk of reductionism.

We are continually reducing all of nature, including human beings, to machines or to mechanical cause-and-effect. [67] If nature can be digitized and computerized then we may think that we have full understanding of its behavior and the capability to control all of it. By losing the aspect of relationships (how we relate to the object, how the object relates to the culture, how we relate to God in the use of the object) we lose the meaning of our technical artifacts and the ability to interpret objects and nature, "much like we might the Bible or some other text." [68]

Technology moves us towards "technicism," the idea that everything is technical.

Technicism is an over-reliance on technology, reducing most of life to the technical, and sustaining the belief that, somehow, technology will save us.

> *In short, technicism, or the implicit ideology of technology, is the dominant expression of the humanistic ground motive. Technicism entails the pretension of the autonomous man to control the whole of reality: man, the master seeks victory over the future. He is to have everything his way. He is to solve problems old and new, including problems caused by technicism, so as to guarantee an abundance of material progress.* [69]

Schuurman [70] suggests that the true father of technicism was actually the same Francis Bacon who made such great contributions to our understanding of modern science. Bacon's primary work was New Atlantis, a utopian book detailing "an ideal society in which all power is in the hands of natural scientists and engineers who will make sure that 'progress' happens."

Technology can lead people to utopian thinking

A human-generated utopia is the goal of those who tie future progress to computer-brain research, artificial intelligence, and genetic modifications to end the aging process.

> *Instead of trying to realize a utopia, a Christian perspective should be aimed at developing technologies for an imperfect world. In a way, this is what engineers normally do. In that respect, all this utopian rhetoric must often sound strange to engineers, since they know by experience that, at the very heart of a problem in engineering design, a designer must deal with conflicts in the list of requirements and make appropriate trade-offs. This is what engineers learn in their education, and in practice, they find out the importance of these considerations. Here we see confirmation of what C. S. Lewis claimed in his book Mere Christianity, namely, that the Christian approach is the most rational one. It is an illusion to believe that we can realize a utopia through technology. Rather, we should learn to deal with the imperfection of reality.* [71]

Technology leads to overconsumption and the production of useless goods

Swearengen and Woodhouse, writing from a Christian perspective, warn us that the modern values of "speed, quantity, and the proliferation of variety" all contribute in the West to overconsumption, the production of more than is necessary, with accompanying waste, pollution, and depletion of resources. [72] The industrial push for rapid time-to-market development cycles and 3 to 5 year service life or obsolescence of products, coupled with growing materialism result in an unhealthy social system. The authors urge us to tie this discussion to the area of engineering ethics and include it in the engineering curriculum.

> *Thousands of 'new products' are introduced to the market every year, the vast majority of which are not bought by enough people and soon disappear from the market. Was*

there a societal need for these products? Was 'lower cost to the user' a criterion for developing, producing, and marketing them? In fact, pricing of all the corporation's products must reflect losses from those that 'failed.' Hence, prices on other products of the corporation generally must rise as a result of these "innovations," quite contrary to the ideologically stated reason for product innovation. [73]

Technology can blind us to the results of our designs.

For many in the modern age there is something almost seductive about a highly realistic graphics display or cleverly designed user interface. Teens are often drawn into violent video games and increased tolerance for violence without realizing what is happening. Even at the level of equations and production drawings technology can blind us to the end results of technology. Heie and Swearengen both recount instances in their engineering careers when they were so deep in designing missile systems and nuclear weapons that they never paused to consider the implications of their designs, a fact which later troubled them. [74] [75]

At first thought medical technology seems to be beyond the drawbacks of technology, but as we look deeper there are at least two:

1. While automated diagnostic equipment can greatly help in pinpointing disease processes and faulty organs, at the same time it can diminish a physician's personal skills in diagnosis. [76]
2. Because of huge development costs, small markets, and the possibility of lawsuits therapeutic and rehabilitation equipment (including joint implants, pacemakers, and prosthetic limbs) typically carries a huge price tag. The poorest among us could never afford them, and there are no minimum-feature low-cost alternatives.

TECHNOLOGICAL PERSONALITY

One of the results of widespread technology in modern societies, writes Richard Stivers, is the emergence of the modern technological personality, "the psychological counterpart to the technological society." By experiencing so much of the world through "secondhand experiences" from the media and social media we risk the "loss of attention, memory, thought, and feeling." [77]

With regard to technology and the modern personality Stivers makes these observations: [78]

1. Technical consciousness turns knowledge into abstract information.
2. Technical rationality does not depend on experience, practical knowledge, and moral judgment
3. As technology destroys symbolic meanings, it puts the objective and subjective at odds.
4. The loss of direct experience results in a loss of a sense of reality.
5. Technology appeals to our will to power.
6. Modern technological societies are high-tempo and high stress.
7. There is a decline in logical thought and critical reflection.

8. One tends to live for the moment.

None of the results that Stivers describes fit with the profile of a growing disciple of Jesus.

TECHNOLOGY IMPACTS SOCIETY

Technology, says Marshall, both shapes our options and limits our choices:

> *We now use technology as a part of a world that is itself shaped and made by past and present technology…We live and act within a technically shaped world, one that in turn shapes and limits what we do. We make decisions and we act within the possible choices and options presented to us by a world that we (or others) have already shaped, opened, or constricted by our previous actions and techniques. When we use a tool, we shape a world, but it in return shapes not only what we do but also what we can do.* [79]

Peter Kilpatrick gives the following guidelines regarding technology and society: [80]

1. Technology and its applications will grow increasingly powerful.
2. We must be attentive to drawing clear lines between what we can and what we must not do in applying technology.
3. Our society and culture needs more discussion and debate about what can and should be done and why.
4. Too many in our society believe the maxim Verum quia faciendum (Truth is what can be made) rather than Verum est ens (Being is truth); this leads to society's belief that technology can create a future of our own choosing.

RESPONSIBILITY OF ENGINEERS FOR TECHNOLOGY

Many engineers have recently become analysts of the way that technology is used. As developers of that technology such a position is reasonable. Individual engineers can and should discuss and influence the social uses and limitations of technology.

When is the engineer actually responsible for what happens with the design that he or she produced?

The engineer is responsible when the design in used in the manner for which it was intended. The engineer cannot be held responsible when a design is used in a way far different from what was intended. Huber's book *Liability* [81] provides several examples of lawsuits brought against companies and designers as a result of injuries due to foolishness on the part of the user. A key example was using a lawnmower overhead as a hedge clipper.

> *Technology profoundly transforms society. How should technology be guided toward humane purposes? Who bears primary responsibility? Who but the engineers who*

create new machines, devices, structures, and systems are in the best position to know the properties, the capabilities, the liabilities, and the potential consequences of producing and deploying them? This responsibility is both individual and collective. [82]

That humanity was given the role of shepherding creation towards its destiny in Christ implies joyful responsibility in all areas – others ignore ethics or reduce it to power. That the Mosaic law and prophets were concerned with structural good and evil implies that we should be too – many focus only on individual ethics. That evil arises because we turn away from God and that Christ came to save implies we should not look to (technology) to solve our problems, but should focus on changing the human heart. That we live in God's world implies that ideas emerging from supposedly godless minds might include some genuine insight – I am therefore challenged to sift and discern. [83]

TESTS FOR NEW TECHNOLOGY

Mander proposes that we approach each new technology according the following criteria: [84]

1. *Since most of what we are told about new technology comes from its proponents, be deeply skeptical of all claims.*
2. *Assume all technology "guilty until proven innocent."*
3. *Eschew the idea that technology is neutral of "value free." Every technology has inherent and identifiable social, political, and environmental consequences.*
4. *The fact that technology has a natural flash and appeal is meaningless. Negative attributes are slow to emerge*
5. *Never judge a technology by the way it benefits you personally. Seek a holistic view of its impacts. The operative question is not whether it benefits you, but who benefits the most? And to what end?*
6. *Keep in mind that an individual technology is only one piece of a larger web of technologies, "megatechnology." The operative question here is how the individual technology fits the larger on.*
7. *Make distinctions between technologies that primarily serve the individual or the small community (e.g., solar energy) and those that operate on a scale outside of community controls (e.g., nuclear energy)*

When should we limit technology?

- When it diminishes humanity/personhood
- When it physically harms any person
- When it impairs the poor

- When it clearly violates our privacy
- When it puts one group against another
- When it makes us "slaves" to technology

CONCLUSIONS

Our lives and cultures are deeply tied to technology and its impacts.

- Technology is so much a part of our lives that we don't routinely think about it.
- Technology changes the way we do common tasks.
- Technology definitely makes some things easier, but at the same time complicates life (upgrades, maintenance, repairs, replacement, use).
- New technology eventually displaces the old technology.
- Technology changes the landscape. The transcontinental railroad united the country. Automobiles made suburbia possible.
- We seldom think about the negative consequences of a technology.

When we do ponder technology, is our emphasis on human creativity and ingenuity, or on human misuse of technology? Is our emphasis on Creation or Fall? Technological optimists tend to focus on humans in the image of God. Technological pessimists focus on humans as fallen creatures. Since humans are both (amazing creations and fallen creatures), technology is simultaneously both (positive/ingenious and capable of horrendous misuse), and that's where the problem lies.

We misuse what we've made if we use it

- To obscure what God has made
- To drown out God's image in humankind
- To destroy what God has made
- To worship it as an idol.

Knowing that technology can be misused — or even used destructively — we must be aware of potential problems and put safeguards in place as we use it. The following chapter will look at the theology of technology and some suggested approaches for its use.

REFERENCES

1. Terlizzese, L., "What is Technology?" Probe Ministries, https://probe.org/what-is-technology/
2. Pitt, J., *Thinking About Technology*, Seven Bridges, 1999.
3. Unger, S., *Controlling Technology*, Wiley, 1994, p.3.
4. Allenby B., and Sarewitz, D., *The Techno-Human Condition*, The MIT Press, 2011.
5. Terlizzese, op. cit.
6. Whelchel, R., "Is Technology Neutral?" *IEEE Tech. Soc.* 5(4) December 1986, p. 3-8.
7. Monsma, S., *Responsible Technology*, Eerdmans, 1986, p.19.
8. Simpson, D., "Francis Bacon," https://iep.utm.edu/bacon/
9. Toffler, A. *The Third Wave*, Morrow, 1980.
10. Brynjolfsson, E., and McAfee, A., *The Second Machine Age*, W.W. Norton, 2016.
11. Ermer, G., "What I wish My Pastor Knew About Responsible Engineering and Technology," Center for Excellence in Preaching, Calvin Theological Seminary (2011).
    http://ministrytheorem.calvinseminary.edu
12. Aycock, D., "Christian Objections to High Technology," *Persp. Sci. Chr. Faith* 38 (June 1986): 88-95.
13. Marshall, P., and Gilbert, L., *Heaven Is Not My Home: Learning to Live in God's Creation*. Word Pub., 1998, p.172.
14. Rocha, L., "Technology," https://homes.luddy.indiana.edu/rocha/academics/i101/lec02.html
15. Myers, K., "Technology," Mars Hill Tapes.
16. Balabanian, N., "On the Presumed Neutrality of Technology," *IEEE Tech. Soc.*, Winter 2006.
17. Swearengen, J., *Beyond Paradise: Technology and the Kingdom of God*, Wipf & Stock Publishers, 2007.
18. Postman, N., "Five Things We Need to Know About Technological Change," Talk delivered in Denver, Colorado, March 1998.
19. More, T., *Utopia*, Create Space, 2019.
20. Wauzzinski, R.A., *Discerning Prometheus*, Fairleigh Dickinson University Press, 2001.
21. Cass, S. (interviewing Darin Barney), "Philosophy for a Networked World," *IEEE Spectrum*, Jan. 2001, 127-131.
22. Zachary, G.P., "What Frankenstein Can Teach Engineers," IEEE Spectrum, February 2017, p. 8.
23. Meijknecht, T., and Van Drongelen, H., "How is the Spirituality of Engineering Taught or Conveyed?" *Int. J. Engin. Ed.* Vol. 20, No. 3, 2004: 447-451.
24. Sunshine, G., "Hugh of St. Victor," http://www.colsoncenter.org/the-center/columns/indepth/17398-hugh-of-st-victor-1096-1141

25. Koslowski, P., *Nature and Technology in the World's Religions*, Kluwer Academic Publishers, 2001.
26. Swearengen, op. cit.
27. "Technology," Council for Christian Colleges and Universities, *www.cccu.edu*
28. Strauss, L., Atomic Energy Commission, 1954-quoted in Eisenstein, C., *The ascent of Humanity*, https://ascentofhumanity.com/text/chapter-1/
29. Balabanian, op.cit.
30. Brynjolfsson and McAfee, op. cit.
31. Dickey, C., "A fault in our design," https://aeon.co/essays/technological-progress-makes-us-more-vulnerable-to-catastrophe
32. "Technology," Council for Christian Colleges and Universities, op. cit.
33. Balabanian, op. cit.
34. Newberry, B., "Are Engineers Instrumentalists?" *Technol. In Society*, 29(1) Jan. 2007, p. 107-119.
35. Ibid.
36. Ibid.
37. Adams, C., Letter, *Persp. Sci. Chr. Faith*, March 2008
38. Church Leaders, "Interview with John Dyer," http://churchleaders.com/worship/worship-articles/157116-john-dyer-technology-the-church.html
39. Terlizzese, op. cit.
40. Ibid.
41. Mander, J., *In the Absence of the Sacred: The Failure of Technology and the Survival of the Indian Nations*, Sierra Club, 1992, p. 36.
42. Marshall, op. cit., p. 179.
43. Vanderberg, W., *Our War on Ourselves*, Univ. Toronto Press, 2011, p.13.
44. Ibid.
45. Balabanian, op. cit.
46. Whelchel, op. cit.
47. Swearengen, op. cit.
48. VanderLeest, S., "Technology Devotion," Calvin College.
49. Karmarker, U., et. al., "Marketers Should Pay Attention to fMRI," *Harvard. Bus. Review*, Nov. 3, 2015, https://hbr.org/2015/11/marketers-should-pay-attention-to-fmri
50. Ellul. J., *The Technological Society*, Random House, 1967.
51. Staudenmaier, J., "Technology," in Fox, R., and Kloppenberg, J., eds., *A Companion to American Thought*, Blackwell, 1995:667-69.
52. Ibid.

53. Stearns, D., Opening Remarks, The Digital Society Conference, June, 2012, Seattle Pacific University.
54. Florman, S., *The Existential Pleasures of Engineering*. St. Martin's Griffin, 1996, p. 58.
55. Sleasman, M., "Thinking through Technology Part 1," The Center for Bioethics & Human Dignity, 2008, http://cbhd.org
56. Langdon Winner, quoted in Pieter Vermaas, P., et. al., *A Philosophy of Technology*, Morgan & Claypool, 2011, p.86.
57. Balabanian, op. cit.
58. Sacasas, M., "Neil Postman, Technopoly, and Technological Theology," http://thefrailestthing.com/2011/07/25/neil-postman-technopoly-and-technological-theology/
59. Postman, N., *Technopoly: The Surrender of Culture to Technology*, Alfred A. Knopf, Inc.,1992.
60. Mander, op. cit., p. 31.
61. Ibid.
62. Challies Challies, T., "Technology-An Evil Master," https://www.challies.com/articles/technology-an-evil-master/
63. Carr, N. "The hierarchy of innovation," http://www.roughtype.com/?p=1603
64. Borgmann, A., *Power Failure: Christianity in the Culture of Technology*, Brazos Press, 2003.
65. Schuurman, D., "Forming a Christian View of Computer Technology," *Journal of the ACMS* 2007. http://www.acmsonline
66. Shaull, R., "Technology and Theology," *Theology Today* 23(2) July 1966,p. 271-275.
67. Kallenburg, B., *God and Gadgets: Following Jesus in a Technological World*, Wipf & Stock Publishers, 2011, p.10-12.
68. Van Poolen, L. "Towards a Christian Theory of Technological Thing," *Christian Scholars Review* Vol. 33, No. 3 (2004): 367-378.
69. Egbert Schuurman, quoted in Wauzzinski, R., "Technological Optimism," *Persp. Sci. Chr. Faith* 48 Sept. 1996, p. 144-153.
70. Schuurman, D., "Forming a Christian View of Computer Technology," *Journal of the ACMS* 2007. http://www.acmsonline.
71. de Vries, M., "Utopian Thinking in Contemporary Technology versus Responsible Technology for an Imperfect World," *Persp. Sci. Chr. Faith* (2012).
72. Swearengen, J. and Woodhouse, E., "Overconsumption: An Ethical Dilemma for Christian Engineers," *Persp. Sci. Chr. Faith*, 54(2) June 2002, p. 80-92.
73. Balabanian, N., "Controlling Technology: Should We Rely on the Marketplace?," *IEEE Tech. Soc. Magazine*,19 (2),2000: 23-30.
74. Heie, H., "Christian Engineers as Faith Witnesses to God's Redemptive Purposes for Creation," *Proc. Christian Engineering Engineering Conference* (1999).
75. Swearengen, 2007, op. cit.
76. Postman, 1996, op. cit.

77. Stivers, R., The Technological Personality, *Bulletin of Science, Technology, and Society*, 24(6): Dec. 2004, p. 488-499.
78. Ibid.
79. Marshall, op. cit., p. 179.
80. Kilpatrick, P., "Science, Innovation, Engineering and Technology and Catholic Social Teaching," Technology and Human Flourishing Conference, Baylor University, 2012.
81. Huber, P., *Liability*, Basic Books, 1990.
82. Balabanian, 2000, op. cit.
83. Basden, A., "Ethics of Information Technology," *Ethics in Brief*, Spring 2009.
84. Mander, op. cit., p.49.

CHAPTER 20: TOWARDS A THEOLOGY OF TECHNOLOGY

INTRODUCTION

I recently asked a seminary graduate what link he saw between theology and technology. "Nothing," was his initial answer. "We don't need technology to know God….On the other hand, the right technology might help us to know God better….but so often technology overwhelms theology. We get so focused on the technology that we miss the message." We talked for a while about how modern technology has become a trap for many people, very similar to the effects of getting into debt. It took dedicated teaching in the church, discussions on Biblical principles for finance, and books or seminars by Larry Burkett, Ron Blue, and Dave Ramsay to put things into perspective and find a balance point with money. There is a visible need for a similar discussion and development of a theology of technology.

Do we have a theology of technology? Do we think about the stuff we own?

- How we use it?
- How we relate to it?
- How it impacts our society?
- How it impacts our spiritual lives?

Theology must have an intersection with technology, since technology has become such an integral part of human existence that we seldom think about it. We would be hard-pressed today to live without car, a clock, or a computer (although a smart phone might replace the need for the latter two.) The next step, suggests David Rose of the MIT Media Lab, will be the development of "enchanted objects", everyday objects endowed with sensors and links that anticipate our needs. [1]

We must affirm that God cares about cars, computers and smart phones. Since God cares about everything that affects our lives He certainly cares about technology.

A theology of technology would also link to several other areas-

- The theology of work (Tink); [2]
- The theology of vocation (Veith); [3]
- The theology of business (Chewning); [4]
- The theology of creativity (Conner); [5]
- The theology of innovation (Vincent); [6]
- The theology of design (Halsmer); [7]
- The theology of the near future (Gary). [8]

A fully developed theology might include considerations of God (theology proper), of man (anthropology), of Christ (Christology), of salvation (soteriology), of the church (ecclesiology), and of the end-times (eschatology).

Does technology -or the language of technology - help us to better understand God, man, or any of these topics? I'm not comfortable with the metaphor of humans as machines, of God as giant Computer, or Gamer, or Hacker. [9] More likely, technology may change the way we relate to God or to each other.

Ideally, we can find some direction regarding our use of technology. Unfortunately, the Bible says nothing about smartphones, blue-ray players, automatic transmissions, or modems. While we won't find specific instructions for technology in the Scripture, we will discover some guidelines and the wisdom we need to navigate the issues.

CHRISTIAN OPPOSITION TO TECHNOLOGY

Some believers have opposed technology because of an idea that modern technology is paving the way for the events of the book of Revelation. (The Beast is a name given to a giant computer in Brussels. Artificial Intelligence can become a tool of the Antichrist. UPC bar codes enable the mark of the Beast.)

Christians have approached technology in many of the ways that we approach of all culture (Crouch). [10] We either oppose it, critique it, or blindly embrace it. Ideally, we should develop it, transform it, and redeem it.

At the outset we need to distinguish between

- technology in general (any human-crafted thing);
- technology as technique, which saps our humanity (Ellul); [11]
- technology of machinery and automation;
- specific categories of technology- Agricultural, medical, manufacturing, communication, computing, and specific objects of technology, such as combines, sewing machines, or DVD players.

Vander Leest is clear that technology is an amplifier of both human virtue and vice: [12]

> *Much of the attraction of technology is because it amplifies our abilities, making us each a superhero of sorts. We can extend our vision with telescopes to see farther, microscopes to see closer, MRI and X-Ray machines to see inside. We can extend our limbs with tweezers to grab small slivers, hammers to pound harder, stilts to stand taller. Technology not only makes individuals more powerful, but it also makes nations more formidable. Military inventions have often provided the decisive factor in battle. Think of the advantage of the crossbow over the older bow and arrow. Think of the advantage of aircraft over exposed land troops. Think of the ominous threat of thermonuclear warheads delivered by missile.*

Why do we develop technology? Hopper suggests the following:

> *Technology offers always some new immediacy, some new luxury, along with relief from the boredom of past technologies. The people who do technology most frequently simply assume they are fulfilling society's values: extending life, easing the burden of work, providing new comforts and diversions, and simply solving problems. Some others – such as corporate managers – understand technology to be a vital means of securing economic power, a necessity in economic competition. Others, in government, see it as an essential means of military and international power.* [13]

TECHNOLOGY IN THE BIBLE

If we approach technology as Dyer does [14] we can see technology throughout the Bible. Adam likely used some tool to cultivate the Garden. (This is not explicitly stated. In fact, it may have been a very sophisticated plow since pre-fall Adam was probably a genius.)

We can see technology interwoven throughout the history of humans and of Israel —

1. Adam and his descendants were farming and at some early point using farming tools to cultivate the land.
2. Tubal-Cain was skilled in all areas of metalworking (Gen. 4:22)
3. Noah was given a detailed set of plans for the building of the ark. (Gen. 6: 14-16)
4. Babel (Gen. 11) should not be read as God's objection to human technology, but rather as God's displeasure with human pride and desire to ascend to the heavens.

> *Over the past 200 years, since the advent of modern technology, man has become increasingly secular. The more we can figure out the hows and whys of the world, it seems, the less we need to believe and trust in God and religion. Man has become too confident, too secure with his control over many things in the world and looks at religion as designed for primitive thinkers.* [15]

4. Moses was given a detailed set of instructions for the construction of the tabernacle, including furniture and furnishings. (Ex. 37-38)
5. In the period of the judges, blacksmithing and bronze working were highly developed among the coastal people of Philistia (the Philistines) and by restricting it to their region was used to keep the Israelites defenseless. (I Sam. 13:19)
6. Based on the pattern of the tabernacle, Solomon contracted out the construction of the first temple, including bronze castings "in the plain of Judah in clay molds "(I Kings 7:46), probably a reference to a large sand-casting process.

In each case, it can be assumed that God expected the people to make whatever use of technology was appropriate to achieve the goal. Perhaps this is no surprise, but we should not overlook the fact that there could have been other approaches. God could have made tools unnecessary or provided all the tools that were necessary. God could have specified exactly what to do rather than leave so much open to Noah, Moses and Solomon's initiative. But God's typical

approach when acting in the world is to delegate. God lets us know the goal and an ethical framework, even the wisdom and resources, but then relies on our initiative to work out the details. [16]

7. Throughout the period of kings, suggests Douglas Estes, we see that the chariot in the ancient world enabled kings and warriors to enter battles and also symbolized power and victory in warfare. [17] God sent a chariot of fire to take Elijah to heaven. (2 Kings 2:11)
8. In Hezekiah's day (circa 710 B.C.), a tunnel was completed connecting the Pool of Siloam with the inner city of Jerusalem (2 Kings 20:20, Isa. 22:9). In a remarkable work of "engineering," tunneling was done from both ends and met in the middle.
9. Throughout the accounts of the nation of Israel we see the technology of the day employed for agriculture, construction, defense, large construction, furniture and art, and "engines of war". Mechanical principles were employed in the construction of grinding millstones, winepresses, and olive presses.
10. Since technology is an integral part of human activity, Jesus used the technology of His day: shoes, boats, coins, and roads. [18]

TECHNOLOGY AND CHURCH HISTORY

As we look at church history, we see the large part that technology has played in the kingdom of God. We are told in Galatians that God sent forth His Son "in the fullness of time." Many commentators suggest that the optimum timing for Jesus' birth and ministry coincided with the spread of the Greek language and the development of the Roman road system, making the first missionary journeys much more effective than they would have been before.

Brad Kallenberg describes the medieval monk Hugh of St. Victor (from the monastery of St. Victor in 12th Century Paris) as a prime force in encouraging religious leaders to accept technology (which he termed "mechanical arts) as a blessing from God. Theology and mechanical arts, he wrote in his *Didasacalion*, are mutually supportive. [19]

A bridge, for example, can overcome distrust and enmity by bridging a river or valley between two tribes.

"Mechanical arts have to do with countering the effects of the curse, just as theoretical and practical arts have to do with countering the effects of human depravity through the knowing and following of a gracious God on a redemptive path." [20]

With the understanding that manual work could glorify God, monasteries became centers for technology and innovation.

Gutenberg's printing press then made it possible to place the Bible in the hands of the common man.

Modern Technology

Modern technology differs from previous technologies in some critical ways:

1. Modern technology is not recognizable as having come from the natural world. We can readily recognize the source of things made from wood, clay, stone, animal skins, and even processed metals. Devices fabricated from plastics and semiconductors do not have a clear link to nature.
2. Modern technology is designed using principles and calculations that are not recognizable by looking at the object. Most people with some basic science background can spot gears, levers, lenses, pumps, and other components of physical things. The memory address register, program counter, cache, wireless receiver, and other parts of computer technology are totally hidden from us.

While all technologies were amplifiers of human effort, modern technology amplifies speed and narrows distance in ways that astound us. We can bless - or curse, spread truth - or lies, completely around the globe in seconds. While modern technology does not cause us to sin, it does make it easier to sin. Particularly in such areas as identity theft, malicious viruses, and online pornography, computer technology provides the twin catalysts of access and anonymity.

TECHNOLOGY AND THE CHURCH

In terms of ecclesiology — All aspects of church life — worship, fellowship, evangelism, missions — are being impacted by technology. Technology changes how we worship (electric lights, air conditioning, microphones, speakers, computers, projectors, PowerPoint presentations, mixer boards, guitar amps, even the way church auditoriums are laid out).

There is no question that technology has changed — and improved — many things for the local church:

- Bible study software is available
- Bible background material and sermons are available online
- Bibles are available on smart phones and iPads
- Prayer requests can be texted or emailed
- Announcements can be texted or emailed
- Sermon outlines are projected as PowerPoints
- Hymns and choruses are projected as PowerPoints
- Sermons and transcripts can be archived online

Today's Technology Benefits God's Kingdom

In many ways computer-based technology is, and will be, contributing to the blessing of people and the advancement of God's kingdom:

- Immediate sharing of prayer requests, even from continents away (email, Skype, texts)
- Making emergency needs known (email, web)
- Sharing of Bible verses (email, texts)
- Bible on tablet and phone

- Posting daily Bible readings (email, web)
- Posting of sermons and worship services (web)
- Posting Christian teaching material (web)
- Posting Bible study aids (web)
- Posting Bible material in multiple languages (web)
- Posting material on world missions (web)
- Posting upcoming conferences and seminars (web)
- Software assistance for Bible translators
- SEED Bible (Bible smart phone)
- Virtual reality- Tour of Bible lands and ancient sites
- Virtual reality -Tour of mission work

Church 3.0?

Patrick Lai [21] has described the shift from

- Travel 1.0 (meet with travel agents, multipart tickets) to
- Travel 2.0 (phone calls with airline agents, simpler tickets) to
- Travel 3.0 (all computerized, e-tickets, printed boarding passes, no human interaction needed to select flight, cost, seat, baggage plan).

Shopping has undergone a similar change. International missions is undergoing a similar change.

Will there be a "Church 3.0"? We personally select music and sermons, with no human interaction. That defeats the whole idea of fellowship with real people. ("Don't neglect gathering together." ... Hebrews 12...)

Printed tracts and sermons and radio broadcasts have certainly helped to reach people with God's message, but they aren't a substitute for real people demonstrating love and telling about God's love and faithfulness. Several years ago Joe Bayly wrote a delightful little booklet called "The Gospel Blimp," about a church that decided to blitz their city by buying a blimp from which they would broadcast to every neighborhood and drop tracts in every yard. The results were disastrous: Tracts filled up house gutters and covered the football stadium. The sound system scrambled TV signals. In the end, visiting neighbors in the hospital was the turning point in helping them come to Christ.

> *Joe Bayly gives his interpretation of this modern-day parable in the final chapter. "The little city where the Gospel Blimp was conceived is the world, our latter twentieth century American world, in which Christians work and play, raise children, buy automobiles and face the devil." ...The Blimp? Bayly says, "Why the wonderful Gospel Blimp is every impersonal, external means by which we try to fulfil our responsibility to witness to our neighbors. Gospel programs over the radio, messages on billboards or in tracts; these are some of our blimps." "These are poor substitutes for personal communication of the gospel, the sort of witnessing we glimpse from afar in the New Testament." Bayly says, "Technical, organizational means have one enormous lack: a human heart. They may multiply a voice ten thousand times, but it remains only a voice."* [22]

Questions to Consider

Reflecting on a theology of technology might prompt the following questions:

- Where does technology fit in God's redemptive story?
- Why did God give us the gift of/a capacity for creating technology?
- What are the multiple effects of the fall on technology?
- How does redemption impact technology?
- How does technology change our view of God?
- How do we understand and relate to technological objects?
- What values are associated with technology?
- How does technology change us?
- What problems or dangers are inherent in the use of technology?
- How might technology fit with idolatry?
- How does technology affect our Christian life or spiritual disciplines?
- What design norms should we use in creating technology?
- What guidelines should we develop for use of technology?
- What would a stewardship of technology look like?

Four questions must be asked for any technology —

- Should we even develop the technology?
- If so, how should we design it?
- Should we personally own the technology?
- If so, how should we use the technology?

TECHNOLOGY AND CREATION

Technology fits with each part of God's "grand narrative":

- From Creation- We mimic God in our designing and developing
- From the Fall- Technology is affected by human sin
- From Redemption- Technology can be redeemed and used for God's glory

Creation

In Creation God gave us everything we need (the resources, the physical laws, the abilities) to produce technology.

Humans produce offspring after their likeness. They also produce the product of their ideas. Birds make nests, beavers make dams, and humans make anything their tools can produce. Human creativity reflects the image of God.

"Technological activity," write Campbell and Garner," might in fact be seen as a response to God's call." [23]

Technology is part of God's "common grace" and flows out of Gen. 1:28.

Tim Keller says that between Gen. 1:28 and Gen. 2:15, technology is actually commanded. Adam was to unleash the potential of the earth, not leave it exactly as he found it. [24]

Monsma indicates that "God calls his children as his image bearers to be formers of culture. As such we purposefully take what is given in God's creation and creatively form it into art, language, laws, social mores, societal institutions- and technological tools and products." [25]

For Dessauer, "God continues the creation by means of technology." [26]

From Ellul we learn [27]:

> *Man has been put into the world to complete the work of creation, to gradually take possession of all its goods and to make them useful to himself and his neighbors. Out of this co-creation, thus understood, shines forth the high praise of God in the same way as it does through contemplation and prayer...*
>
> *In Protestant theology we thus find the idea, often set forth in Catholicism, that man has a demiurgic function, that he completes creation, that in some way he creates along with God. If man frees certain created potentialities, if he enriches his stay with marvelous instruments, it is what God wants . . . He rejoices in the progress of his work. . ., in the progressive realization of the possibilities that He mysteriously hid in the heart of the creation . . . In other words, God is the Creator of Techniques . . . The technical operation is sacred; by putting his hand to what has been created in order to transform it, man puts his hand into the hand of God.*

Scott Rae writes:

> *Humans are created in God's image and likeness, and so He charged them to exercise dominion over His creation (Gen. 1:27-28). Their mandate was to subdue and kindly master the earth, unlocking the resources to benefit themselves and their successors- in a sense continuing the spirit of creation by being subordinate "creators" with God in unlocking the secrets of the creation to benefit mankind.* [28]

Technology is the clear result of God's Dominion Mandate and common grace:

> *That ingenuity and wisdom came from God as His "common grace" gifts to humans (Isa. 28:23-29) ...The knowledge and skills necessary to develop the kinds of technologies that enable humankind to subdue the creation are part of God's general revelation.* [29]

God Uses Technology

Like He does with money, God uses technology in the lives of believers —

1. God uses technology to provide for our needs.
2. God uses technology to demonstrate the image of God in humankind.

Dalyrymple writes [30]:

> *If we can marvel not only at the ingenuity of Steve Jobs but even more so at the ingenuity of a God who created Steve Jobs and endowed him with talent and imagination and will, if we can marvel not only at an artificial heart and its capacity to ameliorate human suffering but even more so at the God who fashioned human beings like Paul Winchell with the powers of mind and will to devise an artificial heart, then we will see how we are surrounded by habitual reminders of God's character and majesty. Then we might learn to see watches and mobile phones, contact lenses and computers not as mere physical objects that are spiritually insignificant at best and evidence of scientific materialism at worst, but rather as the physical world's most powerful pointers toward the divine. God uses technology to enable us to explore the universe He created.*

3. God uses technology to enhance human communication and the propagation of His Good News.
4. God blesses us with technology for human pleasure (art, music, travel,).
5. God uses technology to teach us spiritual lessons.

Technology and the Fall

Creation made technology possible and opened up possibilities for great blessings through what we create. Creation, however, was followed by the Fall.

Because of the Fall of humanity, we are not surprised that all of human technology is imperfect, and we often use technology for sinful purposes.

Kolowski specifically links the fall and the origin of technology: "Technology became the prosthesis of fallen man, and we seek with its help to compensate the deficiencies that he has caused for himself and nature by the Fall." [31]

- We may use technology for destructive purposes.
- We may use technology in opposition to God (Tower of Babel).
- We may misuse things that have been made.

The same Internet technology that allows us to access great literature and music from around the world also puts blasphemy and pornography at everyone's disposal.

> *(S)inful human beings misdirect technology in many different ways…We go against God's commands and disregard creation norms, leading to distortions and misdirections of technology. Some examples include computer fraud, disregard for privacy, malicious software (such as viruses and worms), cyberbullying and pornographic websites.* [32]

Technology makes the deadly sins even more accessible —

- Greed: desire to own most of what I see (enhanced by online marketing/shopping)

- Malice: misrepresenting others online
- Lust: internet porn
- Pride/power: technology affords control over others

Fortunately, we know that the Fall is not the end of the story.

Technology and Redemption

It is important for us to realize that Christ's death redeemed *all things* to be subservient to His rule, not just human souls.

"For God was pleased to have all His fullness dwell in Him, and through Him to reconcile all things to Himself, whether things on earth or things in heaven, making peace through His blood that was shed on the cross." (Col. 1: 20)

From Redemption - We learn that God used the technology of the Roman cross to bring about our redemption [33]

From Restoration - We learn that our technology can play a part in overcoming, albeit temporarily, some effects of the fall.

Our approach to technology should be three-fold:

- Restoring technology - from a sinful use that damages others and brings no glory to God
- Redeeming technology - by specifically using it in positive ways to enhance human flourishing
- Responsible technology (Monsma) [34] - designing it in ways that honor our Creator.

We realize that there are multiple purposes for God's people on earth:

- to glorify God
- to know and experience God's salvation
- to serve the Lord
- to exhibit God's salvation
- to demonstrate God's justice and grace
- to make Christ known
- to expand God's kingdom
- to bless others
- to do God's will
- to live abundant and fulfilled lives.

Each of these might be assisted by — or hindered by — technology, depending on how we view and use it.

Technology and our View of God

Technology has changed the way many people conceive of God or of the characteristics of God in our world: [35]

GOD (traditional theology)	TECHNOLOGY (current thought)
God is all-knowing.	Human knowledge will increase. Computers will contain more and more information about the world.
God is all-present.	Interconnections give humanity the impression of omnipresence. Cameras and sensors tied to computers can observe activity almost anywhere.
God is all-powerful.	Human power is now what is possible through technology. Our machines can crush rocks, vaporize solids and join metals.
God is personal, and humans are personal.	God is irrelevant, and humans are primarily machines.
We are dependent on God.	We are dependent on technology.
God is in control.	Humans are in control. We rule the world through our technology.
God is eternal.	Technology can make us eternal by uploading brains to computers.
We are accountable to God.	We are accountable to nothing and to no one. We will use our technology however we want.
There is a spiritual as well as material aspect to life.	There is only a material aspect to life.

According to Schumacher we are living with three illusions: that infinite growth can take place in a finite environment; that there will always be an adequate supply of people willing to be machine slaves; and that science can solve all our problems. These three 'credal statements' form the foundation of a technological ideology. [36]

Our relationships with each other are affected, becoming merely instrumental. Jacques Ellul claims that natural relationships between people are being replaced by 'technological' relationships. We are labelled by what we do rather than who we are. Because our relationship with God is severed, we are losing the concept of the image of God in man. There is then no fundamental bond between us; we simply use each other, like tools, to satisfy our wants and needs. [37]

"Technology must avoid giving the impression that it can create heaven on earth. If it does so, it becomes inhuman." [38]

Does technology ever eliminate our need for Christ? David Jeremiah raises these questions [39]:

- Has technology ever given anyone abundant and eternal life?
- Has technology provided a solution to guilt and sin?
- Has technology shown us God?
- Can technology produce joy and love?

RELATING TO TECHNOLOGY

Technological objects involve not only intended purpose but value, meaning, and relationship. An automobile suggests travel. A cell phone suggests friendship and games. While we think about how we relate to other persons, we seldom think about how we relate to technological objects.

How do we think of our technology? Do we see it as a useful tool, an extension of ourselves, or an absolute necessity? Does our world crash when it doesn't work?

"Ultimately," says Van Poolen, "we can view technological things in a meaningful way because of the overall structure of relational unity given in the divine/human Word, the Logos. In this larger relational unity, the relational character of the quasi-object, hermeneutical text, and localized logos point us to a Christian theory of technological things as containers of information about ourselves: who we are and what we value. These ideas, however, must take shape and form within a larger unity if our interpretation of meaning is to have any reality. This larger unity is that found in Christ, the Logos, the ultimate meaning structure for interpretation." [40]

We are not surprised when psychologists tell us that many of their clients experience self-alienation. People often work at mind-numbing jobs in which they are replaceable parts of a production machine. Because of increased automation they are threatened with losing their jobs. They live in efficiently built suburbs where every house looks the same and where many people spend their leisure hours relating to even more machines (TVs, motorboats, stereos, cars, video games and so on). A psychological problem like self-alienation is often part of the sacrifice technicism requires. But

> *people are beginning to question whether the sacrifice is worthwhile, whether the payoff is big enough.* [41]

Not only have we moved away from the natural world as embrace technology, but we are unable to recreate most of the technology ourselves. Individually, we lack the precision equipment and the skills to make microprocessor chips, cell phones, DVD players, ... Unlike earlier years, when major upsets to life were natural disasters (droughts, wildfires, floods, ..), today's frustrations and upsets primarily come from technology (power outages, computer crashes, traffic jams).

If we were to lose the use of modern technology, most of us could never grow our own food, raise and slaughter animals, or build a house from trees.

Albert Borgmann suggests that technology can open new perspectives if viewed properly.

> *As long as we overlook the tightly patterned character of technology and believe that we live in a world of endlessly open and rich opportunities, as long as we ignore the definite ways in which we, acting technologically, have worked out the promise of technology and remain vaguely enthralled by that promise, so long simple things and practices will seem burdensome, confining, and drab. But if we recognize the central vacuity of advanced technology, that emptiness can become the opening for focal things. It works both ways, of course. When we see a focal concern of ours threatened by technology, our sight for the liabilities of mature technology is sharpened.* [42]

Values Associated with Technology

Technology presents us with technical values which can unconsciously alter our personal values. We need to ask of each technology what set of values are inherent in the technology:

> *James K. Huggins suggests that power, speed, information access, and logical reasoning are all assumptions or values built into the very architecture of computer technology. As a technology it promotes both anonymity and ultimate monitoring capabilities, democratization, and gatekeeper censorship in its applications. From a critical study of philosophy of technology, we can assert to our bumper sticker world that technologies are not all created equal, and not all are value neutral. This is not to say that they are essentially or inherently good or evil, but they are certainly not neutral for they embody values.* [43]

Kallenberg sees these as the primary values of technology: [44]

1. Efficiency
2. Standardization
3. Quantification –putting a numerical value on everything
4. Novelty – equated with "progress"

As a result, those caught up in technology may see the world in terms of

1. Mechanical causation
2. Speed

3. Numerical measurability
4. "One- size-fits-all"

In the extreme, we fail to see God's hand in the world, and we see our neighbor as a commodity. Efficiency is valuable in production machinery and in completing drudgery tasks, but our relationship with others is built on large investments of time and care.

In general, these are the values commonly associated with technology and its use: (Gill) [45]

- Efficiency
- Effectiveness
- Productivity
- Optimization
- Normality -being adjusted to the system
- Success
- Work (above family and fellowship)
- Boundless growth
- Artificiality
- Quantifiability and measurement
- Power and speed
- Standardization

The technical world is pushed by dreams of faster, cheaper, and more.

In America today success is judged by the criteria of technology: numbers, efficiency, and profitability, unfortunately, even in churches. [46]

Ethan Brue reminds us that efficiency is not a Christian value:

> *Christians and non-Christians alike find agreement on one point. God is inefficient. He completely abandons economies of scale and the efficacy of standardization. He is unapologetically wasteful in utilizing every potential color, shape, size, skill, ability as he creates and recreates. God loves diversity. The ridiculously overdesigned creation is a glaring testimony to his lack of optimization. He also entrusts the care of this creation to a group of inadequately trained caretakers, opening the door to a myriad of failures as this group tries to get their minds around the vast diversity of interrelationships and the dynamic potential in creation. He has been known to patiently take thousands of years to teach a story of redemption and outline a process of reclamation, leaning heavily on the work of temporary interns and student teachers to point the way.* [47]

Relating to others, serving and loving them, requires large investments of time and is anything but "efficient."

Balabanian [48] describes and critiques five assumptions of growing technology in an economy-

- Self-seeking
- Elastic wants

- Dominating nature
- Neutrality of technology
- Freedom of choice

Jennifer Alexander has examined the history of science and the "orthodoxies" of the Medieval Church and the Reformation in Geneva. If there is an orthodoxy in modern industrial society it is the orthodoxy of technology and efficiency. That orthodoxy compels us to conform, build, buy, and use more things. [49]

Based on the values associated with it, technology "teaches" us these lessons:

- Newer is always better.
- Older is obsolete.
- Faster is always better.
- Parts are interchangeable.
- Standardization is good.
- The artificial is as good as the natural.
- Every problem can be fixed and solved.

Are the values conveyed by technology the values of God?

> *Swearingen points out that only two of the possible purposes of technology (protection from nature and relief of toil and suffering) are consistent with Biblical values. Most others (to provide material prosperity; to achieve security and world peace; to export democracy and capitalism; to shape our destiny as a species) are not.* [50]

How Technology Changes Us

Neil Postman once said we shouldn't worry about technology changing human nature; We should worry about what part of our humanness technology nurtures. [51]

> *Technology doesn't make us do anything. But it can certainly fuel instincts and reinforce behavior that is already there. In the case of the smartphone, perhaps what is nurtured is our human instinct to want to escape into our individual, subjective, "this is how I want it" worlds where we can access everything and say anything, wherever and whenever we want. But is this the sort of humanness we were created to embody?*
>
> *I'm not so sure.* [52]

Technology has three main effects on society, according to Kallenberg: [53]

1) Reductionism

Everything becomes an approximation.

2) Standardization

Everything becomes interchangeable. In the extreme this even includes people.

3) Instrumentalism

Every object is seen as neutral.

> *In recent times technological advances and scientific expansion have increasingly succeeded in shutting the windows and closing the blinds. The physical replaces the spiritual, the temporal replaces the eternal, and "what is seen" replaces what is unseen (Hebrews 11:3).*
>
> *In this windowless world, God, transcendence, and mystery have become less and less imaginable. All of life is "rationalized." Everything becomes a matter of human classification, calculation, and control. "What counts in a rationalized world," says Guinness, "is efficiency, predictability, quantifiability, productivity, the substitution of technology for the human, and—from first to last—control over uncertainty." Everything's produced, managed, and solved this side of the ceiling, which explains why so many people are restless and yearning, as I was, for meaning that transcends this world—for something and Someone different.* [54]

Mander writes:

> *People who celebrate technology say it has brought us an improved standard of living, which means greater speed (people can travel faster and obtain more objects and information sooner), greater choice (often equated with freedom of choice, which usually refers to the ability to choose among jobs and commodities), greater leisure (because technology has supposedly eased the burden and time involved in work), and greater luxury (more commodities and increased material comfort). None of these benefits informs us about human satisfaction, happiness, security, or the ability to sustain life on Earth. Perhaps getting places more quickly makes some people more contented or fulfilled, but I'm not so sure.* [55]

In the extreme, says Brooks Alexander, technology can seduce and dehumanize us:

> *We become so dependent on technology that we tailor our lives to accommodate its demands. In the end we sustain an obsequious relationship to machines of our creation, and the needs of the machine determine the details of our daily lives.*
>
> *The dehumanizing effect of the technological culture replaces authentic relationships with mutually self-seeking emotional transactions; intimacy becomes manipulation; communication becomes propaganda. Inevitably, we begin to technologize the inner man in order to compensate for our outer losses.* [56]

The remarkable thing about this quote is that it was written in 1990, long before the impact of social media.

TEMPTATIONS OF TECHNOLOGY

Dangers of Technology

We have seen (chapter 19) that certain dangers may accompany our use of technology:

1. Technology can dehumanize people as people take on repetitive industrial jobs.
2. Technology can push society in an undesirable direction.
3. Technology can separate us from nature.
4. Technology carries the risk of reductionism.
5. Technology moves us towards "technicism," the idea that everything is technical.
6. Technology can lead people to utopian thinking.
7. Technology leads to overconsumption and the production of useless goods.
8. Technology can blind us to the results of our designs.

Reinke quotes Jim Samra that "Technology is inherently dangerous because it is the product of purposive human activity, and we need help from God in limiting its use (Tower of Babel)." [57]

Some technology will be used to harm others, some can be harmful to us, and some can lead us away from God. In the extreme, even a cardiac pacemaker can potentially pull us away. ("I've got a pacemaker, so I don't need God.")

If we consider the classical "seven deadly sins," technology brings its own set of temptations:

- Greed -Desire for more (giving in to the advertising)
- Envy - Jealousy of the technical toys my neighbor has
- Lust - The scourge of readily-accessible Internet porn

VanderLeest adds: [58]

- Pride - The idea that our technological efforts can save us
- Anger/malice- Injuring others by our posts or our weapons
- Sloth- Technological convenience can move us towards laziness

What about gluttony?

> *Beyond the food excess of literal gluttony, technology can also tempt us into more figurative gluttony, such as consuming much more energy or other natural resources than we really need, buying gadgets just to fill our pockets, or going one-click crazy on Amazon. Granted, some of our excessive consumerism is because we are trying to keep up with the Joneses (straying into greed or envy). Nevertheless, when we have more than the Joneses yet still keep consuming, we likely have lurched into gluttony.* [59]

Jiggins in *Human Future* suggests that the temptations we face with technology are similar in kind to the temptations placed before Jesus:

1. The temptation to meet all my needs (and have what I shouldn't have.)
2. The temptation to pride
3. The temptation to worship our own skill [60]

In Satan's temptation of Jesus in the wilderness he offered the Son of God "all the kingdoms of the world" if He would bow down and worship him.

Isn't it interesting that this is a gift of the devil not of God? The gift that was offered was magnificent and overabundant but, like the rather more modest free offers that drop through our letterboxes, there is a hidden price to pay. Bowing down and worshipping means giving one's allegiance; putting someone or something first. This is precisely what technicism encourages us to do. We are encouraged to make an idol of our technical skill and the system we have created, so that it will give us in exchange the benefits of our high standard of living and a promise of unlimited progress. There is the hidden assumption that even our wildest desires will be obtained if we only sacrifice on the altar of more research, more organization, more power, more control. [61]

Jesus was very serious about dealing radically with temptation:

So, when you fight that latest technological temptation, certainly use all means at your disposal to resist. If your eye causes you to sin, pluck it out. If your computer causes you to sin, throw it out. The extreme measures that Jesus suggested were, I think, to clearly wake us to the danger of sin and to the need for intense resistance. If you keep your eye and your computer, then certainly also put special measures in place. [62]

"The more we use technology, and commit to technology, the more it makes us a little less human," warns Doug Estes. [63]

Technology and Idolatry

If we say that idolatry means the following, then technology can (does) easily become idolatry.

- Something is pulling our hearts away from God.
- Something can satisfy us apart from God.
- We will depend on something other than God.
- Something other than God gives us meaning,

Consider these aspects of idolatry:

- No sense of humility before God ("When I consider the heavens...what is man?" Psalm 8)
- No thinking about God ("Even as they did not want to retain God in their imagination" Rom. 1)
- No gratefulness to God for Creation and existence ("Neither were they thankful" Rom. 1)
- No recognition of God's existence

- Worshipping the works of our own hands
- Looking to something other than God to meet our deepest needs

How might technology subtly move us toward idolatry?

1. Modern technology can distract us from reality.
2. Modern technology can distract us from God and blind us to the supernatural.
3. Modern technology can blind us to natural world and diminish any sense of awe.
4. Modern technology can make our relationships shallow.

The larger danger is this: Instead of being continuously conformed to image of Christ we are being conformed to the image of what we've made. (Those who worship them shall be like them.)

> *The first commandment was a broad prohibition against faith in other gods, and the second showed a particular concern about faith in the products of man's hands, e. g. engineering and technology. We must not put our confidence and faith in the products of our vocation. On the second commandment, American poet Joy Davidman noted that: "If we are to be saved, it will not be by wood, however well carved and polished; nor by machines, however efficient; or by social planning, however ingenious." Davidman also commented on the ninth commandment forbidding coveting. "There is no use pretending that our elaborate technologies can't be destroyed; like all other civilizations, it can. There is even less sense in pretending we can't live without it; we can, as men did before it was dreamed of. Let us pray to be free of the idolatry of material things..." As an object of faith, technologies such as nuclear energy will disappoint; we need an eschatological faith--to discovering that our treasure must be in heaven, where moth and rust do not destroy. Worshiping or coveting the means or the ends of technologies, or in the Progress they enable, is idolatrous and in defiance of the commandments. Our faith and hope must be in something substantially more durable. The core human dilemmas are sin and death, and technologies can but postpone the second and can affect the first either way.* [64]

Technology separates us from nature and thereby blinds us to God's creation (which declares His glory – Ps. 19)

- We drown out the sound of birds with boom boxes and mp3 players.
- Our city lights obscure the stars.
- In some cities we can't see the sky and clouds because of air pollution.
- We commute to work on subway trains and never see trees or flowers.
- Our furniture is made of plastic instead of wood.
- We sit in an office illuminated by artificial light instead of the sun.
- We use GPS for navigation instead of recognizing natural landmarks.
- Our children play games on their smart phones instead of being awed by the Grand Canyon.
- We spend whole days watching videos instead of getting outdoors to a field or a park.
- Most of us don't grow our own food.

- Our food is purchased in prepared form from a grocery store. We never think about the source of our bread, butter, milk, eggs, chicken, …
- Unless they've been to a petting zoo, most children have never a touched an animal except for the family pet.
- We've never seen a sheep sheared or wool turned into yarn.
- We drive 70 mph on superhighways and miss most of the scenery.
- We study computer modeling of species growth instead of observing actual animals in the wild.
- We build climbing walls in gyms instead of actually climbing on rocks.
- We tear down trees to build subdivisions. ("They paved paradise and put up a parking lot.") [65]

Charles Taylor, in "The Malaise of Modernity," looked at the dangers of technology. Technology "knockers" say that modern technology separates us from nature/the earth, from others, and from ourselves (three separations, which is very much like the results of the Fall). In the extreme, they suggest, there is no "human nature," since technology can change every single thing (physically) about us. [66]

VanderLeest describes our high-tech idolatry:

We worship our tech idols by giving them an honored place in our homes, such as the large HDTV flat screen that is the central and most prominent item in our living rooms. We carry our tech with us everywhere we go, such as our cellphones, cameras, or GPS navigators. We pay careful attention to their care and feeding when we recharge, maintain, and upgrade (it seems our gods are rather needy). The incense of 802.11n WiFi wafts through our rooms and hallways. We have special houses of tech worship, such as the Best Buy down the street or the electronics section on Amazon. We pay our our service plan indulgences for remission of sins. [67]

Walsh and Middleton describe three idols of modern culture:

- Scientism, which allies with
- Technicism, which gives rise to
- Economism (consumerism). [68]

Scientism suggests that our human reason, through methods of science, will allow us to understand everything in our world.

Technicism suggests that technology will (eventually) solve all of our problems. Technicism is based on three widely held beliefs: [69]

1. Technical progress is inevitable.
2. All technical progress will improve mankind.
3. Any problems that arise will have technical solutions.

Consumerism (economism) is the concept that people and institutions exist primarily to feed the economy. "The premise of consumerism is a belief that people can find happiness through

purchasing and consuming material goods. Technology has played a significant role in the spread of consumerism." [70]

In short, we no longer need God to make sense of our world. We no longer need God to provide for us. We no longer need God to give meaning to life. Part of the task of the 21st century apologist-evangelist may be to show the bankruptcy of these ideas.

Marshall writes:

> *What we must do is break with the idol of technology – the idea that we can achieve health, wealth, happiness, and security through it. We must break with the idea that expertise is the key to solving all problems and with the idea that human freedom comes from human control. We must break with the urge that drives us to accept the more sophisticated as the better, the hope that identifies progress with technical accomplishments, the vision that says humans can be brought to fulfillment by manipulating them as we would manipulate objects.* [71]

It is interesting that, unlike computers and smart phones, certain technologies which are essential for life and health, such as insulin pumps, cochlear implants, cardiac pacemakers, and prosthetics, are used with appreciation and seldom become objects of idolatry.

Spiritual Disciplines

How does the technology help or hinder our Bible study, our prayer life, and our worship?

Can we focus on prayer of Bible reading for even five minutes? Technology can disrupt or destroy practices of quietness, reflection, self-examination, and reading and thinking about Scripture (when we're constantly wired and always "on").

Steve VanderLeest recounts a time ten years ago when he neglected to bring his Bible to church and so dug out his smartphone with a Bible app. His family urged him to put it away, since it would be distracting to others and might even appear boastful. [72] Today nearly all the young people in a congregation bring a smartphone and even use it for public reading of Scripture. The biggest temptation is to continue to use it to check email and play games during a service.

VanderLeest [73] reminds us that worship involves much more than a church service:

- We worship by appreciation of God has made
- We worship through stewardship of what God has given
- We worship through development, "unwrapping the gift of creation."

Technology can fit with worship if we can see it as part of God's gift.

As God's people we are simultaneously

- Beloved children (Be trusting)
- Clay in the hands of the Potter (Be moldable)
- Vessels-or tools- for the Maker's work (Be available)

The third role is intriguing. We are both makers of tools and tools ourselves.

> *While we should take care to avoid treating people as tools, the turnabout is not only fair, it is a calling. When we choose to serve the needs of others, we choose to make ourselves a tool, becoming the means to help another achieve their ends. Our tendency to identify with our work is a healthy habit if we choose to be tools in God's hands. Such service, freely given, is admirable. Such service is our calling as servants of the Lord most high.* [74]

Technology and Love for our Neighbors

When we consider the question of how technology fits with loving our neighbors, we must begin with an intention to love our neighbors and then ask how technology can help us to do that.

Trevor Sutton writes that "Our use of technology, according to Luther, should be directed toward our neighbor's well-being. Needles, thimbles, and yardsticks—as well as smartphones, digital tablets, and software programs—are 'crying out' to be used in loving service to others." [75]

In the large sense, technology has

- Improved communication
- Improved health and extended life
- Diminished labor-intensive work
- Provided jobs to millions

On the smaller scale, modern technology makes it possible

- To check on the well-being of our neighbor
- To encourage others on a regular basis
- To order food or gifts for others
- To call the church to prayer for a neighbor's need

Technology, rightly applied, can help us to love our neighbor and even expand our concept of "neighbor":

> *At the end of time, it is not our scientific accomplishments that will be evaluated, but our treatment of those who were needy, imprisoned, or hungry (see Matthew 25:31-46). Indeed, technology has made the question, "Who is my neighbor?" even more broad, since we are able to reach anywhere on a global scale as never before. With responsible technology we can better care for our neighbor, the earth, and all its creatures. In this sense, technology is a tool that can bring shalom nearer.* [76]

EVALUATING TECHNOLOGY

The Amish community has actually taken technology evaluation very seriously, examining each potential technological advance to determine whether it causes more harm than good.

This discovery opened up the possibility that I, as a Christian who was also passionate about technology, could actively engage in the reshaping and redeeming of these new devices. When we think as a technological determinist, we are left with a fairly bleak choice: adopt the new device and suffer the inevitable consequences; or completely reject it and hope you can convince others to do so as well. As Sherry Turkle has reminded us, this is the language of addiction—it's similar to the way an addict thinks about his or her drugs. But when we realize that both engineers and consumers play active roles in the shaping of new technologies, a new possibility arises: the opportunity for a participatory redemption.

This realization also helped me see how I might reintegrate my Christian and engineering selves. If technologies did not have deterministic impacts and did not advance entirely according to their own logic, then it was dreadfully important for more Christians to be actively involved in not only the engineering of new devices and systems, but also their early adoption. If Christians aren't there to inject their own values into the design, production, marketing, and adoption of new technologies, we really have no excuse if we don't like how things turn out. Blaming deterministic outcomes just obscures what is really a lack of engagement. [77]

Should we Make it?

The modern technical paradigm suggests that if something can be tried, it should be tried. If something can be made, it should be made. "Can we build it? Then we should. Will it work? Let's try it and find out… We have the power to create. Then we should create." [78]

Instead, we should do a reasoned analysis:

- Consider the primary use.
- Consider major areas of misuse.
- Consider the unintended consequences.
- Do a cost/benefit analysis.
- Don't develop a product and then create an artificial need for it.
- Don't deliberately build in planned obsolescence.

In most cases, if we examine our motivation for making something, the bottom line is profit.

We need to ask: How will this technology affect —

- Society in general?
- The nation's economy?
- The poor?
- The disabled?
- The church?
- My family?
- My brain?
- My soul?

We must …consider, from the perspective of serving Christ, "Will the technology I use endorse the sinful acts of others, even if I do not use it sinfully myself?"…

I believe this question is perhaps more directly pointed for us today than it was for those before us, even a few decades ago. When the power of technology increases, the ability to affect more and more people increases as well. As knowledge increases, the ability to make technology in more daring or destructive ways increases along with it…

I have found that I can say "yes" to computers and like technology with clear conscience, as long as I can purchase components from makers that I am satisfied do not engage in slave labor and the like. Also, I can only use software that is not stolen with clear conscience, since I place the acquiring of the technology in the same category as its construction (i.e. how it came to me). [79]

Design Norms

Biblical values should guide both our development of technology and our use of technology. A few authors have addressed these matters. Our approach to technology must never be a blind embracing of every new technology and product.

In the area of engineering design, the engineer typically asks these questions–

- Who will use the designed device, component, structure, or process?
- What qualities do the users desire in the resulting product?
- Under what conditions will this be used?
- What are the social, economic, and environmental impacts of this design?

In addition, the Christian designer should regularly ask these additional questions–

- How will this actually be used?
- How does this contribute to God's shalom?
- Should we even design this at all?

Monsma et. al., writing from a Christian perspective, successfully laid out a set of eight norms or guiding principles for those who develop technology: [80]

1. Cultural appropriateness: Technology must fit with the cultural setting where it is used, particularly in terms of scale and centralization. We have classically referred to this approach as "appropriate technology."
2. Open information flow: Instead of secrecy, there must be openness about information access relevant to the technology.
3. Clear communication: Making every effort to explain what's important.
4. Stewardship: All resources must be carefully and wisely used and respected rather than exploited.
5. "Delightful harmony": Technology should include aesthetic considerations so that there is

a melding of function and beauty. It's very use should promote right relationships.

6. Justice: Justice should be provided for both persons and the natural world.
7. Caring (Love): There should be an aspect of both caring for and safeguarding the well-being of persons and nature.
8. Trust: Dependable objects are produced, and work is done in dependence upon God.

Similarly, Swearengen [81] indicates that Biblical technology should

- bring praise to the Creator.
- stimulate humanity's thirst for God's kingdom of activity, dynamism, vibrancy, peace, harmony, and joy.
- serve and promote justice.
- serve God, fellow humans, and nature.
- enhance life without dominating it.
- respect (cherish), preserve, care for, and utilize nature while meeting human needs.
- be culturally appropriate and protect cultural traditions that are not unbiblical, and
- be trustworthy (reliable and repairable) and transparent (full disclosure of impacts).

Guidelines for Use

Individual use of technology might be evaluated by the same types of criteria one might use to evaluate television, movies, or other aspects of culture.

- Is this wholesome and beneficial?
- Does this glorify God or diminish Him?
- Does this cause growth or regression?
- Is this a good use of finances?
- Does this promote or hinder good thinking?
- Does this enhance human relationships?
- Is this addictive?
- Does this oppress or exploit anyone?

In respect to our individual use of technology, Funk has presented a checklist for "prudent technological practice" in the use of technological objects. [82] His approach makes use of a five-point scale of agreement (Strongly Disagree to Strongly Agree) with such assertions as:

- This practice does not require time, attention, or resources that I would otherwise devote to God.
- This practice helps preserve someone's life or promotes someone's welfare.
- This practice does not harm, annoy, or inconvenience anyone.
- This practice does not require time, attention, or resources that I would otherwise devote to others, especially those dear to me.
- This practice uses amounts of natural resources commensurate with the good it yields.

In a similar vein, we might try to evaluate technologies using assertions based on several of the earlier criticisms of technology:

- Use of this technology promotes, rather than degrades, the image of God in humans.
- Use of this technology reminds me of my place in the real world as created by God, rather than trapping me in an artificial world.
- Use of this technology does not promote technicism, reductionism, or utopian fantasies.

Stewardship of Technology

We have seen (Chapter 18) that the primary role of God's people regarding the earth is that of stewardship.

God entrusts to humans —

- money
- possessions
- natural environment
- imagination
- and also, technology.

In a sense, each of these can be used for great good or for evil and destruction.

Like our stewardship of finances and the earth, we also need to see technology from a stewardship point of view. God is the ultimate owner and provider of technology. We are entrusted with temporary ownership for wise management. We use technology to meet our needs, to invest in God's kingdom, to serve and bless others.

- We should optimize the use and minimize the waste of technology.
- We should protect resources needed for the future.
- We should minimize negative impacts of what we use.
- We must realize that we are never the ultimate owners.

From the Garden to the City

John Dyer of Dallas Seminary has summarized 10 Biblical lessons about technology [83]:

1. Technology is God-given
2. Our tools transform us
3. Technology has meaning
4. God wants us to use technology to overcome effects of the fall
5. Technology can be a means of escaping from God
6. God used technology as an integral part of the redemption plan
7. The medium is the message
8. Jesus is more transformative than technology
9. God will redeem human hearts, bodies, and creations

10. We must consider how to use technology redemptively.

Based on his book *From the Garden to the City*, John Dyer offers four Biblically based questions for any new technology (which, he noted, map to Creation-fall-redemption-restoration): [84]

1. *Reflection: (Creation) How does this technology display the imago dei (Gen 1:26-27)? How does it help accomplish the creation mandate (Gen 1:28; 2:15)?*

   When a person creates a new tool, the display of creativity and ingenuity glorifies God even if the inventor was not attempting to do so...

2. *Rebellion: (Fall) How does this technology attempt to live apart from dependence on God (Gen 4:17)?*

   Just as Cain set up the first city as a kind of anti-Garden and a place to live apart from God, all technology has the potential to be used for sin. ..

3. *Redemption: What effects of the Fall can this technology help overcome (Gen 3:7; 1 Tim 5:23)?*

   The first human invention in the Scripture (clothing) was a direct response to an effect of the Fall (nakedness and the elements), and to some degree all technology can be characterized as overcoming an effect of the Fall. Yet some technologies are more redemptively significant than others. .

4. *Restoration: What unintended consequences or shortcomings does this technology bring? Do these make us long for Christ to return and restore all things?*

I put here all of the non-moral, but undesired Neil Postman-type consequences that technology can bring such as how air conditioning tends to make people miss out on nature, remote-controlled garage door openers mean people see their neighbors less often, and cars mean families live further apart...

When these devices fail, rather than causing us sadness and grief, they offer us a chance to reorient our hope away from our technology and toward Christ's return...

The biblical story ends not in a return to a pristine Garden, but with a new earth and a heavenly city full of human technology and culture (Amos 9:14; Rev. 21:21) somehow cleansed of evil and tradeoffs. It is fascinating to think that God cares to redeem not only human souls and human bodies, but also human creations. So, when you get a blue screen of death or an iPhone lockup, rather than curse in disgust, it should be an opportunity to say, "Come, Lord Jesus, Come!"

TECHNOLOGY AND ESCHATOLOGY

Eschatology is that branch of theology concerned with future things. What place does technology play in the future of the church and the world?

Technology gives rise to a number of very different possible scenarios for the future:

1. A technological utopia

Technology and human progress are seen as the means to usher in a new golden age of peace and prosperity…In an introduction to his volume on cyberspace, Michael Benedikt states that "the image of the Heavenly city" is "a religious vision of cyberspace." [85]

2. The disappearance of humans as we destroy the planet with chemicals and deplete energy stores.
3. A robotic or artificial intelligence conquest/destruction of humans.
4. The rise of a new humanity as humans meld with computers (Chapter 22).

None of these scenarios include the Bible's promise of Christ's return, judgment, and a new heaven and earth.

Almost all technological advancement is built on previous knowledge and achievements. In contrast to man's step-by-step building to the future of technology, God can always do something entirely new and redemptive. [86] Regardless of what technology brings to the future, the end result will be the future promised by God.

Derek Schuurman adds: "Technology does not set the timetable for Christ's return. The end if the world will not be ushered in by our technological progress, nor will it be determined by rogue technology that may appear in the future. Instead, the Bible suggests that the coming of the kingdom is tied to proclamation of the gospel to all nations (see Matthew 24:14)." [87]

Technology in Heaven?

Revelation 21 and 22 describe a renewed heaven and earth. The city of God will descend to earth. Will there be technology in heaven? Technology after the resurrection? There possibly could be. The Bible doesn't definitively say one way or the other. Clearly, the universe will be purged and purified ("set free from the bondage of decay") when Christ returns.

We might see some technology in the renewed earth. Revelation describes gates, streets, and fountains. Isaiah 60 and Zechariah 14 mention lumber, precious metals, and even cooking pots. [88] We definitely won't see prosthetics and pacemakers, missiles and torpedoes.

Estes asks: If gates and walls and streets, why not more of technology: radios, smartphones, HDTV's, tablets, jets? [89]

Alcorn writes:

Technology is a God-given aspect of human capability that enables us to fulfill his command to exercise dominion. As we've seen, we will find harps, trumpets, and other man-made objects in the present Heaven. What should we expect to find on the New Earth? Tables, chairs, cabinets, wagons, machines, transportation, sports equipment, and much more. It's a narrow view of both God and humans to imagine that God can be pleased and glorified with a trumpet but not a desk, computer, or baseball bat. Will there be new inventions? Refinements of old inventions? Why not? We'll live in

> *resurrected body on a resurrected Earth. The God who gave people creativity surely won't take it back, will he? The gifts and calling of God are irrevocable (Romans 11:29)."* [90]

Schuurman adds:

> *Albert Wolters suggests, "There is no reason to doubt that computer technology and jazz music will survive, largely intact, in the future restored earth."* [91]

CONCLUSIONS

Both our lives and our theological concepts have clearly been affected by technology. We certainly need a theology of technology. We have looked at some Biblical examples and principles. We are bounced back and forth between incredible potential for good and incredible danger. The following chapters will deal specifically with screen technologies and technologies that could alter what it means even to be human. Believers who work with technology (Christian engineers) need to be at the forefront of critiquing new technologies and promoting guidelines for their use.

"Test all things--hold fast to what is good" (I Thess. 5:21), applies not just to ideas and behaviors, but also to technology.

With practice we can recognize false theologies, analyze philosophies, and critique the contents of movie scripts, yet we are often oblivious about our use of technology. Philosophers talk about the high place of truth, justice, and beauty. Consider two Biblical tests for the use of our technology:

1. Phil. 4:8 (think on these things)
   - Does it promote truth?
   - Is it noble / honorable? (posts on social media)
   - Is it right? Does it promote justice and fairness?
   - Is it pure (free for sin and defilement)?
   - Is it lovely (acceptable, pleasing)?
   - Is it admirable, commendable, of "good report"?
   - Is it praiseworthy / excellent?

2. Fruit of the Spirit (Gal. 5) —
   - Does it promote love for others?
   - Does it promote joy?
   - Does it promote peace?
   - Does it promote patience?
   - Does it promote kindness?
   - Does it promote self-control?

Putting a perspective on technology, we may need to ask —

- Have I seen it as a gift from God?

- Have I thanked God for everything I have?
- Have I prayed about spending money for expensive technology?
- Have I offered it up to God (along with my money, time, talents, mind, and body) for His use and glory?
- Have I thought about how to use it to bless others?
- Am I in any way using it for sin?
- Am I willing to let it go?

Perhaps we need to confess:

- We haven't kept God first.
- We've relied on our technology instead of on God.
- We've given in to temptation with our technology.
- We've grown discontent and too tied to technical concerns.
- We haven't loved our brothers and sisters because we've been too engrossed in our technology.

"Uh, oh -Now you've gone to meddling."

Following Michael Gilstrap [92] we can copy Jesus' model in the feeding of the 5,000: We take the bread (the stuff of this earth), we give thanks (acknowledging that all things come from God); we break it (break it down into its parts), we see it transformed to distribute to and bless the world.

Any object, in fact, including a human person or an item of technology, is sanctified if dedicated to the purpose God intended for it.

David Gill writes:

> *In a Christian worldview, at least, there is an indissoluble relation of means to ends. Our means cannot be independent but must exhibit and partake of the end. There must be no contradiction of means and ends, no talk of (good) ends "justifying' (dubious or evil) means. Our ends must be God's ends, the coming kingdom of God. And while we live "in the night," we must act "as in the day" (Rom. 13:11-14). In a Christian worldview, knowledge carries with it responsibility; we must not dissociate technological research, knowledge, and development from a responsible examination of the consequences.* [93]

Paul Marshall adds:

> *We must believe, day by day, within our factories, workshops, and laboratories, that technology is a means, not an end, a servant, not a promise. We must hold on to the reality that the kingdom of heaven is promised to the poor in spirit, that the pure in heart shall see God, that the meek really will inherit the earth. These are not moral norms for some distant transcendent realm; they are the most fundamental and realistic touchstones for our entire everyday lives, including our development of technology.*

> *In so doing we will no longer need to be driven by the work of our hands. And in so doing, we can rejoice in our wealth of technical skills and expertise. We can liberate technology even as we are liberated from it.* [94]

Finally, Tony Reinke concludes:

> *The ultimate point of technology (in any age) is to point us back to the glory and the generosity and the majesty and self-sufficiency of the Creator himself. And the ultimate goal of technology is to usher us deeper into the creative genius of God, to direct our hearts to God, to adore him and to thank him for our daily bread. God's glory is the end of creation and the aim of all our innovations. He is worthy of our lives, worthy of our best inventions, worthy of all praise.* [95]

REFERENCES

1. Rose, D., *Enchanted Objects*, Scribner, 2015.
2. Tink, F., Theology of Work in the STEM Professions," https://www.slideshare.net/techmission/tow-week1
3. Veith, G. E., *God at Work*, Crossway, 2002.
4. Chewning , R., Eby, J., and Roles, S., *Business Through the Eyes of Faith*, Harper One, 1990.
5. Conner, M., "Theology of Creativity," www.markconner.typepad.com
6. Vincent, L., *Innovation Theology*, Wipf and Stock, 2017.
7. Halsmer, D., et.al., "A Reliable Universe," American Scientific Affiliation Annual Conference, 2009.
8. Gary, J., "The Future According to Jesus," https://jaygary.com/future_jesus/
9. Olmos, M., "God the Hacker," https://secondnaturejournal.com/god-the-hacker-technology-mockery-and-the-cross/
10. Crouch, A., *Culture Making*, IVP, 2013.
11. Ellul, J., *The Technological Society*, Vintage Books, 1984.
12. VanderLeest, S., "All I want for Christmas," *Deus Ex Machina*, December 13, 2011.
13. Hopper, D., *Technology, Theology, and the Idea of Progress*, Westminster/John Knox, 1991, p. 80.
14. Dyer, J., *From the Garden to the City*, Kregel Publications, 2011.
15. Leff, B., "United Technology Against God?" www.aish.com
16. "Technology and the Christian," (web site) http://wikichristian.org/index.php/Technology_in_the_Bible
17. Estes, D., *Braving the Future*, Herald Press, 2019.
18. Estes, p. 157.
19. Kallenberg, B., "The Theological Origins of Engineering," Religious Studies faculty Publication 70, University of Dayton. https://ecommons.udayton.edu/rel_fac_pub/70/
20. Ibid.
21. Lai, P., "New wine in New wineskins," talk presented at LeTourneau University, March 21, 2017.
22. McKeever, J., "Does your Church have a Gospel Blimp?" https://joemckeever.com/wp/church-gospel-blimp/
23. Campbell, H., and Garner, S., *Networked Theology*, Baker 2016.
24. Keller, T., video: "Re-Enchanting Our World," https://www.youtube.com/watch?v=E9gqFnsM_zg
25. Monsma, S. et. al., *Responsible Technology*, Eerdmans, 1986.
26. Dessauer, F., quoted in Koslowski, D., *Nature and Technology in the World's Religions*, Springer, 2014, p.5.

27. Ellul, J., "Technology and the Opening Chapters of Genesis," in Mitcham, C., and Grote, J., *Theology and Technology*, date.
28. Rae, S., "Does the Bible Provide Guidance Regarding Genetic Engineering?" CSB *Apologetics Study Bible*, Holman, 2017, p. 43.
29. Ibid.
30. Dalyrymple, T., "Redeeming Technologies," *The New Atlantis*, 39, Summer 2013, p. 80-88.
31. Koslowski, Nature and Technology in the World's Religions, Springer, 2014, p.5.
32. Schuurman, D., *Shaping a Digital World*, IVP Academic, 2013, p. 55.
33. Dyer, op. cit.
34. Monsma, op. cit.
35. Expanding on Estes, op. cit.
36. Jiggins, A., *Human Future: Living as Christians in a High-Tech World*, *Scripture Union*, 1988, p. 79.
37. Jiggins, p. 107.
38. D'Sa, F.X., "The world as Creation and Creation as a cosmotheandric reality in Christianity," in Koslowski, p.33.
39. Jeremiah, D., radio sermon on Technology March 23, 2015.
40. Van Poolen, L., "Towards a Christian Theology of Technological Things," *Christian Scholar's Review*, 33(3), 2004, p. 376-388.
41. Walsh and Middleton, *The Transforming Vision*, IVP Academic, 1984, p. 143
42. Borgmann 1984, 199, quoted in *Technè* 10:2 Winter 2006 Special Issue: "Durbin, In Search of Discourse Synthesis"/320.
43. Sleasman, M., "Thinking through technology," https://cbhd.org/content/thinking-through-technology-part-i
44. Hatch, D., and Kallenberg, B., "Technology," Dictionary of Scripture and Ethics, Baker, 2011, p. 763-766.
45. Gill, D., "Jacques Ellul and Technology's Trade-Off," *Comment*, Spring 2012, p.51-58.
46. Jiggins, op. cit.
47. Brue, E., "Sola Gratia: Grace in the Engineering Curriculum," *Proc. Christian Engineering Conference*, 2015.
48. Balabanian, N., "On the Presumed Neutrality of Technology," *IEEE Tech. Soc.*, Winter 2006.
49. Alexander, J., *The Mantra of Efficiency*, Johns Hopkins University Press, 2008.
50. Swearengen, J., *Beyond Paradise*, Wipf and Stock, 2007.
51. McCracken, B., "What are Smart Phones Doing to Us?"
    http://www.relevantmagazine.com/life/current-events/op-ed-blog/22043-what-are-smartphones-doing-to-us#5iwC6KhtxrdrvSXt.99
52. Ibid.

53. Kallenberg, B., *God and Gadgets*, Cascade Books, 2011.
54. An excerpt from "Unfashionable" by Tullian Tchividjian, Published July 09, 2009.
55. Mander, J., In the *Absence of the Sacred*, Sierra Club Books, 1992, p. 26.
56. Alexander, B., "Compromise and Vulnerability," *SCP Newsletter* 15:1, 1990.
57. Reinke, T., "A Mini-Theology of Technology," https://tonyreinke.com/2015/07/29/a-mini-theology-of-technology/
58. Vander Leest, S., "Technology Vices," *Deus Ex Machina*, Wednesday, April 20, 2011. www.calvin.edu/weblogs/deusexmachina
59. Vander Leest, S., "Technology and the 7 deadly sins," *Deus ex Machina*, Dec. 30, 2013.
60. Jiggins, p.52
61. Ibid.
62. VanderLeest, S., "Technology Vices, *Deus Ex Machina*," Wednesday, April 20, 2011.
63. Estes, p. 195.
64. Wilson, R., "Integrating our Christian Faith and our Nuclear Engineering Vocation," www.usnuclearenergy.org/cnf/PAPERS-HANDOUTS-CNF-PDFs/2014-JUN-Paper-Bob-Wilson.pdf
65. Lyrics from "Big Yellow Taxi", song by Joni Mitchell, 1970.
66. Keller, T., "Re-enchanting Our World," op. cit.
67. VanderLeest, S., "Technology Worship," *Deus Ex Machina*, Wednesday, April 21, 2010.
68. Walsh and Middleton, op. cit.
69. Schuurman, p. 60.
70. Schuurman, p. 62.
71. Marshall, P., and Gilbert, L., *Heaven is Not My Home*, W Publishing, 1999, p.182.
72. VanderLeest, S., "Why I couldn't read the Bible in church," *Deus Ex Machina*, Wednesday, January 30, 2013
73. VanderLeest, S., "Technology Devotion," *Dynamic Link*, Calvin College, 2012.
74. VanderLeest, S., "All I Want for Christmas," *Deus Ex Machina*, Tuesday, December 13, 2011.
75. Sutton, A.T., "What Luther Would Say to Silicon Valley" https://www.thegospelcoalition.org/article/luther-silicon-valley/
76. Schuurman, p. 118
77. Stearns, D., "Becoming a Christian Engineer," http://techsoulculture.org/2012/06/19/becoming-a-christian-engineer/
78. Estes, D., p. 77-78.
79. "A Christian World View and Technology," A Christian World View and Technology - Part II - http://biblicalcomputing.blogspot.com/2008/02/christian-world-view-and-technology_20.html

80. Monsma, op. cit.
81. Swearengen, J., op. cit.
82. Funk, K., "Thinking Critically and Christianly About Technology," *Persp. Sci. Chr. Faith* 59(3), 2007, p. 201-211.
83. Dyer, J., chapel presentation at LeTourneau University.
84. Dyer, 2011, op. cit.
85. Schuurman, p. 112.
86. "Michael Burdett on Theology and Technology," https://medium.com/subtle-engine/theology-and-technology-2ca9dc7a7f1a
87. Schuurman, p. 118.
88. Schuurman, p. 116.
89. Estes, p. 197.
90. Alcorn, R., *Heaven*, Tyndale House, 2004
91. Schuurman, p. 116.
92. Suggested by Michael Gilstrap in *Geneva Review*, circa 1980.
93. Gill, D., "The Moral Character of Means and Ends," leadershipu.
94. Marshall, P., op. cit.
95. Reinke, T., *God, Technology, and the Christian Life*, Crossway, 2022.

CHAPTER 21: SCREEN-BASED TECHNOLOGY

INTRODUCTION

At this point readers might think that the authors are technology pessimists or somehow negative towards technology. I (Paul) am a huge fan of technology, although I was a late-adapter for many items. I am thankful for electric lights and air conditioning. I use a computer for several hours a day. I appreciate having a GPS display onscreen when I drive. I do hundreds of Google searches each week. I enjoy seeing YouTube clips of songs and movies from my growing-up years. I listen to the radio when I drive home. I've enjoyed movies from Turkey, Germany, and Korea (with sub-titles) … Problems come in when we let the technology become "bigger" than it is, when we fail to see that there are some dangers and drawbacks.

We might classify technology as (1) "big technology -that which impacts a large number of people (electric grid, railroads, factories), and (2) "small technology"-which affects individuals (previously household appliances, now primarily computers and smart phones). It is now possible to be in contact with technology at every waking minute.

Unlike the technology of earlier eras (printing press, steam engine, automobile,..) today's technology (computer, tablet, smart phone, video game) is owned by the masses at almost every age, is never far from our presence, and becomes almost a part or an extension of ourselves. Screen-based technology has immense potential for both good to society and harm to ourselves.

Traditional technology and modern technology differ in multiple areas —

TRADITIONAL TECHNOLOGY	MODERN TECHNOLOGY
Machinery, manufacturing, appliances	Computer-based personal technology
Primarily expanded our physical ability	Expands our metal power and senses
Specific for each use	Used in almost every area of life: work, leisure, worship, travel

External to the self	Seen as extending or merging with the self; can affect our self-identity
Limited time use	Can be used almost all the time
Related to modernist thinking	Fits with postmodern mindset — no clear singular reality

Tim Challies makes these observations about technology: [1]

- Technology involves both risk and opportunity.
- Technology often involves a power shift.

The printing press moved communication from the clergy and the elite to the people (including the followers of Martin Luther). The blacksmith was effectively rendered obsolete by the automobile. Current computing shifts power away from the old and towards the young. [2]

Technology actually changes more rapidly than we can adjust to it. Larry Taunton observes:

> *Technology is always advancing faster than our understanding of its possibilities (or dangers), faster than our capacity to use it for good.*
>
> *The clock served to regulate spiritual life in the monasteries. Originally sunrise and sunset ordered the monks' lives. Later, church bells, rung at hours determined from sundials and water clocks, signaled times for prayer both for the monks and for the surrounding village. The earliest escapement mechanism for a mechanical clock was traced to a Benedictine monastery in the 13th century. Later, clocks made it possible to schedule spiritual events throughout a day. Today, watches and timers on phones make it possible to regulate life down to the minute.*
>
> *In earlier times people respected community elders with their store of knowledge. Today, access to the Internet puts "knowledge" (actually, information) at everyone's fingertips and essentially trivializes knowledge.* [3]

In terms of historical development of screen technology, we've seen this progression:

- Television
- Computer
- Video games
- Internet
- Smart phones

Screen-based technology offers huge benefits:

- Instant access to information, with powerful search capabilities
- Music and video at one's fingertips

- Rapid communication almost anywhere
- Application programs designed to pull people together

Screen-based technology also offers "promises" to the user:

- Increased connectedness
- Increased happiness
- Increased knowledge
- Entertainment on demand

If we remember that it's a tool, use it carefully, control it, and limit our use, this technology can be a great blessing. The difficulty is: We often don't. The average young adult now spends 12 hours or more each day in front of screens.

The power of screen technology, we were told by Marshall McLuhan, is that is a form of media, a channel of mass communication. As such, he famously stated, "The medium is the message." [4]

Screen technology can easily be misused. It can blind us to its results and affect our values. The same Internet technology that allows us to access great literature and music from around the world also puts blasphemy and pornography at everyone's disposal.

Neil Postman wrote that technology re-orders society and redefines how we relate to each other. Once a technology is admitted into a society it simply does what it was designed to do. [5] At the least, we're distracted. At the worst, we're addicted or into idolatry.

Tony Reinke points out these foundational ideas regarding technology: [6]

- Technology development is inevitable. It is built into our humanity and God-given creativity.
- God inspires technology, at least, in general.
- Few areas of technology are inherently harmful.
- None of the technology we have has taken God by surprise.

McLuhan suggested that with technology part of us is augmented and part is amputated. [7] We should consider evaluating technology along the lines suggested by Neil Postman: Clarify what we gain vs. what we lose. [8]

TELEVISION

The earliest screens we owned were those on television sets. The technology was a breakthrough: Analog broadcast TV utilized a wide bandwidth signal containing audio along with video information, swept in lines across an illuminated screen at 525 lines per frame.

We welcomed the TV set into our living rooms, although some called it a "one-eyed monster," and some Christians refused to buy one.

TV differed from movies:

We had to leave our homes to go to the movie theater.

The big screen, large auditorium, fold-up seats, and crowds made it fell very different from home.

Those aspects, plus actors we recognized on the screen, made us very aware that we were watching a story. Television, on the other hand, brought the story into our living rooms and drew us in.

Television changed American lifestyles:

- Adjusting the calendar or daily schedule around shows to watch
- Diminishing family communication
- Staying up late to watch the 11 PM news
- Introducing TV dinners, TV trays, "remote wars," and "couch potatoes"
- The TV set dominated the living room

While the images on early black and white TVs were clearly artificial, color television, especially with high-resolution and large screens can look amazingly real.

In certain ways television set us up/trained us for computer technology. We got used to

- Sitting 2-3 hours in front of a screen
- Bringing new ideas into our homes (some of which we didn't agree with)
- Constant barrage of advertising
- Channel surfing
- Diminished conversation
- Thirty second "sound bites"
- Immediacy, rather than history [9]

Television was carefully designed to hold our attention.

How did it change us personally? We became accustomed to:

- Overstimulation and a diminished attention span
- Being a passive observer
- Believing what we heard
- Diminished critical thinking
- Constant background noise
- Comparing ourselves to others – a "flattening of society" as everyone wanted to be similar to those on the shows
- Finding it much easier to "veg out" in front of a TV screen than to read a book or engage in deep conversation.

Marie Winn's book The *Plug-In Drug* argued that television is addictive and makes children passive and less creative. [10]

Jerry Mander's book *Four Arguments for Eliminating Television* [11], published in 1978, received a good deal of negative press and a welcoming place in such publications as *Mother Earth News*.

Mander's arguments included these ideas:

- Our knowledge is mediated by what we are shown, by someone else's perception of reality.
- There is no place for diverse, independent speech. Only the network executives or program producers get to "speak."
- Television requires all content to fit its format: linear, two-dimensional, and able to be displayed on a small horizontal screen. In addition, TV promotes sensory deprivation: viewing in a sitting position in a darkened room with an artificial brightened screen.
- Television presents an unreal picture of life.
- Television is driven by advertising. Advertising dominates the mind by changing our thinking patterns. The public becomes "unified and homogeneous."

Neil Postman wrote a similar book in 1985, *Amusing Ourselves to Death*. [12]

Postman made the following points:

- Television has largely replaced print material and reading.
- Television satisfies the needs of entertainment rather than information. As a result, we may expect all of life to entertain us.
- There is no depth of intellectual involvement or rational argument.

> *Television, argued Postman, communicates in a different manner than printed material, its emphasis being on images rather than carefully crafted words. As a result, television, as an entertainment device, discourages rational discourse, claimed Postman.* [13]

> *[Aldous Huxley] believed that we are in a race between education and disaster, and he wrote continuously about the necessity of our understanding the politics and epistemology of media. For in the end, he was trying to tell us that what afflicted the people in Brave New World was not that they were laughing instead of thinking, but that they did not know what they were laughing about and why they had stopped thinking.* [14]

> *Christian philosopher Douglas Groothuis argues that television's "unrivaled immediacy, impact and entertainment capabilities…make it a potent agent of truth decay." Declaring television "an unreality appliance," Groothuis advises refusing its enticements. Kenneth Myers observes, "Television is thus not simply the dominant medium of popular culture, it is the single most significant shared reality in our entire society." According to Myers, "Television discourages reflection."* [15]

Francis Schaeffer observed that manipulation of the viewer is easily accomplished with television since (1) every editor has a subjective viewpoint, even if unconscious, (2) viewers think they are seeing external reality with their eyes, and (3) the camera is limited in range and frame size. A small

protest can look like a large riot depending on camera angle and scene framing. [16]

> *In [his] book, Christ and The Media, Malcolm Muggeridge argues that television is an innately evil technological device because by its very nature it alters reality without appearing to do so...The problem Muggeridge sees with television is not so much the problem with technology as the problem of who controls the technology or who creates the value system within which the technology is used... Technological manipulation represents the failure of Christian humane values to influence society.* [17]

Most would argue that television has produced some valuable viewing over the years:

- Televised plays and symphonies
- Presidential debates
- "Masterpiece Theater"
- Billy Graham Crusades
- Early "Star Trek" episodes
- "Modern Marvels"
- The Olympics

Unfortunately, the bulk of programming and viewing consists of sit coms, soap operas, and news (usually with a bias). Years ago, FCC head Newton Minnow called network television "a vast wasteland."

Robert Velarde notes, "Many years ago I read about Vladimir Zworykin, a key figure in the development of television. A Russian-born scientist who ended up working at RCA, he wanted television to become primarily an educational tool. Later in his life he lamented what television had become - a largely mindless medium of entertainment and commerce." [18]

Television has great possibilities for education and evangelism: programs on Christian doctrine, church history, and world missions. Two large obstacles have held this back: the size of the projected audience and the availability of sponsors.

Compared to its potential, television (at least in America) has largely been a disappointment for Christian viewers. Most current programming does not reflect Biblical values, and the largest Christian cable network primarily features televangelists and broadcasts a "name it and claim it" theology.

VIDEO GAMES

The earliest video games were connected to a television set and were pretty simple in design and tame in activity (remember "Pong"?) Today's games reside on a computer or smart phone, utilize amazing graphics, and may be intensely violent.

Some authors point out positive features of video games:

> *According to Henry Jenkins, director of comparative media studies at MIT and cofounder of the Gaming and Learning Research Initiative, playing video games has positive learning consequences. He asserts that gaming promotes rapid decision making on limited information, exactly what's demanded in the increasingly real time workplace. Multi-player games can actually enhance social skills such as the ability to collaborate by requiring players to work with other people over distance, to share knowledge, to resolve disputes quickly, and to stay on task – all critical skills in the emerging global and virtual workplace... Games help players to learn to become really good at what they do by mastering the skills and the mindset to perform at peak. Players learn that practice pays off. Games teach that failure isn't the end of the world, in fact, trial and error is the best way to learn and advance and that persistence pays off. And they promote global perspectives by teaching people to bond around shared experiences not simply national or cultural backgrounds.* [19]

Like television, the games stimulate (over-stimulate) the brain and are often very addictive. While they enhance eye-hand coordination they minimize conscious thought.

The most violent of the games is probably Grand Theft Auto (GTA), which has been released in various versions since 1997. The participant is able to role play as a hardened criminal. GTA has been criticized for including extreme violence, language, murder, prostitution, racial stereotypes, and drunk driving.

Video games, like television, can stifle imagination and creativity, since the storyline is already crafted for us:

> *As for video games, they condition us to the mindless acquisition of meaningless rewards (points), to the destruction of generic enemies, and to accepting choices defined by remote others, the programmers of our lives...The kind of adult that results from a childhood bereft of the opportunity for spontaneous self-directed world-making is someone who will continue to be vulnerable to stories created by others. Not only will he always be in the market for entertainment, but he will be easily manipulable by politicians and advertisers seeking to profit from the acceptance of a certain story... In most video games the child does not create the story, but instead moves through a story that has been created for her. (Ah, how like modern adult life!... The world is finite and its limits have been set by someone else. The only mysteries are those that have been fabricated and doled out.* [20]

While video games cannot be linked to an increase in criminal activity or violent activity, they can be linked to an increase in aggression. [21]

COMPUTERS AND THE INTERNET

The earliest computers (large mainframe computers) were sufficiently difficult to program and removed from the average person that they weren't addictive. With the development of the Radio Shack TRS-80, the Osborne portable computer, and the Atari 400, computers moved into our homes.

What began with the connection of research computers through ARPANET grew into the Internet, now available to anyone with a computer and a network connection. Like the printing press, the Internet opened up the possibility of communication to the common person. Anyone can potentially reach an audience around the globe.

The term "cyberspace" originated with science-fiction author William Gibson and the novel *Neuromancer*. [22] While search engines can open up all the stored libraries and factual information on the Internet, sadly, the majority of web searches look for gossip on favorite movie stars or humorous video clips to pass along.

SMART PHONES

By combing cell phone technology with a microprocessor, the smart phone makes it possible to do all the following on a single hand-held device.

- Make phone calls.
- Send and receive email
- Surf the web
- Access text messages
- Take pictures
- Watch videos
- Play games,

The average adult checks his/her phone over 90 times a day. The average 18-22 year old checks his/her phone over 150 times a day.

DANGERS OF SCREEN-BASED TECHNOLOGY

We are well aware of the common dangers of computer-based technology:

- Our system could get hacked.
- Our identity could be stolen.
- Our financial accounts could be depleted.
- Our system could get infected with a virus.
- Our private information could become public.
- Our personal data could be sold to others.

An equal concern is: What is our technology doing to us as people, especially as people who honor Christ as Lord?

1. Screen technology can limit our abilities

Are computers making us dumber? (No, but our misuse of technology and over-reliance on computers can make us dumber) [23]

- Can't spell? Word processor programs with spell-check features will correct all your spelling.
- Trouble with grammar? Some programs will point out grammar problems.
- Don't know your addition facts or times tables? Your smartphone has a calculator.
- Can't get from point A to point B? Use the map app and GPS.
- Don't remember what day it is? The first display on your phone will tell you the day.

A friend was recently disturbed to overhear his children doing their homework in their rooms:

"Seri, what's 6,448 divided by 26?"

"Seri, what are the capitals of Vermont, Connecticut, and Maine?"

He had to explain that using the smartphone to find answers wasn't the intent of the assignment.

If we don't regularly use any particular skills, we will begin to lose them. What are we beginning to lose?

- Basic number sense
- Basic arithmetic, ability to estimate answers, ability to do simple math in our heads, since we use a calculator for everything
- The ability to sketch and hand-letter
- The ability to read and write cursive documents or to remember how words are spelled
- A sense of direction as we become overly-dependent on GPS. What is directly north of us? Which way do I go to get there? Can you sketch a map for me?
- The ability to memorize (basic equations, simple lists, resistor color codes)
- The ability to read an analog clock or understand an analog display
- The ability to communicate deep ideas as we rely on texts and tweets
- The ability to focus on a task for a few hours
- The ability to diagnose basic problems without Googling the problem
- An interest in the written word as we move to an image-based society
- The ability to read and think deeply as we ponder the concepts on a page

Internet searches promote skimming rather than reading.

Screen technology can make us lazy. Many students gravitate towards the idea that no facts or equations should ever be memorized, since all are available after a quick Google search on the web.

2. Screen technology constantly distracts us.

Bing. There's a new text message. I must answer it.

Ding. A new email just came in. I need to read it.

Ring tone. Phone call. I need to answer it.

I need to see if anything new is posted on social media.

I need to resume my game or try the newest app.

We've grown used to being interrupted for calls, email, and messages-during conversations, during meals, during work, during homework or even classes. [24] "Students who apparently actually want to learn something also complain of other students watching movies in class, shopping, playing games, or updating their social networking sites, finding such activities distracting," observes Robert Velarde. [25]

We live in a distracted society, says Alan Noble, author of *Disruptive Witness* [26]. Perhaps we are even addicted to disruption. Distraction keeps us from being alone with ourselves, since our thoughts reveal our failings and fallenness. Distraction keep us from thinking about our need for Christ.

Groothuis adds:

> *Cyberspace diversions often magnify nonexistent objects on colorful video screens, combine them with audio effects, and render them "interactive" thus filling our souls with unrealities while the reality of God is ignored or trivialized.....*
>
> *Cyberspace may be the greatest temptation yet offered to humanity to lose its soul in diversion. Having the senses inundated with information or overwhelmed with stimulation is not conducive to a soul finding serenity in the knowledge of the truth.* [27]

Even while we're interacting with a social media app we're often thinking about the next site we want to visit. Wes Avram calls this the FOMO syndrome (fear of missing out):

> *FOMO. The idea's nothing new, of course. It has been a hallmark of youth all along: wanting to know what's happening, keeping one's options open, scanning the terrain for what you want. We've always measured youth by energy and experimentation. By contrast, we've always measured maturity by the ability to move beyond grazing distraction in order to make promises, then to mark those promises with commitments, with persevering and building something that lasts. In that sense, the FOMO of youth is as predictable as the stability of age.*
>
> *Except ... something feels different about this moment, and not just because FOMO has been promoted to acronym status. I think that something has to do with acceleration and mediation. FOMO is now supported technologically, mediated electroni- cally, and monetized for profit in ways we've never seen. It is becoming the signature reason for wiring in. And that might make it the great underestimated impulse behind social media - more powerful than the desire for association and friendship that we're told stands behind it all. FOMO rules. And when it seems like there is so much more to miss out on these days when we can capture the world on a tiny screen in our palms, FOMO also drives. The fear fuels itself.* [28]

Constant distraction gives rise to shallow thinking which, in turn, gives rise to shallow living, says

Tim Challies. [29]

Sherry Turkle of MIT considers the loss of alone time:

> *"The capacity for boredom is the single most important development of childhood ... children who are constantly being stimulated by what's on their phone really don't get the opportunity to look at that world, bring it in, and make something wonderful of it," Turkle said. "If you don't teach your children to be alone, they'll only know how to be lonely."*
>
> *She cited a study where students were asked to sit alone without their phones for 15 minutes. There was an electroshock machine in the room as well. When asked if they would shock themselves while sitting in the room with nothing to do, the consensus was a resounding no. According to Turkle, after six minutes, a significant number of students began to shock themselves. The result of the experiment was alarming: they would rather shock themselves than sit alone.* [30]

3. Screen technology separates us from others

Supposedly, screen technology offers greater connectedness. We are continually using email, text-messaging, Facebook, chat rooms, and phones. In fact, we are ending up more isolated from community. We become more accustomed to relating electronically rather than face-to-face. [31] The classical picture is that of the family sitting together in their living room, each one texting someone else.

Restaurants, which once were ideal locations for conversation, are often centers for distraction. Parents may be talking on their phones while the children are playing games or watching movies. [32] Someone may answer a phone and continue talking while their guest across the table is virtually ignored.

Facebook can provide contact and communication, but not real community. True community is not defined as connecting with those who share similar interests or traits. Langdon Winner defines living communities as "composed of people from different backgrounds who found some way to come together in face-to-face interaction and work things out." [33]

Real, deep, relationships require face-to-face interaction. We lose something essential to real communication when we are unable to observe body language and facial expressions. We lose something of authenticity when we have no physical presence. [34]

Sherry Turkle considers:

> *Technology is seductive when what it offers meets our human vulnerabilities. And as it turns out, we are very vulnerable indeed. We are lonely but fearful of intimacy. Digital connections and the sociable robot may offer the illusion of companionship without the demands of friendship. Our networked life allows us to hide from each other, even as we are tethered to each other. We'd rather text than talk...*

> *Mixed feelings about the drumbeat of electronic communication do not suggest any lack of affection toward those with whom we are in touch. But a stream of messages makes it impossible to fine moments of solitude, time when other people are showing us neither dependency nor affection. In solitude we don't reject the world but have the space to think our own thoughts. But if your phone is always with you, seeking solitude can look suspiciously like hiding.*
>
> *We fill our days with ongoing connection, denying ourselves time to think and dream. Busy to the point of depletion, we make a new Faustian bargain. It goes something like this: if we are left alone when we make contact, we can handle being together.* [35]

Terlizzese adds:

> *We know after all has been said there still remains a side of the gospel that must be experienced or encountered in real people. The gospel must be embodied and not simply read about or talked about. This was the gist of Paul's exhortation to the Corinthians: "you are a letter of Christ . . . written not with ink, but with the Spirit of the living God, not on tablets of stone, but on tablets of human hearts" (2 Cor. 3:3-4). We might as well say written not electronically on the transient screen with flickering pixels, but in flesh and blood and in one-to-one encounters with friends, family, and neighbors. Media, as good as it is, cannot substitute for personal experience of God and fellowship with others...*
>
> *Social media can facilitate friendship, but it cannot replace it. We are warm-blooded creatures and need other warm-blooded people to have community, something a computer screen cannot provide. Social media serves as a supplement to community, not a substitute*! [36]

In the extreme, the result is an overall lack of empathy. [37]

4. Screen technology is (deliberately) addictive

If television was somewhat addictive and we were slightly drawn in to what was presented, computers/Internet were more so, and smart phones are very addictive, involving us personally.

We may take a few minutes to look up a song or a TV show we watched as a kid or to track down an old friend. A problem arises when those few minutes expand to hours- time we could spend with family. Screen time gets pulled from

- Sleep
- Family time
- Social interactions
- Physical activity

There is no question in the minds of most professors that screen-based technology is addictive. We have seen too many promising students shipwreck in classes because they stayed up all night doing Facebook or video games.

Steve Jobs didn't let his kids have an iPad. He knew how addicting they can be.

Games "reward" success -We can move up to the next level challenge, accompanied by a dopamine rush.

Jonathan Lett notes that tech creators use the best findings in psychology and neuroscience to "hack our brains": [38]

B.J. Fogg of Stanford coined the term "persuasive technology." It is now possible to create hardware and software that change what people think and do.

Tristan Harris (Center for Human Technology), formerly of Google, sees the task of Google and others to "hook people" by exploiting human vulnerabilities.

Sean Parker, formerly of Facebook, indicated that Facebook was created to exploit human dynamics and direct our attention.

The documentary video *The Social Dilemma* presents detailed documentation of the deliberate addictive properties of social media. [39]

Scott Dunlap, who designed apps for tech companies admitted:

> *We realized our apps were more addictive than chemically addictive substances," he said. "I got them reaching for their phone 120 times a day just with my app. And then we would all high five each other and then we would go, 'Wait a minute. Is this a good thing? Are we doing the right thing?* [40]

5. Screen technology messes with our brains

Every experience we have creates a change in our brain. Screen technology improves some skills while diminishing others.

> *In his recent book iBrain: Surviving the Technological Alteration of the Modern Mind, leading neuroscientist Gary Small explores how digital media appears to be changing the very structure of our brains. The digital revolution has "plunged us into a continuous state of partial attention," and in this state people "no longer have time to reflect, contemplate, or make thoughtful decisions."* [41]

Extensive use of Screen-Based Technology enhances:

- Eye-hand coordination
- Visual awareness
- Task-switching
- Asynchronous communication

At the expense of

- Critical thinking
- Reflection
- Deep analysis

- Self-control
- Memory
- Focus

The "print-oriented brain" of the previous five centuries is being replaced by the "digital brain." [42]

Nicholas Carr: "When we go online we enter an environment that promotes cursory reading, hurried and distracted thinking, and superficial learning." [43]

Supposedly those who are skilled with screen-based media are able to "multitask," to handle several media tasks at once.

> *A 2009 study at Stanford University investigated the effects of multitasking, a common mode of operating with students who are "digital natives." Contrary to the general impression that multitasking can be productive, the study concluded that multitaskers were much more distracted by "irrelevant environmental stimuli" (Ophir et al. 15583). Their conclusions found that intensive multitaskers are "sacrificing performance on the primary task to let in other sources of information."* [44]

Screen technology moves us to an image-based culture where feelings count more than thoughts. [45]

Doreen Dongen Magee has written and spoken extensively on the impact that screen technology has on human brains: [46]

- Whereas reading and personal conversation can involve most of the brain, with screen activity only part of the brain is involved.
- Little activity takes place in the frontal lobe and prefrontal cortex, areas linked to decision analysis and critical thinking.
- Video games reward multiple decisions per second and feed release of adrenaline, norepinephrine, and endorphins, creating a combination of high alertness, readiness for action, and sense of pleasure.
- The brain never waits to be stimulated. We expect constant input, stimulation, and entertainment.
- Attention spans become shorter. We begin to lose the ability to focus.
- Patience is diminished. We give up on any web page that doesn't load in two seconds.

6. Screen technology puts pornography one click away.

Obtaining degrading images of the human body used to require travel to a store in the seedy part of town or mail order shopping- now available on a home computer. Easy to stumble upon, since many smut-peddlers buy up web addresses that are a single letter different from popular web addresses.

Dangers

- Exploits women.

- Turns people into objects, dehumanizes individuals
- Presents a corrupted view of sex
- Promotes stimulation in isolation
- Is deliberately addictive
- Moves the user into areas of secrecy
- Is damaging to marriages
- Can prompt aggression towards women in a few individuals

Internet porn is a billion-dollar industry impacting millions of viewers.

7. Screen technology makes it easy to denigrate others

Why is it that so many talk posts and YouTube videos with comments get flooded with insults and cursing? There is something about the anonymity of a screen name makes it seem alright to put others down, to say things you wouldn't say in person.

In the Book of James we read: "Out of the same mouth proceed blessing and cursing. My brothers, these things should not be." (James 3:10)

Even Zoom meetings can allow us to become sloppy in our relationships. When our audio and video is muted, there's no eye contact, no necessity to pay attention. We could act disrespectfully or even play a game during the meeting.

"Most technological channels of communication give us a way to mute the conversation and tune out the speaker. When the person is physically present with us, we have less control and we will likely be more hospitable and respectful in our listening." [47]

8. Screen technology confuses information with knowledge.

Data and information are not the same as knowledge and wisdom. Wisdom, in fact, is the optimum use of knowledge.

Screen technology deluges us with information. When flooded with information, we may give up on understanding something altogether.

We speak of information "as if the life and the universe is a collection of data." [48]

Instead of knowing the foundations of various fields and building from these young people are using smart phones and Google to access what they think they need.

We are losing the ability to do documented research and to evaluate the validity of our sources. The Internet can be a powerful source of information -and misinformation. Some is valid, some is incorrect, and some is deliberately misleading.

> *We have limited capacities for knowledge and wisdom. Knowing what matters most—truths about God, ourself, and creation—takes time and effort. Being awash in information is not the same as gaining knowledge (truth received in a rational way). Americans are usually well-informed ignoramuses. We have oceans of facts or*

> *information at hand, but little knowledge. Wisdom is the proper use of knowledge. Americans typically have no idea how to handle all the data thrown at them: the more information, the less meaning.* [49]
>
> *In a Technopoly, Postman states that acquisition of information takes priority over everything else. Information, in a sense, becomes deified. Gaining information becomes man's primary goal. In man's quest for information, more information is created. Information begets more information. An information glut soon occurs. Postman believes that in a Technopoly, information exists without reason. He states, Information appears indiscriminately, directed at no one in particular, in enormous volume and at high speeds, and disconnected from theory, meaning, or purpose.* [50]

Unless the files are backed up multiple times it can be easier to lose information electronically compared to hard copies.

In the extreme, if we follow the program mindset, we find the ultimate in reductionism:

- Information is merely data.
- Data is merely a binary representation.
- Binary is merely 1's and 0's.
- All that you experience and all that you are is compressible to a pattern of ones and zeros.

9. Screen technology can obscure the world around us

A student who is staring at his cell-phone screen while walking down the street is virtually oblivious to the rest of the world, the real world around him: potential accidents, people with needs, nature's beauty...

Andrew Kimbrell calls the effect "techno-cocooning":

> *As a result of techno-cocooning, huge segments of the population have become autistic in relation to the natural world. Non-human creation is almost completely ignored; when we do notice nature, it is usually viewed on television or glimpsed from a whizzing car, train, or plane. For the short periods when we are in nature, it is usually experienced as technological recreation (re-creation) mediated through the roar of RVs, motor boats, jet skis, snowmobiles, and other power toys.* [51]

New injuries arise that didn't exist twenty years ago:

- Accidents caused by texting while driving
- Accidents caused by texting while walking: bumping into walls, walking into traffic, falling into ponds

10. Screen technology redefines the self

Don Ihde [52] explained the idea of technology interacting with and changing the concept of "self". We perceive the world through technology and find ourselves changed by technology.

> *New technologies suggest new ideas about embodiment: our "reach" extends to global sites through the Internet; we enter cyberspace through the engines of virtual*

reality. In {the book Bodies in Technology} a leading philosopher of technology explores the meaning of bodies in technology–how the sense of our bodies and of our orientation in the world is affected by the various information technologies. [53]

From Scripture and from observations we can make these generalizations about the human self:

- The self is valuable to God (sinful, but never worthless)
- Each self is unique
- The self is primarily known in relationship to God and to others.
- The self is localized in space
- The self is one. A healthy self is integrated and singular. We usually conclude that multiple personalities and multiple "masks" are signs of dysfunction.

"Loss of self" has been associated with

- brain injury
- chronic illness
- abusive relationships
- depression
- bereavement and loss
- schizophrenia
- terror and evil

We should have a reasonable view of ourselves and deliberately place the needs of others above ourselves. Modern technology, on the other hand, can lead to four abnormal views of the self.

(1) Plurality of self [54]

Multiple roles (teacher, mother, wife, committee member) are different form multiple selves.

Role playing games and avatars have led people to create alternate selves with alternate lives. For those who live "virtual" lives- their internet selves may seem as real as -or better than -their physical lives.

(2)The "disembodied self"

Doug Groothuis explores the idea of a "disembodied self":

Cyberspace is often referred to as a disembodied medium because information is produced and exchanged through computers via telephone lines without the physical bulk of paper or the face-to-face element of conversation... cyberspace interaction is perceived as weightless and disembodied. Some who become immersed in cyberspace technologies lose a sense of their own bodies in the process. [55]

[Challies]: You (D. Groothuis) wrote, for example, of those who sought in cyberspace "the emancipation from the drag of the body?" How have your thoughts on this matter developed in the past decade? Have new innovations lessened your concern? Have your concerns been proven at all wrong?

> *[Groothuis]: With the rise of social networking-Facebook, MySpace, Twitter, etc.- the temptation to avoid the face-to-face world has increased. There are more toys to distract one from this mode of being. I wrote of simulated worlds in The Soul in Cyberspace, but they had not reached the proportions of SimLife or SecondLife, which are entire "cultures" for the disembodied.* [56]

"The disembodied context of cyberspace may also spark false hopes for a digital resurrection without the flesh, an escape into the datasphere." [57]

(3) The fragmented self

Many people experience a slight fragmentation, in that the face we present to the world is better or smarter than we know ourselves to be. Those who have experienced severe torture often suffer extreme fragmentation.

(4) The augmented self.

Earlier technology was clearly a tool, one that we used when we needed. Smart phones, the other hand, are seen by many young people as an extension of themselves, like an arm or a leg that they cannot be separated from.

> *Cell phones have become extensions of our very selves. With them we cut ourselves off from others, diminish meaningful, face-to-face human interaction, escape the reality that surrounds us, and in general cause us to behave rudely without our even knowing it.* [58]

11. Screen technology can increase stress.

With the advent of the smart phone we can be on-call 100% of the time. We can take our work with us at all times, even on vacation. The sense is that life is speeding up, and we must speed up to catch up with it.

Technology changes radically every five years, and new hardware and software appear every year. We need to keep up with the latest changes at work.

We sense that we are missing out if we don't have the latest version of everything. "We are all advised," said philosopher/social critic Langdon Winner, "to worship at the shrine of Our Lady of Perpetual Upgrade." [59]

We feel a need to keep up with Facebook, Twitter, and Instagram. The result is near-continuous stimulation.

> *If we surround ourselves by too many stimuli, we force our brains into a state of continuous partial attention, a state in which we keep tabs on everything without giving focused attention to anything. When in this state of continuous partial attention, "people may place their brains in a heightened state of stress. They no longer have time to reflect, contemplate, or make thoughtful decisions. Instead, they exist in a sense of constant crisis-on alert for a new contact or bit of exciting news*

or information at any moment. Once people get used to this state, they tend to thrive on the perpetual connectivity. It feeds their egos and sense of self-worth, and it becomes irresistible." [60]

12. Social media can be damaging to young people.

A disturbing number of American teens are anxious, depressed, or suicidal, conditions often fueled by social media. What begins as a way to connect often winds up producing:

- Constant comparison of oneself to others
- Envy
- Feelings of inferiority
- Narcissism, self-promotion
- Rating of others
- Bullying

Social media for teens is driven by the mindset- What will people think of me based strictly on what I post?

In my dozens of conversations with teens, parents, clinicians and school counselors across the country , there was a pervasive sense that being a teenager today is a draining full-time job that includes doing schoolwork, managing a social-media identity and fretting about career, climate change, sexism, racism-you name it. Every fight or slight is documented online for hours or days after the incident. It's exhausting. [61]

For the tech companies, people are treated as commodities. You are your data.

13. Screen technology "Scripts" Us

Kallenberg considers how technology forces us into given patterns:

Technology has a way of scripting our lives in ways that, though invisible to us, change our expectations and desires so long as we are being so scripted. A myriad of artifacts and infrastructures trick us into behaving in particular ways. Not one of us can enter our own homes without some version of the grasp-twist-push action commensurate with doorknobs. In other words, doorknobs script our lives so that we cannot go through the day without grasp-twist-push. Similarly, we generally make right-angle turns with our cars, because we move across the surface of the earth on a roughly orthogonal grid paved with asphalt. And so on. [62]

Screen technology has created a myriad of new unconscious motions unknown to previous generations: Reaching for the phone, swiping across a screen, clicking on a link, scrolling with our thumbs.

14. Technology changes our view of leisure

Mander writes:

As for leisure, I believe that what passes for leisure in our society is actually time-

filling: watching television or buying things. Many writers have argued that given the consequences of automation and robotics, most free time may soon be spent searching for increasingly scarce jobs. And as Marshall Sahlins and others have pointed out ...stone-age societies had more than twice the amount of leisure time we do today, which they used to pursue spiritual matters, personal relationships, and pleasure. Finally, people such as Ivan Illich have said that if you include the time needed to earn money to pay for and repair all the expensive "time-saving" gadgets in our lives, modern technology actually deprives us of time. [63]

15. Technology changes how we relate to the world

James K.A. Smith notes:

The habit of using a smartphone implicitly teaches me to treat the world as "available" to me and at my disposal—to constitute the world as "at-hand" for me, to be selected, scaled, scanned, tapped, and enjoyed...A way of relating to a phone becomes a way of relating to the world...And while we don't go around swiping our hands in front of us to change the scenery, perhaps we unconsciously begin to expect the world to conform to our wishes, just as our smartphone does. In short, my relation to my smartphone—which may seem insignificant—actually shapes my relation to the world. [64]

16. Additional dangers

Screen technology, when wrongly used.

- Can distract us from worship
- Can let us down (when it fails)
- Can drain our funds
- Can further separate rich and poor regions (technology "haves" and "have-nots")
- Can make us forget that we are mortal and finite
- Can desensitize us to real human needs.

EVALUATING OUR USE OF SCREEN TECHNOLOGY

We seldom stop to evaluate our choices. Responsible use of screen technology would continually monitor what the technology is doing to us.

According to the book *iGods*, screen technology raises these questions: [65]

- Amazon: What should we own?
- Google: What information is important? (Who decides?)
- Facebook: What is friendship?
- Social media: What should we know about people?

Some tests for screen technology:

- Does this technology make me more aware or less aware of God's presence?

- Does this enhance or hinder the Gospel?
- Does this help or hurt the poor?
- Does this help me to think clearly, critically, and creatively?
- Does this help or hinder my prayer life?
- Does this help or hinder restoration?
- Does this help or hinder the establishment of peace, including personal peace?
- Does this help or hinder my growth in Christ-likeness?
- Is it necessary? Useful? Strictly a toy or a luxury?
- Is it distracting?
- Does it obscure the natural world?
- Does it enhance the image of God in man?

How will this technology affect?

- how I spend my time?
- my overall health?
- my pace of life?
- my stress levels.
- how I process information?
- how I relate to God?
- how I relate to others?
- how I view the world?
- my finances?
- the environment?

HANDLING OUR TECHNOLOGY

Everyone who writes about the problems with technology is quick to add that the solution is not to throw away our computer and smart phone but to handle them wisely.

Consider the lessons associated with technology:

- The lesson of priority – monitor the use of our time
- The lesson of contentment –Do we need the newest release to be content?
- The lesson of stuff– Do I need more stuff?
- The lesson of ultimate ownership– Who really owns all that I own?
- The lesson of liberty – vs– I will not be enslaved by anything
- The lesson of intentional glorification– What am I really here for?
- The lesson of transparency – Is there anything I wouldn't want my spouse to know? My church to know? God to know? (He knows.)
- The lesson of surrender

Evangelicals often emphasize the concept of "surrender" – our bodies, our choice –making (our plans), our bank accounts–all were given to us by God, and we offer them back to Him. We "hold

everything in an open hand." If we apply this to technology: our computers, our smart phones, our TV's, our iPods, we give thanks for them, then offer them back to God.

1. Begin with humility. Think and pray about how best to use it.
2. Step back from it -Importance of partial detachment from the technology-force ourselves to realize that his is only a tool, no matter how sophisticated it appears. Unless we need it in our work, limit email checking to twice a day at given times and for a limited time.
3. Analyze how much you're using it and if you're addicted.
4. Take specific steps if you detect a problem.

How should we handle technology when we recognize a problem? [66]

- self-awareness
- self-control
- self-denial
- breaking addictions
- take a technology fast
- take a technology Sabbath

Why do we need a break-a Sabbath- from technology?

- So that we can reconnect with others, in person
- So that we can experience some quiet, and be open to God's direction
- So that we can break the "addiction" to various devices
- So that we can find some actual needed rest.
- So that our minds remain capable of thinking creatively and performing basic calculations
- So that we can clearly see nature as God made it (Ps. 19).

5. Keep life balanced:

- Prayer and worship
- Work and play with screens
- Time with family and friends (in person)
- Time outdoors
- Exercise
- Rest/sleep

6. Deliberately do some non-tech things

- Take a walk- appreciate nature
- Read a classic book
- Write notes on paper
- Draw pictures
- Play games, including board games
- Tell stories
- Visit a neighbor

CONCLUSIONS

The balanced Christian position doesn't focus only on the benefits of technology (Creation) or only on the drawback and dangers due to our sin (Fall), but looks at both Creation and Fall simultaneously. We can see potentials and the pitfalls of each technology.

Consider screen-based (information-communication) technology —

POTENTIAL	PITFALL
Can make us smarter	Can make us dumber (minimum reading and deep thinking)
Can connect us	Can separate us (family sitting at the dinner table texting others)
Can make earth cleaner	Can make earth less clean (millions of non-recycled computer parts)
Can make us safer	Can make us less safe (IEDs build from discarded phones)
Can create jobs	Can destroy jobs (online shopping putting department stores out of business)
Can save us time	Can cost us time (learning new version softward; updates and repairs)

If we handle it wisely, our screen technology can be a valuable tool and "servant". If we let it get out of hand, it will be a terrible master.

REFERENCES

1. Challies, T., *The Next Story*, Zondervan, 2011, p. 43.
2. Ibid.
3. Taunton. L., "Technology and its Evil Uses," The Larry Taunton Show, broadcast of June 4, 2012.
4. McLuhan M., *Understanding Media*, MIT Press, 1964.
5. Postman, N., *Amusing Ourselves to Death*, Viking, 1975.
6. Reinke, T., *God, Technology, and the Christian*, Crossway, 2022.
7. McLuhan, op. cit.
8. Postman, N., *Technopoly*, Vintage, 1993.
9. Challies, p. 37.
10. Winn, M., *The Plug-In Drug*, Viking, 1977.
11. Mander, J., *Four Arguments for Eliminating Television*, William Morrow, 1978.
12. Postman, N., 1975, op. cit.
13. Velarde, R., "Christianity and the Medium of Pop Culture," A Reasonable Imagination, January 2, 2009, http://robertvelarde.blogspot.com
14. Postman, 1975, op. cit.
15. Velarde, R., "Christianity and the Medium of Pop Culture," A Reasonable Imagination, op. cit.
16. Schaeffer, F., *How Should We Then Live?* Crossway, 1976, p. 240.
17. Kubricht, P., "The Modern Technocratic Society: The Church's Response," *JASA 33* (September 1981): 178-180.
18. Velarde, R., "Christianity and the Medium of Pop Culture," A Reasonable Imagination, op. cit.
19. DiRomualdo, T., "Harnessing the Passion and Skills," Wisconsin Technology Network, https://wtnnews.com
20. Eisenstein, C., *The Ascent of Humanity*, Chapter IV, https://charleseisenstein.org
21. Dodgen-Magee, D., Screen Technology chapel series, LeTourneau University, September, 2014.
22. Gibson, W., *Neuromancer*, Ace, 1984.
23. Carr, N., *The Shallows*, W.W. Norton, 2010.
24. Turkle, S., *Alone Together: Why We Expect More from Technology and Less from Each Other*, Basic Books, 2011.
25. Velarde, R., "Laptops in Class," A Reasonable Imagination, March 16, 2009.
26. Noble, A., *Disruptive Witness*, IVP, 2018.
27. Groothuis, D., *The Soul in Cyberspace*, Baker, 1997.
28. Avram, W., "Connecting with a Theology of Technology," http://reflections.yale.edu/article/ibelieve-facing-new-media-explosion/connecting-theology-technology#sthash.Pnvo1kTq.dpuf

29. Challies, op. cit., p. 117.
30. CNN Staff, "Electric Sheep," http://money.cnn.com/mostly-human/electric-sheep/
31. Terlizzese, L., "What is Technology," Probe Ministries https://probe.org/what-is-technology
32. Velarde, R., "Cell Phones =Increased Incivility," A Reasonable Imagination, October 14, 2008.
33. Winner, L., "Technology as Big Magic," *IEEE Tech. Soc.*, Fall 1998, p. 2-16.
34. Vanderleest, S., "Two Tales of Technology," http://www.booksandculture.com/articles/webexclusives/2014/april/two-tales-of-technology.html?paging=off
35. Turkle, op. cit., p. 203.
36. Terlizzese, L., "The Church and the Social Media Revolution," Probe Ministries, https://probe.org/the-church-and-the-social-media-revolution/
37. Dodgen-Magee, op. cit.
38. Lett, J., "Tech Kills, unless You Kill it First," LeTourneau University chapel presentation, September 5, 2018.
39. Argent/Netflix, *The Social Dilemma*, movie, 2020.
40. CNN Staff, op. cit.
41. Schuurman, D., "Technology Has a Message," http://www.cejonline.com/?issue=december-2013
42. Challies, p. 45.
43. Nicholas Carr, quoted by Schuurman, D., op. cit.
44. Schuurman, op. cit.
45. Challies, p. 53.
46. Dodgen-Magee, op. cit.
47. Vanderleest, op. cit.
48. Challies, p. 58.
49. Challies, T., "Interview with Douglas Groothuis," http://www.challies.com/interviews/the-soul-in-cyberspace-an-interview-with-douglas-groothuis
50. McNabb, C., "Reflections on Neil Postman's *Technopoly*".
51. Kimbrell, A., "Cold Evil: Technology and Modern Ethics," Twentieth Annual E.F. Schumacher Lectures, 2000, neweconomics@neweconomicsinstitute.org
52. Ihde, D., *Bodies in Technology*, U. Minnesota Press, 2001.
53. Publisher's Review of Ihde, *Bodies in Technology*.
54. Ingram, J., "Theology and Technology" lecture, Francis Schaeffer Lecture Series, Covenant Seminary, 1998.
55. Groothuis, D., "Christian Scholarship and the Philosophical Analysis of Cyberspace Technologies," *J. Evang. Theol. Soc.* 41(4), 1998,p. 631-640.
56. Challies, interview with D. Groothuis, op. cit.

57. Groothuis, p. 75.
58. Velarde, R., "Cell Phones=Increased Incivility," op. cit.
59. Winner, op. cit.
60. Challies, p. 125.
61. Schrobsdorff, S, "The Kids are Not All Right," *Time*, November 7, 2016, p.47.
62. Kallenberg, B., *God and Gadgets*, Cascade Books, 2010.
63. Mander, p. 26.
64. Smith, J.K.A., "In the Beginning was... Technology," https://www.thebanner.org/features/2016/02/in-the-beginning-was-technology
65. Detweiler, C., *iGods*, Brazos Press, 2013.
66. Dodgen-Magee, op. cit.

CHAPTER 22: BRAVE NEW WORLD OF TECHNOLOGY

INTRODUCTION

This was a story that circulated in the 1980's:

Imagine yourself twenty years in the future. The world's most massive computer has been assembled and loaded with every available data file in existence. The inventors are entering the most difficult questions known. Let's see what the machine answers.

Question: "Is there a God?"

Answer: "There is now. Bow down to me!" [1]

Where will unbridled technology take us in the coming years?

In his insightful book *Thank You for Being Late* [2] Thomas Friedman describes what he terms the "age of acceleration." The world changed massively in 1958 when Jack Kilby of Texas Instruments developed the integrated circuit, making it possible to incorporate thousands of transistors onto a single, tiny, block of silicon. The world changed again in 2007, this time with acceleration: [3]

- Apple introduced the iPhone
- Facebook went public
- Google bought YouTube
- Google incorporated the Android device platform
- Amazon launched the Kindle
- IBM began building Watson, its cognitive computer
- Intel introduced non-silicon device technology

Recent technological advancements impacting our lives now include:

- Advanced processors (including multiple processors on a chip)
- Miniaturized sensors (capable of transmitting real-time data)
- Faster and smaller memory (formerly a trade-off between these features)
- Complex software
- Expanded networks (linking hard wire, optical fiber, and wireless links)
- Cloud storage (off-site but continually accessible)

Whereas massive technological changes took two or three generations for adaptations, today the changes are occurring in 10 to 15 years, and we are struggling to adapt to all the changes. [4]

Friedman's study presents these key ideas: [5]

- Change is happening faster than ever before.
- The changes are occurring primarily in technology, but also in globalization (new global markets and suppliers) and in nature (Climate Change).
- The Industrial Revolution led to new prosperity for many but also to 70 years of Marxism in Russia.
- Farms gave ways to factories which gave way to science jobs which are giving way to knowledge jobs.
- We can't really anticipate what the new jobs will be. We need to stay flexible.

> *It isn't merely the increase in computing power per se that is challenging and disrupting institutions and traditional ways of doing things. The emergence of artificial intelligence technologies, robotics, nanotechnologies, revolutionary gene-editing techniques (such as CRISPR), and software platforms (such as GitHub) that partially automate the writing of software are taking the computer and information revolution to entirely new levels of power, sophistication, and complexity. The velocity of technological change is increasing and isn't likely to abate in the foreseeable future, and organizations—including churches and Christian ministries—that seek to survive and thrive in this new dynamic environment must be nimble and resilient.* [6]

The "brave new world" of modern technology that's emerging focuses on three primary areas:

1. Artificial Intelligence
2. Robotics
3. Augmented humans-Transhumanism, cyborgs, and the singularity

What happens when the tools we create become more powerful than we are?

- Could they take over?
- Could they destroy us?
- Would we try to merge with them?

These are the kinds of questions tech writers are wrestling with. To many the matters sound like something from a science fiction novel, but these are, in fact, the issues that the engineers and computer scientists of Silicon Valley are dealing with.

MODERN TECHNOLOGIES MEGA SHIFTS

Gert Leonhard has analyzed ten major shifts that are sweeping through society and presenting challenges never considered. He considers them to be "technological forces combining to create a perfect storm for humanity." [7]

1. Digitization - turning media and entire industries into a digital format
2. Mobilization -making everything mobile and controllable by apps
3. "Screenification"- viewing and controlling everything through computer and phone screens
4. Disintermediation- removing the "middleman" in sales and customer service

5. Transformation-changing the existing parts into new things
6. "Intelligization" -making use of "deep learning"
7. Automation- substituting machines for humans wherever possible
6. Virtualization - decentralization through simulation and cloud computing
7. Anticipation - developing computers and robots that anticipate our every need
8. "Robotization" - employing robots and machines in every area of life and every line of work

ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) refers to advanced computing, particularly software, which mimics, and may surpass, human intelligence. In the extreme, AI is seen by some as producing an artificial being that appears to be human.

Traditional areas have included

- Pattern recognition
- Game playing
- Autonomous control
- Decision-making

While some may think of artificial intelligence as the stuff of far-off science fiction, low-level AI is already built into much of society: self-focusing cameras, automobile distance measuring, sorting of applications and resumes, internet search algorithms, and many social media apps.

Mathematician Alan Turing (1912-1954), developer of code-breaking machines during WW2, was a pioneer in computing theory before the actual development of the digital computer (1946).

John Von Neumann (1903-1957) proposed a computing machine which included stored memory and stored programs.

Norbert Wiener of MIT (1894-1964) developed the field of cybernetics, a combination of computing, information, and feedback control theory.

In 1943, Warren McCulloch (1898-1969) and Walter Pitts (1923-1969) proposed a mathematical model of a neuron, the basic element of our nervous system. A series of excitatory or inhibitory inputs are weighted and summed, and he output decision is based on whether a threshold is exceeded. This concept, with increased complexity, is the basis of neural networks in use today.

Professor John McCarthy (1927-2011) of Stanford coined the term "artificial intelligence" in 1956 as "the science and engineering of making intelligent machines" which "take action to maximize their success." McCarthy also developed the LISP language as a basic tool. McCarthy was clear in his writings that AI was merely copying human intelligence and that computers would never achieve "consciousness."

Herbert Simon (1916-2001), with backgrounds in Economics and Management Science,

investigated the relationships between data, causality, and decision-making. Simon developed expert systems and problem solving software and proposed "emotional cognition."

Allen Newell (1927-1992) was associated with Simon in program development and made contributions to the areas of heuristic problem-solving, speech recognition, and human-computer interaction.

Marvin Minsky (1927-2016) developed advanced robotic systems, proposed thinking machines, and anticipated AI solving some of humanity's biggest problems.

AI techniques

Artificial Intelligence is not a monolithic technique but rather involves a number of approaches to mimic human thinking by computers:

- High-speed "brute-force" calculations
- Decision making - machine actions that mimic human decisions, using such techniques and ranking and prioritizing
- Artificial neural networks -networks that mimic biological neurons to recognize relationships in data based on input "training sets"
- Autonomous control -programmed control of machines or robots without requiring human supervision
- Machine learning - computer algorithms to improve output by iteration using massive data and "experience"
- Expert systems - a computer simulates the reasoning of a human expert
- Natural language processing-recognizing voices and words with ability to answer or respond
- Pattern recognition-data analysis using algorithms to recognize patterns in data (text and images)
- Machine vision - camera input connected to image recognition
- Fuzzy logic-computer problem solving using a range of values (instead of binary 1 and 0) to model logical reasoning with vague or imprecise statements
- Heuristic game theory- developing rules for learning to play with strategy using interdependent decisions
- Genetic algorithms -a method for optimization using random "mutation" and "survival of the fittest" algorithms

Uses of AI include:

- Speech recognition
- Language translation
- Extremely dense encoding and decoding
- Facial recognition
- Medical diagnostic assistance, including interpretations of ECGs, X-Rays, and MRI images

- Control of landing systems
- Detecting fraudulent activity
- Creating and breaking codes
- IBM's Deep Blue (which won at chess)
- IBM's Watson supercomputer (which won at Jeopardy!)

In the works, but not quite ready for prime time, are efforts to produce self-driving cars and self-piloting airplanes.

Weak and Strong AI

Philosophers, as well as computer scientists, are interested in the potential of AI and draw a distinction between "Weak AI" and "Strong AI."

In "Weak AI" (Narrow AI) a computer system is able to carry out a specific task, usually better than a human could handle it. Weak AI systems become valuable tools to assist us and to help us understand learning.

"Strong AI" (General AI), on the other hand, refers to generalized intelligence, thinking at the level of a human. Proponents of strong AI expect to see computers achieving consciousness, sentience (sensory awareness), understanding, and initiative. Many believe this is an impossible (or dangerous) goal. [8]

> *Narrow AI learns to do a specific task or group of tasks where general AI has the capacity to learn across a broad spectrum of fields or skills. Although the latter seems relegated to the distant future, the former already exists and is becoming pervasive. As narrow AI continues to grow, we must recognize that the technology brings potential for good, but also harm.* [9]

The Turing tests

Alan Turing proposed what has become known as the "Turing test", a way to determine whether answers coming from a box are generated by a human or by a machine---

> *...Alan Turing's classic paper "Computing Machinery and Intelligence" seems an apt topic for a blog post. It is in this paper that Turing sets out his famous "Imitation Game," which has since come to be known as the Turing Test. The basic idea is as follows: Suppose a human interrogator converses via a keyboard and monitor with two participants, one a human being and one a machine, each of whom is in a different room. The interrogator's job is to figure out which is which. Could the machine be programmed in such a way that the interrogator could not determine from the conversation which is the human being and which the machine? Turing proposed this as a useful stand-in for the question "Can machines think?" And in his view, a "Yes" answer to the former question is as good as a "Yes" answer to the latter.* [10]

Searle's Chinese room

Philosopher John Searle differed with Turing about the potential for computer thought:

> *Searle argues that the case for "strong AI" is mistaken and proceeds to frame his argument by introducing the "Chinese room" thought experiment. In this experiment, a person who understands only English is locked in a room, and messages written in Chinese are passed into the room. Furthermore, the person has access to a comprehensive set of English instructions for manipulating strings of Chinese characters...To those outside the room, it would appear as if someone in the room understands Chinese-even though he does not. Searle argues that a computer is essentially a symbol-processing machine; it cannot be said to understand, and therefore cannot be said to think.* [11]

If a computer someday claimed to be conscious, what would that look like?

The computer says: "I'm a conscious computer. I know that I'm composed of silicon circuits. I know who programmed me. I compute, therefore I am."

How would we ever know whether the statement was spontaneous or whether the machine was simply programmed to "say" this?

Ethical issues

Bossman suggests nine major ethical issues in Artificial Intelligence: [12]

1. Unemployment. What will life be like once computers and robots take over all the jobs?
2. Inequality. How will income be distributed once wealth is concentrated in the hands of those who own AI-driven firms?
3. Humanity. How will human interactions change once we are interacting frequently with machines (as if they were people)?
4. Artificial stupidity. How can we protect ourselves from machine failures?
5. Racist robots. How can we prevent bias in robotic judgments?
6. Security. How can we protect AI systems from malicious use?
7. Evil genies. What if AI turned against humans as an unintended consequence? (Bossman gives the example of a computer that successfully eradicates all cancer-by destroying all human life.)
8. Singularity. What happens when humans are no longer smarter than the machines they've made?
9. Robot rights. Will intelligent machines have legal "rights" related to "quality of life" and survival?

AI Challenges and Dangers

1. Invasive loss of privacy

Using cellphones with GPS and cameras in the streets with facial recognition it is now possible to track a person's movements and to know where he or she has been from minute to minute. With Siri, Alexi, and social media it is already a given that major tech firms assemble a profile of an individual using AI to aim advertisements that will appeal to them. [13]

At first glance the idea of placing cameras in every store and street corner and monitoring citizens seems like a reasonable way to prevent or to solve crimes. The possibility for misuse, however, is huge. China has begun using these techniques to monitor its citizens, tying the findings to a "social credit" system. Only those whose behavior fits the party model are allowed the benefits.

In normal society, conversations last for a few minutes and then disappear. In the surveillance society, every word is recorded and available for years.

> *Having conversations that disappear as soon as they occur is a social norm that allows us to be more relaxed and comfortable, and to say things we might not say if a tape recorder were running. Over the longer term, forgetting-and misremembering- is how we process our history. Forgetting is an important enabler of forgiving. Individual and social memory fades, and past hurts become less sharp; this helps us forgive past wrongs.* [14]

The Evangelical Statement on Artificial Intelligence contains the following statement:

> *Article 8: Data & Privacy*
>
> *We affirm that privacy and personal property are intertwined individual rights and choices that should not be violated by governments, corporations, nation-states, and other groups, even in the pursuit of the common good. While God knows all things, it is neither wise nor obligatory to have every detail of one's life open to society.* [15]

2. Manipulation

Shoshana Zuboff is the author of *The Age of Surveillance Capitalism*. In her book she spells out where we have come with social media AI: [16]

- For 20 years Google and Facebook (and later, Amazon and Apple) have persuaded the public to surrender privacy for the sake of convenience. Enormous amounts of data have already been collected on millions of citizens.
- Instead of tracking statistical population trends, individuals can be studied and targeted using AI algorithms.
- Our choices, our searches, our purchases, and even our faces become data that businesses own.
- Information collected not only predicts our behavior but can be used to influence and modify it for "the highest probability of business success."
- "Nudging and coaxing" can take place not only for shopping but for political ends in an attempt to influence our voting. Cambridge Analytica employed targeted messages, false stories, and direct emotional manipulation.

Zuboff vividly brings to life the consequences as surveillance capitalism advances from

> *Silicon Valley into every economic sector. Vast wealth and power are accumulated in ominous new "behavioral futures markets," where predictions about our behavior are bought and sold, and the production of goods and services is subordinated to a new "means of behavioral modification."*
>
> *The threat has shifted from a totalitarian Big Brother state to a ubiquitous digital architecture: a "Big Other" operating in the interests of surveillance capital. Here is the crucible of an unprecedented form of power marked by extreme concentrations of knowledge and free from democratic oversight. Zuboff's comprehensive and moving analysis lays bare the threats to twenty-first century society: a controlled "hive" of total connection that seduces with promises of total certainty for maximum profit — at the expense of democracy, freedom, and our human future…With little resistance from law or society, surveillance capitalism is on the verge of dominating the social order and shaping the digital future — if we let it.* [17]

From the Evangelical Statement:

> *Article 8 -*
>
> *We deny the manipulative and coercive uses of data and AI in ways that are inconsistent with the love of God and love of neighbor. Data collection practices should conform to ethical guidelines that uphold the dignity of all people. We further deny that consent, even informed consent, although requisite, is the only necessary ethical standard for the collection, manipulation, or exploitation of personal data—individually or in the aggregate. AI should not be employed in ways that distort truth through the use of generative applications. Data should not be mishandled, misused, or abused for sinful purposes to reinforce bias, strengthen the powerful, or demean the weak.* [18]

3. Social decision making

The current push is for computers to provide more and more to society. Computers are lightning fast and store mammoth amounts of data.

Massive funding has been invested into AI research, since computers can recognize patterns in data. Hopes have been expressed that law and criminal justice would benefit from AI, as well as healthcare and transportation. [19]

Would we really want critical decisions in health care, economics, politics, or the military to be made autonomously?

- Computerized lawmakers? Making federal law?
- Computerized judges? Making decisions about life, death, and prison sentences?
- Computerized counselors? Making decisions about families and child custody?

If an expert system, based on a mountain of data about individuals, can predict their future actions within a tiny margin of error, it can predict how a community of voters would vote. In that case, some argue, why bother having them cast a ballot?

What could go wrong in such a system?

I continually run into

- Billing errors
- Health record errors
- Airline pricing errors
- Calculation errors
- System failures
- Security breaches

resulting from

- Incorrect data entry
- Confusing instructions
- Incorrect input information
- Program bugs
- System hacks

Are we willing to trust critical decisions entirely to machines?

Machines are effective and efficient, but are these our only values to consider? What about empathy and compassion? What about ethical decision making? We can't program human feelings into a machine. [20]

Automated decision making assumes that our decisions are predictable, but they are not. We sometimes make "gut choices," sometimes risky choices, occasionally irrational choices, as part of being human. Except perhaps for jury duty, most of us like the freedom to make decisions and may be reluctant to surrender that ability to machines.

4. Internet of us

By means of the Internet of things (IOT) everything that can possibly be connected will be connected to the Internet. All variables will be sensed and controlled. Some of the potential applications are appealing:

- Automobiles and appliances sense the need for maintenance or repair and initiate it themselves.
- A system senses the weather, generates the weather forecast, and sets out the best jacket and/or umbrella for the day ahead.
- A "personal assistant" senses tenseness after work so puts on appropriate music and prepares a meal of comfort food.

Where could this lead? If humans are also connected to the Internet, humans are considered as things. [21]

Would we lose our decision-making ability in all the small choices of life?

In all computer-based applications we need to consider —

- What can go wrong if the system fails?
- What could happen if someone malicious hacks into the system?
- What does this mean to our human dignity and lifestyle?

5. Runaway AI

Many of those working in AI are convinced that super-intelligent machines are inevitable.

> *We can conclude that at some point in our ancestral past consciousness emerged through the gradual development of the evolution of our species that gradually gave rise to H. sapiens. We can then validly infer that such a quantity as consciousness may also emerge in other machines that we construct and imbue with artificial intelligence.* [22]

Philosopher Christopher DiCarlo raises several issues regarding conscious AI: [23]

- Will the AI system develop a sense of selfhood once it becomes conscious?
- Should conscious AI systems be afforded ethical and legal rights?
- Will the AI develop a value system?
- Will the AI system want to survive?
- Will the AI system want to replicate?
- Will the AI system turn on its creators (the Frankenstein effect)?

Coupled with the certainty that machines will become more and more intelligent is the fear that intelligent machines will achieve ultimately consciousness and take over our civilization. Various bloggers suggest that if we turn all major decisions over to AI the machines will logically conclude that all humans should be destroyed. [24]

> *Given that what Bostrom calls a "superintelligence" will have power that vastly outstrips our own, it is possible that such an entity could take control of our species and our planet. Furthermore, there is no guarantee that its preferences and goals would align with our own. We might attempt to direct our creations by giving them directives, but we must proceed very carefully when doing so. In short, "be careful what you wish for."...*
>
> *A superintelligence interested in solving some particularly complicated problem might determine that the most efficient way of solving it is to convert our entire planet and all of its resources into a giant supercomputer.* [25]
>
> *(T)he possibility of any threat to humans, even if small, is real enough that some are advocating for precautionary measures. More than 8,000 people, including Hawking, Noam Chomsky, and Elon Musk, have signed an open letter warning against potential "pitfalls" of AI development. Ryan Calo, a Washington University law professor, argues for the development of a Federal Robotics Commission to monitor and regulate developments so that we don't innovate irresponsibly.* [26]

The scenario sounds like a science fiction movie. The idea that AI will eventually reach the point where robots or computers conquer society seems a far-fetched possibility. AI computing will be smarter and faster than human intelligence, but achieving actual consciousness is an entirely different hurdle.

Humans vs. computers

Computers can perform millions of calculations in a second and can process enormous amounts of data, but computers will never think like humans.

> *Much of the early work in artificial intelligence assumed that intelligence can be abstracted from implementation—what John Haugeland called GOFAI ("Good Old Fashioned Artificial Intelligence"41) or what others have called "symbolic AI." GOFAI claims that intelligence is symbolic computation; hence, it is possible, in principle, to implement intelligent processes (of "the same scope … as human action") in any sufficiently powerful physical symbol system, including, in particular, a human brain or a digital computer. Workers in symbolic AI have tended to focus on problems that require high-level human intelligence (e.g., playing chess, or expert performance in a domain such as medicine). While many such problems have yielded to this approach, everyday acts that we take for granted (e.g., distinguishing visually between a dog and a cat), or even things that "unintelligent" animals do routinely (e.g., moving around in a complex world), have proven intractable for symbolic AI. [27]*

Humans are different from, and in many ways, better than machines.

- Humans are self-aware.
- Humans are naturally curious.
- Humans are willful and creative.
- Humans remember things from childhood.
- Humans respond (at times) emotionally.
- Humans can respond with compassion and kindness.
- Humans can seize on a spontaneous idea.
- Humans can think about the Golden Rule (How would I like to be treated?)
- Humans can size up a scene and notice what might happen.

Humans:

- Have a life history
- Have emotions
- Have a conscience
- Remember experiences, not just facts
- Make new linkages based on metaphors
- Enjoy food, music, and pleasurable sensations
- Grow and develop

- Can often see the "big picture" at once
- Instantly recognize pictures
- Can show mercy, compassion, and kindness
- Can celebrate success
- Have both conscious and subconscious minds
- Ponder deep questions
- Identify with and relate in friendship with other humans
- Can relate to God

Human memories are holistic. We recall facts and times, place, sensations, emotions, decisions — and sometimes exhibit faulty memory. Computer memory can only be coded as a pattern of 1's and 0's.

Computers are excellent at generating potential results of scenarios but are not good at creating scenarios.

Human creativity is not easy to quantify —

- We sometimes look at the "big picture," other times at the details.
- We sometimes recall something out of the blue that may be useful to solving a problem.
- We encourage brainstorming with "outside the box" thinking to generate new solution approaches.
- We sometimes connect things in unusual ways to solve problems. The taco we ate for lunch may suggest some new "rolled-up" design that we never tried before.

Dr. Robert Marks of Baylor has spoken on "Some Things Computers Will Never Do": [28]

> *Many AI researchers believe intelligence arises from algorithms... Algorithmic approaches to AI — and those are the only type we know how to build-cannot produce the creative intelligence that AI researchers employ when they create their machines...*
>
> *Human creativity...occurs, not algorithmically, by following a (possibly very complex) set of steps, but often in a "flash of insight." Mathematicians, musicians, writers, engineers, and artists all testify to this. Deep insights often occur unbidden. Roger Penrose... years ago established that the human mind is not a computer and that, as a result, cannot be creative.*

Even if we make use of the most sophisticated neural nets, we (humans) must supply the training data. The neural net adjusts the weighting of nodes until the system is optimized, but there is no reasoning involved. The computer does not know the goal of the system, does not understand what is doing, and has no pleasure in successfully completing the task.

Machines will never experience happiness, have multi-dimensional memories, or be able to love.

History/overview

Background - The concept of a robot goes back to a Polish play by Karel Capek from 1921 titled R.U.R. (Rossum's Universal Robots), about a set of mechanical workers who revolt. "Robot" initially meant "worker" in Polish.

By the 1960's multi-axis mechanical robots had a significant place in manufacturing (welding, assembling, spraying,...) The media, meanwhile, continued to portray robots as walking, talking, often human-like machines (think R2D2, C3PO, from Star Wars, Gort from the old movie The Day the Earth Stood Still).

Robots have proven most useful in replacing human workers in manufacturing tasks that are extremely repetitive (circuit board assembly, parts moving) or dangerous (automotive welding and painting).

Robot concerns

1. Work - Will robots take over our jobs?

Many are concerned that intelligent machines-primarily advanced robotics-will take over our jobs, causing massive unemployment and income loss. (Actually, manufacturing owners would decide to replace human workers with robots on a massive scale.) The concern that millions of jobs could disappear has led some in Silicon Valley to propose a national guaranteed annual income for every citizen. [29]

Now, I can envision robots replacing humans in many process-oriented jobs:

- Bank tellers
- Store shelf-stockers
- Fast food cooks
- Ticket agents
- Repairmen
- Cleaners
- Waiters
- Trash pickup
- Truck drivers
- Salesclerks

As robots begin replacing human workers, we may question whether actions that are good for the economy are also good for individuals. The IMF warned of a "death spiral" from robot workers: [30]

- Increased replacement of workers by machines
- Increasing unemployment, coupled with falling wages

- Increasing inequality, if robots primarily replace low-skill jobs

Jay Richards of the Discovery Institute summarizes a different perspective: [31]

1. Increasing automation may be sold as a kind of techno-utopia (sit and watch machines do all the labor), but we were designed to work. It is simply not healthy to have nothing to do.
2. At most 50% of current jobs might be taken over by machines. While this is a huge disruption, it does not need to be catastrophic. We've been through this before: When the nation was founded 95% of work was agrarian. By the end of the 20th century only about 6% of Americans were full-time farmers. In a healthy economy, new jobs replace old jobs.
3. Machines may be powerful, but they will never become spontaneously creative like humans can be. We should focus on our competitive advantage over machines. We need to be adaptable for the next transition, providing what the public needs next.

2. Relationships -will robots become part of the family?

With the development of humanoid robots with human features, voices, and soft exteriors, robots are being considered for human companionship. "The potential issues which will arise are unlike any situations we have seen before and will require a thoughtful, multi-disciplinary response. While previous generations of industrial robots were basically stationary and walled off from workers for safety, the new generation of robots are mobile, human-like in appearance, and designed to touch and comfort people." [32]

The steps are these:

- Machines begin replacing humans.
- Machines become teachers and babysitters.
- Machines begin taking over some human services-care for the elderly or children.
- Machines are able to recognize our emotional state and comfort us.
- Machines become replacements for friends, companions, and lovers.

The robot that captured media attention in 2017 was Sophia, a female robot, creation of Hanson Robotics. Sophia appears lifelike and answers questions in a convincing manner. Sophia was actually granted citizenship by the nation of Saudi Arabia.

Advanced humanoid robots have programmed emotions. They monitor faces, gestures, and spoken words for cues to emotional states, then respond with appropriate facial expressions and language to mirror or diminish the humans' emotions.

The purpose of the human-likeness effect is "empathy":

> *In many cases the end goal is empathy with robots or paving the way for 'seamless' social integration. Sophia is listed as having service robotics application in business, medical/healthcare, and education. However, the creation of human-robots for these sectors can easily become an attempt not only to meet practical needs, but emotional needs too. For example, android carers [caregivers] for the elderly can*

be more easily seen as a substitute for human interaction than a non-human robot, potentially leading us to neglect the relational essence of care for the older members of society. [33]

Professor Kerstin Dautenhan University of Hertfordshire introduced some of the work she is doing related to the psychological impact of robots on people. When presented as a 'cuddly toy' they can be helpful to emotionally challenged children. When they appear human-like they are unsettling. The symposium went on to consider whether robots had moral rights as well as moral responsibilities. Could they be sentient, (that is, able to feel pain and pleasure)?

My reflections include:

If humans are made in the image of God, would it be unexpected if humans proved able to manufacture sentient robots that are, to a degree, autonomous beings?

If Love is a vector quantity, could this be programmed into a robot? [34]

As robots become increasingly human-like, humans must avoid becoming emotionally involved with a machine. The concept of sex with a robot, which has been proposed [35], is disgusting and a violation of God's design.

The Bible is all about relationships, particularly real human relationships.

In a world where technical people already may have difficulties with relationships and where screen time already replace much of face-to-ace communication, emotional machines will not make us more human or more compassionate.

3. Warfare – Will robots become the soldiers of the future?

Possibly the next step in warfare will be the linking of AI with autonomous robot soldiers. Certainly, the technology to do so is already present.

An individual soldier is no match for a mechanized warrior, so robot armies will likely face enemy armies composed entirely of robots.

In the extreme, warfare would resemble a video game, with the best player winning a battle.

The concept of robotic soldiers may seem appealing at first when we think of them replacing – and sparing the lives of – equivalent human soldiers. These robotic soldiers, however, would be programmed killing machines. If they should get hacked, go haywire, or be controlled by a tyrant, no population would be safe. The idea of killer robots is strongly opposed by Stephen Hawking, Elon Musk, and other high-tech leaders. "Once developed, there will result conflict on a scale greater than ever and at timespans faster than humans can comprehend." ...

The founders [of the movement] wrote: "Once developed, lethal autonomous weapons will permit armed conflict to be fought at a scale greater than ever, and

> *at timescales faster than humans can comprehend. These can be weapons of terror, weapons that despots and terrorists use against innocent populations, and weapons hacked to behave in undesirable ways... "We do not have long to act. Once this Pandora's box is opened, it will be hard to close."* [36]

It is likely that in the near future drones and other robotic weapons will be fully autonomous. That is, they will not be remotely controlled by soldiers but will rather make decisions on their own.

> *This raises an interesting ethical problem. Typically, it is thought that autonomy also confers moral responsibility. To be autonomous is to be in control of oneself. Therefore, if an autonomous agent chooses to perform some action, that agent is responsible for that action...*
>
> *When a drone is controlled by a soldier, that soldier irresponsible for the actions of the drone. When there is fully autonomous who is responsible if it kills innocent civilians, destroys whole cities, or executes enemy prisoners of war?*
>
> *A prerequisite for fighting a just war is that someone be morally responsible for each enemy death that occurs.* [37]

An additional question might be raised: Would military robots be subject to the Geneva Conventions? [38]

Robots and Ethics

Realistically, a robot might be programmed poorly or could experience a software failure that would render it dangerous to humans. Typical is the example of the coffee-serving robot. This machine is programmed to carry out a single task: to deliver coffee to its owner. Unless the robot were equipped with machine vision and pattern recognition algorithms to identify humans who might be in the space, anyone who happened to be in its path would be perceived as an obstacle and knocked out of the way.

Science fiction author Isaac Asimov proposed three rules of robotics:

- First Law: A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
- Second Law: A robot must obey orders given it by human beings, except where such orders would conflict with the First Law.
- Third Law: A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

These are fictitious, not scientific – ideal rules if robots were built that could obey them

On one level we will face choices regarding the application of robots and their interfacing with humans. The "dignity and integrity of the person and the fundamental rights of the individual" [39] are primary concerns here. A second level must address rules for the robots themselves (robot ethics), "the code of conduct that designers implement in the artificial intelligence of robots."

[40] What must we program into robots in order that their interaction with humans is proper and ethical? A third level is proposed by the authors: The ethics of robots as moral agents themselves, assuming robots reach the place of having freedom of choice, conscience, and awareness of the consequences of their actions. [41]. Such robots could be held responsible for, and found guilty of causing, injury or death. This is strictly hypothetical and ascribes true human qualities to machines.

Would it be possible for machines to learn behaviors by observing people? Learning machines typically "learn" by executing multiple repetitions to minimize error, to converge on a target value, adjusting weights and correcting connections. Machines can recognize similarities and absorb new data. They are not capable of asking reflective learning questions, like

"Why did that happen?"

"How can I use these phenomena?", or

"What metaphor might describe this?"

Machines might be programmed to copy what people do, and to respond in a manner like people respond. The result of observing humans could be disastrous. Robots would watch our actions and learn pride, greed, prejudice, and mistreatment of others. Copying our depravity would multiply it in our machines.

TRANSHUMANISM

The western world has observed three shifts:

- From reliance on nature to reliance on God/religion.
- From reliance on religion to reliance on science.
- From reliance on science to reliance on technology, as savior of society.

The implications are staggering Engineers could become the high priests of the new religion. In the arena of transhumanism this is already happening.

A transhumanist is a person who is not satisfied with his or human limitations and actively seeks change for himself/herself or for the human race, altering humans to be more than they are. Transhumanism is seen as a step towards the (inevitable) posthuman condition. Posthumanism–creating a new species of humans who transcend human limits

The earliest use of the term and concept of "transhumanism" can be traced to Julian Huxley, the evolutionary biologist and brother of Aldous Huxley (*Brave New World*) from a speech given in 1957:

> *"I believe in transhumanism: once there are enough people who can truly say that, the human species will be on the threshold of a new kind of existence, as different from ours as ours is from that of Peking man. It will at last be consciously fulfilling its real destiny."* [42]

For the advocate of transhumanism, our human bodies are our prime obstacle or limitation to becoming what we should be. Posthumanism has always seen the human body as the major

human limitation. For the modern posthumanist, the goal is nothing short of immortality. Among the attempts to extend human life are (1) biological, including genetic alterations, (2) cryogenics (cryopreservation), freezing the body, with a plan to unthaw and restore the body after the technology is perfected, and (3) melding the person and the computer (related to the concept of "the singularity").

Categories of transhumanism

1. The enhanced human

For engineers working in the field of active or neuro-prosthetics, the goal is to restore, as much as possible, normal body functions: locomotion, lifting, grasp, hearing, vision. Typical hardware includes electrodes, amplifiers, motors, microcontrollers, miniature video cameras, miniature microphones, and sensory stimulators. Once a prosthetic arm can flex and extend it is a relatively small matter to ramp up the signal intensity, which would give the wearer greater-than-normal strength.

2. The cyborg

A cyborg, as originally envisioned by neural researcher Manfred Clines, is a man-machine system, part organic and part mechatronic, some combination of mechanical, electronic, and computer.

British engineer Kevin Warwick of Reading University actually became the first human cyborg, first implanting an RF transmitter into his forearm and later implanting a 100-electrode array in to his median nerve. Warwick is able to control robotic arms over computer networks.

Are people with pacemakers and neurophysiological implants already cyborgs? No. These are simply replacement parts, not technical enhancements. Permanent changes to the body intended to provide powers beyond those of ordinary humans is the stuff of science fiction and comics (Six Million Dollar Man, Captain America, Iron Man), not realistic surgery.

3. The singularity

Closely related to the cyborg is the concept of the singularity.

"Within thirty years," wrote Vernor Vinge in 1993, "we will have the technological means to create superhuman intelligence. Shortly after, the human era will be ended." The concept is a point of time, yet in the future, known as the singularity.

The Singularity has two interpretations: (1) the point in time at which computers become more intelligent and more powerful than humans (basically, self-aware), and (2) the point in time at which it will be possible to upload human brains to computers. Numerous movies have portrayed, or hinted at, this concept. "Bicentennial Man", "Short Circuit", and "A.I." are examples of such Hollywood inventions. It was even the focus of an episode of the popular television series, "Numbers"

Ray Kurzweil, inventor of the Kurzweil reading machine, has popularized this concept of "The Singularity," a point in time in which standard laws break down. His popular definition of the Singularity has become the point at which computers overtake human minds or human minds are

understood so well that they can be uploaded to computers, thus preserving the individual.

Kurzweil makes his case based upon these assumptions:

1. Computation is growing exponentially
2. We should have the hardware to recreate human intelligence within twenty years
3. Our knowledge of how the brain works is growing exponentially
4. The brain is characterized by a genome of only 23 bytes
5. We should have a complete map of the human brain within thirty years
6. Technology itself is an exponential evolutionary process

Kurzweil writes, "if you follow these trends further, you get to the point where change is happening so rapidly that there appears to be a rupture in the fabric of human history; some people have referred to this as the 'Singularity.' This is a term borrowed from physics, meaning a point of infinite density and energy that's kind of a rupture in the fabric of space-time." [43]

The IEEE dedicated an entire issue, *Spectrum*, June 2008, to the concept of singularity. Authors Koch and Tononi began their IEEE article with this statement:

> *Would you sell your soul on eBay? Right now, of course, you can't. But in some quarters, it is taken for granted that within a generation, human beings – including you, if you can hang on for another 30 years or so – will have an alternative to death: being a ghost in a machine. You'll be able to upload your mind – your thoughts, memories, and personality – to a computer. And once you've reduced your consciousness to patterns of electrons, others will be able to copy it, edit it, sell it, or pirate it. It might be bundled with other electronic minds. And, of course, it could be deleted."* [44]
>
> *"Across cultures, classes, and aeons, people have yearned to transcend death. Bear that history in mind as you consider the creed of the singularitarians. Many of them fervently believe that in the next several decades we'll have computers into which you'll be able to upload your consciousness—the mysterious thing that makes you you. Then, with your consciousness able to go from mechanical body to mechanical body, or virtual paradise to virtual paradise, you'll never need to face death, illness, bad food, or poor cellphone reception. Now you know why the singularity has also been called the rapture of the geeks. The singularity is supposed to begin shortly after engineers build the first computer with greater-than-human intelligence. That achievement will trigger a series of cycles in which superintelligent machines beget even smarter machine progeny, going from generation to generation in weeks or days rather than decades or years. The availability of all that cheap, mass-produced brilliance will spark explosive economic growth, an unending, hypersonic, technoindustrial rampage that by comparison will make the Industrial Revolution look like a bingo game."* [45]
>
> *Leaders in the fields of artificial intelligence and robotics such as Ray Kurzweil and Hans Moravec argue that the information contained in the brain constituting a person's memories, experience, and personality can be digitized. Therefore, in the*

near future, highly sophisticated imaging devices will scan the brain to collect this information and in turn upload it to a computer. Once this information has been organized and stored, it can then be downloaded into a robotic or virtual reality host. With frequently updated and multiple backups, the uploading and downloading process can be repeated indefinitely. Consequently, one's virtual self can be virtually immortal. [46]

Advancements in understanding the brain include functional MRI studies, Brain-Computer Interfaces (BCI), Deep Brain Stimulation, and BrainGate. [47] [48]

Nick Bostrom suggests several advantages for mind uploading, including: (1) uploads would not be subject to the aging process; (2) uploads could be regularly backed-up, so that they could be restarted if something unplanned occurs, potentially allowing them to live indefinitely; (3) from an economic perspective, an uploaded life would be much cheaper, because it would not need physical food, housing, transportation, etc.; (4) an uploaded individual would think faster within a computer than in a biological substrate (a thousand times faster!); (5) uploads could move at the speed of light as an information pattern, which would be particularly advantageous in a future age of space settlements; (6) it would be easier to implement radical cognitive enhancement in an upload than in an brain.13 In a nutshell, this is mind uploading: a technological project through which human beings will presumably be freed from the physical limitations and suffering (even death) imposed by our biological condition arguably without losing our personal identity. [49]

Winyard writes that:

Transhumanism anticipates a convergence in this century of five "techno sciences": [50]

- Biotechnology

- Nanotechnology

- Information & Communication Technology

- Neuroscience

- Robotics

Transhumanism is built on a set of (materialistic) assumptions:

- No real distinction exists between humanity, nature, or machines. [51]
- Humans have evolved to the abilities they now have and their place in the universe with no input from any God.
- Humanity's present limitations do not represent the endpoint in our transformation. [52]
- Making tools has evolved into designing computers and high technology.
- The human brain is simply a computer-like machine, and our memory stores who we are.
- Intelligence is primarily recognition, memory, computation, and rule-based decision making, things a computer can do.

- Intelligence and consciousness are algorithmic.
- Computer technology is increasing at such a rapid rate that it will soon surpass human abilities in every area.
- Humans are primarily limited by our physical bodies, subject to injury and eventual death.
- We are "on the cusp of a new revolution in science and technology." [53]
- We will soon understand all the functions of the brain.
- Brain circuits can be activated or read out by electronics.
- We are close to being able to merge the human nervous system with a computer.
- The next step in human evolution, as well as our only hope of survival, is to create the technical posthuman by completing the merging.
- Humans are free to pursue transformation through various technologies. [54]

Problems with transhumanism

1. Transhumanism is a self-absorbed attempt to play God.

Transhumanism appeals to human pride and is absolute idolatry. All the focus on man and "improving mankind." There is no place for God, no dependence on God, and no thought of glorifying God through the processes.

Transhumanism is extremely self-centered. The goal is MY human improvement, with no focus on feeding the hungry, helping refugees, or solving an energy crisis.

2. Transhumanism offers a false "salvation".

Transhumanism dangles the hope of life forever by immortalizing the brain.

> *Secular transhumanism aspires to eternal life without reference to Christian thought. Rationalism and materialism are its presuppositions. The origins and history of human life are irrelevant compared with its destiny. Science and technology are transhumanism's means of salvation. The goal is complete freedom from natural limitations, including morphological freedom, the ability to shape our bodies at will, or to eliminate them completely through some form of virtual existence.* [55]

Real salvation is promised by God and is far superior.

3. Transhumanism loses the meaning of being human.

To be human is to be made in the image of God, with all that that entails. To be human is to be limited. What's needed is contentment with our bodies and with being human.

4. Transhumanism blurs the Creator-creature distinction.

This is fine for transhumanists, who often chafe at the concept of humans being created beings with given limitations. It does make sharing the Gospel with transhumanists that much harder.

5. Transhumanism is modern-day Gnosticism.

In the classic heresy of Gnosticism the body was despised as material and limiting. Transhumanism is high-tech gnosticism. The body is clearly seen as an obstacle.

> *Tomorrow, transhumanists hope to eliminate the limitations of human bodies, even making them fashion accessories. Uploaded minds could choose to live exclusively in virtual worlds or be instantiated in whatever form is desired. This would blur distinctions between robotic and biological bodies, which are thought of as complex biochemical machines, ones that are flawed because they are subject to senescence and death. Further, it would allow for multiple simultaneous instantiations, eliminating a basic fact of life: human beings can only be at one place at one time. Going one step further, Natasha Vita More, the wife of Max More, views morphological freedom as opening the door to new art forms. Anyone dissatisfied with their body—natural or artificial—could choose a new bodily form, or no body at all! In these ways, human existence is to be radically changed, with transhumanism opening the door to one or more post-human species.* [56]

6. Transhumanism creates a new species of being, the enhanced human, or techno sapiens.

Transhumanism will set up two different categories of people- enhanced and non-enhanced (ordinary), resulting in second-class status for most of humanity.

> *Aldous Huxley's 1932 dystopia Brave New World divided the genetically engineered population of the future into alphas, betas, and gammas, as I recall. The alphas were the natural-born leaders with enhanced intelligence, and the gammas were bred (or manufactured, really) for menial jobs such as elevator operators (Huxley's crystal ball didn't include much in the way of automation). Huxley avoided the problem of having the gammas rise up in revolt when he made their genetic makeup include a natural-born enjoyment of menial tasks.*
>
> *I don't know about you, but I wouldn't want to live in such a world...The enhanced types will do just fine—the people we need to start thinking about defending are the poor, the discriminated against, and the unborn, now and perhaps even more in the future.* [57]

7. The transhumanist upgrade is not available to everyone.

There simply are not enough resources available for human enhancement for all, and to focus on human enhancement under such conditions can enhance disparity and injustice. [58] The complex surgery to link a brain to a computer is so costly that only the (super) rich will be able to afford it.

8. Transhumanism provides no guarantee of goodwill for the population.

If I were given the opportunity to receive enhanced senses, intellect, or muscular power, would I really want to take it? Would I always and only use it like a righteous superhero (Superman, Green Lantern, the Flash) for the public good? Would I trust others with enhanced powers to use them

virtuously? Unfortunately, I have a strong awareness of human depravity.

Those enhanced may despise ordinary humanity. Those enhanced may overpower or enslave ordinary humanity. Enhancement may actually bring about the extinction of humanity (Humans 2.0)

> *If we start transforming ourselves into something superior, what rights will these enhanced creatures claim, and what rights will they possess when compared to those left behind?* [59]

9. The proposed connection is not physically possible currently and likely never will be.

Neuroscience Problems of the Singularity

The electrical pathways in the brain do not involve conventional electron flow but rather the transfer of ions across neuron cell membranes, the firing of millivolt action potentials, and chemical transport across synapses.

While we have traced the pathways for motor control (muscle activation) and sensory input we don't know how rational thoughts arise or how to decipher them in the nervous system.

We don't know how actual memories are stored. Human memory is not like machine memory, which contains bit patterns for everything stored. We may recall a number, an equation, or a phrase, but we can also recall successful projects and enjoyable experiences from the past.

The connection involves mixing binary circuits, with information coded as ones and zeros with voltage levels in silicon circuits with biological neural "circuits" coded by action potential spikes transferred by transference of sodium and potassium ions across cell membranes. The only way to interface at present involves an electrode with an amplifier whose output is a voltage waveform.

We really don't know where human memory resides or how it is coded for storage.

We really don't know where the conscious "self" resides.

While we are able to elicit motions, record sensations, and study emotions, we don't know how to record or decode verbal thoughts.

> *Specialists in real rather than artificial brains find such bionic convergence scenarios naive, often laughably so. Gerald Edelman, a Nobel laureate and director of the Neurosciences Institute, in San Diego, says singularitarians vastly underestimate the brain's complexity. Not only is each brain unique, but each also constantly changes in response to new experiences. Stimulate a brain with exactly the same input, Edelman notes, and you'll never see the same signal set twice in response. 'This is a wonderful project--that we're going to have a spiritual bar mitzvah in some galaxy,' Edelman says of the singularity. 'But it's a very unlikely idea.'...*
>
> *A healthy adult brain contains about 100 billion nerve cells, or neurons. A single neuron can be linked via axons (output wires) and dendrites (input wires) across synapses (gaps between axons and dendrites) to as many as 100 000 other neurons. Crank the numbers and you find that a typical human brain has quadrillions of connections*

among its neurons. A quadrillion is a one followed by 15 zeroes; a stack of one quadrillion U.S. pennies would go from the sun out past the orbit of Jupiter. [60]

Physical Roadblocks to the Singularity

Physicist M. Kaku notes the following:

First, the dazzling advances in computer technology have been due to Moore's law. These advances will begin to slow down and might even stop around 2020-25.

Second, even if a computer can calculate at fantastic speeds like 10 (16) calculations per second, this does not necessarily mean that it is smarter than us.

Third, even if intelligent robots are possible, it is not clear if a robot can make a copy of itself that is smarter than the original...Intelligence is more than just memory and speed.

Fourth, although hardware may progress exponentially, software may not. Software is totally different; it requires a human to sit down with a pencil and paper and write code.

Fifth, as we have seen in the research for reverse engineering, the staggering cost and sheer size of the project will probably delay it to the middle of this century.

Sixth, there probably won't be a "big bang," when machines suddenly become conscious. [61]

10. Even if the upgrade were possible, it is material and vulnerable.

The goal of transhumanism is immortality, but nothing we manufacture can promise that. The hope that computers can enable a person to live forever assumes that the circuitry itself can last forever. No manufactured item lasts indefinitely. Few cars and electronic gadgets from the 1960's are still functioning today.

The enhanced or uploaded human is not really independent. He or she is actually more dependent than the ordinary person by being dependent on functioning components and batteries. Current pacemakers, myoelectric arms, and cochlear implants all require batteries. Ideally, they last several years, but they are dependent on circuitry and voltage supplies.

In addition, anything linked to a computer runs the risk of being hacked or corrupted.

11. Transhumanism desires to deny the reality of death.

Fallen man is mortal upon the earth by God's limitations. God knows our weakness and the hour of our death.

Heb. 9:27 – "It is appointed unto man once to die, and after that the judgment."

Eccles. 3:1-2 – "For everything there is a season and a time for every purpose under heaven – A time to be born and a time to die..."

Eccles. 7:2 – "Death is the destiny of every man…"

Eccles. 9:2 – "The same destiny overtakes all… The hearts of mankind are full of evil, and there is madness in their hearts while they live; after that, they join the dead."

John Wyatt writes that in God's providential care of his creation then human beings are not meant to live forever in their degraded fallen state. The human lifespan is limited, not just as a curse, but out of God's grace. [62]

12. Transhumanism involves a risky and radical surgery.

Brain implants or neural links directly to a computer will provide a permanent change to an individual (radical surgery). It can't be easily undone if something goes awry.

13. Transhumanism runs into the "duplication" problem

Where does the real "self" reside?

Engineering reasoning and boundary analysis (including the issue of the "duplicator" machine) can demonstrate the difficulties inherent in this concept. Consider the duplication problem, illustrated by Spock (of "Star Trek" fame) and Calvin (of "Calvin and Hobbes" fame): Calvin devises a duplicator to make another of himself, then argues with this duplicate as to which one is really himself. Spock beams himself down to a planet's surface, so that all of his atoms are rearranged exactly the same as they were before leaving the ship. His body and memory are exactly the same as before, but is Spock's self-awareness the same?

Technically, the singularity can be understood by reducing the human being to three parts – the body, the memory, and the self. This third quantity, the self, is the most elusive to definition. Depending upon one's Basic Worldview, it may be the soul, the spirit, or simply self-awareness. Self-awareness consists of that that which remains after accounting for the body and the memory.

14. Ultimately, the transhumanist is less human, rather than more human

Faz Rana writes:

> *If we become too enamored of and too dependent on technology, we run the risk of losing the joy of being biological creatures that are part of nature.*
>
> *Some would argue that this loss dehumanizes us. As theologian Ted Peters explains," the threat [of dehumanization] comes from our attempt so to identify with our technological production that we forget our relationship to the natural world." In short, with technology we run the risk of losing our human identity when we become tempted to subordinate human values for impersonal technological advances.* [63]

Christian observations

Transhumanism represents a new return to modernity (science and technology will save us), rather than postmodernity. It is absolutely tied to a belief in progress and seen as next step in

human development -techno-Darwinism.

The Singularity assumes that our memories are us and that we make decisions based on computable rules.

We make far too little of life and consciousness if we think they can emerge spontaneously given enough time.

Even if consciousness could be packaged and prolonged, the resulting "person" would be trapped forever in a computer or a robot.

For the Christian, the expectation after death is not life-extension or continued brain function but the resurrection of the body with a renewed earth and heaven.

What transhumanists currently desire will actually be the condition of all redeemed humanity after Christ's return, all by the power of, and to the glory of, God Himself: life without end, glorified bodies without injury or disease, expanded knowledge (and also the presence of Christ and separation from sin.)

Christians have taken a wide range of views on transhumanism, Those with a bent towards prophecy see it as strongly tied to end-times scenarios and the mark of the Beast. Others suggest that all Christians are transhumanists since we look forward to a post-resurrection body that will be capable of far more than our current physical bodies. Advocates of transhumanism, however, are interested in merging the body and the machine in the current time frame or the near future.

Most transhumanists do not express a goal of becoming enhanced to better help and serve others. Rather, they are typically seeking new powers for themselves.

Transhumanism will sap thousands of hours and billions of dollars that might be better spent alleviating starvation and spreading the message of Christ.

CONCLUSIONS

We have become increasingly more comfortable with AI/robotic technology: [64]

- Apple Siri/ Alexa - asking questions of a machine
- Roomba vacuum -convenience and labor -saving; robots in the home
- Social media- creating a "mindful" of oneself online
- Screen time- hours of technical interaction

We are "set up" to accept the next wave of technology, which will be even more intrusive.

Leonhard proposes the following new "rights" for citizens of the digital age: [65]

1. The right to remain "natural"/biological/non-augmented
2. The right to be "inefficient" (slower than a machine)
3. The right to disconnect, to totally unplug ourselves from the machine for long periods of time

4. The right to be anonymous
5. The right to employ people instead of machines for any industrial tasks

From "AI -an evangelical statement of purpose" we read: [66]

Article 12: The Future of AI

We deny that AI will make us more or less human, or that AI will ever obtain a coequal level of worth, dignity, or value to image-bearers. Future advancements in AI will not ultimately fulfill our longings for a perfect world. While we are not able to comprehend or know the future, we do not fear what is to come because we know that God is omniscient and that nothing, we create will be able to thwart His redemptive plan for creation or to supplant humanity as His image-bearers.

Questions for the future:

- Where do we draw the line at modifying humans?
- When is a modified human no longer human?
- What is the imago dei? What does it actually mean to be made in the image of God?
- What is the real you?

Alcorn writes:

"What makes you you? It's not only your body but also your memory, personality, traits, gifts, passions, preferences, and interest. I believe all of these facets will be restored and amplified, untarnished by sin and the curse." [67]

Tied to a computer?

During my youth many people who were victims of polio and other diseases had lungs and diaphragms that could not function. Before the development of portable ventilators their only hope for life was confinement on their back inside an "iron lung," a total-body machine which "breathed" for them. The idea of being trapped forever inside a robot or computer is not an appealing prospect.

> *...(I)t is no mere coincidence that C.S. Lewis, in his novel, This Hideous Strength, used just such an idea to picture the final chapter of human history. He depicts a scientific research center, built over the site of Merlin's well, in which the brain of the leader is artificially kept alive by a network of wires, tubes and computers. The brain continues to direct, to communicate to "live" after its body has died. What for (some) people... is the highest expression of human hope - man transcending his own mortality through science - was for Lewis the most demonic expression of human science. Lewis could find no more horrible specter to communicate his urgent concern for the human future than the fusion of man and machine with the intent of overcoming human limitations.* [68]

The promise of technological immortality, says Tony Reinke, is the culmination of the "Gospel of Technology," an arrogant rejection of God. "The spirit of Babylon is the spirit of transhumanism." [69] In Revelation 18 we see Babylon boasting of self-sufficiency, even over death. Yet Babylon is burned to the ground and sunk in the sea in minutes, reaping the judgment for her massive idolatries.

Living Today

Thomas Friedman offers two thoughts: (1) Remember the Golden Rule. (2) Remember that people still want to connect with people. [70]

For believers looking at the "Brave new world of technology" we advise:

- Don't fear technology and the future.
- Rest in God's sovereignty.
- Don't oppose technology, but continue to discuss –and warn of– the dangers of runaway technology.
- Don't put your whole life online.
- Do what we reasonably can to extend life by healthy living and remedying damage to the body. At the same time, don't go down the rabbit trail of the singularity.
- Celebrate human creativity and human uniqueness as reminders that we are made in God's image.
- Focus on human interactions, as messy and as difficult as they may be.
- Hold forth the hope of new life and resurrection through Jesus as true and far superior to transhuman "salvation."

I don't expect to see conscious AI, but I am concerned that machines will make more and more decisions for us, with loss of privacy and freedoms.

The real dangers include loss of real community, loss of understanding in depth, loss of reality (simulations), and loss of humanity.

The world worries about technology as a monster. Christians need to be more concerned about technology as an idol.

REFERENCES

1. Story from the 1980's, quoted by Stephen Hawking.
2. Friedman, T., *Thank You for Being Late*, Penguin, 2016.
3. Friedman, p. 20.
4. Friedman, p. 31.
5. Friedman, op. cit.
6. Davis, J.J., "Times of Stress, Times of Opportunity," https://www.thegospelcoalition.org/reviews/thank-you-for-being-late/
7. Leonhard, G., *Technology vs. Humanity*, The Futures Agency, 2019, p.32
8. Brown, T., "Dangers and Risks of Artificial Intelligence," https://itchronicles.com/artificial-intelligence/the-dangers-of-ai/
9. Reasons To Believe, "Things to know about artificial intelligence," https://reasons.org/things-to-know-about-artificial-intelligence/
10. Feser, E., "Accept No Imitations," http://edwardfeser.blogspot.com/2015/02/accept-no-imitations.html
11. Schuurman, D., *Shaping a Digital World*, IVP, 2013, p. 50-51.
12. Bossman, J., "Top 9 Ethical Issues in Artificial Intelligence," https://www.weforum.org/agenda/2016/10/top-10-ethical-issues-in-artificial-intelligence/
13. Carnegie Endowment, "Global Expansion of Surveillance," https://carnegieendowment.org/2019/09/17/global-expansion-of-ai-surveillance-pub-79847
14. Schneier, B., *Data and Goliath*, W.W. Norton, 2016, p. 128-129.
15. "Artificial Intelligence-An Evangelical Statement of Principles," https://erlc.com/resource-library/statements/artificial-intelligence-an-evangelical-statement-of-principles/
16. Zuboff, S., *The Age of Surveillance Capitalism*, Profile Books, 2019.
17. Review of The *Age of Surveillance Capitalism*, https://www.publicaffairsbooks.com/titles/shoshana-zuboff/the-age-of-surveillance-capitalism/9781610395694/
18. Evangelical Statement, op. cit.
19. Thomas, M., "The Future of AI," https://builtin.com/artificial-intelligence/artificial-intelligence-future
20. Discussion by Craig and Janet Parshall, In the Market radio broadcast, Nov. 4, 2016.
21. Leonhard, op. cit.
22. DiCarlo, C., "How to Avoid a Future Robotic Apocalypse," *IEEE Tech. Soc. Magazine*, December 2016, p. 56-61
23. Ibid.
24. TV Tropes, "Kill All Humans," https://tvtropes.org/pmwiki/pmwiki.php/Main/KillAllHumans
25. Superintelligence The singularity & Existential Risk

26. "Is AI a threat to Christianity?" https://www.theatlantic.com/technology/archive/2017/02/artificial-intelligence-christianity/515463/
27. Bjork, R., Artificial Intelligence and the Soul, *PSCF* ,Vol.60, Number 2, June 200 p. 95.
28. Dixon, B., "Robert Marks: What Computers Will Never Do," https://evolutionnews.org/2016/12/robert_marks_at/
29. Clifford, C., "Elon Musk says robots will push us to a universal basic income," https://www.cnbc.com/2016/11/18/elon-musk-says-robots-will-push-us-to-a-universal-basic-income-heres-how-it-would-work.html
30. Francis, S., "IMF warns of death spiral caused by global domination of robots," https://roboticsandautomationnews.com/2018/06/04/imf-warns-of-death-spiral-caused-by-global-domination-by-robots/17528/
31. Richards, J., "Will robots Take My Job?" Acton Institute video, November 2018.
32. Verrugio, G., Solis, J., and Van der Loos, M., "Roboethics: Ethics Applied to Robotics," *IEEE Robotics and Automation Magazine*, March 2011, p.21.
33. New, C., "Robots in our image-Three Critical Questions," https://evangelicalfocus.com/jubilee-centre/3219/robots-in-our-image-3-critical-questions
34. Cowan, M., "Centre for Bioethics and Public Policy: A Report," *CEA Perspective*, Winter 2008, p. 22-23.
35. Robbins, S., "Our Sexual Future with Robots," https://scottrobbins.org/2017/07/our-sexual-future-with-robots/
36. Gibbs, S., "Elon Musk leads 116 experts calling for outright ban of killer robots," https://www.theguardian.com/technology/2017/aug/20/elon-musk-killer-robots-experts-outright-ban-lethal-autonomous-weapons-war
37. Vance, C., "Autonomous Killer Robots" https://wmpeople.wm.edu/asset/index/cvance/aws
38. Cowan, op. cit.
39. Verrugio, op. cit.
40. Ibid.
41. Ibid.
42. Huxley, J., "Transhumanism," https://www.huxley.net/transhumanism/index.html
43. Kurzweil, R., "The Singularity," in Brockman, J., *Science at the Edge*, Union Square Press, 2008.
44. Koch, C., and Tononi, G.,"Can Machines be Conscious?" *IEEE Spectrum*, June, 2008, p.55.
45. Zorpette, G., "Waiting for the Rapture," *IEEE Spectrum* June 2008, p.34.
46. Brent Waters -Whose salvation? In Cole-Turner, R., Transhumanism and Transcendence, Georgetown University Press, 2011.
47. Rana, F. and Samples, K., *Humans 2.0*, Reasons to Believe Press, 2019.
48. Braingate, https://www.braingate.org/about-braingate/
49. Gaitan, L., Heaven on Earth: The Mind Uploading Project as Secular Eschatology,

Theology and Science Vol. 17, 2019 - Issue 3, p. 403-416.

50. Winyard, D., "Transhumanism-Christianity Diplomacy," American Scientific Affiliation (ASA) Conference , 2017
51. Terlizesse, L., *Into the Void: The Coming Transhuman Transformation*, Christian Publishing House, 2016.
52. Rana, op. cit., p. 194.
53. Ibid.
54. Ibid.
55. Winyard, D., "Christianity, Transhumanism, and Techno-Syncretism," ASA Conference 2018.
56. Winyard, D., "Transhumanism: Christian Destiny or Distraction?" *PSCF* Vol. 72, Number 2, June 2020, p. 67-81.
57. Stephan, K., "Human Biological Enhancement and the Ethics of Personhood," http://engineeringethicsblog.blogspot.com/2008/04/human-biological-enhancement-and-ethics.html
58. Hoffman, B., "Limits to Human Enhancement," *BMC Medical Ethics* 18 (1):56 (2017).
59. Quoted by Winyard, D., 2013 ASA Conference, "Creativity and Transhumanism".
60. Horgan, John, "The Consciousness Conundrum," *IEEE Spectrum*, June 2008, p.36.
61. Kaku, M., *Physics of the Future*, Anchor, 2011, p. 112-117.
62. Wyatt, J., *CMF Files* No. 31
63. Rana, op. cit., p.137.
64. Schatzer, J., *Transhumanism and the Image of God*, IVP Academic, 2019, p. 106.
65. Leonhard, op. cit., p.140.
66. Evangelical Statement, op. cit.
67. Alcorn, R., quoted in D. Herbert, *Becoming God*, Joshua Press, 2014.
68. Sine, T., *The Mustard Seed Conspiracy*, Word Books, 1981, p. 62.
69. Reinke, T., *God, Technology and the Christian Life*, Crossway, 2021, p. 198.
70. Friedman, op. cit.

CHAPTER 23: WORKPLACE

INTRODUCTION

Haley was excited, but a little apprehensive at the same time. As a recent ME graduate, she had landed a great job at a nationally-known company. She was also a young Christian and eager to represent her Savior well at work. She had heard unpleasant stories of believers who trapped their co-workers at the drinking fountain and read them Gospel tracts. What would she encounter? How would her new colleagues accept her?

> *When the young engineer entered college, he [or she] stepped from a locally exalted area of a high school senior, where he had "learned his way around' by progressive experience, into an area of much broader proportions and possibilities, but where he was new and inexperienced and had to find his way around all over again. As he steps across the collegiate threshold into the area of his chosen profession, the young engineer once again emerges from the relative warmth and security of a compact area that has become well known to him ...into an area of vast proportions, an area where once again the young engineer has become a neophyte...* [1]

As a brand new employee in a firm you will have to prove yourself competent and trustworthy. When you show up the first day some of the old timers may be thinking:

- Does this kid really know anything?
- Is this kid -fresh out of college- going to try to show off knowledge?
- Is this kid going to get up to speed on what we do?
- Is this kid willing to work?
- Is this kid going to fit into our project team?
- Is this kid going to spend all his or her time preaching at me?

Some employers have had crummy experiences with Christian employees, usually because those particular employees had embraced "two-pot thinking." (Chapter 8) No company is going to be pleased to have in their employ a worker who regularly misses work for church events or spends their working hours witnessing to other employees.

IMPORTANCE OF THE WORKPLACE

While an engineering education with its emphasis on problem-solving skills can prepare graduates to move into a number of different careers (We have seen graduates migrate into business, law, medicine, teaching, and pastoral ministry), the majority of engineers will find themselves working for a company and providing technical services.

The majority of our graduates go directly to careers in industry. For those students who have done an internship or co-op the transition is easily made. One goal of the senior design experience is often to emulate the stages of an industry project.

The Company

Part of the purpose of a company is to make a profit (which will benefit the owners, private investors, or stockholders). Every so often students will suggest that it somehow evil for companies to make a profit. While there are many non-profit organizations, a standard engineering firm can't exist if it continually fails to make a profit.

Ideally, the company blesses others in multiple ways:

- Provides valuable goods or services
- Provides jobs and a livable income to workers
- Provides desirable benefits to workers
- Provides meaningful work
- Provides a safe and healthy work environment

Ideally, the company has positive goals for the workplace:

- Supportive work environment
- Employee engagement
- Purpose-driven organization
- Culture of innovation
- Valuing and trusting employees

The workplace is not simply a place to earn a living. For the believer the workplace is where-

- We carry out our vocation (calling)
- We use our talents and gifts
- We live out what we've heard and studied (a lab to put theory into practice)
- We learn God's lessons
- We learn to trust God when the task is beyond us
- We see answers to prayer
- God shapes our character -patience, endurance, integrity
- We serve others
- We are to be salt and light

> *The workplace is one of the few places where believers and non-believers spend much time together and get to know each other deeply. Many people, especially in post-industrial economies, form some of their closest friendships at work. Over a lifetime, people spend about 100,000 hours at work, where they often bond over shared tasks and interests. This gives many opportunities to talk about meaningful topics such as God.* [2]

Here are some of the values of Christians in the workplace. When an employer hires a Christian, the company should know that they are getting someone who

- – will tell the truth (even if they'd prefer a cover-up)
- – will act ethically
- – will not rip off the company
- – will work hard at the office
- – will treat others with love and respect
- – will be a peacemaker, rather than an anarchist
- – will pray for the good of the company
- – will bring new insights (often based on scripture or the Holy Spirit)

Every employed believer really is a gift from God to a given workplace, in the sense that they will exhibit Christ's' values, pray for the company, and bless the employees. Every believer is like an unofficial chaplain in the workplace. You must not, however, begin to think of yourself as "God's gift to company x" or "God's gift to the engineering profession." You can be a blessing only as you let God use you.

Expectations

The new employee has expectations about the job, and the company clearly has expectations about the employee.

What should an employee- especially a Christian employee- bring to the workplace?

1. Competence

You were hired for your ability (or potential ability) to perform as an engineer. Demonstrate a high level of competence, which may require a steep learning curve in the first few months.

2. Diligence

It is important for the new employee (and every employee) give a full day's work to their employer in order to obtain a full day's pay from him. We would contend that to do less constitutes theft. There is good reason to perpetuate the "protestant work ethic".

3. Integrity/ Authenticity

Be absolutely truthful without being cutting and blunt. Don't promise what you can't deliver.

Being authentic includes acknowledging your own sinfulness, admitting your faults, and asking for forgiveness when you mess up.

Authenticity is important. If you lose your temper or mess up a project, admit it, apologize, and turn things around right away. Don't let pride ruin your testimony at work. (Tom Nelson)

4. Loyalty

"No man can serve two masters," said Jesus. You have one employer. Be absolutely loyal-unless it involves compromise of family or ethics.

5. Good attitudes

A positive attitude can make a positive difference. A dose of humility is essential. No one likes a know-it-all, particularly one right out of school who will prove within days at the company how little the newbie really knows. What will graduates face in the "real world"?

- An expectation that they will concentrate for an hour or two in a team meeting or design review
- Face-to-face meetings rather than text-messaging
- Projects that last eight months or possibly two years
- An expectation that they can access a manual and read it on their own
- Work that will seldom be as fast-paced and action-packed as a video game.

Being a witness at work

It is critical for a young Christian engineer to keep this fact in mind: You were not hired to evangelize. You were not hired because you're a believer. You were hired on the basis of your education and skills, your technical ability to do excellent engineering work, your potential value to the company. Hopefully all of your co-workers will one day come to Christ, but you were hired to work. To do other than this is to violate your contact and to fail your employer. Remember that engineering work has value in itself and can be done to the glory of God. Many graduates will attest to this: People earn the right to be heard. Over time, excellent work opens the door for discussion of spiritual things and the good news of Christ. [3]

"Witnessing, from an employer's perspective, is a time consuming, non-productive activity that creates divisiveness within a team." [4]

On the other hand, you have an incredible opportunity to represent Christ in your workplace, and the relationships you make may result in new life for many, but on your own time, not on the company's clock.

> *The reality of the workplace is that it is an environment focused narrowly on the accomplishment of tasks to produce a profit for the employer. The Christian must work as a member of a team, which consists of individuals who were carefully chosen for their ability to contribute to the task - not their spiritual beliefs. In order for the team to function effectively, all members must be able to communicate and work together in a mutually respectful fashion.* [5]

How does a Christian with a desire to see people connect with Jesus share the truth at work? Not by ambushing people at the water cooler, preaching to everyone in the lunch room, or putting tracts on every co-workers' desks. As an employee you have a right to have a Bible at your desk, to identify yourself as a believer, to answer questions, to talk in informal settings. The key is to be recognized as a positive worker.

- Do excellent work.
- Speak the truth.
- Love people.
- Relate well with everyone.
- Build a few strong friendships.
- Practice open communication.
- Welcome questions.

It's a lot easier to share your life once you've built a reputation as a solid worker who's always ready to help and always ready to listen. Pat Gelsinger suggests that you have essentially been invited to tell what Christ means to you once a co-worker has inquired about your faith or opened up about personal details of their life. [6]

Listen, care, and find a point of common interest. Note how Jesus identified human needs, met needs, and related it to spiritual truth.

Almost no one will refuse an offer to pray about a problem or a crisis. ("Do you mind if I pray for you about this?")

After a few weeks on the job you should be able to "fly your flag" and let others know you're a Christian without making a lot of noise. [7] One way that appeals to engineers is to have some intriguing books at your desk by authors like Lee Strobel, Hugh Ross, J.P. Moreland, and William Lane Craig. Be ready to lend these out and to discuss them. Discussions over lunch will not take away from work time, and anything outside of work will never be seen as conflicting with promised duties.

> *If we are open-hearted, we grow to love and care about our co-workers. If we are trustworthy and respectful, co-workers may respond to our compassion with curiosity... They may find this kind of conversation less intimidating, off-putting, or insincere, and may find it more relational, open-minded, and authentic than if they were talking with a stranger or going into a church.* [8]

Everyone has the legal right to have a Bible and personal literature at their desk (read it at lunch hour, not during working hours).

> *There is appropriate business environment and dress. The company can dictate, within limits, how you dress and decorate your work area. This works to your advantage, because most companies no longer allow inappropriate calendars which violate sexual harassment guidelines. If Christian art is allowed, it should be tasteful and non-threatening. I personally have a framed program from a Christmas pageant in my work station. It is colorful, tasteful and reasonable in size. I also have other art that is not related to my faith. If I were to hang several large posters that have large lettering that say - "accept Jesus or go to hell - you degenerate pagan!", obviously it would be obnoxious, insulting, in poor taste, and not bear any fruit. If it is a private reminder of God's goodness in your life, then it is probably OK. If it is an attempt to intimidate, then your motivation is questionable.* [9]

Credibility

Sometimes your role is simply to make Christianity credible, not simply for himself/herself, which is valid, but often for Christianity in general. . In the minds of many Americans unfamiliar with Biblical Christianity (but familiar with media caricatures), Christians are foolish, hateful, political, and prejudiced. This is far from the New Testament ideal. This is related to what my students saw as a goal when guests at a Chinese university several years ago. By their words and actions they had to challenge a widely-held paradigm for a culture that didn't believe that a Christian could be intelligent, compassionate, or valuable in the workplace. Sadly, in many American workplaces a large number of employees have never met a real follower of Christ (or have never met an intelligent and loving co-worker who identified as a Christian.)

I Pet. 3:15 tells us that we should "always be ready to give an answer." This suggests that our live should prompt questions by those who watch us:

- Why did you handle that issue honestly?
- Why didn't you quit?
- Why didn't you let him have it?
- Why didn't you fall apart in that crisis?

In other words,

- Why do you have hope?

A Personal Credo [10]

I am confident that the fruits of the Spirit should be a regular part of our professional persona. After all, didn't the apostle Paul tell the Corinthian church that they were a living epistle known and read by all men? That means that others learn about Christ by observing our lives and, if you will, our projections.

So we need to carefully examine what our co-workers notice about us. Do they see us as patient, kind, gentle, and longsuffering? Or do they see us as selfish, competitive, and pushy about our faith?

Developing a personal workplace credo is one way to reconcile our professional persona with our Christian character. To be honest, it was difficult for me to objectively develop my own workplace credo, so I asked for input from my friends. Here's what we came up with:

- Do my job to the best of my ability (Ecc. 9:10).
- Do not participate in office gossip (Prov. 11:13).
- Act kindly towards everyone in the office (1 Cor. 13:4).
- Give credit to whom credit is due (Rom. 12:10).
- Help my peers to shine, even if it means they do better than me (Phil. 2:3).

Separation?

The typical workplace forces diverse people to work together. Don't be surprised to encounter co-workers with a worldview or lifestyle totally contrary to your own. The tendency of many Christians, however, is to avoid those with sinful lifestyles, since believers are called to be holy (i.e., separated unto God) people. "Come out from among them and be separate." (2 Cor. 6:17) This kind of thinking actually misses the whole point of the Scripture on separation.

I Cor. 5:9-13 reminds us:

" I have written you in my letter not to associate with sexually immoral people--not at all meaning the people of this world who are immoral, or the greedy and swindlers, or idolaters. In that case you would have to leave this world. But now I am writing you that you must not associate with anyone who calls himself a brother but is sexually immoral or greedy, an idolater or a slanderer, a drunkard or a swindler. With such a man do not even eat. What business is it of mine to judge those outside the church? Are you not to judge those inside? God will judge those outside. 'Expel the wicked man from among you.'"

> *I had been guilty of doing exactly what Paul warned the Corinthian church not to do--of attempting to separate myself from those outside the church whose behavior didn't match my standards. But Paul says to do that, you'd need to die--to exit the planet! And why on earth would I expect someone to act like Christ when they don't have a relationship with him? ...As it sooner or later does, the obvious dawned on me--that holiness involves separating myself, not from a world of sinful people, but from the sinful attitudes and patterns so prevalent in my own life. My task was not to convince (others) of their mistake but simply to love them and to share my faith whenever the opportunity arose. I knew, too, that loving them didn't mean adopting an "anything goes" attitude. I could befriend them without caving in to a relativistic worldview.* [11]

Be fully engaged, and work to God's glory. In the process of that working you will open the door to much more.

CHARACTER TRAITS AND ATTITUDES AT WORK

Character traits desired by employers

Many companies will agree with Emerson that character is more valuable than intellect. Employers regularly tell us that in addition to strong communication skills they are looking for some key qualities in the workers that they hire, qualities that are consistent with Biblical values:

•Integrity

•Diligence/perseverance

•Work ethic

•Positive attitude

•Creativity

•Flexibility

•Loyalty

•Humility

•Team-player

•Problem-solver

Attitudes

1. Integrity

   Protect your integrity. Never do anything that will embarrass you if brought out into the open. The consequences of inconsistent behavior are sometimes very unforgiving: trust is lost, friends are lost, self-worth and esteem can be lost….

   Whatever you do, do not get yourself in a position where you have to be warned about a poor behavior or action you have taken. It destroys people's trust in you and maybe your work career. If you have an issue, pray about it, commit it to the Lord and deal with it with men you can trust. The opposite applies - businesses are looking for people and leaders with integrity. [12]

Build trust by being dependable and authentic, by honestly caring for your coworkers. Being authentic includes acknowledging your own sinfulness, admitting your faults, and asking for forgiveness when you mess up.

2. Humility

The believer is called to humility (Prov. 15:33, Jas. 4:10, Lk. 14:11, Phil. 2:3). Humility means we don't see ourselves as better than others, that we recognize our inability to control the world, and that we accept our weaknesses and limitations. [13]

If we do excellent work but brag about it or act arrogantly because of our success, we disqualify ourselves from honoring God with our work.

3. Submissiveness/Obedience

For a very independent, free-wheeling student it may be a shock to their system to suddenly have to report to a boss (manager) who tells him what to do, expects perfect attendance, and expects all reports on time.

In Eph. 6:5-7 we read: "Servants, be obedient to those who are your masters according to the flesh, with fear and respect, in sincerity of heart, as unto Christ; not with eye-service, as people -

pleasers, but as the servants of Christ, doing the will of God from your heart, with good will doing service, as to the Lord, and not to men."

"Servants (or employees are to obey their masters (or bosses) as if they were working for Christ... Subordinates must do their work, as instructed by their superiors. In doing so, they find themselves serving Christ in serving their boss." [14]

Show that you know your stuff, that you are willing to learn, and that you will go the second mile.

4. Loyalty (Faithfulness)

"A faithful man will be richly blessed." (Prov. 28:20)

"Be willing to start at the bottom, master the basics of your current job, brainstorm ways to improve your work, make nonvertical moves, serve your teammates, and do whatever your boss asks you to do-as long as it's ethical. That is the sum total of being a loyal employee." [15]

5. Servant mindset

Employers value workers who are not only knowledgeable and professional but also helpful and supportive.

> *Employers are wising up and looking for people who are servants by nature. Unfortunately, society views servanthood in a demeaning and inferior way. Think about your most cherished relationships...A high degree of servanthood undergirds those relationships. Unselfish serving is love in action.* [16]

2 Tim. 2:24-25 outlines some attributes of a Christian worker: not quarrelsome, gentle to everyone, patient.

Attitudes to avoid [17]

- Arrogance. I am in charge! I know it all!
- Organizational "stove-pipes". Not consulting other centers or other organizations
- Not Invented Here—NIH
- Restricted or suppressed flow of information. I would look bad if I disclosed that. Public belittling of an opposing or conflicting view.
- Misunderstanding of cultures. Not recognizing that they are different. And different is OK!
- Theological attitudes towards work

Knowing (1) that company owners often don't know Christ, (2) that leaders don't share our values, and (3) that the company isn't our home, believers often adopt various attitudes towards their work:

1. Escapism ("I can't wait to get out of this world and go to Heaven." Probably appropriate if you're 90, not if you're 30.)
2. Personal gain ("How much can I get out of this, in terms of money, status, pleasure, and stuff?" Not compatible with Jesus' approach.)

3. Resignation ("I'll do the minimum expected, since my real goal is witnessing." Be prepared not be taken seriously.)
4. Blessing ("I'm here as Christ's ambassador to bless this company.")

David Kim suggests that the closest Biblical model for a Christian working in a company that doesn't honor God would be the people of Israel in exile in Babylon. In Jeremiah 29 they were instructed how-to live-in exile:

Build houses, plant gardens, bless the place where you live. (Jer. 29:5-7) [18]

Whelchel [19] writes that there are four types of Christians in the workplace:

1. "Survivors," who believe the workplace is evil and avoid contact with non-believers;
2. "Sleepers," who don't expect to accomplish much;
3. "Influencers," who believe the Holy Spirit can empower their witness;
4. "Leaders," who expect their impact at work to be transformational.

Leaders:

- Believe that by engaging the Holy Spirit at work, people, businesses, markets, and cities will be transformed.
- Their goal is to change the spiritual landscape of whole organizations in favor of the kingdom of heaven.
- Their strategy is led by the Holy Spirit. Actions speak louder than words. Timing is everything, and leaders diligently pray for value and impact.
- Others trust leaders and listen carefully to what they say.
- Their impact is transformational.

Workplace Super spirituality

A "super spiritual" mindset might conclude that God would like us to spend all of our time reading the Bible or going to church and that work just gets in the way. To the contrary, we find that we are to take all that we read in Scripture and all that (that is solidly Biblical that) we hear in sermons and apply it to work, to family, and to all of life. God, and God's truth, should be fully integrated into every aspect of our lives.

Avoid the common Christian excuses for poor work ("Slackism"):

1. Spiritual things are good; material things are evil.
2. Secular work is second class.
3. Everything on earth is temporary
4. Christ will return soon ("Short-timer's mentality.")
5. We are "King's Kids," and everything should be given to us.
6. Grace means we can be sloppy.
7. We are to rest in the Lord.

Needed: a dose of good theology.

> *It is too common to experience other Christians in the workplace who talk the talk but don't walk the walk. They talk about morality and Christian stuff, but their work is lousy and their attitudes are poor. They may deliver poor product to the client or treat clients poorly or complain about their jobs or slander colleagues. Such negative behavior hurts workplace morale, undermines work relationships, and adversely affects clients.* [20]

Overman adds:

> *"We must do our labor as unto the Lord, be it preaching or plumbing, recognizing that when done unto Him, all work is worship; and we must acknowledge that the Kingdom of God is a reality in whatever part of His field we're planted, understanding that the world and all it contains belongs entirely to Him.*
>
> *In short, we must occupy until He comes again."* [21]

Five things never to do at work:

1. Don't use company email for personal correspondence, especially if it is embarrassing to your company. Be loyal to your employer. Company email is for company work.
2. Be careful about using your personal smartphone with the company's wi-fi. Anything you send can potentially be intercepted. Don't send bad stuff.
3. Don't trash your boss in a company survey. "Confidential" is not the same as anonymous. Respond to all surveys professionally.
4. Avoid tagging your picture in social media. "Why were you at the zoo on Thursday instead of at work?" Show up for work.
5. Don't use top management's open-door policy to backstab your boss. Remember the policy guideline of Matthew 18. Go directly to the person you have problems with.

BLESSING AND IMPACTING THE WORKPLACE

Making a Difference in the Workplace

What does it take to have a spiritual influence at work? According to Bill Peel there are three essentials: [22]

1. Competence -striving for excellence, like Daniel did
2. Character- Christ-like character, including love, joy, peace, patience, kindness, goodness, faithfulness, gentleness, self-control (Gal. 5)
3. Concern for others

What does it take to impact the world?

2 Timothy 1:7 –"God has not given us a spirit of fear, but of power, of love, and of a sound mind."

- Power is prayer and reliance on God's strength

- Love is genuine sacrificial love for others
- A sound mind suggests clear thinking honest answers to honest questions

Unfortunately, many outside the church don't have regular contact with Christians and assume believers are weak, hateful, and ignorant. This is the impression conveyed by some movies, atheistic talk show guests, and by a few weirdos (carrying signs that read "The world will end tomorrow" or "God hates you.")

When you're the new hire established workers are not sure what to make of you. They may already have preconceived notions of what Christians are like. You will have to earn their credibility, respect, and trust.

John Kolak makes the following points about how Christian engineers can make a difference in the workplace: [23]

1. Help others to be successful.
2. Encourage and embolden others.
3. Always give others credit. Let supervisors know when others were helpful.
4. Always take the high road with integrity and ethics.
5. When you see a need, meet a need.
6. When you see a problem, fix a problem.
7. When you bring a problem to management, bring a plausible solution (or a few).

Peter Wagner has suggested these directives: [24]

- Have a vision for your workplace.
- Be approachable. Don't "hide in a cubicle with Bible verses pinned to the walls."
- Be real. Don't project an image that Christians always have perfect lives.
- Be adaptable without compromising on truth or morality.
- Realize that influence in the workplace is achieved through success.
- Give credit to the Lord for help in tough situations.

The steadfast faithfulness of the powerful, God-fearing man produces fruit that the lost can see. I tell you truthfully, one God-fearing man, who makes sincere friendships that are totally free of strings, will bear more fruit than a thousand wagging tongues with no love, no depth behind them. [25]

What does it mean to be salt and light in an engineering firm?

- Show up and be consistent
- Do excellent work
- Go the second mile
- Work with a good attitude (Phil. 2)
- Ask God for insight and creative ideas
- Offer creative alternatives

- Be a blessing to your co-workers
- Handle conflicts well
- Sometimes- be the conscience of the company
- Be Christ's ambassador to the company

Your presence in the workplace, bringing who you are as a spiritual being and glorifying God in all you do, should make the workplace more palatable. People should not be high-fiving one another when you have a sick day. You should instead make the workplace a more pleasant environment. Be salt. Salt, in the days before refrigeration, also preserved food, and your presence in the workplace, bringing who you are as a spiritual being, should make the workplace a more secure environment...

James chapter 5:16 says, "The effectual fervent prayers of the righteous avail much." When you can't do anything else, you can always pray, and there is power in your prayer.

So be salt by making the workplace more secure with your intercession, be salt by making the workplace a more palatable place, and be light. Illuminate. Make a difference by the insights you bring based upon the knowledge you have of sacred scripture. Many times, simply paraphrasing a biblical insight will help you to be a force for good, particularly when in the workplace people are facing right-versus-right conundrums. [26]

Scripture provides a number of guidelines for workers in any field:

- Do all things to the glory of God. (I Cor. 10:31)
- Whatever your hand finds to do (whatever is a legitimate task), do it with all your might. (Eccl. 9:10; Col. 3:23-24)
- Work for the Lord, not for people. (Col. 3:23)
- Work without grumbling and complaining (and thereby shine as lights in a dark world). (Phil. 2:14-15)
- Respond with respect and obedience, even if masters (bosses) are unkind and unreasonable. (I Pet. 2:18)

We are called to work, and to honor God with our work.

Proverbs and the Workplace

The book of Proverbs is full of direction for workplace success. [27]

We are taught to:

- Be diligent (not lazy, not a "sluggard"). (Prov. 10:4)
- Be wise (not foolish), particularly heeding instruction. (Prov. 12:1)
- Be faithful. (Prov. 28:20)
- Be humble (not prideful, since pride is a snare) (Prov. 11:2)

- Be righteous (not wicked, avoiding the snares of the wicked) (Prov. 29:6)
- Be honest in all business dealings (Prov. 11:1)
- Be gracious in speech (Prov. 16:24)
- Respond well to correction (Prov. 13:18)
- Work with integrity (Prov. 10:2)
- Work, don't just talk (Prov. 14:23)
- Plan for the future (Prov. 16:3)
- Be a peacemaker (not one who stirs up strife) (Prov. 29:22)

Proverbs tells us that hard work is God's primary way of providing for us and the people in our lives (12:11-12; 27:23-27, 28:19). This theme runs all the way through to the New Testament. In 2 Thessalonians 3:10, the Apostle Paul tells us that "if anyone is not willing to work, let him not eat." In addition, Proverbs tells us that all of our work should be committed to the Lord (16:3). This means that all of our work as Christians should be directed towards God. Whether you are a lawyer, a teacher, a physician, a construction worker, a student, or a stay-at-home mom, God is inviting you to commit your work to him. Jesus is your real boss. This transforms all of our work, no matter how mundane, into worship (1 Corinthians 10:31). Ultimately, Jesus did all of the work for our salvation by dying in our place on a cross. This means that we can work hard without becoming addicted since our identity is tightly secured in Jesus and not our job. [28]

Praying for work

The believer as employee should benefit his or her company/organization by continual prayer for the workplace, even though it won't be known by most employees. What would you pray about?

- For all those in leadership
- For all believers that you work with
- For salvation of all co-workers

Eldred suggests committing the issues of the day to God before leaving for work: the key items of the schedule, the people at each meeting, the issues and problems he'd expect. [29] James 1:5 promises that if we lack wisdom, he will provide as we ask.

> *When we ask in the morning, God promises to answer. Prepare yourself spiritually for each workday, and at the end of your prayer time, get up and walk, knowing God will participate with you and give you what you need when you need it.* [30]

> *What prayer does is to bring God into our vocations...When we pray we recognize our dependence on Him, and we turn ourselves over to His will. When we pray in our vocations, we recognize their connection to God-to His will, His judgments, and His grace...* [31]

God may directly intervene, may resolve the problem through another person, may give us unique insights, or may move us to repentance and forgiveness.

"However God chooses to answer our prayers, whether by changing the situation or changing us, we have given the outcomes to him." [32]

Daily prayer:

- Give thanks for God's goodness and enablement
- Give thanks for work and for your company

Ask for Yourself:

- For your own life, lived before the Lord
- For ability to carry out your duties
- For your current projects
- For insight and positive contribution
- For any interpersonal struggles
- For ability to be Christ's ambassador and to represent Him well

The Company:

- To prosper and be successful
- To bless others through its products and services

CEO and executive management:

- That God would bless their lives and families with health and strong relationships
- That they would be strong and courageous
- That they would make wise and righteous decisions
- That God would work mightily in their lives

Workplace atmosphere:

- For excellent interactions between management and employees
- For healthy, positive relationships
- For cooperation and teamwork
- For honest dealings throughout the organization
- For safety and for good ethical decisions

Co-workers (in general, and by name):

- For excellent relationships with them
- For good health and good work
- For God's blessings on their families
- That they would be drawn to Christ or grow in Him

Immediate concerns:

- Success of current projects
- Ability to solve current problems

If work is to be worship, it must also be excellent. God longs to put his people in positions of influence-for his glory- but there must be an increasing dependence upon the Holy Spirit for excellence before he'll open that door. We can't reduce the

Spirit to simply helping us pray or preach or witness or behave. God can also give creativity and guidance to us as he told Moses he did to Bezalel (Ex. 31:1-6). The Holy Spirit can give wisdom in solving problems, making wise decisions, and in dealing with crisis at work and in doing so, elevate you to places of influence within your workplace (Prov. 22:29). [33]

Workplace Culture

Understanding the "culture" of the workplace can help a worker to navigate some of the pressures and issues that arise. An ethnic culture contains certain values, norms, and behaviors, and these are also found in the workplace. Most people can readily think of different workplaces characterized by- white shirts and ties vs. "casual Friday every day"; highly organized vs. sloppy; aloof vs. best buddies; strong chain of command vs. highly interactive; fear and insecurity vs. security.

Writers on organizational culture suggest four major types, usually tied to the personality of the leader: [34]

- Hierarchical- structured, rigid
- Dependable- stable, little change
- Enterprising /Creative -dynamic, characterized by change
- Social -collaborative

Harvard Business Review suggests six characteristics of corporate culture: [35]

- Vision
- Values
- Practices
- People
- Narrative (history, story told)
- Place (offices or cubicles or open space?)

We're aware of some of the typical personalities/personas in the workplace:

- The controller - must be in charge, even if he or she has zero authority
- The "boot-licker" ("You're a two-faced, insincere apple polisher, Smedley. If only my whole organization was like you.")
- The avoid-work-at-any-cost (think Wally in the 'Dilbert" comic)
- The clueless manager (think Dilbert's pointy-haired boss)
- The womanizer ("skirt-chaser") - He won't last very long in today's anti-harassment environment
- The complainer -Nothing can possibly make him happy
- The braggart - "I once completed fourteen prototypes in 23 seconds."
- The "porcupine" -excellent technically, but so "prickly" that management has to keep him away from clients

Workplace Flourishing

Christian engineers who find themselves in leadership have an opportunity to create a workplace atmosphere where employees flourish. The leaders of the Best Christian Workplace Institute have identified eight "drivers" associated with the "healthiest" workplaces. [36] These factors are

1. A fantastic team (teamwork, passion for excellence)
2. Life-giving work (role satisfaction, enjoyment of work)
3. Outstanding talent (recruited and retained)
4. Uplifting growth (development and recognition)
5. Inspirational leadership (character, integrity)
6. A sustainable strategy (goals, quality programs)
7. Rewarding compensation (fair and appropriate)
8. Healthy communication (listening, involvement)

Aspects of engineering flourishing:

- Desirable career opportunities
- Technological support
- Appreciation for skills and efforts
- Challenging work
- Supportive environment

"What creates a healthy workplace culture? Employees who feel valued and appreciated by their leaders are more likely to go above and beyond for the company. In a healthy workplace culture, people look forward to coming to work every day because they feel engaged and know that their work truly matters." [37]

"Be sure you know the condition of your flocks, give careful attention to herds." (Proverbs 27:23)

Unhealthy Workplace atmospheres include:

1. "NIH" mentality: not-invented -here
2. "My project" atmosphere
3. Stifling of creativity
4. No communication
5. Slaves to the company

The opposite of a positive, vibrant workplace would be a toxic, unhealthy workplace, characterized by secrecy, threats, fear, extensive political jockeying, or a physically dangerous environment.

Boundaries

We need to respect the boundaries of our job and the self-esteem of our coworkers. If we become skilled at a process we must avoid the temptation to take over another's project ("Here,

let me show you how to do this right…") or to work extra hours primarily to promote ourselves or to make other workers look bad (by comparison.)

Taking on more and more work isn't necessarily good servanthood and usually will rob time from your family.

Cloud and Townsend warn against getting saddled with other people's tasks. Occasionally helping out a responsible co-worker is different from getting pulled in to an irresponsible worker's mess:

> *Many responsible people who work next to under-responsible people bear the consequences for their coworkers. Always covering for them, or bailing them out, they are not enjoying their work or their relationships with these people. Their lack of boundaries is hurting them, as well as keeping the other person from growing.* [38]

Sometimes we need to say, "I'm sorry, but that's not my responsibility, not what I'm supposed to accomplish."

Workplace Communication

Our communication in the workplace should honor the Lord and the dignity of others. We're told to "speak the truth in love" (Eph. 4:15) and to let our "conversation be seasoned with salt." (Col. 4:6) Kay Arthur suggests these guidelines for all communication: [39]

- No matter how foolish their actions were, don't ever call someone stupid.
- Don't call someone a liar. You could say, "I don't think that's correct (or true)."
- If you can't honestly give praise, give encouragement. ("I think you can do better.")
- Always offer hope, even when taking disciplinary actions.

Keep everyone informed of problems before they get out of hand. Keep in mind that bosses don't like surprises (except at Christmas), and especially don't like surprises with bad news.

> *As Christians we do not hide information but work in a spirit of discussion and dialogue, making every one a part of the team. This creates an atmosphere of trust and draws everyone into the decision making process making them take ownership of the decisions. This leads to a higher commitment to the decisions and quicker implementation. This improves the overall performance of the team.*
>
> *Jesus said "Do unto others as you would have them do to you." So if I want them to trust me, I have to first trust them and share information with them. This is what a Christian does naturally, reflecting the nature of the God he serves.* [40]

WORKPLACE POLITICS

Office Politics

Office politics happens. It's a fact of life in some companies. It's usually not pretty: maneuvering

and manipulating people; backstabbing; lying; flattery; hijacking projects; blaming others; power struggles; pitting one group against another.

The primary Biblical example of office politics was Daniel and the other Persian leaders. They grew jealous of his success and plotted to have him thrown into the lion's den. Notice that the only thing they could get him on was his prayer habit. [41]

How do we survive the politics of the workplace as believers? [42, 43, 44]

- Be aware of what's going on, and try to stay outside of the fray.
- Don't take sides. Try to be fair to all.
- Don't get pulled into a coup.
- Resolve conflict Biblically (including Matthew 18 steps).
- Understand the difference between growth ambition and selfish ambition.
- Determine to be Christ's representative in your workplace.
- Realize that most of the actions in power politics are sinful.
- Pray for your fellow workers and for God's Kingdom.
- Ask for advice when needed.
- Trust God for your reputation.
- Speak the truth in love. (Eph. 4:15)
- Be positive. Don't be a complainer. (Phil. 2:14)
- Remember Christ's Golden Rule. (Matt. 7:12)
- Emphasize openness and honesty. Keep everyone informed.
- Never sabotage another's reputation.
- Grow the people above you and below you.
- Avoid "in groups" and "out groups."
- Rejoice with those who rejoice, even if they advance above you.
- Give people credit for what they do.
- Network with others to help them succeed.
- Avoid "silos".
- Encourage workplace friendships, not continual competition.
- Promote people based on qualifications and ability, never based on favors and favoritism.
- Influence decisions in a positive way. Don't be silent. Your input counts.
- Keep good record of decisions and expenses to cover yourself and co-workers involved.
- Explain reasons behind major decisions. Don't make decisions based on emotions.
- Don't be surprised when someone unqualified or incompetent gets promoted. "Dilbert" is a snapshot of reality.
- Remember that project success involves project completion and keeping the boss happy.
- If you can't praise someone, at least encourage them.
- If someone is jealous of your success, treat them like an enemy, Biblical style: love them; bless them; do good to them. (Mt. 5:43-45)

- You will likely hear dozens of rumors and complaints. Keep some things to yourself.
- Keep your boss informed, including your career goals.

What do we do when we find ourselves caught up in the politics?

- Recognize feelings of jealousy when someone less qualified gets promoted.
- Recognize our own selfish ambition.
- Recognize the desire for people to "get what they deserve."

Confess the wrong attitudes. Turn the area over to the Lord, trusting Him with your concerns.

WORK-LIFE BALANCE

Time

The pressure of time is perhaps the greatest pressure of the modern workplace.

> *When we think of time pressure, perhaps no thought comes as quickly to mind as the workplace. The stressors we experience there , according to business consultant Douglas Labier, "are rooted in pure bombardment: the accumulation of too much work relative to the time we have, too many demands from our work and personal lives, and too many decisions facing us and not enough time to deliberate about them. In short, too much to deal with in a world which is too busy, and...in which we all feel tremendous pressure to make the right decision right now."* [45]

Entrepreneur Ken Eldred writes, "The myth of conventional wisdom is that the serious Christian is somebody who will work significant hours -always going the extra mile, if you will. How can we be committed to our work and only work a forty-hour week?" [46] After pondering 1 Tim. 5:8 on taking care of one's family and Mt. 6:33 on seeking first God's Kingdom, "I came up with basically forty hours a week to do my work. It was clear that I could only be a forty-hour-a-week kind of guy in order to keep my priorities straight." [47]

Forty to fifty hours dedicated to work will probably be the goal for those who establish a quiet time, set Sunday aside for worship and rest, spend "quality time" with family, and get adequate sleep and exercise. One or two weeks a year- during a project crunch- may require to eighty hours, but this is clearly unsustainable.

When is a company overstepping its bounds regarding time expectations? I would suggest that this is happening if work continually interferes with family life or church activities. Don't take a job with any company that suggests that they "own you now," or that they get to "control your life", no matter what they offer.

Juggling work, family, and faith

Pat Gelsinger is an electrical engineer, was chief engineer on several major microprocessor projects, and was for several years the senior vice president at Intel. Gelsinger has written a helpful

book, *The Juggling Act*, on balancing the demands of life. He likens the life of a corporate engineer to a juggler trying to keep three plates in the air and spinning (work, family, and God). His primary suggestions are these: [48]

1. Set a course. Develop a personal mission statement and clear goals for your life.
2. Establish your highest value. Make God the highest priority. "Create patterns and reminders to help you remain in consistent dialogue and relationship with Him." (p.212)
3. Firmly establish your second- highest value. Protect your time with your spouse and family. Keep track of how your time is spent.
4. Keep both God and work in proper order. Remember that you are ultimately working for God.
5. Keep true to your mission statement. Find mentors to teach you and peers to help keep you accountable. (p.213)
6. Have a clear witness. Once you have a reputation as a great employee you have the credibility to influence others.(p.214)
7. Integrate faith into your work and family. Practice the principles of balance and learn from failures.

There will always be some times of intense work or emergencies that arise that squeeze out family time with overtime, Saturday work, or weekend travel. These should be the exception, and long getaways with spouse or family should balance them out. Hard work, but not workaholism, is the goal for Christ's people.

Gelsinger offers a way to prioritize one's use of time:

> *Prioritize God — "Create a unique relationship between yourself and God that is consistently reinforced by the way you use your time to remain in dialogue and relationship with Him. Choose routine areas of your life to remind and encourage you. Have daily devotion time with God."*
>
> *Prioritize Family — "Establish your family relationships in such a manner that other factors do not squeeze out that precious family time. Put clear boundaries in place and be prepared to make tradeoffs such as those between work and family that will be clear evidence of where your priorities truly reside."*
>
> *Work Hard — "Be a great employee. Realize that you are not working for your boss, your president or your company. Instead, you are working for God. Recognize that He is the singular source of our ultimate reward. Look past anything that might distract you from being a great employee."* [49]

Workaholism

Workaholism is a very subtle danger, since at its heart it is based on a positive virtue, namely hard work.

Cotham writes, "Workaholism is a disease…The workaholic is driven to stay at work…Work is the most important dimension in life." [50] Workaholism is an addiction that can be hard to break. There is a "high" associated with over-work. Multiple causes are possible: [51]

- A sense that this is expected of a good worker
- An attempt to find meaning in life through work
- An attempt to compensate for feelings of inferiority
- An unconscious desire to avoid responsibilities at home

Workaholism is often tied to perfectionism and to burnout. It's primarily an issue of priorities. God and family must outweigh work.

Ambition isn't sin (but it could be). Should you seek a promotion to leadership?

- Make sure it isn't just power or ego
- Make sure it doesn't hurt your family
- Make sure it offers expanded opportunities for ministry/service

DIFFICULTIES AND CHALLENGES

Reality check: (especially for millennials)

No job is perfect. There will always be some parts that you don't enjoy and some parts that seem useless or boring (e.g., government paperwork). Hopefully there is some regular satisfaction related to your work.

Reality Check

There will always be some part of the job that isn't enjoyable, whether it's reports, financials, audits, convincing managers, pleasing clients, or meeting deadlines.

> *Everybody wants their job to feel less like work, and they're not willing to do work. They want to go home, have fun, enjoy what they're doing, and get paid for that. ..I believe that job satisfaction is very important,…but at the same time, work is work."… And no matter where you go, work will always be work.* [52]

General Tests and Challenges

God is at work in the life of every believer, working to transform us into the likeness of Christ. Much of the transformation involves the Bible and prayer, but some can involve daily pressures and challenges, and our response to them. James 1:2 talks about the testings of life and the good result they can produce.

> *Count on it. A job at any level in one of the world's workplaces will bring "tests and challenges." Those make up the "painful toil" and the "thorns and thistles" God told Adam would fasten on his work as a result of sin. Apart from Christ, those can lead people to hate their work and become bitter. But in Christ, even those "thorns and*

thistles" have been redeemed and made into instruments for our spiritual growth in grace. Even so, they still prick and sting. Your computer freezes when you're tight against a hard deadline. The boss rejects your ideas, only to bring them up as his own at the next staff meeting. A client you had cultivated for months suddenly switches to another supplier. Your corporation merges with another, and your job gets downgraded in the shuffle. Pressures of this sort put to us to the test. Do we really believe God works in all things for our good? Even these things? [53]

When difficulties arise:

- Reality check: What's really going on here?
- Attitude check: How am I responding? In a Christ-like manner?
- Resource check: What's actually available to help us deal with this issue?
- Spiritual check: Have I turned this over to the Lord, or am I trying to solve the whole thing myself?

Workplace Activities

Building friendships with co-workers can open up some tricky situations. When a friend at work invites you to join him to get stoned or watch porn with him the best approach is to refuse without a big noise and offer an alternative -maybe come with you to a ball game or water skiing.

Draw the line in your mind of what you won't participate in. You don't have to go to a strip club or out- drink the boss or put up a banner or lead the pride parade to keep your job. You can't be forced to participate in Pagan Week activities.

"If you find yourself in a bad establishment, call yourself a cab. Do it quietly and leave without fanfare. Your absence will send a strong signal to your co-workers that you do not wish to participate in such entertainment in the future. " [54]

No employer can legally force an employee to participate in activities that violate his or her religious beliefs. At the same time, don't insult your co-workers every time you refuse. You can simply say, "No thanks, I'm not comfortable with that."

You may find yourself totally opposed to the lifestyle of some co-workers. They may even try to make life difficult for you. The Biblical response: Love them anyway, in the strength that Christ provides. You don't have to agree with them to work with them and treat them kindly.

Diversity, Equity, and Inclusion (DEI)

The current mantra in many large companies is "Bring your whole self to work." In other words, identify and proudly discuss your ethnic background, personal interests, and sexual orientation.

Studies show that the most successful businesses encourage an environment in which employees can bring their "whole self" to work. Employees need to feel comfortable, willing, and able to talk about what is most important to them. Employers benefit

when they recognize and respect an employee's religious identity, including their beliefs and practices.

In today's increasingly competitive global business environment, companies need to draw upon the unique talent and diverse experience of every employee. Employees that feel free to bring their entire self and identify to work demonstrate higher levels of innovation, creativity, and positive working environments, directly affecting business success. [55]

The key is to be proactive and to create a fully level-playing field. ("Ok, you get to talk about your personal life and deepest issues, but we also get talk about our lives with no restraints." "Your race or gender may be the most important thing in your life. I'll listen. But I get a chance to say what is most important to my life and why.") While this will create a level of concern and discomfort if immoral behavior gets applauded, this policy certainly opens the door for believers in Christ to identify themselves as Christians and explain what they believe. ("This is who I really am, and this is what means the most to my life.") Let others know clearly that your moral standard is the Scripture and that you don't hold hatred for them. In fact, because of Christ, you love them, and you want good for them. [56]

Kent Johnson has established an organization to help corporations deal with diversity and inclusion in a healthy manner (Religious Freedom and Business Foundation):

Kent Johnson recently retired from his role as a Senior Counsel at Texas Instruments Incorporated and now serves as a consultant to multinational companies on topics related to religious accommodation and faith in the workplace. Kent helps companies see the appropriate role of religious expression and religious diversity at work, in order to strengthen corporate cultures of trust, mutual respect and organizational effectiveness.

A passionate advocate of diversity and inclusion, Kent also helps companies in certain jurisdictions navigate their legal obligation to accommodate employees' religious expression while carefully avoiding any impression of compulsion to participate in or agree with such expressions. [57]

Basic principles of the Religious Freedom and Business Foundation: [58]

- Respect for all people, whoever they are.
- The right of all human beings to be treated with dignity and fairness, as we ourselves would like to be treated.
- The right of people to live and speak according to their beliefs, insofar as that right doesn't impinge on the rights of others.
- A desire for facts (and not prejudice) to drive decisions.
- A desire for friendship, and even reconciliation, across cultures.

The end result of healthy equity and inclusion is to "humanize" the workplace. The results are positive for everyone:

What happens when the workplace at all ... levels is more humanized? Productivity and efficiency increases as well as the ability to live out our callings as image-bearers of God. All of us—whether directors, managers, or assistants—have the opportunity to re-humanize our workplaces. In Creation Regained, Albert Wolters writes, "The healing, restoring work of Christ marks the invasion of the kingdom into the fallen creation." And as [Jonathan] Edwards said, "Our union with Christ gives us participation in his nature." How can we participate in his nature and see the restoring work of Christ invade our broken workplaces? [59]

Sexism and Harassment

The workplace must be a place of safety. At the same time we live in a sex-charged culture, fueled by Hollywood. Sexual harassment and assault can't be tolerated for a second. Any incidents must be investigated. Peoples' lives, health, and mental well-being are at stake. At the same time, no one must be considered guilty by suspicion alone. Peoples' reputation, character, and career are at stake.

"Sexual harassment in the workplace is prohibited under Title VII of the Civil Rights Act of 1964. Guidelines were issued by the Equal Employment Opportunity Commission in 1980 incorporating sexual harassment in the workplace as a violation of Title VII." [60]

Sexual harassment - any conduct of a sexual nature that "has the purpose or effect of substantially interfering with an individual's work performance or creating an intimidating, hostile, or offensive environment." [61]

Sexual harassment is everyone's responsibility. As a Christian, you are working with people created in God's image. You owe it to Him to treat others with respect and dignity. Beyond that, we as Christians also have a responsibility to look out for those around us who have less power and protect them from those who abuse power advantages...

First, show respect for the people around you... You might start by cultivating an attitude described in 1 Timothy 5:2 as you treat older women as your mother and younger women as your sister.

Second, be sure that you judge people only on their job-related competence and character.

Third, listen to the people around you. If someone is uncomfortable with something, pay attention to him or her. Avoid dismissing another person's feelings. If someone reports harassment to you, take it very seriously.

Finally, while some may be comfortable with hugs and arms around shoulders, it's better to err on the side of less physical touch. A safe rule of thumb is to stick with handshakes and high fives when interacting with people at work. [62]

Suggestions:

- Pray for wisdom.

- Be courteous, helpful, and respectful to all.
- Talk openly about your family and arrange for your family to meet your co-workers.
- Don't discuss appearance.
- Don't write anything that could be misunderstood or misinterpreted.
- Create emotional boundaries.
- Avoid even the appearance of wrongdoing. (1 Thess. 5:22)

Can the pendulum swing too far? Unfortunately, in an effort to avoid both temptation and sexual harassment, some male workers have essentially avoided all interaction with female coworkers, making them feel marginalized, like second-class citizens [63, 64]. There has to be a balance point, where healthy collaboration is possible.

Suggestions for men: [65, 66]

- Understand the value and equality of women before God. (Gal. 3:28)
- Do not disparage their gender, even in jest.
- Include them as an essential part of the team.
- Ask for their opinion and value their input.
- Be friendly without being seen as flirtatious.
- Find neutral discussion topics beyond cars, hunting, and football (vacations, history, music, animals…)

Difficult co-workers

Workers with unhealthy personalities can make life difficult for a conscientious worker (compulsive critic, bully, competitor who wants your job).

- Pray for them regularly.
- Respond with deliberate kindness, never in kind. (Matt.5:43-48)
- Be willing to forgive 490 times.
- Realize that you can't change another person.
- Realize that some people have been shaped by enormous hurts and trauma.
- Distance yourself from someone who's truly toxic.

Here's a startling idea that I've heard: Try viewing your co-workers differently. The person who is always an irritation may actually be God's gift to you, to help you to develop mercy and compassion.

Hostility

At times we may sense outright hostility to a Christian position.

> *Our problem is that we live in a society as hostile to the aims of [a Christ-centered] philosophical life—a life in pursuit of moral integrity, the truth, and union with God—as was Athens in the time of Socrates. Our fellow citizens do not understand our preference for spiritual goods over material prosperity. They despise us because we disapprove of pleasures everyone else accepts. Chiefly, though, I think they are*

impatient with our impractical fixation on intangible truths. [67]

Recognize that some workplaces may actually seem hostile to any expression of faith. One corporate policy manual even included the statement, "Religious expressions are not tolerated in the workplace." [68] *...Likely such extreme reactions may arise from workers who've "gotten burned" by cultists or even by overzealous believers who were former co-workers (hypocrisy in lifestyle, lack of love, lack of effort, judgmental attitudes, constant preaching). Establishing credibility then becomes a primary effort. Co-workers need to understand that Christianity is not about church or religion nut rather about Jesus Himself and the transformed life He creates. We need to be genuine, hopeful, righteous, faithful, and relational.* [69]

Ethical issues

Geisler and Douglass catalog a number of ethical issues and decisions based on a survey of 300 workers: [70]

- Good attitude at work (77%)
- Difficult co-workers (74%)
- Difficult customers (66%)
- Laziness or low motivation (65%)
- Disagreeing with the boss properly (58%)
- Supporting the boss or company (51%)
- Sexual pressures (44%)
- Balance of work and Family (42%)
- Dishonesty (40%)

Do ethical work. Exhibit Christian character.

Temptation and Sin

The workplace can be a place of huge pressure. Our flesh wants respect and recognition, and we want to be in control. "Anger, ego, pride, and boasting create tension in the workplace." [71] These "heart idols" need to be brought to the cross. We need to learn to walk in the Spirit at work.

It's not easy being a Christian in the workplace. Secular ideology is so pervasive in the professional environment that we often have a difficult time fitting into the culture of the office. Many of us simply "go with the flow," choosing to participate in the promotion of secular thought and values rather than risk being ostracized and ridiculed by defending the absolute truth of Christianity and the moral certitude of the distinctively Christian vision.

It's easy to see why. How many times have you been involved in conversations with co-workers who staunchly promote the "great goods" of pornography, spousal

infidelity,... sterilization, population control, euthanasia, abortion, etc., and you are the only one speaking out for the truth? [72]

Do it anyway.

Mason writes:

Christians in every workplace feel pressure to participate in activities we know are not compatible with God's Word. Do we put God's truth above the apparent comfort of fitting in? This is not a call to shrill judgmentalism at work, but it may mean standing up for the person being scapegoated for the department's failure, or being the first to vote in favor of dropping a misleading advertising campaign. It could mean admitting your own role in perpetrating an office conflict or writing an honest performance review despite the pain it seems to incur. These are ways of speaking God's words to others at work. [73]

R. Paul Stevens and Alvin Ung, in *Taking Your Soul to Work*, look at the destructive effects of sin, specifically "nine deadly sins," in the workplace [74]. Obviously sloth will destroy productivity, and envy can result in a competitive spirit, with attacks on another's reputation. Pride leads to ambition and arrogance. The other sins may not be as visible but are equally ruinous. Greed feeds fat salaries and bonuses only for top executives. Lust gives rise to sexual harassment and illicit affairs. Gluttony -eating or drinking to excess-results in reduced mental alertness and unhealthy bodies. Anger is often linked to rage, mistreatment, and control of others. To these classic seven Stevens and Ung add restlessness and boredom as workplace destroyers.

Each of the sins has an opposite counterpart, part of the fruit of the Spirit (Galatians 6). [75]

Pride	Joy
Greed	Goodness
Lust	Love
Gluttony	Self-control
Anger	Gentleness
Sloth	Faithfulness

Envy	Kindness
Restlessness	Patience
Boredom	Peace

WORKPLACE SURVIVAL

"If I see my workplace as a mission for God, my attitudes and behavior are likely to change in a remarkable way." [76]

Once you accept a position with a salary offer you are committed. You've given your word. Don't go back on your word even if you receive a much better offer the next week.

Don't expect too much from work. Understand that work will not provide nurturing, emotional support, self-esteem, or sincere approval. [77]

Set up your limits up front (like Daniel did- Daniel 1:8). Know

- What you can realistically accomplish in a given time frame
- How much overtime you're willing to work
- Where actions become unethical
- Where you draw the line on social activities
- What you'll say about a co-worker
- Where you will establish emotional/relational boundaries with the opposite sex.

Suggestions:

- Resolve to love the Lord with all your heart, soul, mind, and strength.
- See your work as an area of worship. (Note Chapter 8 of this book).
- Remember that the kingdom of God is not meat and drink, but "righteousness, peace, and joy in the Holy Spirit." (Rom. 14:17)
- Realize that in the workplace we produce, and we are also changed.
- Look for one or two other believers in the company. Encourage each other and begin meeting regularly for prayer.
- Seek out a mentor when you begin a new job.
- Know what your job entails...and what it doesn't.
- Write out a personal mission statement, a values statement, and a list of priorities.
- Make helping people a goal of your work. [78]
- Become increasingly valuable to the organization. Always be a learner. Learn the basics.

Learn the job and the company inside-out. [79]

- Your goal should be to add value to your company. Joseph and Daniel are workplace examples. They were absolutely trustworthy and brought godly insights to difficult situations.
- Seek to create beauty and order through your work. [80]
- Realize that, in practice, engineers spend only part of their time designing. Large amounts of time are dedicated to communicating with clients, management, technicians, and other engineers.
- Be fully engaged with work when at work and with family when home.
- Don't just put in your time. Deliberately seek the good of the organization.
- Keep your focus. Life is not about gaining stuff or success.
- Participate in office activities as much as possible (picnics, ball games, fishing) while avoiding the outings to strip clubs and sleazy bars.
- Look for specific opportunities to bless others, to minister to co-workers. [81]
- Use new learning to expand your perspectives. Read beyond your interests and comfortable set of ideas. [82]
- Look for ways to expand your outreach. Consider short-term or long-term assignments overseas.
- Separate your work from your paycheck. You don't ultimately work for your boss. Do your work primarily for the Lord. Expect the Lord to provide for your needs, in part through your job.
- Have a mindset of seeking service, peace, and justice. Remember that engineering is a serving profession.
- As appropriate bring the presence and power of Christ into situations. Pray continually for all projects and co-workers. Be identified as a follower of Christ. Be willing to be the conscience of the company.
- Go for excellence, not perfection.

Understand the financial realities

Engineers are often uncomfortable with the financial side of industry, but it is a necessary part of the equation. Companies are in business to make a profit, and they can't stay in business unless they do. That's not an evil thing, unless the goal is to shortchange the workers, destroy all competition, or charge unbearable prices.

When the bottom line is all that matters:

- Safety or quality may take a back seat.
- Companies may be bought and sold without regard for employees.
- Stock values in a given quarter may be more important than productivity.
- A good product may be discontinued.

THEOLOGY OF THE WORKPLACE

Theological Assumptions concerning Workplace

Christian Overman builds a workplace theology with the following components: [83]

- My entire workplace and everything in it was spoken into existence by the Creator's willing choice (John 1:3)
- All aspects of God's creation in my workplace speak of His power and rightful position of authority over all. (Romans 1:20)
- My workplace is affected by corruption due to humanity's sin. (Romans 5:12)
- My workplace and everything in it has not been forsaken by God, in spite of the Fall. (John 3:17)
- My workplace and everything in it remains God's own possession, and therefore everything in my workplace has great significance. (Ps. 24:1)
- Spiritual forces exist that oppose God and His work in my workplace. (Eph. 6:11-12)

Seven Approaches to Faith and the Workplace [84]

Adapted and expanded from Abel Raj

1. The workplace as a target for evangelism: Work is the platform for evangelism of business leaders and professional elites.

2. Tent-Making: Equipping Business professionals are equipped and mobilized to be missionaries to cross-cultural context that are difficult to penetrate otherwise; an alternative to the traditional missionary model.

3. Business for Missions: Corporate philanthropy which specifically supports Christian Missions organizations as donors.

4. Business Ethics: Focuses on the moral and ethical values of Christianity and how they can be integrated into the workplace.

5. Corporate Social Responsibility (CSR): Looks for ways to be more responsible in the local and global community, and in sustaining the earth. In practice this often means donating/ supporting not traditional cross- cultural missions projects engaged in social and community development and environmental causes.

6. Business as Missions: In contrast to the model in which a single professional moves to an impenetrable cross-cultural setting, this model sets up an entire business in the cross-cultural context for the purpose of evangelism, discipleship, and social transformation. These real business products and services often provide jobs, products and services to the host country that otherwise did not exist, thus making it more holistic than traditional missionary approaches.

7. Theological Economics: this approach critically engages the assumptions and practices of current economic models from a biblical-theological perspective, and seeks to develop economic ideologies that are informed in concert with foundational theological commitments which include vocation, mission, justice, and social

responsibility.

CONCLUSIONS

The current interest in theology and practice related to the workplace is a relatively recent evangelical emphasis and an important area that had largely been neglected. Prior to the 1970's the primary focus for Christian living was on the church (the building and the organization), often with spiritual health associated with attending at least four sessions at the church each week. After the 1970's, family (which had often been neglected) became a major area for teaching, particularly with the popularity of programs like Focus on the Family. Since about 2000 work and workplace have become prominent in evangelicalism. This shift is welcome, as long as the pendulum doesn't swing too far, so that church or family get shorted. We need all three (work, family, church) clearly taught, and kept in the right balance.

David Kim, in his lecture and teaching series "The Soul of Work" [85] suggests that we are missing a major dimension of work when we don't connect it to God's kingdom and we don't pour our heart and soul into it. Since the world sees work as dehumanizing and meaningless, believers can bring a new, energized vision of work as an expression of our identity before the world and before the Lord and an opportunity to restore some of the brokenness of our world.

"We have a threefold ministry in our work life: pointing those around us to God (a ministry at work), serving and creating via the work itself (a ministry of work), and redeeming the practices, policies, and structures of institutions (a ministry to work)." [86]

"Do not be conformed to the pattern of this world, but be transformed by the renewal of your mind." (Rom. 12:2)

"Put away your old self (your former way of life), corrupted by deceitful desires, and be renewed in the spirit of your mind." (Eph. 4:22-23)

Kotiuga suggests:

> *In the context of the workplace, the former way of life could represent the following exhortations:*
>
> • *Work hard so that you can be: promoted, earn more money, buy the things you want.*
>
> • *Do what you need to do to get ahead.*
>
> • *Talk about your successes, because if you don't, no one will. Make sure that those who report to you make you look good, get their work done the way you want it done.*
>
> • *Business is business, the job must get done.*
>
> *The renewed self could be represented by the following in responses:*
>
> • *Work well so that you fulfill your responsibilities.*

- *Be promoted so that the Holy Spirit can further influence through you.*
- *Be financially responsible for yourself so that you can care for others.*
- *Care for those who report to you so that they can flourish and enjoy a productive work life.*
- *Create an environment where everyone knows they matter because every person is made in God's image.*
- *Allow God's righteousness to prevail and behave in such a way that His holiness is not corrupted.*
- *Don't steal your employer's time, be faithful in how you do your work.* [87]

Realize that there will be a natural tension between the goals of a business and the goals of the Kingdom, but a believer can navigate the dual citizenship. Values important to business: competition, independence, and assertiveness. Values important to God: Loving the Lord with all our being and our neighbors as ourselves. [88]

> *Because workplaces' ultimate aims—generally maximizing profit—are different from Christians' ultimate aims, we should expect to experience tension in our dual roles as followers of Christ and workers in the non-church workplace. Although most workplaces are not intentionally evil—just as many parts of the Roman Empire were not actively hostile to Jesus' followers—it can still be challenging for Christians to serve God in their work.*
>
> *Following Christ makes us able to trust God for our provision, and trusting God for our provision leads us to work for the benefit of others in need. These principles underlie a variety of practical instructions for life at work (especially in the book of James) and theological insights for understanding the place of work in the life of faith.* [89]

While the world holds that people go to work for power, prestige, and possessions, the believer goes to work to glorify God and to serve and bless others, to have a spiritual impact. [90]

REFERENCES

1. Wickenden, W., *A Professional Guide for Young Engineers*, ECPD, 1978, p.11.
2. Messenger, W., "Mission in the Workplace," Lausanne Movement, https://lausanne.org/content/lga/2013-06/mission-in-the-workplace-encouraging-access-and-transformation-through-workplace-ministry
3. Johnson, K., "Workplace Issues," LeTourneau University chapel, March 19, 2015.
4. Bruce, C., "The Christian in the Engineering Workplace," http://www.mindspring.com/~brucec/l3car_christian.htm
5. Ibid.
6. Gelsinger, P., *The Balancing Act*, David C. Cook, 2010.
7. Peel, W., and Larimore, W., *Workplace Grace*, LeTourneau University Press, 2014.
8. Messenger, op. cit.
9. Bruce, op. cit.
10. Simler-Goff, D., "A Personal Cedo," http://www.lifenz.org/upload/campaign/groups-leaders/Workplace%20Faith.pdf
11. Spangler, A., Praying the Names of God, "The Holy One of Israel" (posted Sept.1, 2016), www.crosswalk.com
12. Kleener, P., "Integrity in the Workplace," Promise Keepers, http://www.promisekeepers.org.nz/integrityintheworkplace
13. Bakke, D., *Joy at Work*, PVG, 2005, p.241.
14. Veith, G., *God at Work*, Crossway, 2002, p72-73.
15. Whitted, T., *Outgrowing Your Space at Work*, Revell, 2016, p. 176.
16. Whitted, p. 140.
17. NASA, "Reflections of a Chief Engineer," http://www.nasa.gov/pdf/552580main_Reflections_of_a_Chief_Engineer_Buzzard.pdf
18. Kim, D., "The Soul of Work," https://www.youtube.com/watch?v=ZDUMTiWe_U4
19. Whelchel, H., "Four Ways Christians Live and Work in the Marketplace," https://tifwe.org/four-ways-christians-live-and-work-in-the-marketplace/
20. Theology of Work, "Modeling Christ in the Workplace," https://www.theologyofwork.org/the-high-calling/blog/modeling-christ-workplace-through-work-well-done
21. Overman, C., "Assumptions that Affect our Lives," https://www.goodreads.com/work/quotes/1403944-assumptions-that-affect-our-lives
22. Peel, op. cit., p.65
23. Kolak, J., "Taking your faith to work," Letourneau Univ. talk, Oct. 2012.
24. Thompson, L., "Making an Impact in the Workplace," http://www.focusonthefamily.com/faith/faith-in-life/living-in-hd-overview/making-a-difference-in-the-workplace
25. Bruce, op. cit.
26. Black, B., "Bridging the Religious and Secular Divide," Heritage Foundation, http://www.

heritage.org/research/reports/2014/06/bridging-the-religious-and-secular-divide

27. Krejcir R., "How to be a Christian in the workplace," http://www.discipleshiptools.org/apps/articles/?articleid=41215&columnid=
28. Frontline Fellowship, Proverbs Study Guide, https://lausanne.org/content/lga/2013-06/mission-in-the-workplace-encouraging-access-and-transformation-through-workplace-ministry
29. Eldred, K., *The Integrated Life*, Manna Ventures, 2010, p. 143.
30. Ibid.
31. Veith, op. cit., p. 150-151.
32. Ibid.
33. Vassar, J. R., in Russell, M., *Work as Worship*, Russell Media, 2012, p. 21.
34. Leadership IQ, "Organizational Culture Quiz," https://www.leadershipiq.com/blogs/leadershipiq/quiz-whats-your-organizational-culture
35. Doeing, D., "6 Characteristics of Corporate Culture to Better your Company," https://www.g2.com/articles/corporate-culture
36. BCWI presentation at LETU Aug. 2016, website.
37. Warner, C., "Culture Assessment," http://blog.c12group.com/craig-warner
38. Cloud, H., and Townsend, J., *Boundaries*, Zondervan, 1992, p. 204.
39. Arthur, K., "Precepts for Life" broadcast Feb. 1, 2018.
40. Lee, P. K., "Why Christians Become Indispensable in the Workplace," http://campuslinklive.org/christians-become-indispensable-workplace/
41. Collins K., "Office Politics (Daniel 6)," http://www.kencollins.com/life/hope-11.htm
42. Ibid.
43. Jensen M., "Office politics for Christians," https://www.eternitynews.com.au/opinion/office-politics-for-christians-what-to-do-when-your-workplace-is-a-battlefield/
44. Manson C., "Office Politics and the Christian," http://www.everydaychristian.com/blogs/post/office_politics_and_the_christian/
45. Swenson, R., *Margin*, NavPress, 1992.
46. Eldred, K., in Russell, *Work as Worship*, p. 112-113.
47. Ibid.
48. Gelsinger, op. cit.
49. Balancing Faith, Family and Work," Finding God in Silicon Valley, https://findinggodinsiliconvalley.com/pat-gelsinger-ceo-of-vmware-balancing-faith-family-and-work/
50. Cotham, P., *The Heart and Soul of Business*, Providence House,1998, p. 207.
51. Ibid.
52. Whitted, op. cit., p. 71.

53. Peabody Peabody, L., "Becoming Christ-Like," http://www.calledintowork.com/workplace-ministry/becoming-christ-like/
54. Bruce, op. cit.
55. "Training," Religious Freedom and Business, https://religiousfreedomandbusiness.org/training
56. Johnson, K., op. cit.
57. "Kent Johnson," Religious Freedom and Business, https://religiousfreedomandbusiness.org/kent-johnson
58. "Danger-Danger and Hope," Religious Freedom and Business, https://religiousfreedomandbusiness.org/2/post/2021/04/danger-danger-and-hope.html
59. Jenkins, B., B., How to Humanize the Workplace, Gospel Coalition, https://www.thegospelcoalition.org/article/how-to-humanize-the-workplace
60. Messiah College, "Sexual Harassment," https://www.messiah.edu/info/20574/need_help/830/sexual_harassment
61. Ibid.
62. Garner, J., "4 Ways Christians Can Fight Harassment in the Workplace," https://www.crosswalk.com/family/career/christians-and-sexual-harassment-in-the-workplace.html
63. Thomson, S., "#MeToo Movement," https://www.weforum.org/agenda/2018/03/metoo-campaign-women-isolated-at-work/
64. Dedrick, C., "has our sex-charged culture ruined male-female work relationships," https://www.crosswalk.com/blogs/christian-trends/has-our-sex-charged-culture-ruined-male-female-work-relationships.html
65. Theology of Work, "Male-Female Relationships in the Workplace," https://www.theologyofwork.org/the-high-calling/blog/male-female-relationships-workplace
66. Whatley, F., "Why Men and Women Can and Must Work Together," https://research.lifeway.com/2018/04/20/why-men-and-women-can-and-must-work-together/
67. Milco, E., "Christian identity in the workplace," https://www.firstthings.com/web-exclusives/2016/08/christian-identity-in-the-workplace
68. Rupert, D., "Five ways to be a Christian in the workplace," http://www.patheos.com/blogs/thehighcalling/2014/11/five-ways-to-be-a-christian-in-the-workplace-and-not-freak-out-human-resources/
69. Ibid.
70. Geisler, N., and Douglass, R., *Integrity at Work*, Baker, 2007, p. 17.
71. Bonacci, J., "6 Issues with Christianity in the Workplace," http://www.identityfulfilled.com/6-issues-with-christianity-in-the-workplace/
72. Burke-Sivers, H., "Taking Christ into the Workplace," http://www1.cbn.com/churchandministry/taking-christ-into-the-workplace

73. Mason S. , "Workplace lessons from Ezekiel," http://centerforfaithandwork.com/article/workplace-lessons-ezekiel
74. Stevens, R.P., and Ung, A., Taking Your Soul to Work," Eerdmans, 2010.
75. Ibid.
76. Bakke, op. cit., p. 252.
77. Cloud and Townsend, op. cit., p. 212.
78. West, R., *Go to Work and Take your Faith Too*!, Smith and Helwys, 1997, p.80.
79. Whitted, op. cit., p. 77-88.
80. West, op. cit., p. 86.
81. West, p. 95.
82. West, p. 137.
83. Overman, C., *God's Pleasure @ Work: How a Biblical Worldview Invigorates the Workplace and Renews the Community*, Ph.D Thesis, Bakke Graduate University, 2007.
84. Mason, S., "Seven Approaches to Faith and the Workplace," Faith in the Workplace Initiatives.
85. Kim, op. cit.
86. Eldred, op. cit., p. 107.
87. Kotiuga, N., "Spiritual Formation at Work," dissertation, Bakke Graduate University, 2017.
88. West, op. cit., p.6.
89. Theology of Work, "General Epistles and Work," https://www.theologyofwork.org/new-testament/general-epistles/?title=New_Testament_Articles/680_General_Epistles_and_Work
90. Peel, op. cit. p. 73.

CHAPTER 24: EDUCATION

INTRODUCTION

August had arrived, and Barry was excited to begin work as a professor (actually, an assistant professor) of engineering at a well-respected university. He had completed his Ph.D. that spring, published a paper with his advisor, and applied for several tenure-track positions. During his undergrad studies several faculty members had made a positive impact on his life and career plans. He now hoped to similarly inspire his students and hopefully help some of them to find life in Christ. How would it go?

For a small number of engineers their career path/calling takes them to a place where they are educating engineering students. Both authors have spent the bulk of their careers in higher education, primarily as engineering faculty at LeTourneau University, a Christian institution.

Engineers interested in faculty positions have at least four possible areas of schools to explore:

- Public university
- Private university
- Private Christian university
- Overseas university

It should be noted that students pick majors and even colleges for a variety of reasons, some less logical than others.

"I've eliminated Tennessee, Syracuse, Auburn and Kalamazoo," Jeremy's girlfriend tells her guidance counselor.

"Too big? Too far away? Too expensive?"

"I look terrible in orange," she responds, "What do you have in a teal liberal arts college?" [1]

IMPORTANCE OF THE UNIVERSITY

Many in our society are questioning the value of higher education, primarily because the tuition costs have skyrocketed, and the job market has not been stable. That's partly correct: A degree in Frisbees, Action Movies, Gender Studies, or Marxist Poetry will not guarantee employment sufficient to pay off the student loans it required. Professional studies (medicine, law, architecture, and engineering) still require formal degrees, and many curricula prepare students for employment after college.

This great Western institution, the university, dominates the world today more than

> *any other institution: more than the church, more than the government, more than all other institutions. All the leaders of government are graduates of universities, or at least of secondary schools or colleges whose administrators and teachers are themselves graduates of universities. The same applies to all church leaders. . .. The professionals, doctors, engineers, lawyers, etc. have all passed through the mill of secondary school, the college, and the university. And the men of the media are university trained. . .. The universities, then, directly, and indirectly dominate the world; their influence is so pervasive and total that whatever problem afflicts them is bound to have far-reaching repercussions throughout the entire fabric of Western civilization. No task is more crucial and urgent today than to examine the state of mind and spirit of the Western university.* [2]

History of higher education

University education largely grew out of the medieval schools in Spain and Italy, where the emphasis was placed on religion and culture. Science came somewhat later. While there were small academies, tutors, rabbis and disciples, and libraries in Greece, Israel, and Egypt, a formally approved association of faculty and students with certified learning dates to 1088 A.D. at the University of Bologna (Italy). Canon law and theology were the initial subjects. Oxford in 1096 was the earliest English-speaking University. The title "university" suggested the unity of knowledge and meaning.

Purposes of Higher Education

Educators don't all agree, and administrators don't all agree, on the actual purpose of higher education-- whether it exists primarily to help students learn deeper things in general, to prepare students for careers, or to enhance students' character. (It would seem like such a foundational understanding ought to be our starting point for all academic discussion.) Some of the suggested goals include:

- To help each student to achieve full potential -to become all that he or she is capable of being. (This is a classical idea.)
- To prepare a knowledgeable, informed, and responsible citizenry. (This harkens back to John Dewey's theories from the last century.)
- To prepare a workforce for industry.
- To transmit knowledge and culture.
- To broaden the student -to expand the horizons of the student by exposure to history and other cultures.
- To create knowledge and also to "articulate the values that our knowledge should enable us to have." [3]
- To search for truth.
- To develop character.
- To develop one's skills for vocation.
- To produce a "fairer and more just society." [4]

- To teach communication, logic, and critical thinking skills.
- To educate students in the mindset and values of society.
- To develop lifelong learners.
- To create clones of the faculty.

In 2011 Richard Kahlenberg gave a convocation speech in which he outlined five purposes he saw for higher education: [5]

> *1. To ensure that every student, no matter the wealth of her parents, has a chance to enjoy the American Dream.*
>
> *2. To educate leaders in our democracy.*
>
> *3. To advance learning and knowledge through faculty research and by giving students the opportunity to broaden their minds even when learning does not seem immediately relevant to their careers.*
>
> *4. To teach students to interact with people different from themselves.*
>
> *5. To help students find a passion—and even a purpose in life.*

The educational goals of "Modernity" would be: [6]

- Pass on a unified body of universal scientific knowledge
- Equip a world of rational citizens
- Build a more rational world leading to freedom, justice, truth, and material prosperity

In the 1963 Robbins Report, (British) universities were tasked with four functions: "instruction in skills" and "the promotion of the general powers of the mind so as to produce not mere specialists but rather cultivated men and women", as well as "the search for truth", and the transmission of a common culture and common standards of citizenship. [7]

Zietsma adds:

> *Two widely held beliefs about education seem to be implicit in policy and curriculum advocacy in secular education systems today. First, education should prepare a labor force to meet job market needs through appropriate skills and training. Second, education should empower individual self-expression in order to ensure a diverse, pluralistic society.* [8]

While we could agree with many of the goals for education, we notice that some key ideas about education are not included in the standard list of purposes:

- To glorify God through learning about His world.
- To connect all of knowledge to the Lord.
- To prepare young people for service to the Lord and to others.

For this reason, there is a place for Christian education.

PROBLEMS WITH EDUCATION

At various times in history, and in various regions (even today) some Christian groups have opposed higher education. Their reasons for doing so seem logical: (1) Knowledge can lead to pride and can move us away from growth in the Lord. (2) Higher education has often been used to deliberately move students away from trust in God.

"Knowledge puffs up," according to 1 Corinthians 8:1. If I know things that you don't, that knowledge can easily become a point of pride for me. It is essential that we emphasize and maintain a spirit of humility in our learning.

Higher education is not necessary for character development. An apprenticeship can build character, as the student learns to show up for work, follow instructions, exhibit industriousness, and get along with others.

Many students have encountered university professors, particularly in disciplines like philosophy, whose stated goal is to rattle or destroy the faith of their students. (Few professors will take kindly to a debate in class, especially if the outcome is to make them look foolish. Lots of prayer, a respectful attitude in class, and private meetings in their office to explain the case for Christian truth are usually the best approach.) Some professors will push on students not to crush them but to force them to think through their positions and to express them clearly and coherently.

CHRISTIANS IN HIGHER ED.

Christians are impacting higher education in three primary ways:

1. Serving as Christian faculty at "secular" institutions

Importance of being a "missional professor"

2. Serving as Christian administrators (chairs, deans, presidents) at "secular" institutions

The leader "sets the tone" for the entire program. Such a leader can both model and insist upon quality and integrity in every aspect of academics.

3. Serving as Christian faculty at Christian institutions.

Christian faculty at "secular" institutions have an enormous opportunity to impact students but may feel stifled in their ability to speak openly about spiritual matters. State institutions are often gun-shy concerning the "separation of church and state." The approach may be like blessing the workplace as a believer, knowing the owner is hostile to Christianity.

I recall my own undergraduate days at a large state university. Most of the faculty were brilliant but unapproachable, available primarily to their individual graduate students. I spent very little time in any of their offices. One young faculty member, who taught Physical Electronics, was clearly different. He made an effort to make the class both understandable and enjoyable. He seemed

to have a personal interest in the students. The following summer I ran into him and his family off campus, and some pieces fell into place. They were involved in a local church, and he saw his teaching as ministry. He was living as salt and light in engineering. I decided then that if I ever wound up in academia I wanted to do similarly.

Several of the struggles and opportunities mirror those of Christians in the industrial workplace:

- The faculty member was hired to teach in a particular area, not to preach.
- A new faculty member needs to "prove" himself or herself before colleagues will take them seriously.
- It is essential to find a prayer partner or a team of fellow believers as soon as possible.
- When a question is asked about faith it is "fair" to answer that question with one's testimony or to quote scripture.
- Few people will refuse an offer to pray for them at times or struggle, sickness, or pain.

Faculty who, live for Christ will want to be salt and light in the academy, living for Christ in the midst of teaching and research. Gould [9] notes that faculty can either focus on "making a name for themselves" or on making God's name great. God's response to the former was seen at Babel (Gen. 11:4).

Christian faculty have been able to do these kinds of things:

- Introduce themselves (in the spirit of "full disclosure") on the first day of class someone who has experience in the field, loves teaching, and is a follower of Jesus. ("I'll be glad to answer any questions if you drop by my office.") This only seems fair, since other faculty introduce themselves as atheists, feminists, Marxists, and so forth.
- Alternatively, tell students that they follow Jesus on the last day of class, after a well-taught semester.
- Keep a Bible and books on apologetics (available for loan) in their office.
- Set up a website that includes professional interests and what matters to them
- Invite students to chat during office hours.
- Invite students to visit in their homes and meet their family.
- Sponsor a chapter of Inter Varsity, CRU, or Navigators on campus.
- Deliver a talk for a Christian organization.
- Sign their name endorsing an ad in the school newspaper at Christmas or Easter.
- Share inspirational thoughts (perhaps a paraphrased proverb or parable) at the start of class, without citing chapter and verse.

Various resources are available for Christians on a "secular" campus:

- Veritas Forum [10]
- *Finding God at Harvard* [11]
- The campus-oriented Urbana missions conference [12] now includes a track for those pursuing education as a career.
- Originally Christian Leadership Ministries of CRU, now Faculty Commons, serves faculty and graduate students. [13]

- The InterVarsity Faculty Track, now Graduate and Faculty Ministries [14], empathizes development of "4 Loves":

Love God and one another

Love your campus

Love your academic discipline

Love our world

Paul Gould's *The Outrageous Idea of the Missional Professor* presents these ideas for the Christian faculty member at a state institution: [15]

- "For professors, the university context is front and center as a mission field, a place where people are in need of redemption and ideas are taught that either further of hinder the progress of the gospel." (p. 22)
- "Scientific naturalism and postmodernism have become the dominant worldviews or stories that shape our university and culture today. And by and large these worldviews don't have the intellectual resources to cultivate a life of moral and intellectual virtue." (p. 42)
- The missional professor has the platform to represent Christ to faculty and students.
- The professor should be prepared to share Christ when the opportunity arises.
- He or she must have more than a Sunday School understanding or Christianity.
- The faculty member can carry out research that undergirds (rather than tears down) Christian theism.
- Academic disciplines are comprised of four components: the guiding principles (core presuppositions), the guiding methodology, the data set (specific domain of knowledge), and the guiding narrative (history and philosophy of the discipline).
- "Faithfulness to Christ will transform an academic discipline." (p. 104)

The book *A Grander Story* [16] includes stories from various faculty members on how they brought Christ into their classrooms. Walter Bradley emphasizes engaging with students. John Walkup describes experiences with collaboration and mentoring.

An additional opportunity available to Christian faculty is to teach overseas for a year or more, particularly in a "closed" country.

CHRISTIAN HIGHER EDUCATION

Unfortunately, many parents desire a Christian higher ed. experience for their children primarily because it's "safe" (drugs, immorality, and atheistic teachings are unacceptable). To focus only on these aspects is to miss the positive benefits of an education with Christ at the center.

There is a legitimate place for a specifically Christian approach to all the disciplines of higher education. Except for the input from an occasional believing professor, a student at a state

institution will never hear course content approached from the position (1) that God is creator of all, (2) that humans are made in God's image and therefore valuable, and (3) that our knowledge and our lives should be directed to the glory of God.

Originally the University had as a major purpose the unifying of knowledge under a single banner (the knowledge of God), hence the name, uni-versity. Over time the stated purpose of higher education has become much more humanistic:

John Dewey: the purpose of education is to produce well-informed citizens.

State University of New York: "Let each become all he is capable of being."

Neil Postman (*The End of Education*): the purpose of higher education is to propagate and advance society's modernist narrative (material progress through scientific advancement). [17]

Those who approach higher education from a Christian perspective see a different set of purposes:

John Henry Newman (1801-1890) -

> *Newman argued throughout his writing, especially in his The Idea of a University, that educated people should cultivate what he called a "philosophic habit of mind." This "philosophic habit" was essentially one that could see human life and the world comprehensively... Newman also saw that the highest kind of learning required a community setting in which friendship thrives.* [18]

Arthur Holmes (1924-2011) - "The Christian college is distinctive in that the Christian faith can touch the entire range of life and learning to which a liberal education exposes student." [19]

Gordon Smith wrote:

> *The mind is renewed by truth. Classrooms and libraries are ideal places in which to respond to the apostolic injunction that we take every thought captive for Christ. The discipline of study is an essential component of spiritual formation. Rigorous intellectual exercise is good for the soul. Few things are so redemptive as the honest exploration of truth.* [20]

Ronald Iwasko told faculty: "The world doesn't need other worldlings, no matter how skilled or academically equipped with whatever sheepskin in hand. It needs people who by their very character and life-patterns cause others to note that 'they have been with Jesus,' And you won't get that out of a textbook or a toolbox." [21]

Philosopher Nicholas Wolterstorff emphasized that the Christian college is tied to the body of Christ and to the mission of the church, including:

- Moral culture
- Truth
- Dignity of all humanity
- The Gospel itself

- Community
- Worship
- The rule of Christ over all things.

> *As institutions, we are to witness to the coming of shalom, to serve all people (not just Christians) in relieving misery and pain and in responding to the wounds of humanity. The goal of Christian higher education is to change the world by making it a place of human flourishing…Although the focus of a school is disciplined study, the framing goal should be promoting shalom.* [22]

David Dockery has written, "Learning that is shaped and formed by faith results in living that is shaped and formed by faith." [23]

In 1994 Mark Noll wrote a provocative book titled *The Scandal of the Evangelical Mind* [24] (which he updated twenty years later). His argument was that Christian education was often shallow, with little real scholarship. Such a position was not in line with the thinking of Jonathan Edwards, John Wesley, Francis Asbury, or Charles Hodge, who held that rigorous intellectual activity was not only necessary but could be a way to glorify God. Fortunately, the situation has improved, particularly within those schools associated with the Council for Christian Colleges and Universities. At this point over one hundred schools whose faculty and mission are specifically Christian have joined the CCCU:

> *The Council for Christian Colleges & Universities is a higher education association of more than 185 Christian institutions around the world. Since 1976, the CCCU has served as the leading national voice of Christian higher education. With campuses across the globe, including more than 150 in the U.S. and Canada and more than 30 from an additional 19 countries, CCCU institutions are accredited, comprehensive colleges and universities whose missions are Christ-centered and rooted in the historic Christian faith. Most also have curricula rooted in the arts and sciences. The CCCU's mission is to advance the cause of Christ-centered higher education and to help our institutions transform lives by faithfully relating scholarship and service to biblical truth.* [25]

The "integration of faith and learning" (discussed in the next section) is hallmark of CCCU institutions.

> *According to the Council for Christian Colleges and Universities [CCCU] (2013) "there are over 4,000 degree-granting institutions of higher education in the United States. These include 1,600 private, nonprofit campuses, about 900 of which define themselves as religiously affiliated" (Context of U.S. Higher Education, n.d.). Of the 900 religiously affiliated, however, only 119 of the institutions that identify as Christ-centered institutions and meet a set of organizational criteria qualify for membership in the Council. The CCCU identifies these campuses as ones that have a strong commitment to a Christ-centered education and who hire Christian faculty, staff, and administrators (Member Characteristics).* [26]

Michael Goheen writes:

> *In this task [higher education], a Christian university participates in two venerable traditions. The first is that scholarly tradition within western culture stretching back to the Academy of classical Greece; the second is the tradition of Christian participation in higher education which had its beginnings among the early church fathers, flourished in the Middle Ages and was refined during the Reformation and in subsequent ages. As Canadian Christian academics in the twenty-first century, we do not seek to create an academic ghetto in which we might devise a new "Christian" scholarship from the ground up. Instead, we seek to participate in the ongoing work of scholarship from within a Christian tradition which seeks to carry out its academic task in the light of Scripture.*
>
> *We understand the overall purpose of a Christian university education to be to equip young men and women to serve as witnesses to Christ's victory in the various vocations they will take up in society. They are to be witnesses not solely by using the opportunities for evangelism that their positions may afford, but by testifying to the transforming power of Christ in every aspect of their professional or vocational conduct as teachers, homemakers, businesspeople, lawyers, journalists or artists, or in whatever other tasks to which God may call them (Cross and Our Calling).* [27]

The true Christian university is neither a church nor a mission organization. It is an educational institution totally infused with Christian truth. The purpose of Christian higher education, suggests Arthur Holmes, is to educate responsible Christians, to help them to "work in the arts and sciences and thereby to understand all of life from a Christian perspective." [28]

True Christian education

- Should begin with, and be grounded in, God Himself.
- Acknowledges God as the Source of all knowledge.
- Uses all of knowledge to glorify God.
- Emphasizes Christ as Lord over every area and discipline.
- In every way encourages students' faith in God and points to His reality.
- Should address whole-person education (body, soul, and spirit), not simply building up the mind.
- Should address worldview and ultimate questions.
- Should emphasize reality and truth.
- Should approach all disciplines Biblically.
- Should integrate faith and learning.
- Should equip and disciple students.
- Should ensure that Christian community exists, to worship and serve together.
- Should address Christian character.

Value of Christian higher education

Christian higher education has certain key values:

- Christian faculty are present as role models.
- Courses are taught from a Christian worldview.
- The potential exists for deep fellowship and community among the faculty.
- Students are encouraged, rather than discouraged, to grow as Christians.
- The "integration of faith and learning" is encouraged.

Educator Steven Garber explores the importance of Christian higher ed. in his book The *Fabric of Faithfulness*. [29] In order for a graduate to remain strong in the Lord after graduation, to maintain a desire to change the world, to keep from being corrupted by money and power, Garber discusses three things that must be built during the college years:

- Convictions
- Character
- Community

Convictions are basic beliefs, some of which also tie to behavior.

Character is related to integrity, which has its root in "wholeness."

Community stresses the importance of "like-minded people," who encourage each other to do right and to stay the course. In the Christian community this includes prayer for each other.

Halvorson states:

> *For the Christian, a primary purpose of education is to understand God and His world from His perspective (as best we are humanly able), so that we are equipped to glorify Him by loving Him and serving Him. God calls His people to serve Him in a marvelous multitude of callings—from the most humble to the grandest. Whatever our calling, we want to be equipped to serve with excellence and joy...Most seventeen- to nineteen-year-olds do not know with certainty the role to which God is calling them. College provides an opportunity to learn more about the world and about oneself. This is a period when many people wrestle with the big life questions of who am I, where do I come from, and what is my purpose in life?*
>
> *Colleges offer professors who have devoted their professional careers to expertise in a particular discipline. When a professor is integrating into the subject matter God's perspective—whether in humanities, history, art, math, music, or any other area—college students are gaining a fuller understanding of God and His works. Conversely, when God is not made a part of the curriculum in each of the various fields, professors are implicitly teaching that God either does not exist or does not have any relevance to that subject. Hundreds of years ago, Martin Luther cautioned Christian parents not to turn their offspring over to the pagan thinkers of the day when he advised parents not to send their children where the Holy Scriptures are not supreme.* [30]

Plantinga adds:

> *As C.S. Lewis once said, we are trying to retake territory that has been captured by the enemy. We are trying to recapture society, culture, and all creation for Jesus Christ. We will need the right attitudes for this recapturing program, including the attitude of delight.*
>
> *So, in a Christ-centered college we learn what we can about creation itself. We learn the functions and beauty of numbers and sets of numbers; we learn the wonder of cells and cell division. In The Medusa and the Snail Lewis Thomas, a truly distinguished scientist, wonders at all the fuss over test-tube babies. The real marvel, he says, is not the change of incubators, but rather the sheer joining of sperm and egg and the cell that eventually emerges from this union—a cell that can grow into a human brain. "The mere existence of that cell should be one of the greatest astonishments of the earth. People ought to be walking around all day, all through their waking hours, calling to each other in endless wonderment, talking of nothing except that cell." ...*
>
> *In all these areas and many others, we become equipped. Of course, we become equipped for jobs. But that's not the final point of college education. The reason is that as Christian people we shall still have to ask what those jobs themselves are for. How will the job I'm preparing for serve God by serving other people? How will it clean a lake instead of polluting one? How will it offer opportunity to marginalized people rather than crowd them still further out to the rim of things? How will it yield an honestly built product or genuinely useful service that will anticipate the new heaven and earth? In other words, how will the knowledge, skills, and values of my Christian college education—how will these things be used to clear some part of the human jungle, or restore some part of the lost loveliness of God's world, or introduce some novel beauty into it? That is, how do my education and work make for shalom?* [31]

A Christian foundation for education will affect why we teach, what we teach, who we teach, and how we teach:

- Our courses
- Our curriculum
- Our relations with students, and
- Our scholarship

Typical aspects of specifically Christian higher education-

- Regular chapel programs
- Classroom devotionals
- Dorm/floor student chaplains
- Student-led worship times
- Prayer meetings for students, faculty, and decisions
- "Life-groups" (discipleship groups)
- Integration of faith and knowledge in the classroom

- Prayer for students during office times
- Annual Missions Emphasis Week
- Spring Break Missions Trips
- Community service and outreach

It is important that true knowledge and wisdom, once known, not be either lost or corrupted. Each generation, therefore, has the responsibility to transmit its knowledge of truth, undiluted and undistorted, to the succeeding generation. This is the ministry of teaching.

The wonderful three-fold goal of teaching must be as follows:

- *to transmit the truth in fullness and purity*
- *to train the student with love and wisdom*
- *to glorify Christ, in whom perfect love and absolute truth will be united forever.* [32]

A Christian approach to education is built on four propositions: [33]

1. Every discipline can glorify God.
2. Every discipline can bless others.
3. Every discipline is tainted by the Fall.
4. Every discipline can help to mitigate the effects of the Fall.

Neuhaus writes:

1. *There is no such thing as a university pure and simple...A Christian university does not have a dual identity but a clear identity--a clear identity based upon a definite understanding of the kind of university it intends to be.*
2. *Church affiliation does not make a university Christian.*
3. *While conviction is more important than affiliation, affiliation can help sustain conviction.*
4. *A Christian university is not a church but is part of the church's mission... (T)he university's specific task is discovering and transmitting the truth and cultivating the life of the mind. While a Christian university is not a church, it is from the church and serves the church, enabling the church to serve the world more fully.*
5. *The faculty determines the character of the university.*
6. *Freedom, including academic freedom, is necessarily related to truth. "You will know the truth and the truth will make you free." Freedom that is not grounded in truth is built on the shifting sands of fashionable opinion and brute power. Truth, if it is really truth, can never be the enemy of the search for truth*
7. *Within the university, differences, including religious differences, are engaged in the confidence that all that is truly true is ultimately one.*
8. *It is within the Christian understanding of reality-that everything finds its role. In that understanding, nothing that is true or good or beautiful can be excluded. The work of a Christian university in service to the fullness of truth is to anticipate the promise described*

by St. Paul in Ephesians 1 as God's "plan for the fullness of time, to unite all things in Him, things in heaven and things on earth"

9. *A Christian university rejects the dichotomies that pit truth against truth...(that generate any) dichotomy, even an antitheses, between faith and reason, heart and mind, facts and values, belief and knowledge, devotion and learning.*
10. *A Christian university will settle for nothing less than a comprehensive account of reality. Not content with the what of things, it wrestles with the why of things; not content with knowing how, it asks what for.*
11. *If Christian truth does not illumine and undergird every quest for truth, it is questionable that Christianity is true.* [34]

Mission, vision, purposes

> *The mission of the school is the day after day after day training, educating, instructing of the student. The vision is the hoped for, prayed for, anticipated result of fulfilling our mission.*
>
> *Mission is our temporal academic purpose. Vision is our eternal spiritual purpose. But the temporal must precede, not exceed but precede; the temporal must precede the eternal. If we don't do our work well, if we do not provide the education that student deserves and the parents are paying for, if we don't have that as our immediate day by day priority, in other words if we don't bother to prepare for tomorrow's lessons, chances are that, that we will endanger the vision we hold for the eventual adult discipleship of our graduates.* [35]

At various times Christian universities have chosen models and missions based on Scripture:

- John Brown University: Emphasize a personal wholeness model with competence and Christlikeness; development of head, heart, and hand.
- LeTourneau University: Emphasize the four-fold development outlined in Scripture- Jesus increased in wisdom (intellectual growth), in stature (physical growth), in favor with God (spiritual growth), and in favor with men (social growth). (Luke 2:52) Currently: Ministry to "every workplace, every nation."
- Calvin University: Emphasize the virtues that come from Scripture, including integrity, compassion, and justice.

David McKenna has looked at eight dimensions of an organization and concluded that a Christ-centered college or university is:

* *Centered in the name of Christ for our identity.*
* *Permeated by the DNA of Christ in our character.*
* *Consistent with the image of Christ in our personhood.*
* *Obedient to the timing of Christ in our life cycle.*
* *Motivated by the mind of Christ as our driving force.*
* *Unified by the love of Christ in our relationships.*

** Integrated as the grace of Christ in our functions [our life]; and*

** Accountable to the judgment of Christ for our faithfulness.* [36]

A set of tensions or balance factors will always exist at the administrative level:

- Academic quality
- Financial soundness
- Christian foundation- In all instruction, and in handling all decisions in a Christian manner

The Christian university must be diligent in certain ways:

- It must properly represent any views it disagrees with, rather than presenting "straw-man" arguments.
- It must be able to demonstrate a Biblical warrant for practices it forbids but that society endorses.
- It must keep faith vibrant so that constant chapel and Bible study don't become boring or routine rituals.
- It must maintain a high level of scholarship and intellectual pursuit along with Bible teaching.
- It must emphasize "academic freedom" and yet insist on values and practices originating in Scripture.
- It must not provide a "bubble," but intentionally prepare students for the "jolt" of graduating to work in the "real world."

Integrating Faith and Learning

The integration of faith and learning is hallmark of CCCU institutions. The earliest use of the term and concept of integration was by educator Frank Gaebelein in The *Pattern of God's Truth* (1954). [37]

> *Christian colleges and universities that continue to exist (and grow) in the United States often operated with a dualistic conception of the relationship between faith and learning - which is just to say that they had little sense of any integral relationship between the two. Instead, what made a college "Christian" was the presence of a chapel, the prescription of certain mores in the forms, and a blanket of prayer over the whole project.* [38]

Various approaches to integration have been suggested. The emphasis may be placed upon:

- Attitude and motivation
- Scripture and theology
- Integrative questions
- Worldview aspects
- Presuppositions of the discipline
- Foundations of the discipline
- Ethics

- Character formation
- Service in practice
- Vocation and theology of work
- Creation/fall/redemption

As we examine various university disciplines it seems evident that some areas (like mathematics) pose very little conflict with Christian truth and may, in fact, readily point to God's design, while others (like psychology) may traditionally have strong humanistic underpinnings and require significant thinking to integrate with Biblical truth (which is being done at many Christian universities).

Derek Schuurman offers this example of integration:

> *Even something as technical as computers can be placed within the grand biblical narrative. To use this field as an illustration of this... approach, we begin by recognizing that computer technology is part of the latent potential in creation. Furthermore, the development of computer technology is an exciting cultural activity in which we respond to God by faithfully unfolding this aspect of creation. This includes the plethora of possibilities in computer hardware and software designs along with myriad creative applications opened up by this technology. Tragically, the fall into sin has brought distortions in the world of computing and software. Along with creational goodness we observe numerous examples of how computers are misdirected in ways that bring harm to the self, to the environment and to others. And, like anything else in creation, the human heart can be drawn to place its trust in technology, which has the potential of becoming an idol. We are called to participate in Christ's kingdom by seeking normative ways of developing and applying computer technology. This process begins by recognizing the social, political, environmental, ethical, aesthetic and justice aspects that accompany our technology and directing them in ways that show love and care. We need to move beyond the false dilemma of asking whether technology is good or bad and instead discern both its creational structure and its direction. As students and teachers of computing, we are called to wrestle with what constitutes responsible computing and how to employ it in service of all kinds of flourishing. Ultimately, we look forward to the time when all things, including technology, will be made new, but in the meantime we strive to make "some imperfect models of the perfect world to come."* [39]

Regarding the natural sciences Markos writes:

> *Not just for the biological sciences, but for all those theoretical sciences that are built on an invisible foundation of numbers, the evidence for intelligent design lies all around us. How can there fail to be purpose and order in a universe so finely tuned, so perfectly poised? And yet it is not only in the intricately balanced laws of nature that God shows his presence. He can be seen as well in the mysteries and paradoxes that continue to befuddle our most brilliant minds.*
>
> *Of all scientists, physicists are perhaps the most open to such mysteries and paradoxes. What better conundrum for these number-crunching gamesters to unpack than the*

> *2-in-1 (Incarnation) inscribed within the 3-in-1 (Trinity). If the Incarnation is real, then it bends time and space in a new and thrilling way that no self-respecting physicist could ignore. The doctrines of the Nicene Creed, when rightly understood, do not halt research into the unknown but beckon it on.* [40]

For Engineering, the natural areas of integration (intersection) would include:

- Creation as foundational to all of science and discovery.
- The Dominion mandate (Gen. 1:28) as the warrant to do engineering.
- Seeing God as Designer when we approach design.
- Choosing engineering projects that benefit mankind and fit with responsible stewardship.
- Acting ethically in all decisions; exploring the place of Biblical ethics.
- Handling technology responsibly.

Essential Consistency

Thomas Sharp has warned:

> *Any contradiction between the curricular content (what we write and speak), and our example of pure Biblical-Christian values (what we are), deposits in our students seeds of unbelief and rebellion against God the Creator. Thus, eradicating the purpose for education in the first place - the perpetuation of the Biblical Christian world view! Specifically, and even more disconcerting, any disagreement that exists between what is being taught in the written curriculum either at home, school, or at church and the lifestyle behaviors of the one doing the teaching ultimately destroys the developmental intention of the written content.* [41]

"The ultimate aim of faith-learning integration," says Hasker, "is not merely to complete the integrative task within each discipline but to enhance our overall vision of reality in the light of Christ." [42]

ENGINEERING EDUCATION

As the economy gets tight and tuition costs continue to rise more parents (and students getting loans) are looking at the potential employability of graduates and at their "return on investment" (ROI). Fortunately, engineering programs have always done well in this area.

Ideally a student is being prepared not only with technical knowledge but is also growing in terms of character, integrity, ethics, and work ethic.

Preparing Engineers

Most non-engineers seem to think that engineers spend all their time looking at equations and crunching numbers. Obviously, engineers do use equations and calculations to complete designs, but industry work involves much more than numbers. In a study of what engineers actually do, James Trevelyan noted that engineering practice often involves multiple tasks that aren't taught in school:

[43]

- Analysis and prediction of performance, costs, and uncertainties
- Funding requests, including informal negotiation
- Regulatory approvals
- Plans and contracts
- Reliable procurement and production
- Intellectual property decisions
- Engineering management
- Reliable service and support

Engineering may be considered the ideal balance of theory and practice. (A sign on one of our labs used to declare, "Theory is when you know everything, but nothing works. Practice is where everything works, but no one knows why. In our lab we perfectly combine theory and practice: Nothing works, and no one knows why.")

West point established the first American engineering program for the U.S. Corps of Engineers in 1802. By 1910 a typical engineering program would include Mathematics, Physics, Natural Science, Drawing, Machine Shop, Surveying, Materials, Machines, Language, and Philosophy. With the beginnings of the "Space race" in the 1960's the curriculum heavily began science and theory focused.

By the 1980's an engineering curriculum included courses in Digital Electronics, Microprocessors, and Computer Science to prepare students to work with technology that didn't even exist thirty years earlier.

I have heard the lament several times at education conferences that "engineering education hasn't changed in fifty years." Actually, it has changed significantly.

- In the 1960's all the classwork was based strictly on engineering sciences. Curricula were strong in math, science, and courses like Fluid Mechanics and Thermodynamics
- There was little to no emphasis on, or expectation of, engineering design or capstone (senior) design.
- Most schools had no team-based projects or project emphasis.
- Ethics was not a part of most curricula.
- Portable application software and microcontrollers weren't around yet
- Computers were room-sized and fed by punched cards. Smaller calculations were done on slide rules. (Remarkably, the U.S. got a man to the moon with slide rule calculations and this form of education.)
- Microcontroller chips did not exist yet. All programming was done in FORTRAN.
- All formal classes consisted of blackboard-based lecture style classes.
- Teaching excellence was not nationally encouraged, and retention was not a concern. Many schools introduced their freshmen to engineering with the phrase, "Look to your left. Look to your right. At the end of four years only one in three of you will be finishing here."

Current practice in engineering education emphasizes technical theory, engineering design, and professional practice. All students must complete a capstone design experience built upon prior coursework and culminating in a detailed design.

Curriculum

At the risk of treating students like manufactured things, developing an engineering curriculum is in many ways similar to approaching an engineering design problem. We have in our minds what the finished product should look like, what the clients (future employers want), and what kinds of constraints are on the system. Based on inputs and experience we need to develop the process to produce the output. The finished product-: entering professionals, with engineering knowledge and skills

According to the education criteria established by the accreditation agency ABET [44] an engineering curriculum must contain at least 30 credit hours of math and science, 45 hours of engineering topics, and appropriate general education courses. In addition, the program must prepare students to achieve seven stated outcomes and to demonstrate attainment of those outcomes in a continuous improvement process based on assessment.

Outcomes

Student outcomes (abilities that graduating seniors should possess) are outcomes (1) through (7), (plus any additional outcomes that may be articulated by the program).

1. *an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.*
2. *an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.*
3. *an ability to communicate effectively with a range of audiences.*
4. *an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.*
5. *an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.*
6. *An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.*
7. *an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.* [45]

In addition to technical skills, such as problem-solving, lab measurement, and design, current education emphasizes the development of "soft skills" (communication, planning, teamwork).

Liberal arts and Engineering

Liberal Arts must be part of an engineering curriculum. They are part of a broad education, primarily valuable in establishing a common base with others, particularly non-engineers. It is interesting to note that most non-American engineering curricula, especially in Asia, rely heavily on high school history and literature background, and contain few or no non-technical courses. It has been stated for years but has never not been shown that liberal arts courses help to make engineers ethical.

Value of the humanities:

- Broaden the engineer
- Give us common background
- Help us to communicate with others

"The goals of liberal education will include not only self-understanding, but also an understanding of other people and of social institutions and processes." [46]

> *(Great texts) were known to give form and power to students' minds, to encourage them in goodness, and even to shape the culture in which they were to live. Whether poetry, philosophy, history, or math, the books were thought to reveal important things about their specific moments in history as well as enduring qualities of human nature. They educated students in their own essential humanity. The capacity for good and evil, wisdom and folly, courage, humility, beauty—all these things and more were richly presented and deeply understood through great texts. This was the kind of learning Newman understood to be infinitely valuable to human life on both individual and social levels.* [47]

> *Almost all those in academia agree with the value of liberal arts subjects are to "round out" an engineering education in order to make a "whole person" of the graduate. Engineering faculty largely agree that engineering students (and faculty) can learn a great deal from liberal arts faculty and their publications, particularly in the valuable area of "soft skills." Through our interactions on campus and the ABET 2000 Criteria we have certainly seen that engineers benefit from interaction with arts/humanities faculty and the materials they develop. Examples include dealing with team members and clients, interpersonal communications, understanding one's abilities and growth areas, communicating concepts to a wide audience, understanding ethical theories, wrestling with ambiguity in those situations which are not clearly black and white, and understanding social impacts of design.* [48]

Will more liberal arts produce better engineers? It depends on the course material. Liberal arts courses should be selected as carefully as technical courses. Traditional history, literature, and courses in modern thought can be valuable. I'm not convinced that "Twentieth Century Anarchy," "Marxist Poetry," "Roots of Rap," or "Movies about Cats" will improve our empathy or our skills. We do need to be able to understand and communicate with a wide range of people. We need to be sensitive to human needs.

Problems with making engineering a subset of liberal arts:

- Students may disdain practical application
- Students may value only ideas
- Students may disdain education that prepares them for a career
- Students may disdain the idea of profits

We don't want engineers to write and think like humanities people. State results succinctly and emphasize physical laws and codes in design, not feelings.

Some have suggested that because of its broad range of topics (math, science, engineering science, design, communication, teamwork, ethics, costing, leadership), engineering has become "the new liberal arts." [49]

The "holistic engineering education" approach emphasizes that engineering includes much more than applied sciences. In addition to creativity and technical ability, higher education for engineers (particularly for engineers) should include some discussion of, and growth in, what Daniel Goleman has termed "emotional intelligence." [50] "EQ" involves such topics as:

- Awareness of one's own emotions and emotional state
- Self-control
- Self-motivation
- Awareness of the emotions of others
- Relationship skills
- Developing empathy for others

Modern approaches to engineering education include:

- Active learning- maximum student participation and involvement, particularly during the class.
- Problem-based learning (PBL) - building the course around a particular problem to be solved- ex.
- Service learning (EPICS) [51]-learning objectives are combined with volunteer service or projects done for nonprofit agencies
- Design-based learning (CDIO) [52] - emphasis on practical skills for industry along with theory: Conceive -Design -Implement -Operate
- Reflective learning- (TIDEE-IDEALS) [53]-emphasis on students monitoring and assessing their learning experiences
- Hybrid learning - a mix of digital online and in-class experiences in a single course
- Flipped classroom- providing the lectures online (outside of class) and using class time to review and practice problems.
- "2020 skills" - Based on the National Academy of Engineering 2004 report "The Engineer of 2020," various skills need by the year 2020 were outlined: leadership, teamwork, managing change, working in diverse multicultural environments, working globally, synthesizing engineering, business, and societal perspectives [54]

- Global service learning-an overseas experience built around a community-driven project

Recent models of unique engineering education include:

- Olin University – customer-centered, active learning
- Rose-Hulman University- "design spine" throughout curriculum
- Harvey Mudd College – engineering clinics, doing design work for major clients
- Univ. of Texas at El Paso -Leadership engineering curriculum
- Kern Entrepreneurship programs [55]

At a conference of the ASEE George Ricco listed the following as "underlying issues" which should be considered in engineering education: [56]

- Agency
- Consciousness
- Transcendence/Immanence
- Knowledge
- Phenomenology
- Identity

All are addressed, indicated Ricco, by European philosophers, but we note that most are also addressed by Christian philosophers and can be related to God's triune nature and Creation.

CHRISTIAN ENGINEERING EDUCATION

At this point in time over twenty-five CCCU and non-CCCU affiliated Christian schools have initiated engineering programs. There are many options for interested students in a variety of denominational and non-denominational institutions.

What Christian Faculty Can Emphasize

- Wonders of Creation
- Value of each person
- Humans designed in the image of God
- Ethics to God's glory
- Service mentality
- Limits on what we design
- Thinking Biblically about technology
- Working out compassion, justice, and reconciliation in the world and the workplace

Regarding accreditation requirements/expectations, Christian institutions are able to offer the following: [57]

- Consider professional and ethical responsibilities from a Christian viewpoint
- Emphasize communication that is both truthful and effective
- Understand global and societal contexts for design along with Biblical stewardship of

resources
- Interpret contemporary issues from a Christian worldview

Christian faculty respond to students in their entirety, including
- Relationally
- Cognitively
- Morally
- Emotionally
- Spiritually

Only one answer?

Because the Bible repeatedly states that there is only one God and only one way to God, and since a handful of moral commandments exist, some Christian students carry this idea over into their engineering work. They struggle with the idea that a problem could have multiple possible solutions. Certainly, a math problem or an engineering problem reducible to a single equation will have only one (correct) answer. On the other hand, how to get across a river or how to design a new car –these are problems with many possible answers.

> *The use of Christian perspectives to inform engineering design can be incorporated into classroom instruction by assigning particularly relevant scripture passages (narratives) as part of the background research associated with a customer needs statement. For example, when considering the cost benefits of additional design efforts to accommodate a device's use by physically imparted individuals, relevant narrative passages from the Gospels that document Jesus' healing miracles or passages from the Old Testament prophets related to God's concern for the poor and downtrodden could be used to emphasize the importance of accommodative alternative designs.*
>
> *Even engineering science courses, which may contain little design content, should contribute to a student's awareness of extrinsic design elements. For example, electrical materials courses, which normally cover topics related to the electrical properties of materials, can address issues of materials toxicity and environmental impact, end-of-life recovery, and safety. Or a course in electromagnetics can cover the effects of EM radiation levels on living organisms. A course in software development could cover issues of human computer interaction that relate to system utilization by individuals with sensory impairment and other physical disabilities. A course in thermodynamics could address issues of energy conservation, energy efficiency and energy production by-products (pollution). A course in machine design might address issues of appropriate technology, sustainability, and maintainability.* [58]

Christian Pedagogy

Beyond the aspect of content (*what* is taught), the area of pedagogy looks at the methods

(*how* it is taught). We have seen such specific approaches as Feminist pedagogy and Liberationist pedagogy. Is there a unique Christian pedagogy?

Christian education involves a distinctively Christian approach and the use of Biblical principles and teaching practices. Based on ideas of James K.A. Smith, Hughes writes that "learning truly happens through embodied practices that inscribe a particular view of the good life in the hearts of our students." [59]

The goal of Christian higher education is not to create budding young socialists, radicals, or social justice warriors, but skilled professional who love God and serve others. Aspects would include:

- Value of the individual
- Desire to develop both mind and spirit
- Unchanging truth
- Jesus as model teacher
- Analogies and biomimicry

Christian pedagogy requires faculty to "mirror the person of Christ in all their daily educational choices." [60]

Loving the students and showing mercy will not mean that every student gets an A, or that every student will necessarily pass the class, but that all students will be respected and should sense that the faculty love them.

Christian education will cover the same basic topics as "secular" education (for example, calculus, physics, statics, circuits, design), but with these value-added aspects-

- Worldview: specifically Theistic worldview
- Biblical epistemology: truth exists external to us; our minds are designed to know reality
- Specific integration of faith and learning
- Ultimate goal: the glory of God; the kingdom of God
- Goal for the student: knowledge, skills, and wisdom (beyond mere facts)
- Emphasis: "whole-person education": growth spiritually and socially as well as academically
- Foundation: Intentional, bathed in prayer
- Evangelism: may take place naturally, in the context of learning and mentoring
- View of the world: amazing, valuable but fallen
- View of the student: unique, valuable, but prone to human temptation (including cheating)
- Mindset: love, humility
- Atmosphere: trust, peace, welcoming
- Community: learners, worshippers
- Faculty: role models
- Place of profits: never the goal of life, but not evil

Most pedagogy begins with assumptions about the nature of truth and the nature of the human

person.

Christian pedagogy has these unique starting points —

- All (actual) truth is God's truth. Truth is unchanging, rather than subjective/relative.
- Truth can be received from both reason and revelation.
- There is real truth to be discovered and conveyed, not simply pragmatism.
- Truth is conveyed to be applied.
- Teaching can be done from a distinctly Christian worldview, combining faith and reason.
- Teaching should orient students to truth. It should lead to seeking God or seeing His actions. It should promote loving actions.
- Teaching should result in transformation, both informing and renewing the mind.
- Teaching and learning can be done to the glory of God.
- Every student, as God's creation and image-bearer, is incredibly valuable.
- The Christian classroom should be a joyful, hospitable environment for learning.
- Faculty teach out of genuine love for their students.
- Many of the students are brothers and sisters in Christ of the faculty.
- The students should know that their lives matter, their voices matter, and their spiritual lives matter. [61]
- The professor should know each of the students. (God knows each of us individually).
- The professor is not the all-knowing one, but a fellow pilgrim and fellow-learner.
- Faculty should openly admit when they don't know something and can't answer a student's question. (Then they should hunt down an answer.)
- It is a divine privilege to instruct and to pray for the students God has prepared.
- The faculty's work is a calling and a ministry.
- For the faculty, every class is an opportunity to bless students.
- Teaching is basically "speaking the truth in love."
- The faculty should be well-prepared and aim for excellence. (Jesus taught with authority -Mark 1:22).
- The professor should be enthusiastic about the Lord, about the subject, and about conveying it to students.
- The professor should constantly coach and encourage.
- Faculty will relate to students as mentors, elders, and "parents."
- Faculty will follow up with students who are sick, injured, or hurting and help to restore them.
- The professor should make every reasonable effort to help students learn, with patience and compassion.
- The goal is that the students deeply understand the material, including experiencing various "Aha!" moments.
- Faculty should make all expectations crystal clear.
- Professors should assign grades reasonably and fairly, not penalizing a student for

something trivial. They should not pass a student who doesn't know the material.

- Faculty can minimize fear by explaining test formats and giving multiple tests and assignments for the grade.
- All faculty members are unique and will develop their own teaching identity.
- The faculty member trusts the Holy Spirit for unique insights and creativity.
- Character development and ethical formation is as important as technical knowledge.
- Faculty should emphasize the value and inter-connectedness of all courses required.
- Faculty should try to engage the whole person- mind, multiple senses, emotions, body.
- Stewardship, obedience, service, and character should be interwoven with facts of the discipline.
- Faculty should encourage ongoing analysis and reflection: What did I learn? What helped me to learn? What do I need to understand? What is the Lord showing me?
- Faculty should set high standards so that students excel.
- Faculty should practice good stewardship of the students' time as well as their own. All learning activities should have specific goals.
- When faculty insist on excellent and timely work, it is out of love for students (not "meanness").
- The student should be encouraged to see their time in college as a part of "God's grand story."

> *Neil Postman writes in The End of Education that educational ends need to be supplied by a grand narrative that "tells of origins and envisions a future … and, above all, gives a sense of continuity and purpose." The Bible provides us with that grand narrative and the framework of creation, fall and redemption. This approach holds in tension the goodness of creation as well as the potential idols and distortions that are embedded in the foundations of each discipline. Al Wolters writes, "It is the task of every educator to sift out the valuable insights of a tradition and make them fruitful for further progress as well as to expose and reject falsehood and illusion within that same tradition."* [62]

> *Students …develop their academic discernment. In the course of life, they will be exposed to an assortment of truth and falsehood, beauty and abomination, good and bad. Just as the best way to discern a counterfeit is by knowing the genuine, so, too, students develop discernment by becoming well acquainted with what is true, beautiful, and good.* [63]

For the development of "soft skills," including teamwork and project management, the Bible offers guidelines: Spiritual gifts related to the Body and its members-every part is unique and valuable (1 Cor. 12), Nehemiah's rebuilding project for principles of project management.

In "incarnational teaching" the teacher/professor makes the subject alive for the student:

- The teacher/professor brings Christ into the classroom

- The teacher/professor comes down to the student's level
- Maximum student interaction

Pedagogy Based on Jesus' Methods

Many current approaches to teaching are actually rediscovering methods used by Jesus (the Master teacher). James Bartlett of NDSU made these observations on Jesus' teaching methods: [64]

1. Jesus Christ taught in a real world environment
2. Jesus used Problem Based Learning
3. Jesus used interdisciplinary teams. The family and the church are designed to be interdisciplinary teams
4. Scriptures encourage outcome assessment.
5. God's Word and God's Spirit communicate to believers (a type of distance education)

How did Jesus teach? He

- Found a point of contact
- Asked questions
- Offered a "level playing field" [65]
- Used everyday examples
- Had a goal for each listener
- Put the teaching into practice –sent out the 12, sent out the 70

Levi Carvalho noted that Jesus' teaching included at least ten elements: [66]

- *A mentor with godly character*
- *A mentor with a perfect blend of word and deed in the power of the spirit*
- *A mentor with a mission*
- *A core of disciples, personally chosen by the master*
- *Discipleship through common living*
- *Participation non the mission of the master*
- *Short projects (without the master's presence) in the context of discipleship*
- *Subsequent correction by the master*
- *A plan for the future*
- *Power from on high obedience in the absence of the master*

Ideal education, then, is a combination of information transfer, character formation, and bestowal of power so that learners/disciples can change the world.

Bruce Wilkinson has written on seven laws of the learner, based on Scriptural principles: [67]

1. Law of the Learner

Teachers are responsible to cause students to learn.

Teachers exist to serve the students.

Communicate the subject with the students' needs and interest in mind.

2. Law of expectation

Expect the best.

Expectations empower others when rooted in love.

Examine/exhort/excite (stir up).

3. Law of application

Apply what's taught of life change.

The goal of discipleship is maturity and equipping.

4. Law of retention

The goal is maximum mastery of the necessary minimum.

Focus on-and review- the most important concepts.

5. Law of need

Awaken the interest before delivering the content.

Seize attention/stir curiosity/stimulate felt needs.

6. Law of equipping

Teachers are given primarily to equip, rather than merely to explain.

Equipping requires knowledge, skill, and a long-tern commitment.

7. Law of Revival

Aim for continual spiritual and academic renewal.

Keep the flame burning.

Faculty should emphasize spiritual formation along with professional development. Schuurman writes:

> *In a spiritual formation project led by Syd Hielema at Redeemer University College, several ideas were explored to encourage spiritual formation in the classroom. Among these were ideas such as practicing hospitality in the classroom, encouraging virtues such as respect and wonder and a longing for shalom, and cultivating a collegial ethos among the faculty. Faculty were encouraged to make connections between different classes and co-curricular activities. Faculty and staff were encouraged to worship alongside students in chapel, to disciple them in learning communities, and to get to know them through judicious conversations outside the classroom. Faculty can also explore ways to encourage students to develop spiritual and intellectual disciplines and provide opportunities for students to experience reverence and awe. Faculty can serve to model epistemological humility in the face of perplexing issues as well as showing care and concern.* [68]

Constructivism in Education

Just as there are philosophical divisions between a realist and anti-realist approach to science and to mathematics, a divide has developed in recent years in the understanding of educational theories. Constructivism, as begun by Jean Piaget and Vygotsky, can bring the nature of the real world into question. While it correctly observes that students build knowledge upon prior knowledge, it may suggest that there is no basis in reality that matches that knowledge. [69]

Character and Virtue Development

Industry leaders tell us that certain character traits are highly valued in prospective employees and will figure strongly in their success in the company. Interestingly, several of these traits map closely to Christian virtues taught in the Bible.

Christian institutions value character development along with skills development. Calvin University has specifically spelled out their intentions to develop Christian virtues and to define those virtues:

> *In the following list we name and describe those virtues we think play a special role in the life of the mind and the building of community…The list is neither systematic nor exhaustive. It is, rather, exemplary, tailored to the mission of the college as an academic institution. Moreover, it does not seek to suggest, by describing the virtues under separate headings, that the virtues can be possessed in isolation from each other. Abstracted virtues quickly become vices: diligence becomes workaholism, honesty degenerates into brutality, and generosity slides into carelessness. The virtues must be mutually tempered and ultimately bound by the master virtue of love. As God's chosen people, we are enjoined by St. Paul to clothe ourselves with "compassion, kindness, humility, meekness, and patience," but above all to clothe ourselves "with love, which binds everything together in perfect harmony" (Colossians 3:12 and 14).* [70]

WORKPLACE TRAITS	CHRISTIAN VIRTUES
Honesty	Integrity
Loyalty	Faithfulness
Cooperation	Peacemaker

Positive attitude	Joyfulness
Work ethic	Industry
Respect (no arrogance)	Humility
Self-discipline	Self-control
Patience	Patience
Diligence	Peserverance
Wisdom	Wisdom
“Team-player”	Love, kindness, sacrifice
Encouragement	Encouragement
Contentment	Contentment
Good resource management	Stewardship
Proper relationships with opposite sex	Kindness, purity
Initiative	Courage

Ingenuity	Spirit-inspired creativty

Calvin has emphasized fourteen key virtues and incorporates these into their core curriculum: diligence, patience, honesty, courage, charity, creativity, empathy, humility, stewardship, compassion, justice, faith, hope, and wisdom. [71]

Christian Professors

The stereotype of a college professor is well known:

- Brilliant in a single area
- Somewhat eccentric
- Rumpled in appearance
- Wearing a tweed jacket with leather on the elbows
- Absent minded ("Which way was I coming from? Have I already eaten lunch?")

Why do we need professors?

Many subjects can be learned on your own once you have some learning tools and some basic background. Why are engineering professors valuable to the learning process?

1. They take a huge subject and break it into thirty or forty pieces that can be learned, step by step, over a semester.
2. They show students how what they're learning fits into the big picture of their discipline and with real-world applications.
3. They explain the difficult concepts in detail. This is particularly true in Calculus, Circuit Theory, Dynamics, and Thermodynamics, where many concepts are far from intuitive.
4. They provide exercises (homework problems) using the material and feedback (testing and grading) to show whether students have learned the material.
5. They make the subject interesting and, hopefully, exciting. (Usually by their own enthusiasm)
6. They push, challenge, and encourage students to put in the effort and complete the course.

The traditional expectation is that faculty will be involved in (and evaluated regarding) four areas:

- Teaching
- Scholarship/research
- Healthy interactions with colleagues
- Service (committees, task forces, organizations).

Why would one pursue/ continue in an academic career?

- A desire to use one's engineering expertise.
- A love for students and for helping them learn

- A knack for communicating technical material
- A desire for independent research development
- A flexible summer schedule
- More freedom to choose one's career path

The Christian professor has these roles:

- Teacher
- Role model
- Mentor/advisor
- Discipler
- Scholar

Elton Trueblood wrote:

> *He* [Timothy Dwight, President of Yale] *knew that the real assets of a college are not buildings or systems, but men. He knew that the teacher is an enkindler and that the test of his success lies in the kind of fire he lights. The greatness of any college is directly proportional to the number of its teachers who are truly effective in this sacred function.* [72]

Christian faculty relate to students in unique ways:

1. As brother or sister in Christ. Here we relate to students as fellow believers and apply the various "one another" passages of the NT. (Serve, love, pray for, encourage, build up,...)
2. As elder or shepherd.

The Christian faculty member, in the context of the college, often acts like an elder/shepherd for the students. He or she should be continually desiring the upbuilding of each student in Christ and be available for counsel and help. As such, the pattern for shepherds in 2 Peter would apply:

- Goal: Build them up (prepare them for life and ministry)
- Motive: Pleasing God; Service; not self-exaltation, not gain
- Necessary attitude: Humility ("Don't lord it over the flock.")

3. Like parents, looking out for their well-being.

A major admonition to parents is this: "Fathers, do not exasperate (embitter) your children..." (Col. 3:21) What exasperates children?

- Harshness (Be direct, but no need to be harsh with students.)
- Unreasonable expectations (Set the bar high, but not out of everyone's ability.)
- Favoritism
- Discouragement (Give them hope that they can learn it if they invest the effort.)
- Discipline without explanation (Always indicate how the grade was calculated. Don't take off points without explanation.)
- Inconsistency (Don't change the rules once the game has started. Make sure the students

know in general what to expect from day to day.)

DANGERS FOR FACULTY

Intellectual pride

Faculty are highly educated individuals, and awareness of their intellectual achievements may propel them towards intellectual pride. Two reality checks can diminish this danger: (1) Every aspect of our being and every accomplishment in our lives is a gift from God. ("What do you have that you didn't receive?" (1 Cor. 4:7) (2) Ph.D.'s are experts in a relatively narrow field of knowledge. Once they're removed far enough from their own field they are usually as clueless as everyone else.

Perfectionism (also a key danger for students)

A perfectionist is never satisfied with his/her own work-or that of others. Students who are perfectionists will simply not turn in an assignment rather than turn in an assignment that might earn a B (or anything less than A+). The result always harms themselves. Perfectionists need to strive for excellence and their best effort for God, not a perfect result (which is too often never completed.) Perfectionism is largely fear of failure, and a life driven by fear is not in line with the Lord's purposes.

Seven Deadly Sins of Faculty

Using a list that was catalogued in the Fourth Century, Benton [73] examines seven deadly sins committed by professors that he has observed in the Academy:

- Sloth - The professor is very busy, but never about the classroom. He shows up late, fails to keep office hours, and invests minimum effort in grading and preparing.
- Greed - The professor is after status, rather than big bucks.
- Anger - Faculty meetings turn into disputes over petty opinions, power, and personal resentments.
- Lust - Faculty fall prey to affairs and adultery, often coupled with favors and power.
- Gluttony- Professors with unhealthy lifestyles battle alcoholism and obesity.
- Envy -Professors may become jealous of others' offices, salaries, or faculty ranks.
- Pride - Faculty may exhibit a sense of superiority because of their position or apparent knowledge.

("The process of becoming a professor should [actually] involve the recognition of how little one knows.")

Academic professionals are subject to the same basic temptations as the average person, although in a slightly different context. All of these "deadly sins" are ugly responses and certainly fall short of God's glory.

EDUCATION AND ETHICS

These principles should be kept in mind by faculty:

- Faculty must maintain standards of honesty and accuracy in teaching.
- Faculty should give their best effort to help students master what is being taught.
- Each student must be treated fairly and impartially.
- Faculty must maintain privacy of student records. (FERPA agreements)
- Faculty must avoid conflicts of interest.
- Faulty must assign and report grades carefully and honestly.
- Faculty must relate in a proper and professional manner with all other faculty.
- Faculty must handle all research and publication with honesty and proper diligence.

Educational Idolatry

Education and accumulated knowledge can lead people to think that we don't need God.

Education is a good thing…in its place. As soon as it becomes the most important thing in our lives, as soon as we sacrifice our integrity or our relationships or our fellowship with Christ for grades or academic achievement, we have made education a horrible idol. Chelsea Kingston wrote: [74]

"Since it's socially acceptable to pursue education at any cost, we're not too bothered when the pursuit of academic achievement begins to rule our lives," Kingston wrote. "We hardly notice when fellow Christians size up one another based on their alma mater — or even their children's preschool."

Idols of Education

In The End of Education Neil Postman describes four idols, four "gods that fail," which are presented to students as the purpose for their education: [75]

1. Economic utility - The reward for education is a well-paying job.
2. "Consumership"_- Education allows you to buy more toys.
3. Technology -Technology will equalize learning opportunities.
4. Multiculturalism (tribalism) -Education should emphasize our differences.

ENGINEERING STUDENTS

How faculty relate to students

Students are entrusted to a Christian college by the parents and by God. The majority of students enter college at a crucial stage of their lives. Having left home, their ideas develop independently of their parents, though built on the foundation of what was believed, lived, and taught. The staff and faculty are the students' sub-shepherds, responsible for caring oversight and answerable to the Great Shepherd. [76]

For Christian faculty, students are simultaneously

- Our customers (they or their parents pay the tuition)
- Our brothers and sisters
- Our fellow-learners
- Our "children"

Ideally, students should flourish during their time in college.

How we view our students can have a significant impact on the way in which we teach our students. Based on Niebuhr's models of Christ-Against-Culture, Christ-Embracing-Culture, and Christ-Transforming-Culture, Holtrop considers three modes of relating to students: [77]

1. *Students are primarily depraved creatures; therefore, faculty must be authoritative and must limit all possible sinful behavior.*
2. *Students have incredible potential; therefore, faculty must welcome, and provide outlets for, every form of creative expression.*
3. *Acknowledge both the sinful nature and God-given talents of the student; therefore, faculty should emphasize personal transformation, personal responsibility, motivation, and application of knowledge for "shalom-building."*

Connecting with students

A faculty member should be a student's mentor, cheerleader, role model, and friend but never his/her buddy.

Get to know who the students are.

- Unless you have a class of 50 or more learn their names early on.
- Ask them about their hometown, goals, and interests.
- Read and comment on their T-shirts (realizing that some are from Goodwill and mean nothing top them.)
- Ask them for input.
- Do a one-minute icebreaker question at the start of most classes.
- Tell them who you are.
- Tell them about your own days as a student, including struggles and ultimate successes.
- Give them a relevant story from your own experience.
- Tie a problem to a story or a movie (Star Wars, X-Men, etc.)
- Utilize art, music, stories, to get ideas across.

Intrusive Advising

This is an area that Bill Graff really honed in his career. "Intrusive advising" means that the faculty member sets the agenda for some of the one-on-one meetings with a student and asks probing questions —

- How are you doing overall?
- Are you enjoying engineering classes?

- How is this particular class coming?
- How much time are you investing in this class?
- How are you spending your time outside of class?
- Are you attempting all of the homework?
- Are you asking for help when you don't understand things?
- Are you getting decent sleep?
- Have you made some friends in the class?
- What are your plans for the summer?
- Are you looking into an internship?

And for Christian students at a Christian institution –

- Do you have a quiet time habit in place?
- Do you have some friends who encourage you?
- Have you found a church to plug into?
- How are you doing in your walk with Jesus?

There will be a few students who just don't "get it."

- Some think there's a trick or a secret formula for engineering problems.
- Some get lost in the weeds.
- A few want to do the bare minimum.
- Some see classes as one more hoop to jump through.
- Some develop misconceptions that trip them up.

Dealing with these situations is obvious but not necessarily easy.

- Provide plenty of examples, and let students know that there is no sleight-of-hand involved.
- Help them see the big picture as well as the most necessary details.
- Straighten out misconceptions as soon as they're discovered.
- If students are discouraged, encourage them.
- If students are confused, "unconfuse" them.
- If students are distracted, try to focus them.
- If students are unmotivated, try to inspire them.

Praying for Students

It is a special privilege of believing professors to pray for those students assigned to their classes or advising rolls. What can they pray?

- That each of the students would solidly know the Lord and grow in Him.
- That they would learn the material well and complete each course successfully.
- That God would develop the fruit of the Spirit in them.
- That they would stay healthy and work safely.
- That they would form solid friendships and encourage each other's growth.
- That they would stand against temptations (including cheating) and know victory over sin.

- That they would find a rewarding job (or grad school placement) that fits their skills.
- That they would develop as ethical, service-minded professionals.
- That they would have excellent marriages and raise strong children.
- That the school's program objectives would be realized through them.
- That they would extend love, justice, and shalom through their work.

EDUCATION, WORLDVIEWS AND THEOLOGY

What place does worldview have in education?

For the naturalist (humanist), education is the key to all social development and progress.

For the pantheist, education is part of the unity of all things. The classifications and comparisons inherent in education should be upsetting to a pure pantheist.

For the Christian theist, education is valuable for the study of God's world and glorifying God.

From creation we find that humans were made with a true capacity for understanding (at least in part) the world and for learning. Because of the fall we know that false ideas may be taught and true ideas may be misused. From redemption and restoration, we are encouraged to teach truth, to connect to a Biblical worldview, and use what is taught to bless others.

Worldview Concepts and Education

- *God is sovereign over all creation, including the field of education.*
- *We make a connection to God's claims in every subject (not just biblical studies or chapel) and in all behavior.*
- *God reveals Himself though His creation.*
- *In spite of the fall into sin, the original goodness of creation still shines through the character, structure and connectedness of things.*
- *The (purpose of) school is to equip students with the vision and skills for the redemption of this earth.*
- *This is not a throw-away world; God will renew it rather than destroy it. This makes all actions to improve life on earth worthwhile.* [78]

For Engineering Sikkema and Vander Werff present some "Guiding Principles for A Christian Curriculum": [79]

- The world (and everything in it) was created for God's glory.
- God gave us dominion over creation and instructs us to develop and conserve it (at the same time).
- We are creatures … always finite, currently sinful.
- Our sin caused creation's suffering. We have a responsibility to ease suffering by engaging the human and non-human creation.
- We live in the already and not yet of Christ's kingdom.

How does our worldview influence our concept of education? Goheen points out that modernism and postmodernism yield different goals for education: [80]

> *For the modernist, the goal is to pass on a body of unified scientific knowledge, equip rational citizens, and create a world with justice, peace, and material prosperity.*
>
> *For the postmodernist, the story of progress is no longer accepted, and the unified body of knowledge is fragmented. In its place they look for three modern constants described by Neil Postman: economic utility, consumerism, and technology. The goal of education is merely to pass on useful information and marketable skills.*
>
> *The Christian, however, sees education as a process of equipping students to be witnesses to the power of Christ in every vocation and in every aspect of their profession.*

Part of the purpose of all education is to pass on the culture's "grand narrative"—

> *Historically, education can be seen as the vehicle by which modernity's 'grand narratives,' the Enlightenment ideals of critical reason, individual freedom, progress and benevolent change, are substantiated and realized." Take away this story of civilizational progress and the modern mass education loses a central dimension of its raison d'etre (Brian Walsh).*
>
> *The issue [is] not whether education is rooted in a grand story, but which grand story it shall be rooted in? If the tale of capitalistic progress is beginning to fray at the edges then perhaps this is an evangelistically opportune time for Christian education to offer another story--one that replaces the self-salvation of economic progress with the tale of a coming Kingdom of redemption* [81]

Christian Engineering Professor Bill Jordan wrote:

> *There are several areas in which my Christian worldview is relevant to my students:*
>
> 1. *It provides me with a real, physical universe to work with.*
> 2. *It allows me to prioritize what problems I should work on as an engineer.*
> 3. *It provides me with a motive to be an engineer. Specifically, it motivates me to use my engineering skills to help other people.*
>
> *This Christian worldview is consistent with established engineering ethics guidelines.* [82]

Hoackley outlines several "theological issues informing a philosophy of education": [83]

- Doctrine of the fall and its consequences — is the intellect distorted or merely limited?
- View of the sources of religious authority — scripture or scripture and tradition?
- Relative emphasis on the doctrine of creation — is the natural world worth studying in its own right?
- Understanding of discipleship — personal holiness or social engagement?

- Doctrine of conversion/sanctification — radical break or long process?
- Doctrine of the Holy Spirit — what is God's role in guiding the intellect of believers?
- Eschatology — are social and environmental ills cured by radical divine intervention or the continued work of the church?

A theology of Higher Education

1. Higher Education provides a training in intellectual virtue (honesty, integrity, courage, openness to judgment). Higher education provides training in reason.
2. Higher Education properly provides an induction into a certain kind of moral community: a reasoning community united by forms of virtuous intellectual exchange.
3. Universities are - or can be - powerful agents in pursuing the common good of society.
4. Education inherently takes the form of a interplay between wisdom and delight, in which wisdom seeks the flourishing of all God's creatures together before God, whilst delight registers the distinctive way of being of each creature called to share in this flourishing. [84]

CONCLUSIONS

Knowledge can glorify God if it is used; knowledge is improper if not used. The Hebrew concept of knowledge was: To know is to do. From Jesus' parable of the talents we know that to deliberately "bury" what the Lord entrusts to us is wicked, lazy, and displeasing to God.

George Grant writes, "Educational excellence from a biblical perspective is thus not so much concerned with the amount of data accumulated in a student's head, but a way of thinking and acting woven into a student's life." [85]

Goals of Education for Christian Faculty

1. Truth

   The central purposes of the members of university communities are to teach and seek truth. In a Christian university the central purposes are also to teach and to seek truth, but a truth understood, built on, and informed by the Word; that is, God's truth. [86]

When institutions claim to be "in pursuit of truth," they miss it if they don't recognize that truth is not simply factual nor not merely impersonal, but Personal (Jesus says, "I am the Truth..."). Instead of seeking truth we need to let the truth (God's truth, reality) find us." The Christian tradition knows that we are the evasive ones, and the truth is pursuing us." [87]

"The search for God's truth-Christian scholarship- and teaching are the central characteristics that distinguish the Christian university from other Christian communities." [88]

2. Love

   The Apostle Paul teaches us to think that the goal of Christian education, of all

> *teaching and instruction, is the life of love (1 Timothy 1:5). It does not matter what the subject is…The goal is to be the same: increase in love for God, for God's world, and for the people around us. When the goal of instruction is love, the fruit of teaching and learning will be profoundly and beautifully evident to the watching world.* [89]

3. Wisdom

In the light of human limitations (finitude) Daniel Trier presents wisdom as the "guiding theological concept for educational endeavors." [90] Wisdom is the right use of knowledge, given a high place in Psalms, provers, and Ecclesiastes.

"Biblical wisdom embraces knowing God, growing in virtue, and exploring the world." [91]

"Wisdom navigates apparent tensions between creational delight and missional sacrifice." [92] We will ultimately recognize the goodness of God's original creation and the simultaneous need for God's divine redemption in our world.

"Wisdom integrates human knowledge, skill, and virtue, as they are encompassed by the need for God's gracious revelation." [93] To achieve wisdom, listening must be humble, and speaking must be truthful.

4. Personal Relationship

Education leader Parker Palmer, author of *The Courage to Teach* [94] encourages us that teaching is an act of unselfish giving, an act of love. In true education, he suggests, we build "a relationship between the knower and the known, between the self and the world." [95] Unfortunately, most teaching is handled with such a collection of objective facts and at such a distance that students may conclude that the material presented has nothing to do with their lives. A true education, indicates Palmer, will include the subjective side of knowledge. [96] Good teaching should impact not only the intellect, but also the emotions and the will. Astronomy and science should create a sense of awe. The injustices of history should stir a righteous anger as well as compassion for the victims. In the end we should ask: "What will I do with what I have learned?"

Teaching Philosophy

> *A Christian philosophy of education differs from educational philosophies of the world. The Christian philosophy of education is faithful to God's purposes for the Christian student and Christian educator as demonstrated through God's Word, God's Works, and God's Spirit. Such a philosophy acknowledges the omnipotence, omnipresence, and omniscience of God in all its ways. Both the educator and student of a Christian philosophy of education become filled with the knowledge, wisdom, and understanding of God. God's Word, God's Works, and God's Spirit become integrated and applied to all of life.*

Since God is the creator of all knowledge and the beginning of knowledge is the fear of the Lord, there is no curriculum, course, topic, or simple complete thought where the discovery of God's thoughts would be unexpected. Therefore, the educator and student with a Christian philosophy of education apply diligence to think God's thoughts after him, which brings both glory to God and heaven to earth through the life of the educator and student. [97]

"There are those who seek knowledge for the sake of knowledge; that is Curiosity.

There are those who seek knowledge to be known by others; that is Vanity.

There are those who seek knowledge in order to serve; that is Love." [98]

REFERENCES

1. Kirkman, R., and Borgmann, J., "Zits" comic strip, Nov. 29, 2016.
2. Malik, C., *A Christian Critique of the University*, North Waterloo Acadic Press, 1990.
3. Attributed to Clark Kerr, former president of the University of California.
4. Attributed to Steven Schwartz
5. Kahlenberg, R., "The Purposes of Higher Education," http://chronicle.com/blogs/innovations/the-purposes-of-higher-education/30258
6. Goheen, M., "Christian University Education", PPT, www.slideplayer.com
7. The Conversation, "We are losing sight of education's true purpose," http://theconversation.com/we-are-losing-sight-of-higher-educations-true-purpose-73637
8. Zietsma, D., "What good is Christian education?" http://www.christiancourier.ca/columns-op-ed/entry/what-good-is-christian-education
9. Gould, P., *The Outrageous Idea of the Missional Professor*, Wipf and Stock, 2014.
10. Veritas Forum, www.veritas.org
11. Kullberg, K.M., *Finding God at Harvard*, IVP, 2007.
12. Urbana Missions Conference https://urbana.org
13. CRU Faculty Commons, www.facultycommons.com
14. IVCF Graduate and Faculty Ministries, https://grf.intervarsity.org
15. Gould, op. cit.
16. Hove, R. and Holleman, H., *A Grander Story*, CRU Press, 2017.
17. Postman, N., *The End of Education*, Knopf, 1995.
18. Whalen, J., "John Henry Newman and the Liberal Arts," https://www.realcleareducation.com/articles/2020/12/18/john_henry_newman_and_the_liberal_arts_110522.html
19. Holmes, A. *The Idea of a Christian College*, Eerdmans, 1975.
20. Smith, G., "Spiritual Formation in the Academy: A Unifying Model," *Faculty Dialogue* No. 26, 1996.

21. Iwasko, R., "Mid-Course Corrections" address at LeTourneau University, August 29, 1985.
22. Wolterstorff, N., Joldersman, C. and Stronks, G., *Educating for Shalom*, Eerdmans, 2004.
23. Dockery, D., *Integrating Faith and Learning in Higher Education*, Ethics and Religious Liberty Commission, 2000, p. 14.
24. Noll, M., *The Scandal of the Evangelical Mind*, Eerdmans, 1994.
25. CCCU, https://www.cccu.org/about/#heading-our-work-and-mission-0
26. Ellis, E., *Faculty Interpretations of Faith-Integration in Classroom Practice*, thesis, Baylor University, 2014.
27. Goheen, M., op. cit.
28. Holmes, p. 8.
29. Garber, S., *The Fabric of Faithfulness*, IVP, 2007.
30. Halvorson, M., "State school? Christian college?", http://www.equip.org/article/state-school-christian-college-navigating-many-choices/
31. Plantinga, C., "Educating for Shalom" https://www.calvin.edu/about/who-we-are/our-calling.html
32. ICR, "Christian Education," http://www.icr.org/christian-education
33. Sikkema, J., and Vander Werff, J., "Guiding Principles for a Distinctively Christian Curriculum," http://blogs.dordt.edu/engineering/2014/03/19/overview-guiding-principles-for-a-distinctively-christian-engineering-curriculum/
34. Neuhaus, R. J., "A Christian University," Summary quotes, *First Things*, January 1996.
35. D. Bruce Lockerbie, quoted in thesis, Pethtel, G., *Christian Education in the 21st Century*, 2011, Cedarville, Digital Commons.
36. McKenna, D., *Christ-Centered Higher Education*, Wipf and Stock, 2012.
37. Badley, K. "The Faith/Learning Integration Movement in Christian Higher Education: Slogan or Substance?" *Journal of Research on Christian Education 3* (1994): 13-33.
38. Ellis, op. cit.
39. Schuurman, D., "Approaches to Christian Education: From Elusive Towards a Larger and Deeper Approach," *Pro Rege*, March 2016.
40. Markos, L., "Christian Education in a Woke World," https://americanreformer.org/2021/11/christian-education-in-a-woke-world/
41. Sharp, T., "Science According to Moses -The Foundation of a Biblical World View" quoted in Kohl, C., Faculty Integration Paper, Cedarville Univ.
42. Hasker, W., "Faith-Learning Integration: An Overview," *Christian Scholars Review*, March 1992.
43. Trevelyan, J., "Mind the Gaps: Engineering Education and Practice," January, 2008, https://aaee.net.au/wp-content/uploads/2018/10/AAEE2010-Trevelyan-Engineering_education_and_practice_gaps.pdf
44. ABET www.abet.org

45. ABET EAC Criteria, https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2022-2023/
46. Holmes, op. cit., p. 35.
47. Whalen, op. cit.
48. Graff, R. W., Leiffer, P., Batts, M, and Leiffer, M., "What Fuzzies Might Learn from Techies," ASEE Conference 2010.
49. Eisenstein, B., "Make No Small Plans," *ties Magazine*, Jan. /Feb. 2000, p. 1.
50. Goleman, D., *Emotional Intelligence*, Random House, 2005.
51. EPICS, https://engineering.purdue.edu
52. CDIO, www.cdio.org
53. Davis, D., et. al., "Assessing Professional Skill Development in Capstone Design Courses," *Int'l. J. Engin. Educ.* 27 (6) Jan. 2010, p. 1308-1323.
54. National Academy of Engineering, *Educating the Engineer of 2020*, National Academy Press, 2005.
55. Kern Family Foundation, www.kffdn.org
56. Ricco, G., "Underlying Issues," ASEE Annual Conference, 2016.
57. Natzke, J., and Ninteman, N., "The George Fox University Freshman Experience: A Projects Based Integrative Approach to Engineering Design," ASEE Annual Conference, 2005.
58. Eisenbarth, Stephen, Kenneth Van Treuren. "Christian Worldview and the Engineering Context," Christian Engineering Education Conference, 2004.
59. Hughes, K., "How to Teach Like an Anglican: Developing a Distinctly Anglican Pedagogy," https://anglicancompass.com/how-to-teach-like-an-anglican-developing-a-distinctly-anglican-pedagogy/
60. Kieser D., and Parsons, J., "Characteristics of Christian Pedagogy," *Christian Teachers Journal*, 24(4), Oct. 2013.
61. Hughes, op. cit.
62. Schuurman, op. cit.
63. Henk, R., "Love of Wisdom and a Christian Liberal Arts Education," LeTourneau University, 2001.
64. Bartlett, J., "Learning Engineering Pedagogy from the Master Teacher," CEEC Proceedings, 2002.
65. Concept attributed to John Rankin, Mars Hill Institute
66. DeCarvalho, L., "Jesus' Model of Education," *Mission Frontiers*, March-April 2003, p. 14.
67. Wilkerson, B., *Seven Laws of the Learner*, Multnomah, 2005.
68. Schuurman, op.cit.
69. Jordan, W., "Engineering and Theology-Approximations to Reality," Engineering Metaphysics Conference, PPT, www.slideplayer.com
70. Calvin University, An Engagement with God's Word: The Core Curriculum of Calvin College,

2006,p.31. https://calvin.edu/dotAsset/6b0baf84-0bbf-4b63-978b-ef775afea3b9https://calvin.edu/dotAsset/6b0baf84-0bbf-4b63-978b-ef775afea3b9

71. Calvin University, "Virtues," http://www.calvin.edu/~rbobeldy/idis110/sardine/virtues.htm
72. Trueblood, E., *The Idea of a College*, Harper, 1959, p. 47.
73. Benton. T., "Seven Deadly Sins of Professors," Chronicle of Higher Education,...
74. Kingston, C., quoted in Young, B., "Facing the Idol of Education," https://www.liberty.edu/champion/2016/03/facing-the-idol-of-education/
75. Postman, op. cit.
76. Henk, op. cit.
77. Holtrop, S., "Christian Views of the Student," http://inallthings.org/christian-views-of-the-student/
78. Worldview Statements were taken from the Christian Educators Journal - Bert Witvoet, "Ten Worldview Statements for Christian Schools" CEJ (February 2002):34
79. Sikkema, J., and Vander Werff, J., op. cit.
80. Goheen, op. cit.
81. Goheen, M. "Living at the Crossroads," PPT, https://missionworldview.com
82. Jordan, W., "The role of a professor's world view in engineering education," ASA conference, 1995.
83. Hoeckley, C., "Liberal Arts Traditions and Christian Higher Education," Institute for Liberal Arts, Westmont College, n.d.
84. Higton, M., *A Theology of Higher Education*, Oxford University Press, 2012.
85. Grant, G., "A Passion for Truth," *Tabletalk*, Sept. 2006, p. 8-11.
86. Caldwell, D., "Bonhoeffer's Life Together and the Christian University," *Faculty Dialogue* #12, Fall 1991.
87. Palmer, P., "The Violence of our Knowledge: Toward a Spirituality of Higher Education," The *Southern Baptist Educator*, August 1993, p. 7-13.
88. Caldwell, op. cit.
89. Moore, T.M., "The End of Christian Teaching," *Breakpoint Worldview*, Sept. 2006, p.14.
90. Trier, D., "The Gift of Finitude: Wisdom from Ecclesiastes for a Theology of Education," Christian Scholars Review 48(4) Summer 2019, p. 371-390.
91. Ibid.
92. Ibid.
93. Ibid.
94. Palmer, P., *The Courage to Teach*, Jossey-Bass, 1998.
95. Palmer, 1993, op. cit.
96. Ibid.
97. Bartlett, op. cit.
98. Attributed to Bernard of Clairvaux.

CHAPTER 25: ENGINEERS AND WORLD MISSIONS

INTRODUCTION

"All power is given to Me in heaven and on earth. Go therefore into all the world and preach the Gospel to every creature, baptizing them in the name of the Father, and the Son, and the Holy Spirit, teaching them to observe all that I have commanded you, and, lo, I am with you always, even to the end of the age." (Matthew 28:19-20)

These words of Jesus, spoken after the Resurrection and before the Ascension, commonly known as the Great Commission, are considered the marching orders for world missions for every follower of Christ. Scholars have pointed out that a better rendition of the second phrase in Greek might be, "As you are going into all the world, preach the Gospel to every creature..." In other words, it is assumed that we will go beyond our original neighborhood and that some will go to the ends of the earth. In the process, we are to make Christ known. It is the purpose of God that all people, in all nations, should have the opportunity to hear the Good News of Christ and to respond. In simplest terms, the goal of missions is: to get God's good news to the nations.

Missions is the activity of the church in crossing borders (geographic, ethnic, cultural, linguistic) to present the Good News of salvation to people who often have little to no access to the Gospel.

For many young Christians "missions" has a dual edged aspect. It conveys adventure in a foreign setting and operating in the heart-purpose of God. On the other hand, it suggests being uprooted from everything familiar and tackling an enormous task. Fortunately, God provides what's necessary for a person to do missions, and mission boards are very careful about who they accept.

Every believer can be involved in world missions through studying the needs and opportunities, praying for specific countries and missionaries, and giving to mission work. Many will participate in short-term mission projects, often during their student years. A few will become long-term missionaries overseas.

Overseas Christian mission work originates in the New Testament and is a major component of most evangelical churches. Engineers have been involved in various phases of missions and international development.

BIBLICAL BASIS FOR MISSIONS

Two of the key themes of modern missions are (1) that the God who created us is a "missionary God" who desires all peoples on earth to respond to Him, and (2) that the Bible is a missions - focused book. Beginning in Genesis, God wanted people to represent Him and to move out with the

knowledge of Him. Abraham was promised that through him (that is, through his seed) all nations of the earth would be blessed (a reference to the coming of Christ). The Jewish nation was to be a light to the nations, but failed when they fell into idolatry. For New Testament Christians, Christ's death and resurrection is to be proclaimed to the world.

Mission ideas in the Old Testament

Gen. 12: 3 - (to Abraham): "I will bless those who bless you, and I will curse whoever curses you;

and all peoples on earth will be blessed through you."

Gen 22:18 - (to Abraham): "And in your seed shall all the nations of the earth be blessed, because you have obeyed My voice."

Ps. 2:8 - "Ask of Me, and I shall give you the heathen for your inheritance, and the uttermost parts of the earth for your possession."

Psalm 22:27 - "All the ends of the world shall remember and turn to the Lord, and all the families of the nations shall worship before You."

Ps. 33:8 - "Let all the earth fear the Lord: let all the inhabitants of the world stand in awe of him."

Ps 86:9 - "All nations whom You have made shall come and worship before You, O Lord, and shall glorify Your name."

Ps. 96:3 -"Declare His glory among the heathen, His wonders among all people."

Ps. 117:1 - "O praise the Lord, all nations! Praise Him, all people!"

Isa. 2:2 -"And it shall come to pass in the last days that the mountain of the Lord's house shall be established on the top of the mountains, and shall be exalted above the hills, and all nations shall flow unto it."

Isaiah 6 - "And I heard the voice of the Lord saying, "Whom shall I send, and who will go for Us?" Then I said, "Here am I. Send me!""

Isa. 45:22 -"Look unto me, and be saved, all the ends of the earth: for I am God, and there is no ne else."

Isa. 56:7 - "I will bring them to My holy mountain, and make them joyful in My house of prayer; their burnt offerings and their sacrifices shall be accepted upon My altar, for My house shall be called a house of prayer for all people."

Isa. 66:19 -"And I will set a sign among them, and I will send those who escape unto the nations: to Tarshish, Pul, and Lud who draw the bow, to Tubal, and Javan, to the isles far off who have not heard My fame nor seen My glory; and they shall declare My glory among the Gentiles."

Dan. 7:14 - "And there was given to Him dominion, and glory, and a kingdom, that all people, nations, and languages, should serve Him: his dominion is an everlasting dominion, which shall not pass away, and His kingdom shall not be destroyed."

Joel 2:28 – "And it shall come to pass afterward that I will pour out My Spirit upon all flesh; and your sons and your daughters shall prophesy, your old men shall dream dreams, your young men shall see visions." (prophecy of Pentecost)

Micah 4:2 – "And many nations shall come, and say, Come, and let us go up to the mountain of the Lord, and to the house of the God of Jacob; and He will teach us His ways, and we will walk in His paths: for the law shall go forth from Zion, and the word of the Lord from Jerusalem."

Hab. 2:14 – "For the earth shall be filled with the knowledge of the glory of the Lord, as the waters cover the sea."

Zech 14:9 – "And the Lord shall be king over all the earth: in that day there shall be one Lord, and His name the only one."

Mal. 1:11 – "From the rising of the sun to the going down of the same My name shall be great among the Gentiles; and in every place incense shall be offered unto My name, and a pure offering: for My name shall be great among the heathen, says the Lord of hosts."

Mission ideas in the New Testament

Matthew 28:18-20 – "And Jesus came and spoke unto them, saying, "All power is given to Me in Heaven and on earth. Go therefore and teach all nations, baptizing them in the name of the Father, and of the Son, and of the Holy Spirit, teaching them to observe all things that I have commanded you. And lo, I am with you always, even unto the end of the world."

- Christ has all authority in the universe
- Christ sends us into the world
- Christ will always be with us

Mt. 24:14 – "This Gospel of the kingdom shall be preached in all the world, as a testimony to all the nations, and then shall the end come."

Mk. 13:10- "And the gospel must first be made known among all nations."

Mk. 16:15 – "And He said unto them, Go into all the world, and preach the gospel to every creature."

Luke 3:5-6 – "Every valley shall be filled, and every mountain and hill shall be brought low; and the crooked shall be made straight, and the rough ways shall be made smooth; and all flesh shall see the salvation of God."

Luke 24:46-47 – "Thus it is written, and thus it was necessary for Christ to suffer and to rise from the dead the third day, and that repentance and remission of sins should be preached in His name among all nations, beginning at Jerusalem."

Jn. 20:21 –"Then said Jesus to them again, Peace be unto you: as my Father has sent me, even so I am sending you."

Acts 1: 8 – "You will receive power when the Holy Spirit comes upon you, and you shall be My

witnesses in Jerusalem, in Judea, in Samaria, and unto the ends of the earth (unto the uttermost parts of the earth)."

This was exactly the pattern we see in Acts- the church began in Jerusalem (ch.2), spread throughout Judea (ch. 5,8), reached into Samaria (ch.8), then to foreign lands (ch. 13).

Acts 13:2-4 - "As they ministered to the Lord and fasted, the Holy Spirit said, "Set apart for Me Barnabas and Saul for the work to which I have called them." And when they had fasted and prayed and laid their hands on them, they sent them out. So they, being sent forth by the Holy Spirit, departed for Seleucia, and from there they sailed to Cyprus."

The first missionary journey began bathed in prayer.

Rom. 1:5 -"By Him we have received grace and apostleship, for obedience to the faith among all nations."

Rom. 1:14-15 - "I am debtor both to the Greeks and to the barbarians, both to the wise and to the unwise; therefore, as much as is in me, I am ready to preach the Gospel to you also who are at Rome."

Rom. 10:14-15 - "How then shall they call on Him in whom they have not believed? How shall they believe in him of whom they have not heard? How shall they hear without a preacher? How shall they preach, unless they are sent? As it is written, How beautiful are the feet of those who preach the Gospel of peace, and bring glad tidings of good things!"

The quote is from Isa. 52:7. The motivation is to send.

Rom. 15:9-10 -"And that the Gentiles might glorify God for His mercy; as it is written, For this cause I will confess to You among the Gentiles, and sing unto Your name. And again he says, Rejoice, you Gentiles, with his people."

2 Cor. 5:14-15 - "For the love of Christ compels us; because we judge that if One died for all, then all were dead; And He died for all, that those who live should no longer live unto themselves, but unto Him Who died for them, and rose again."

2 Cor. 5:20 -"Now then we are ambassadors for Christ, as though God appealed to you through us: we urge you in Christ's place, be reconciled to God."

Phil. 2: 10-11 - "That at the name of Jesus every knee should bow, of things in heaven, and things on earth, and things under the earth; And that every tongue should confess that Jesus Christ is Lord, to the glory of God the Father."

Rev. 5:9 - "And they sang a new song, saying, "You are worthy to take the book and to open the seals, for You were slain, and You have redeemed us to God by Your blood, from every family and tongue, and people and nation..."

Rev. 7:9 - "After this I looked and saw a great multitude, which no man could number, from all nations and families and people and tongues, standing before the throne and before the Lamb, clothed in white robes and with palms in their hands."

In summary, we find multiple reasons for world missions:

- Obedience: God commands it. Jesus gave us a "great commission."
- Need: All are lost without Christ.
- Love: God's love is spread abroad.
- Strategy: God's Kingdom is expanded.
- Freedom: People are freed from fear and superstition.
- Praise: God's praise is declared in every nation.
- Transformation: Societies are transformed and blessed by the knowledge of Christ.
- Worship: God should be worshiped "from the rising of the sun to its setting."
- Glory of God: We are to "declare God's glory to the nations."

John Piper has written: "Missions is not the ultimate purpose of the church. Worship is. Missions exists because worship doesn't." [1]

"The end of the story-the 17 worship scenes we witness in revelation 5-19 reveals how the ultimate international worship service will bring the history-long story of God's mission to a glorious crescendo," writes Steve Hoke. [2]

HISTORICAL BACKGROUND

The Beginnings

Missions began about AD 50 with the journeys of the Apostle Paul through Asia (now modern Turkey) and Macedonia (now Greece). We do see a basic missionary "strategy" in Acts:

The Apostle Paul first went to synagogues (in those cities of the Roman Empire that had a Jewish population and a synagogue) and tied Christ to OT prophecies. In Greece he began where people gathered (by a riverside).

After several individuals had come to Christ and received extensive teaching from Paul or from his associates, he appointed elders and left a growing church as he moved to another region, always maintaining contact with many of those he had discipled. Paul's desire was "to boldly go" where no one had yet gone to preach the Gospel to "unreached people."

"And so I have made it my aim to preach the gospel, not where Christ was already known, lest I should build on another man's foundation." (Romans 15:20)

The basic pattern continues today:

- Sending
- Preaching
- Planting
- Follow-up
- Reporting back

Historical summary

Ralph Winter outlines missions in five epochs: [3]

- 50-400 AD -to the Romans
- 400-800 AD -to the Barbarians
- 800-1200 AD -to the Vikings
- 1200-1600 AD to the Saracens (the Crusades- a failure for evangelization)
- 1600-2000+ AD -modern missions

By 200 AD Christian churches existed in much of Southern Europe and North Africa.

The Gospel then reached the British Isles and Scandanavia.

By 1523 Franciscan missionaries had arrived in Mexico.

A comprehensive survey of missions history is provided by Ruth Tucker in her book From *Jerusalem to Iryan Jaya*. [4]

Modern Missions

The modern world missions movement began in 1793 with William Carey's journey to India.

William Carey (1761-1834), A British shoemaker, ignited the modern missions movement when he wrote a major treatise on the need for world missions and convinced the Baptist Missionary Society to send him and his family to reach the people of India.

William Carey was inspired by Jesus' prayer that God's kingdom would come, that His will would be done on earth as it is in heaven: "When He had laid down His life and taken it up again, He sent forth His disciples to preach the good tidings to every creature, and to endeavor by all possible methods to bring over a lost world to God." [5]

Carey's route was arduous: a several month ocean voyage, settling in for 41 years, learning the culture, and learning multiple languages, to be able to communicate the Gospel. The results were long term: translating the Bible, establishing schools, establishing a bank, showing humane treatment for leprosy patients, establishing a printing press, studying botany, advocating for agricultural reform.

Carey's model was followed by Adoniram Judson in Burma, Robert Moffat in Africa, and Robert Morrison in China.

Three eras

Ralph Winter developed the idea of three eras in modern missions: [6]

(1) Coastal -prompted by William Carey- Christian missions reached t the world's coastlands between 1800 and 1910.

(2) Interior –Hudson Taylor's example in China prompted a new wave of missions to inland areas between 1865 and 1980.

(3) Unreached people –Cameron Townsend, founder of Wycliffe Bible Translators, emphasized ethnic groupings rather than political nations, leading to the new emphasis on reaching the unreached peoples of the world, since 1935.

Prominent mission leaders have included:

- Nicolaus Zinzendorf (German, 1700–1760), sponsored and visited missionaries to the West Indies
- William Carey (British, 1761–1834), founder of modern missions; translation, evangelization, and reform in India
- Adoniram Judson (American, 1788–1850), forty years in Burma, translated the Bible
- J. Hudson Taylor (British, 1832–1905), China, founded China Inland Mission
- David Livingstone (Scottish, 1813–1873), missionary to Africa and explorer
- C.T. Studd (British, 1860–1931), famous cricket player, missionary to the Congo
- Robert Moffat (British, 1795–1883), missionary to South Africa
- Mary Slessor (Scottish, 1848–1915), missionary to Nigeria
- Amy Carmichael (Irish, 1867–1951), missionary to India, founder of orphanages
- Samuel Zwemer (American, 1867–1952), missionary to Arabia and Egypt, Princeton seminary professor
- Henry Martyn (British, 1781–1812), missionary to India and Persia
- Robert Morrison (Scottish, 1782–1834), translator and evangelist in China and Macau
- Gladys Aylward (British, 1902–1970), missionary to China
- Eric Liddell (Scottish, 1902–1945), Olympic runner (Chariots of Fire), missionary to China
- John (1907–1934) and Betty (1906–1934) Stamm, (Americans) martyred in China
- Charlotte "Lottie" Moon (American, 1840–1912), missionary to China
- Jim Elliott (American, 1927–1956), martyred in Ecuador
- W. Cameron Townsend (American, 1896–1982), missionary and linguist in Guatemala, founder of Wycliffe Bible Translators
- Ralph Winter (American, 1924–2009), missionary to Guatemala; founder, U.S. Center for World Missions
- Don Richardson (Canadian, b. 1935), missionary–translator in Indonesia, author of Peace Child

TRADITIONAL MISSION EFFORTS

Traditional mission work involves the tasks of outreach, cross-cultural evangelism, discipleship, and church planting.

In general there are three approaches to missions:

1. Strategic– All planning is oriented to a specific goal (e.g., Reach the people of Malawi with the Gospel).

2. Need-based- Resources are directed to an immediate need, along with evangelism (e.g., Respond to the earthquake in Haiti).
3. Opportunity-based - Being alert to new opportunities to minister to some population, including sharing the Gospel (e.g., Establishing a small company in an Asian country.)

We find three different approaches for three different kinds of society:

1. Tribal society (frontier or pioneering missions)

This is what we usually think of as "missions."

- Locate the tribal group or village.
- Build a relationship of help and trust.
- Begin learning and translating the language, if it isn't a documented language.
- Begin sharing the Gospel message in the language of the people.
- Once a few believers are present, begin training leaders and establish a church.
- Build up the Body with solid teaching on doctrine and Christian living.

David Hesselgrave outlines ten steps in the process: [7]

- Missionaries commissioned
- Audience contacted
- Gospel communicated
- Hearers converted
- Believers congregated
- Faith confirmed
- Leadership consecrated
- Believers commended
- Relationships continued
- Sending churches convened

2. Peasant society

Missions in the 19th century was primarily directed towards rural areas. Medicine, education, and agriculture were keys to reaching a community. By the late 20th century leaders realized that international poverty could not be overcome by "trickle down" of wealth from the rich to the poor but by radical transformation of lifestyle. [8]

Steps include community development, community health, movement away from dependency, local industry.

> *Through community development, the Transformational development stream is creating a better future for the poor. Those living in poverty are often caught in mutually reinforcing systems that disempower them and mar their identity.* [9]

Missionaries address their economic needs along with presentation of the Good News.

3. Urban society

The 20th century often emphasized city-dwellers. Urban missions requires a totally different approach.

- Most citizens have a higher level of education and income.
- People are often reached through their vocation or interests- business, education, medicine, arts, technology, computing.
- Outreach often begins with Bible Studies or small worship in homes.
- The Encuentro con Dios strategy in Lima, Peru and other major cities of South America involved building churches in upper-class neighborhoods and then reaching out to middle and lower class neighborhoods.

Specialized mission tasks include:

- Bible translation
- Missionary radio
- Medicine and health services
- Development (note next chapter)

Translation Missions

Through such organizations as Wycliffe Bible Translators many skilled linguists have learned previously unwritten languages, developed a written form for the language, and translated part or all of the scripture into that language.

MISSIONS MYTHS AND MISCONCEPTIONS

1. Missionaries destroy the local cultures.

This is an idea that comes from humanistic anthropology and from the movie Hawaii (based on James Michener's novel). Ideally, worship can fit with existing parts of the culture (art, music, language). Clearly, parts of the culture that don't fit with God's standards will need to change (tribal warfare, devil worship, child brides, sacrifice, infanticide,...).

Don Richardson wrote:

> *Missionaries introduced cultural change, but not arbitrarily and not by force. They brought only changes required by the New Testament or required for the survival of the people. Often the two requirements overlap (for example, the cessation of Wai Wai child sacrifices).* [10]

2. Missionaries want to export/establish western culture.

This has occurred in the past and was both a misdirection and a failure. A classic example was John Eliot's work among some Algonquins in 1644. He believed that his own culture was the standard they needed to follow. They lived like Englishmen and fought on the side of the Massachusetts Bay

colonists against other tribes, but after several years little remained of Eliot's missionary efforts. [11]

3. Missionaries feel superior to the local people.

This may be a temptation for some missionaries working among "primitive" peoples, but missionaries soon realize that they could never survive in the brush without supplies from outside. They are wise about technology and western culture, but not wise about survival and the local culture.

4. Missions is unnecessary since all people are eventually going to heaven.

That is the theology of "universalism." According to Scripture, however, all people have sinned and all need a Savior. Everyone needs to hear about Jesus.

5. Missions is unnecessary since immigration to the U.S. is so large.

Many have come to our country from foreign lands and should be shown love, including the Gospel. Millions still live across boundaries, requiring believers to "go."

6. The goal of missions is to develop churches under western control.

One goal of missions is to produce indigenous churches, with local leadership. Some missions consider their work in an area complete when the national church is self-supporting and able to send out missionaries itself.

7. Missionaries go to the jungle.

Missionaries went to the jungle in the early years missions to of India and Africa. Today a few people still live in the rainforests, but millions live in modern urban centers.

8. All missionaries basically do the same thing.

The tasks of missionaries is huge. Some preach, some translate, some do medical work, some provide technical support, and some fly planes.

9. Missions produces "rice Christians."

A "rice Christian" is someone who coverts to Christianity for material benefits (food or medical help), not for true belief. In some regions it is useful and polite to respond to every invitation with a positive response. Missions needs help for everyone with no strings attached, a clear understanding of the message, a challenge to "count the cost" of following Jesus, and ongoing teaching and discipleship.

10. Missions breeds religious "syncretism."

Syncretism is the merging of Christian truth with pagan beliefs or practices, diluting the truth of the Bible (for example, combing witch doctor visits with Christian worship). To avoid the danger, only the Gospel and Biblical truth should be emphasized, sound doctrine must be taught, and the

culture must be carefully analyzed: some parts kept and pagan practices rejected.

11. Missionaries always get to see the fruit of their labor.

Unfortunately, in the tougher regions, a missionary may spend his/her career planting or translating, and the following generation of missionaries will see a significant "harvest."

12. It is demeaning for missionaries to raise support.

The pattern in the book of Acts was support from various churches and individuals. Those who assisted the Apostle Paul and his associates became partners with him in the mission cause. There is something important about being invested in persons and projects and simultaneously committed to prayer. (The drawback would be the amount of time and effort required to build up a support team, often repeated every four years.)

13. Every kind of ministry is actually "missional."

Local ministry and societal transformation have a place, but there is clearly a need for missionaries sent with the Gospel to foreign lands.

14. Missionaries are super-spiritual and gifted.

Missionaries will tell us that they are ordinary people being used by God. (We have observed, however, that many missionaries come from families that grew up overseas and already have a love for the people and a fluency in their language.)

MISSIONS TODAY

Most of what Americans consider to be "mission work" is long-term evangelistic activity outside of our country, work that traditionally was termed "foreign missions." "Missions" has expanded to include multiple associated tasks, but outreach to "distant shores" will always be a primary focus of missions. Evangelicals hold that missions should be important to every believer: Not everyone will go overseas, but everyone should be informed about international trends and specific needs, should pray regularly for specific people "on the field", and should contribute towards the effort. David Bryant termed this mindset "becoming a World Christian."

> *Non-Christians comprise about 70% of the world's population. These people are found in every nation, although more concentrated in some nations than in others. There are more than two dozen nations, with 24% of the world's people, which are less than 1% Christian.* [12]

The world has changed in significant ways that impacts world missions.

- Travel is far easier than it was a century ago. Most regions of the world can be reached by plane plus train, jeep, or boat in one or two days.
- Much of the world has internet connectivity and cell phones.

- Communication by email and electronic document transfer is available in all but the most remote regions.
- Countries which were "closed" to the Gospel and to outsiders fifty years ago are "open" today, and vice versa.
- Events in one part of the world are known worldwide and can have wide-range impact within hours.
- In the words of Thomas Friedman, "The World is Flat" [13] Globalization is here to stay. Largely due to technology, the world is now interconnected and business is possible with companies in every part of the world.

As a result,

- A missionary may serve in four different countries in the course of their lifetime.
- Missionary strategy is dynamic and flexible. Resources are allocated differently from year to year as the geopolitical climate changes.
- As fields become "fully mature," with the presence of a strong national church, Western missionaries are pulled out and deployed elsewhere.
- As it becomes overly expensive for some mission organizations to maintain their equipment and fleet of planes, services may be contracted out to national companies.
- Furloughs (home visits and fund-raising) that took place every four years and lasted a full year may be exchanged for shorter breaks every year or two.

What characterizes the contemporary approach to world missions?

1. A specific focus on identifying and bringing the Gospel to previously unreached peoples. This has involved global mapping projects, identification of ethnic groups and languages with a limited number of speakers.
2. In-depth cultural and language preparation for those going to a given field.
3. Specifically training local leaders in both Bible and church leadership.
4. Turning mature churches over to the national church. In countries where mission work has been successful and a strong national church exists, mission groups make plans to leave the country.
5. A focus on ministry to the whole person or whole community. In addition to proclaiming the Gospel and planting churches, most mission groups also assist with medical work, food and water, or literacy.
6. Work with short- term missions projects. A team may go overseas for a specific project for anywhere from a week to a few months. The primary benefit may actually be for those involved, who return with a deeper understanding of the mission work and a commitment to prayer and support.

CLASSICAL VS MODERN MISSIONS

CLASSICAL MISSIONS	MODERN MISSIONS
Head overseas for a lifetime	Return home for furlough every 3-4 years
Work in one region for life	May move to new fields if a field closes
Fields remain open indefinitety	A field may close when the national church is strong
Language is often learned on arrival in the country	Language school before beginning work in a country
Takes week or months to communicate with home	Daily communication possible via texting, Skyle, and email
Support is financial	Support includes language school, transportation, MK schools, and often retirement plan
Often individual effort	Nearly always a team effort

Current trends in world missions include: [14]

1. A shift to the non-western world as senders (South Korea, Brazil, Nigeria, and the Philippines have become major contributors to world missions.)
2. Focus on "people groups"
3. Short-term missions- project teams, internships, and student mission trips
4. Broad cooperative efforts
5. Assistance to persecuted groups and ethnic minorities

Sweeny documents these additional trends in world missions: [15]

1. A focus on the whole person - spiritual needs, plus needs of body and soul
2. Moving away from the West as geographic center of Christianity-serving from anywhere
3. Urbanization and a focus on reaching the cities

"At one time, the stereotypical, albeit tongue-in-cheek, image of a missionary was a man in khaki shorts and a pith helmet trying to convert cannibals while trying to stay out of the cooking pot

himself. Now, the missionary is mainly a city dweller, working with ethnically diverse populations, putting up with public transportation and traffic jams, and trying hard to influence those who can influence others in local neighborhoods and networks." [16]

4. Use of modern technology-cutting communication times in Papua from six weeks to mere seconds
5. Entrepreneurship- Business as Mission
6. Foreign-supported indigenous workers

Howard Brant of SIM discusses these recent shifts in world missions [17]:

1. Christianity as a worldwide phenomenon, no longer associated primarily with the Western world.
2. Living in a globalized (connected) world, with international travel possible to almost any site, worldwide internet and phone communication, and continual newsfeeds from every continent.

We see a constant flow of people across borders as well as products and information.

3. An emerging globalized (connected) church, where leaders are known and messages and critical prayer concerns are shared worldwide.

Brant further points out the downside to the "global village": [18]

> *There is another element to globalization that we all need to recognize. Globalization brings its own philosophy of life. The social scientist calls it "post modernity." And while there are many definitions of "modernity" and "post modernity," its result is that more and more of our society is becoming secularized through materialism and pluralism. Materialism tends to smother spirituality and eventually drives out godliness. Pluralism strikes deep at the foundations of values and erodes faith. In the Western world, these two giants have birthed a pervasive secular mindset that is now challenging the "missionary spirit." While they have yet to deliver the knockout punch, they have managed to land major body blows that have weakened essential qualities such as strong faith and the willingness to sacrifice for the Gospel. If one doubts this point, just look at the declining statistics of career missionaries from the Western nations.*

Recent approaches to outreach include:

- Business seminars, which provide initial contact
- English classes
- Specialty coffee shops
- Internet cafes
- Cultural festivals
- Youth camps, sports camps, English camps

Seasoned missionaries note the importance of emphasizing language study and gaining some fluency before beginning outreach.

MILLENNIALS AND MISSIONS

Mission leaders are aware of certain mindsets prevalent among today's Millennial generation. Students interested in missions must be clear that the Christian message is not compatible with postmodernism, universalism, or a self-oriented lifestyle. At the same time, mission leaders are making changes to be more compatible with Millennial thinking:

- Becoming leaner, more agile in structure
- Avoiding duplication of efforts
- Moving out of regions where churches are well in place
- Making furloughs more flexible (instead of a full year after four years on the field, supporting shorter furloughs after two, three, or four years)
- Using modern technology wherever possible
- Using local workers where possible

Recent Concepts in Missions

10-40 window - the land mass between 10 degrees and 40 degrees north latitude across Africa and Asia, containing most of the population who have not heard the Gospel

People group - "an ethnolinguistic {common culture and language} group with a common self-identity that is shared by the various members...A common history, customs, family and clan identities, as well as marriage rules and practices, age-grades and other obligation covenants, and inheritance patterns and rules are some of the common ethnic factors defining or distinguishing a people." [19]

Unreached people group (also called "hidden peoples") - an ethnic or language group which has no known churches, Christian believers, or contact with believers

Unreached peoples (is) a term now synonymous with two others—hidden peoples and frontier peoples... "An unreached people group should be defined as a people group within which there is no indigenous community of believing Christians able to evangelize this people group without outside (cross-cultural) assistance." [20]

How did the concept of "unreached people-groups" come about? Ralph Winter, the founder of the William Carey Library and the U.S. Center of World Missions, working through the Lausanne Committee on World Evangelization, championed the concept of "unreached people-groups" in the late 70's and 80's. He asserted that the ethne of Scripture that we are supposed to reach are not political nation-states at all. They are, instead, cultures within those countries, possessing ethnic and linguistic identities distinct from others.

Today 7,400 people groups are unreached, 639 people groups representing 500M people have no Gospel portion in their language, and 218 people groups (5.7 million people) have no contact whatsoever with any Christians.

Global mapping projects - Presentation of graphical information in support of missions.

Specialized maps help visualize regions and cities, ethnic groups, hidden peoples , populations, languages, religions, economic conditions, water and health needs, aviation resources, and the status of Christian outreach.

Contextualization - Properly understood, contextualization refers to making the Gospel understandable in the culture. Worship should be appropriate to the culture, rather than a copy of American worship. What must not change is the message of the cross and a Biblical lifestyle.

Power encounters - demonstration of God's power, often in answer to prayer, which allows a missionary to overcome cultural (and spiritual) resistance to the Gospel.

E scale [21] - E1: evangelism within one's own culture; E2: evangelism of people in a similar but different culture (communication essential); E3: evangelism of people in radically different culture.

Adopt-a-people efforts - a commitment by a local fellowship to see a church established among a particular unreached people group. Steps include gathering information, consistent prayer, and networking with missionaries working with the group. People groups are chosen based on: country, macro-religion, population, evangelical resources, threat level, freedom index, and physical exertion (difficulty of physical access). [22]

Business as Mission - establishment of businesses worldwide as a context for employment, evangelism, discipleship, and community.

Redemptive analogies - This is a concept developed by missionary-anthropologist Don Richardson in his book *Peace Child* [23]. Richardson suggest that embedded in every primitive culture is some story or tradition that provides a bridge to the Gospel. His research began with his work among the Sawi people of New Guinea. In their culture warring tribes can be reconciled only if a child from one tribe is given as a gift to the other tribe.

Redemptive Lift - the improvement in all sectors of society (lower crime rate, lower drug use, better education, better overall health,...) that results from the transformative power of the Gospel.

Insider Movement - the presence of Christian believers within the established cultural and religious structures of a nation. While it may protect believers for a time in an area where it is dangerous to be a Christian, "Insiders" always run the risk of syncretism and are looked on with scorn by those openly -known believers who have risked their lives and lost their families to follow Christ.

"The excluded middle" - Missiologist Paul Hiebert's term for the spiritual dimension hat many primitive cultures know by experience. Our technological culture recognizes God (sometimes) and the material world (always), but can't handle the middle area of demonic spirits. [24]

DAWN movement (Discipling a Whole Nation) - "DAWN aims at mobilizing the whole Body of Christ in whole countries in a determined effort to complete the Great Commission by working towards the goal of providing an evangelical congregation for every village and neighborhoods of every class, kind and condition of man in the whole country." [25]

HOW TECHNOLOGY HAS CHANGED MISSIONS

Technology has changed the way we do most things, including world missions. The major historical example of technology coupled with outreach would likely be the Spanish mission effort in Texas in the 1700's. Franciscan Friars built large compounds, where they taught Spanish and the Bible to the Indian population. Along the way they introduced farming and herding techniques, teaching the local men to build aqueducts, grist mills, and farm implements.

Modern technology has totally transformed most mission efforts:

1. Transportation

   Instead of spending weeks at sea to reach the destination, missionaries can reach most sites by air in a day or two.

2. Communication

   Instead of waiting for months to receive mail from foreign sites, missionaries can exchange immediate email updates with families, sending offices, and supporters.

3. Radio evangelism

   Short wave broadcasting into countries "closed" to the Gospel has resulted in thousands of conversions and discipleship efforts.

4. Translation assistance

   Computers have made it possible to save completed translation work and to rapidly translate repeated phrases. Dedicated software for translation assistance has been developed.

5. Medical assistance

   Modern medical equipment, including basic surgical suites, is now available in mission clinics around the world.

6. Development assistance

   Water, power, housing, and bridges have been provided to isolated communities. (See next chapter for detailed discussion.)

7. Local economy

   Technology has made it possible for small businesses to get started in local communities around the globe.

8. Donor assistance and record keeping

   Computers are being used in every mission for donor receipts, website publicity, and financial and personnel records.

ENGINEERING AND MISSIONS

The following insights came from discussions with a mission leader:

The next wave in missions will largely be technical people, rather than seminary-trained people, because the former are welcome in closed countries.

There is a need for seminary-trained people to pick up technical skills and a growing need for believers with technical skills to prepare to transition to foreign sites.

Engineers with backgrounds in appropriate technology, cross-cultural adaptation, and disciple-making would be very useful to the mission.

The mission could immediately use engineers with skills in C++ programming, MatLab, PCB design, microcontrollers, gyroscopes and accelerometers, construction design, and water supply.

Steve from Mission: Moving Mountains wrote this: [26]

"Working on a team that also includes medical, agricultural, and theological specialists, engineers empower people to use locally available resources while discipling them to follow Jesus with their whole life. Imagine designing a rain collection system, a clean water system, or an enclosed oven, and teaching people how to teach others to do the same. These projects can save people's lives from dirty water, dehydration, and burns from open-fire ovens. This is what it can look like to disciple people holistically, with a vision of seeing a whole community transformed by the gospel."

Alan from Trans World Radio posted this:

"TWR has internships, short-term projects and long-term opportunities to serve God by using your engineering skills. They need engineers to construct, maintain, and upgrade their world-wide network of antennas and transmitters. What a great way to make a global impact in 230 languages and 160 countries." [27]

More than in the past, believers with technical skills are important to missions:

- Engineers are designers and technical problem-solvers. Their skills can be valuable to many missions agencies or individual projects.
- Some mission groups are primarily technical in nature- missionary radio work, EMI
- Many mission groups have some technical needs- often computing, communications, software assistance
- With an increase in the number of countries closed to the Gospel engineers and technical people are often welcome in these countries.

Engineers can play a variety of roles in the mission effort.

1. Traditional missions -evangelism and church planting
2. Translation work

Because of their logic, creativity, and attention to detail many engineers have contributed to the work of Bible translation, both as support staff and as linguists. (Note Wycliffe Bible Translators)

3. Technical support for mission agencies

   Many mission groups have some technical needs- often computing, communications, software assistance. Engineers have provided IT and telecommunications assistance for many mission organizations.

   Most mission groups are in continual need of computer assistance and network development. Electrical engineers are specifically suited for work with missionary broadcasting and have been essential to the work of HCJB, TWR, and FEBC.

4. Specifically technical support missions

   Engineering Ministries International (EMI) and Missionary Tech Team (MTT) provide technical assistance to churches and overseas missions.

5. Specifically technical missions

   These would include wide-scale radio broadcasting, flight support (JAARS, MAF), and construction work. Missionary radio is highly technical and involves many engineers in design, implementation, and maintenance of broadcast equipment.

   Engineers and engineering technologists make up a large part of the staff of Trans World Radio and SonSet Solutions.

6. Tentmaking

   Tentmaking refers to self-supporting missions work overseas, typically in a country "closed" to traditional missionaries. Most of the original tentmakers taught English for universities or government agencies. Today there is a growing need for high tech specialists and agriculture assistance. Many U.S companies have established foreign offices and need engineering personnel willing to work overseas.

7. International Development (see chapter 26)

   Among most evangelical organizations modern missions provide physical help as well as spiritual, addressing poverty (develop earning capability), disease (clinics and hospitals), and illiteracy (education and literacy training). In addition to planting churches, groups like the Christian & Missionary Alliance, whose focus is missions-evangelism, will train leaders, provide clean water, help with disaster relief, build clinics, and establish schools.

8. Business for Mission/Business as Mission [28]

   Business as Mission- establishment of businesses worldwide as a context for employment, evangelism, discipleship, and community.

Radio ministries

HCJB radio (Heralding Christ Jesus' Blessings), founded by Clarence Jones and his partners, began daily broadcasting in December of 1931 in Ecuador with a 200 watt transmitter. For over 60

years HCJB was "the voice of the Andes" for South America, with some broadcasts beamed into Asia. HCJB ended its worldwide shortwave broadcasts in 2009. The local station that remains continues to transmit to Ecuador. HCJB Global became the sending agency Reach Beyond, which also explores creative ways to transmit and broadcast the Gospel. In 2014 the HCJB Global technology Center in Indiana, which began by designing high power shortwave transmitters, became an independent ministry known as Son Set Solutions.

FEBC (Far East Broadcasting Company) was founded by Bob Bowman and his partners in 1945 to evangelize China. Primarily through transmitters in the Philippines FEBC reached China, Mongolia, Central Asia an India. Today they broadcast from 149 stations and transmitters in 145 languages.

TransWorld Radio (TWR) was founded in 1954 by Dr. Paul Freed to broadcast the Gospel using short-wave radio transmitters to areas that were hard to access. Within a few years transmitters were located in Morocco, Monte Carlo, Eswatini (Swaziland, Africa), Cyprus, Guam, Uruguay, Central Asia, and Bonaire (Caribbean).

Technical Support Organizations

Missionary Tech Team (MTT) provides professional architects, engineers, graphic designers, computer experts, and mechanics to support specific projects needed by mission agencies and ministry organizations.

Engineering Ministries International (EMI) provides technical assistance via volunteer teams to international ministry projects (hospitals, orphanages, water projects).

"EMI sends teams of design professionals around the world to assist Christian charities on-location in the areas of architecture, engineering, land surveying, construction management and more—all on a not-for-profit basis." [29]

STEPS TOWARD MISSIONS INVOLVEMENT

Preparation for missions often involves taking some Bible courses, language courses, or cross-cultural courses. Moving towards "official" mission service will involve:

- Contacting the mission board with your desire to serve.
- Beginning a formal application.
- For many, paying off debts and student loans.
- Interviews with regional representatives and national staff.
- Identification of skills and potential region of service.
- Building up a prayer and support team. (Many agencies require a given level of promised support before releasing a candidate to travel overseas.)
- Completing training and psychological evaluations. (This step could take up to a year.)
- Closing out house or apartment, applying for visas, packing.

One a missionary candidate gets the green light to travel, the first year or more is often spent in intensive language study.

Tentmaking

A unique approach to world evangelism has developed over the past fifty years based upon a Biblical model – a "tentmaker" is a self-supporting Christian worker in a foreign land. Many "closed" (or "creative access") countries are officially closed to traditional mission work but open to technical professionals.

According to the book of Acts, the Apostle Paul often provided for his daily needs and supported his missionary work by making and mending tents (items of canvas), since he had trained at some point as a tentmaker. Self-supporting missionaries ("international workers"), particularly in closed or limited access countries, are often termed "tentmakers."

Tentmakers are self-supporting Christian workers whose skills provide access to "creative access" countries.

With an increase in the number of countries closed to the Gospel, engineers, teachers, and technical people are often welcome in these countries.

The term and concept come from the example of the Apostle Paul: In Acts 18:3 we learn that Paul was a tent-maker (or leather-craftsman) by training and at times supported himself with this skill while traveling. Acts 18 describes how Paul worked with Aquila and Priscilla since they were all tentmakers.

> *It might seem surprising that a man of Paul's stature would have had to work to support his ministry. After all, he was an educated man who had even sat under the teaching of the renowned Gamaliel (Acts 22:3). In spite of this, Paul, like many others in full- or part-time ministry, found it necessary to supplement his income with outside work. Actually, it was common for rabbis to learn a trade in addition to their studies of the Scripture, for it was thought that a rabbi should be able to be self-supporting. Therefore, it was not unusual for men like Paul to hold second jobs.* [30]

Paul's teaching and model

Ruth Siemens, one of the pioneer 20th Century tentmakers wrote this about Paul's work:

> *In Antioch…Paul and Barnabas almost certainly supported themselves (1 Cor. 9:6). Paul's triple claim in the same chapter that he had never had donor support would make that likely. Luke does not give us more information about these early years because Acts has a limited purpose—to show how the gospel was taken from Jerusalem to Rome, and how a strictly Jewish religion became a predominantly Gentile faith. But a number of the hardships in Paul's four long lists of sufferings in 2 Corinthians must fit into these first fourteen years of Paul's ministry…*

He would fully support himself to gain credibility for himself and the gospel, to identify with working people, and to model a holy Christian life in an unholy marketplace, a biblical work ethic, and unpaid evangelism. But Paul's example included much more: His thorough teaching of the whole counsel of God, his simple communication, his love for the people, his willingness to endure suffering and the Holy Spirit's power in his life. [31]

Following the pattern of the apostle Paul, many believers have gone overseas as self-supported workers with a specific skill (tentmakers) with a goal of reaching others in countries typically closed to traditional missions.

It is important that tentmakers not be "mavericks" or lone rangers, that they be well-equipped with Biblical knowledge and language skills, and that they balance their time between work and ministry. [32]

It is equally important that the technical job not simply be a "cover" for spiritual work. The tentmaker overseas must do excellent engineering work and must be a blessing to the nation, all of which earn opportunities to build relationships and to share Christ's love.

What were the reasons for the Apostle's tentmaking? [33]

1. It gave him credibility. He was not preaching for a financial reward, nor was he a "people-pleaser."
2. It allowed him to identify culturally and vocationally with the working-class people of the Roman Empire.
3. It gave him the opportunity to model Christian living at work and a Christian work ethic.

Paul had written to the Thessalonians that he did not even accept free food and lodging from his hosts! He says in the 2 Corinthians 11 passage that he will not let anyone rob him of his claim to make the gospel free of charge. This suggests that the Judaizers were accusing Paul of receiving donations secretly from some source—that his claims to self-support were dishonest. Paul insists he receives no such funds.

He volunteers his ministry without pay from any source—for a very personal reason. He could not give his ministry to the Lord as a gift, because that is a debt he owes. "Woe is me if I do not preach the gospel!" But he says, "I can make it free of charge!" (1 Cor. 9:15ff) He could do it without pay! He had a right to financial support, but would forego it. He turns his manual labor into a daily act of worship—of gratitude to the Lord! (This is something every lay person can do! It can transforms the most boring or difficult job into worship!) [34]

Tentmaking offers certain clear advantages for Christian work overseas: (1) Lay people can give converts models for life and witness in the working world. (2) Lay people can infiltrate every structure of society, in a way that religious workers cannot. (3) Lay people can effectively engage culture at home and abroad in a way religious workers cannot. [35]

Short Term Missions

While the lives of the early missionaries were spent almost entirely on foreign soil, recent mission efforts combine long-term missions commitment ("career missionaries") with short-term activities (students and professionals spending a week to a few months on an overseas project). Those involved in short-term missions must be aware of the negatives and overcome them.

Pros [36]

Those involved

- Experience another culture
- See first-hand the work of missionaries
- Confront real poverty
- Usually provide some needed expertise
- Consider or confirm God's call to missions
- Grow in faith
- May provide spiritual and emotional encouragement
- Are motivated to pray and give to missions

Cons [37]

Those involved

- May confuse "decisions" for Christ with discipled believers
- May provide "band-aids," not real solutions
- May promote an image of western culture as superior
- Are usually ignorant of their impact on the culture
- Usually cannot follow-up relationships or complete projects
- May not be using time and money in the best way

Many long-term missionaries prefer to use local help on projects, even if it takes much longer, since it builds relationships and provides jobs.

Unfortunately, many short-term projects have involved a team showing up to "help" and actually getting in the way of the worker's efforts, especially if the missionary has to train and entertain the visitors. If a short-term project is coordinated with missionaries on the field it must be carefully planned. It may be more useful for the team to work with a church in the region, rather than with a career missionary. Engineers and other technical personnel have been able to assist with building construction, vehicle maintenance, well-drilling, and alternate energy solutions.

BECOMING A WORLD CHRISTIAN

Missions mobilizer David Bryant (*In the Gap*) emphasized two key ideas for modern believers:

"The Gap" - the real separation between God and man, and the separation between God's

original intention for mankind Christ's final restoration. [38] "World Christians"- believers whose focus is on world missions as a life-central cause (whether they go overseas or not). World Christians are keenly aware of "the Gap" and the part they can play. Bryant describes his mindset this way:

> *My whole relationship with Christ will be unified around His global cause...I want to get involved in the cause where I'm needed most, to close the Gap at some point so that precious lives can be won to Christ and brought home to the Father, so that Christ's Kingdom can break through.* [39]

World Christians will say:

> *We want to accept personal responsibility for reaching some of earth's unreached, especially from among the billions at the widest end of the Gap who can only be reached through major new efforts by God's people. Among every people-group where there is no vital, evangelizing Christian community there should be one, there must be one, there shall be one. Together we want to help make this happen.* [40]

Bryant suggests three steps that every believer can take in moving towards being a "world Christian": [41]

1. Build the vision by studying the cause
   - Keep a world map handy -think beyond the bounds of your state or nation
   - Read books and magazines on missions and international issues
   - Attend missions conferences or training events
   - Visit other cultures
2. Reach out to the world in love
   - Pray regularly
   - "Adopt" a hidden people group
   - Reach out to international visitors
   - Life a simplified lifestyle, with a "wartime" mindset
3. Give the vision to others

Help others catch the vision of a lost and needy world, hidden peoples, and involvement as world Christians.

CONCLUSIONS

Recent obstacles

Howard Brant defines five "dangers to world missions": [42]

1. Shifting theology. A national drift towards universalism, where somehow everyone can be saved even without hearing the Gospel.

2. A shift from ministering to the lost to ministering to the needy. We run the risk of a pendulum

swing to the opposite extreme: Earlier, missions may have downplayed meeting physical needs; now it may downplay meeting spiritual needs.

3. A loss in willingness to suffer or even die for the cause of the Gospel.

4. An emphasis on fitting the church into the culture instead of emphasizing the counter-cultural aspects (to every culture) of the Kingdom message.

5. A gulf between Western mission agencies and international churches and mission agencies.

Perspective

David Hesselgrave wrote:

> *To me, that mission {Christ's worldwide Gospel} is the greatest and most important enterprise on earth. It has its human dimension, since we who are engaged in it are human and all too subject to human weaknesses. But it also has its Divine dimension because God the Father conceived it, god the Son commanded it, and God the Holy Spirit directs it.* [43]

Missions is clearly Trinitarian: The Father sent the Son, the Son sent the Spirit, and the Spirit sends believers into the world. [44]

Not every believer will go somewhere overseas, but every believer can pray and can support the cause.

We know the end of the story: Christ's mission may struggle, but it will not fail. People from every tribe and language will one day worship God at His throne.

REFERENCES

1. Piper, J., *Let the Nations be Glad*, Baker, 2010.
2. Hoke, S., A Glorious Pursuit, *Mission Frontiers*, March 2001, p. 20-23.
3. Winter, R., "The Kingdom Strikes Back," in Winter, R. and Hawthorne, S., *Perspectives on the World Christian Movement: A Reader*, William Carey Library, 1999.
4. Tucker, R., From *Jerusalem to Iryan Jaya*, Zondervan, 2004.
5. William Carey, quoted by Vishal Mangalwadi, in Bush, L., "A unifying vision of the church's mission," 2004 Forum for World Evangelization.
6. Winter, R., "Three Eras of Mission History," in Winter, *Perspectives*, op. cit.
7. Hesselgrave, D., *Planting Churches Cross-Culturally*, Baker Academic, 2000.
8. Bosch, J., Transforming Mission, Orbis, 2011.
9. Bush, L., "A unifying vision of the church's mission," 2004 Forum for World Evangelization, p.xiii.
10. Richardson, D., "Do Missionaries Destroy Culture?" In Winter, *Perspectives*, op. cit.
11. Wood, R., "Learning from our mistakes," *Mission Frontiers*, Sept.-Oct. 2010, p.4-5.
12. Status *Status of Christianity*: The World, International Congress on World Evangelization, July 1974.
13. Friedman, T., *The World is Flat*, Farrar, Straus, and Giroux, 2005.
14. Five Current Trends "Five Current Trends in Missions," http://www.puritanboard.com/showthread.php/47308-Current-Trends-in-Missions
15. Sweeny, M., "Future Trends in Missions," http://christianstandard.com/2012/11/future-trends-in-missions/
16. Ibid.
17. Brant, H., *Redefining Missions for the 21st Century*, SIM Report, 2004.
18. Ibid.
19. Quoted by Holste, S. and Haney, J., "The Global Status of Evangelical Christianity," *Mission Frontiers*, Jan.-Feb. 2006, p. 8-13.
20. Definition attributed to Ralph Winter.
21. Concept developed by Ralph Winter.
22 "Finishing the Task Report," *Mission Frontiers*, Jan.-Feb. 2006, p. 15.
23. Richardson, D., *Peace Child*, Regal, 2005.
24. Hiebert, P., "The Flaw of the Excluded Middle," *Missiology*, Jan. 1982, p. 35-47.
25. NC2P "NC2P, a DAWN-type strategy?" https://nc2p.org/nc2p
26. "Ask a Missionary," https://www.askamissionary.com/question/45
27. Ibid.

28. Lai, P., *Business for Transformation*, William Carey Library, 2015.
29. EMI, https://emiworld.org/services/technical-assistance
30. Saggio, J., "Tentmakers," *Ministers Connect*, 2008.
31. Siemens, R., "Why Did Paul Make Tents?" http://aztem.org.au/why-did-paul-make-tents/
32. Hamilton, D., Tentmakers Speak, William Carey Library, 1987, p.15.
33. Siemens, op. cit.
34. Ibid.
35. Ibid.
36. Andrus, B., "Thoughts on Short Term Mission Trips," Hope Fellowship Church, April 2, 2017.
37. Ibid.
38. Bryant, D., *In the Gap*, Inter-Varsity, 1981, p. 4.
39. Bryant, p. 179.
41. Bryant, p. 176-193.
42. Brant, H., op. cit.
43. Hesselgrave, D., *Today's Choices for Tomorrow's Mission*, Academie/Zondervan, 1998, p. 24.
44. Bosch, op. cit.

CHAPTER 26: INTERNATIONAL DEVELOPMENT

INTRODUCTION

Jim had spent his two weeks of vacation in Ecuador. The highlight was visiting Ted, an old friend from school who was now working in an indigenous village.

"Ted, I know exactly what these people need. In fact, I have a source who would donate a dozen solar panels. I'll be glad to pay the shipping. What do you say?"

"Jim, my brother, I appreciate your heart, but there's a few things you don't understand:

First, 'these people' are an ethnic group with a unique language and a long history. Each one has a name and a family.

Second, the village chiefs are not usually receptive to strangers telling them what they need.

Third, if those solar panels don't fit with their lifestyle they will never bother to use them.

Fourth, those villagers who aren't yet believers will likely smash the panels because they think they contain spirits.

Fifth, Amazon doesn't ship here anyway."

One clear area where engineers can make a difference overseas would be the realm of relief and development efforts, but it must be done wisely to be useful.

"International development" usually refers to efforts directed to improving the daily life of people in less-developed countries.

Developing countries are typically defined by a number of problem criteria:

- Low GNP per capita
- High birth rate
- High unemployment (few real jobs that generate income)
- Heavy dependence on agriculture (little manufacturing or services)
- Income inequality (a few very rich and most in extreme poverty)
- Low capital formation
- Poor infrastructure (roads, transportation in general, communication)
- Poor human services (education, health)

When people talk about "developed" countries, that's very often code for "wealthy" ones. That's not to say that so-called "developed" nations don't have significant populations living in poverty as well, but poor countries typically lack most of the

other elements that go toward defining a place as developed: quality educational systems, a strong economy and banking structure, access to health care, high literacy rates, high life expectancy and so on...

At the same time, development and poverty alleviation aren't necessarily synonymous. Depending on how broad a view you take of poverty alleviation, they could essentially be the same thing when you get right down to it. However, development projects can tackle a multitude of diverse issues and goals, from improving access to clean water to eradicating illiteracy in rural regions to increasing women's participation in politics. [1]

Basic human needs (usually addressed by development projects) include:

- Water
- Sanitation
- Shelter/housing
- Energy
- Health
- Education

MISSIONS AND DEVELOPMENT

For many mission agencies working in Africa and Asia development accompanies the proclamation of the Gospel.

- Development is a tangible expression of God's love and makes the message credible.
- Development is essential because God cares about all aspects of a person's life, not only their soul.
- In regions where starvation is a daily occurrence or health conditions are critical people may be physically and mentally unable to respond to the Gospel until they are fed or their life is restored.

Why development is needed (the case for Christian help)-

1. Pervasive poverty affects 3-4 billion people on the earth.

Of the earth's population- [2]

- 22% live in extreme poverty, surviving on less than $1.25 per day.
- 43% live in poverty, surviving on less than $2 per day.
- 11% lack access to clean water.
- 36% lack adequate sanitation.
- 20% lack usable energy sources.
- 20% lack adequate housing.

One -fourth of the world's poor live in 39 of the world's poorest countries.

Three diseases alone — malaria, TB, and AIDS — result in more than five million deaths

per year and half a billion new infections, virtually all in the world's poorest countries. The poor are routinely exposed to situations and conditions that attack their health — disease, malnutrition, parasites, and bad water. Poor health, in turn, saps their energy, limits their capacity, and kills their children. They live in places where doctors and medicines are largely unavailable, and even if such health care were available, they lack the money to pay for it. In short, poverty leads to poor health, which in turn leads to greater poverty — one more strand in the web that traps the poor. [3]

2. The teachings of Scripture:

From the Bible we have these statements —

Isa. 58:6-7:

"Is not this the fast that I have chosen: to lose the bands of wickedness, to undo the heavy burdens, to let the oppressed go free, and to break every yoke? Is it not to share your bread with the hungry, and to bring the poor who are cast out into your house? when thou see the naked, to clothe him; that you don't remove yourself from your own flesh?"

These words require little explanation. God will delight in His people when they obey Him. When the hungry are fed, the poor are cared for, and justice is established, He will hear and answer His servants' prayers; He will guide them and protect them, and they will be a light to the world. This is a vision of God's people transforming God's world in God's way. [4]

Matthew 25:37-40:

"Then shall the righteous answer Him, saying, 'Lord, when did we see You hungry, and fed You, or thirsty, and gave You drink? When did we see You as a stranger, and took You in? or naked, and clothed You? Or when did we see You sick, or in prison, and came unto You?'

And the King shall answer and say unto them, 'Truly I say unto you, inasmuch as you have done it unto one of the least of these my brothers, you have done it unto Me."

The modern interpretation, sadly, is this:

For I was hungry, while you had all you needed. I was thirsty, but you drank bottle water. I was a stranger, and you wanted me deported. I needed clothes, but you needed more clothes. I was sick, and you pointed out the behaviors that led to my sickness. I was in prison, and you said I was getting what I deserved. (RESV — Richard E. Stearns Version) [5]

Luke 10:35-37 (Good Samaritan):

"Which of these three do you think was a neighbor to the man who fell into the hands of robbers?"

The expert in the law replied, "The one who had mercy on him."

Jesus told him, "Go and do likewise."

James 2: 15-17

"If a brother or sister has no clothes and lacks daily food, and one of you says to them, 'Go in peace, be warmed and filled,' but you fail to give them those things which are necessary for their body, what good does it do? Even so faith, if it has no results, is dead, being alone."

Rephrasing Cain - I am my brother's keeper.

I do have some responsibility for the lives of others.

3. The hole in our Gospel

Neglecting the physical needs of people when evangelizing the poorest nations is a significant failing and is, in the words of Richard Stearns' book, *The Hole in our Gospel*. [6] Stearns, president of World Vision, looks at this lack of help as "the hole in our Gospel."

The case he makes is significant, but the wording is unfortunate. There's no hole in the Gospel (the power of God for salvation), only in our living out of the Gospel.

> *For the first time in the history of the human race, we have the awareness, the access, and the ability to reach out to our most desperate neighbors around the world. The programs, tools, and technologies to virtually eliminate the most extreme kinds of poverty and suffering in our world are now available. This is truly good news for the poor — or is it?*
>
> *Not really, because we are not doing our part.* [7]
>
> *Here is the bottom line: if we are aware of the suffering of our distant neighbors — and we are — if we have access to these neighbors, either personally or through aid organizations and charities — and we do — and if we have the ability to make a difference through programs and technologies that work — which is also the case — then we should no more turn our backs on these neighbors of ours than the priest and the Levite should have walked by the bleeding man.* [8]
>
> *It's easy to see how this dividing of the gospel left both sides with only half a gospel, that is, a gospel with a hole in it, as each became satisfied with their particular piece. But this diminution of the whole gospel left both camps with just a shadow of the tremendous power of the good news proclaimed by Jesus. His gospel encompassed not only the forgiveness of sins and the saving of our souls but also the fullness of the coming kingdom of God through a society transformed by His followers. This "holey" gospel, on the other hand, reduced the full gospel of Christ to a series of transactions that, for one side, involved the mechanics of soul winning, and for the other, would reform the world through social and legislative changes.* [9]
>
> *We must move beyond an anemic view of our faith as something only personal and private, with no public dimension, and instead see it as the source of power that can change the world. Faith is the fuel that powers the light that shines in darkness.* [10]

The world needs the good news of Jesus. Poor and starving people also need tangible help to survive.

CASE FOR COMPASSION

No matter how we slice it, believers cannot ignore the world's physical hurts.

The child with malaria is part of our common humanity, created by our heavenly Father.

The starving man is unable to function, let alone listen to a Gospel presentation, until his body is fed.

The impoverished woman who responds to Christ is now my sister in the Lord and can't be abandoned.

"It's not my fault that others are suffering," says Richard Stearns, "but it is somehow my responsibility to help if I can." [11]

The Lausanne Covenant

The principal evangelical document concerning world missions in the past fifty years has been the Covenant generated from the first Lausanne Congress on World Evangelization. [12]

The Lausanne Covenant emphasizes the uniqueness of Christ, the necessity of the Gospel, and the need to cooperate to complete the task. Evangelism is described as "the whole church -taking the whole Gospel-to the whole world."

In addition to the priority of salvation, the Lausanne Covenant includes these statements:

> *The Bible as a whole shows us the passion and compassion of God's heart*
>
> *For the least of these as well as for the lost*
>
> *For those dying of hunger, AIDS, and war, as well as those who are dying in their sin*
>
> *For the landless, homeless, family-less, and stateless, as well as those who are without Christ, without God, and without hope in the world...*
>
> *The God who commands us to disciple all nations also commands us to do justice, love mercy, and walk humbly with our God.* [13]
>
> *We may not all give an identical definition of justice or injustice, or share the same economic or political theories and remedies. But we are all appalled by the immense numbers of people who do not have enough to eat, whose shelter and clothing are inadequate, and whose opportunities for education, employment, and medical care are minimal.* [14]

Poverty and Development

Romans 8:22 speaks of creation groaning. The results of the Fall are widespread and devastating.

Results of the fall include:

- Separation
- Bodies that suffer injury, sickness, and death
- Struggles
- Futility

Medicine, communication networks, and clean water supplies are good things, things in line with restoration of a fallen world.

We need to see ourselves as agents of reconciliation in a broad scope. Spiritual reconciliation underlies everything, but other areas also need restoration: [15]

- Relationships
- Justice
- Health and safety
- Economic situations
- Refugee status

These are too important to be trusted to politicians.

World Vision, a Christian relief organization, for example, has provided help with:

- Food and agriculture
- Water and sanitation
- Health
- Economic development/ Overcoming local poverty
- Providing a clean water supply
- Providing a basic infrastructure
- Providing disaster relief and rebuilding

Engineering for Hope is a Christian development organization. Engineering for Hope declares these values:

1. Jesus loves the world, and wants us to love Him by loving the world with every resource we have
2. We are engineers and engineering students who want to use our passions and gifts in engineering as resources to serve the world
3. We will provide sustainable engineering help to developing places
4. We believe that each culture was created uniquely by God and we therefore want to partner with each culture to develop solutions to their problems, not our perceptions of their problems.

5. We believe that each culture has something to offer us, and we want to experience that culture as we work there, not as tourists but as students of that culture
6. As much as possible, we want to support the local economies by using local material, labor, and resources
7. We want to give engineers and engineering students opportunities to love the world through giving, teaching and leading teams, and helping to serve the mission [16]

Disaster relief

Certain agencies are very successful in responding to international disasters: hurricanes, earthquakes, mudslides, floods, tsunamis. The needs are very similar:

- Clean water
- Emergency shelter
- Food
- Medical help and supplies
- Communications
- Clean-up and rebuilding

World Vision and Samaritan's Purse have a strong track record for emergency assistance, along with the International Red Cross.

DEVELOPMENT PROBLEMS AND FAILURES

International development can be a powerful force for good, but it can also be done badly, in fact so badly that it negates the good.

There are many stories of organizations with good intentions who set up a project overseas only to have it abandoned to rust or rot shortly after the agency left.

> *All around the world one can find donated equipment that is rusting away, latrines that have never been used, community associations that have been disbanded, and projects that disintegrated soon after the nonprofit organization left town. Despite an estimated $2.3 trillion in foreign aid dispersed from Western nations during the post-World War Two era, more than 2.5 billion people, approximately 40 per cent of the world's population, still live on less than two dollars per day.* [17]

What kinds of things go wrong?

1. Failure to link evangelism and development

For evangelicals, the primary task of missions is world evangelization. We have seen that the work is incomplete if it neglects physical needs. On the other hand, it can be a temptation to get so enmeshed in a development project that the Gospel gets neglected and missions is sidetracked. The temptation is to label everything we do as "missions."

"May our mission definitions be driven not by our personal interests, prejudices, and preferences, but by the passions and purposes of the God of the nations," write Denny Spitters and Matthew Ellison of Pioneers. [18]

2. Dependency and paternalism

Avoid creating dependency

> *Good intentions can translate into ineffective care or even harm. The food we ship to Haiti, the well we dig in Sudan- all seem like such worthy efforts. Yet those closest to the ground-on the receiving end of this outpouring of generosity-quickly admit that it may be hurting more than helping? How? Dependency. Destroying personal initiative. When we do for those in need what they have the capacity to do for themselves, we disempower them... We fly on mission trips to poverty -stricken villages, full of pity and suitcases bulging with giveaway goods, trips that one Nicaraguan leader describes as effective only in "turning my people into beggars."*

Giving to those in need what they could be gaining from their own initiative may well be the kindest way to destroy people. [19]

Avoid paternalism

Paternalism involves a mindset, policies, or practices in which a benefactor nation or organization, supposedly acting in the best interests of others, makes the recipients feel inferior and like little children. It may restrict their freedom and responsibility, ultimately preventing their growth and independence. ("We're your parents-we know what's best for you.") If we give the impression of affirming the superiority of the giver and the inferiority of the receiver, it reinforces the position of poverty: hopelessness, powerlessness, and helplessness. [20] Eventually the efforts and the relationships will fail if resentment develops.

Forms of paternalism:

- Resources (I have the material that you need.)
- Spiritual teaching (I have the exact spiritual teaching that you need.)
- Knowledge (I have the specialized knowledge that you need.)
- Labor
- Management

We must avoid "poorism" or "religious tourism," which can become a "growth industry."

- Make sure your motives are right -desiring to help others in the best way possible, rather than desiring to make yourself feel good.
- Always affirm the dignity of the poor.
- Avoid creating a sense of dependency.
- Take time to evaluate the problems -take time to listen.

Formerly: "I'm an outsider. I'm here to help you. I see certain needs, and we can help with those."

Currently: "We are brothers and sisters. What do you see as your greatest needs? How can we work together to meet those needs?"

Corbett and Fikkert (*When Helping Hurts*) define three stages of poverty alleviation: [21]

(1) Relief - urgent and temporary provision of emergency aid to reduce suffering from a crisis -often requires resources from outside

(2) Rehabilitation (Recovery) - restoring people and communities to their pre-crisis conditions - may still need others to come alongside them

(3) Development- process of ongoing change and moving forward, establishing right relationships (including supporting themselves)

"One of the biggest mistakes that North American churches make, by far" say Corbett and Fikkert, "is applying relief in situations in which rehabilitation or development is the appropriate solution." [22]

In other words, there is a legitimate place for giving everything to a community during an emergency, but that level of support backfires if there is no crisis at all, or once the crisis conditions are over.

Lessons from Corbett and Fikkert- [23]

- Poverty alleviation is the ministry of reconciliation- moving people towards living in right relationship with God, self, others, and creation.
- Focus on people and processes, not projects and products.
- Begin with a focus on assets, not needs.
- Community involvement is essential.

Community involvement is participation —

"Participation is not just the means to an end but rather a legitimate end in its own right." [24]

The best situation is community- initiated participation- "Local people set their own agenda and mobilize to carry it out without outside initiators and facilitators."[25]

Those who would help must understand:

- That there are no "quick fixes." Prepare to be in there for the long haul.
- The problems that can arise in poverty alleviation.
- The underlying causes of poverty.

"Poverty is the result of relationships that do not work, that are not just, that are not for life, that are not harmonious or enjoyable. Poverty is the absence of shalom in all its meanings." [26]

3. Shoddy engineering

Some organizations have been so eager to provide help that they cobbled together a solution

that lacked planning, good materials, and sound engineering principles.

In the past, too many technical development projects have involved shoddy engineering practice and amateurish, "seat-of-the pants" design, often because no one with an engineering background was involved at all. Just because the projects are low-tech and low-cost, the quality of engineering should not be sacrificed.

Good, established engineering practice should be applied, and the engineering method should be utilized.

Following the principles of the engineering design cycle, engineers will:

- Clearly define the need(s); identify the problem
- Determine constraints and technical specifications
- Generate various candidate solution approaches
- Evaluate the approaches and choose the most workable
- Implement the solution
- Test and evaluate, refine as necessary to meet the spec's

Considerations of functionality, reliability, maintainability, and aesthetics should be included. Any relevant standards should be addressed.

4. Providing what nobody wants or will use:

Too often a project originates in a church or classroom in the US, is transported to an overseas site, and is put into service by the American team, who are surprised to learn, months later, that it isn't working or isn't being used. Successful projects are requested by a local village or by a missionary there or by development workers in the country. Nothing beats "boots on the ground."

Misapplied Technology

One of the greatest dangers of providing technological assistance to the developing world is the possibility of providing exactly what people don't need. (Providing solar cells when the pressing need was clean water.)

One organization noted that women came to the village well each evening to draw water by hand with buckets. They installed a pump to replace the bucket effort and were surprised when it wasn't welcomed. The well wasn't simply a water source. It was a community gathering place, and the pump did not replace the social value of the well.

In 2007 Nicholas Negroponte, head of the MIT Media Lab, proposed the "one laptop per child" project. The world's children need computers, he explained, and proposed dropping them from planes into remote villages. Children would figure out how to use them, and great advances in poor societies would occur.

Brian Winston, in a critical article entitled "Let Them Eat Laptops," pointed out that the plan was a supreme example of Western hubris and technicism:

The children of the South no more have his computer than they have adequate shelter, clean water, health care or peace. But in the First World the possibilities of a really cheap laptop are now being actively explored... It is the social sphere (in which the technological is but one of many forces) where the fate of entities like Intel or the One Laptop Per Child not-profit organization is determined. Negroponte, faced with this reality, is attempting to water-down the essential technicism of his plan: 'It's an education project,' he now claims, 'not a laptop project.' But a 'laptop project,' as Intel and others clearly understand is what it is. Negroponte's vision, narrowed by his belief in the machine, is producing not the social amelioration he so confidently predicted but cheaper computers for privileged Westerners. One Laptop Per Child is rapidly becoming a classic example of the limitations of technological determinism, essentially because as a technicist, Negroponte ignored essential social realities in his initial vision... Meanwhile, the malnourished Third World child, to the surprise of the technicist perhaps but not to those who put societal forces first, will, laptop-less, have to starve a little longer. [27]

"Do No Harm" in Development

The idea of doing more harm than good may discourage some from even attempting overseas aid. That should not be our mindset, according to Monty Lynn, Rob Gailey, and Darren Reese. Their book *Development in Mission* [28] lays out a positive approach. The key theme is that of "holistic mission," defined as mission that links the Biblical call for evangelism and discipleship with the Biblical call to address the needs of the poor and marginalized. This is tied to "transformational development," defined as "a redemptive process focused on persons, communities, societies, and the connections between them... The intended effect is for all to participate in God's compassion and justice, which moves the world towards flourishing, or shalom." [29]

Their approach to holistic missions is built on these concepts: [30]

- Move from short-term fixes to relational and sustainable solutions.
- Move from projects and products to processes and people.
- Involve principles from theology, missiology, global development, research results, best practices, and local voices.
- Understand the connections between poverty, education, health, and community development.
- Begin with humility and listening.
- Don't discard all of the UN's Sustainable Development material because you disagree with a secular approach or with pieces of it.
- Focus on projects with the greatest potential impact.

Sustainable Development

What is sustainable development?

- Sustainable development has been defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

- Sustainable development calls for concerted efforts towards building an inclusive, sustainable and resilient future for people and planet.
- For sustainable development to be achieved, it is crucial to harmonize three core elements: economic growth, social inclusion and environmental protection. These elements are interconnected and all are crucial for the well-being of individuals and societies.
- Eradicating poverty in all its forms and dimensions is an indispensable requirement for sustainable development. To this end, there must be promotion of sustainable, inclusive and equitable economic growth, creating greater opportunities for all, reducing inequalities, raising basic standards of living, fostering equitable social development and inclusion, and promoting integrated and sustainable management of natural resources and ecosystems. [31]

The United Nations set forth the following development goals: [32]

(1) Poverty alleviation.
(2) Hunger eradication.
(3) Good health and well-being for all.
(4) Equal opportunity to all for getting quality education.
(5) Promoting gender equality.
(6) Clean water and sanitation for all.
(7) Affordable and clean energy.
(8) Economic growth for all countries irrespective of caste, creed, and religion.
(9) Innovation and uplifting of industrial infrastructure.
(10) Reduced inequalities.
(11) Sustainable and environment-friendly cities and communities.
(12) Reduced responsible consumption and enhanced production.
(13) Climate action to prevent damages from natural calamities.
(14) Preserve life below water.
(15) Contribute towards goodness for life on land.
(16) Peace, justice and strong institutions.
(17) Sharing partnerships among the countries for fulfilling the common goals.

Christians and Sustainable Development

Christian and other religious perspectives understand that a human being is more than the sum of their parts. We know that a sense of purpose and fulfilment in life needs more than a good education. We know that peace and contentment with life comes from more than being free of illness. And we know that hope is deeper than having enough food on the table. Not for a moment are any of those things irrelevant. On the contrary the UN should be praised for its bravery in setting out this list of

goals. But they demonstrate a limited understanding of human flourishing.

We must accept the challenge the SDGs offer and go beyond it. We are called to bring good news to the poor, to bind up the broken hearted, to proclaim freedom for the captive and the SDGs provide an excellent starting point. But they can't be the end point. [33]

Farley adds these thoughts:

There is one major problem with the SDGs: they have a narrow, secular understanding of what wellbeing actually is. They lack a Christian perspective and are worse off for it.

Christian and other religious perspectives understand that a human being is more than the sum of their parts. We know that a sense of purpose and fulfilment in life needs more than a good education. We know that peace and contentment with life comes from more than being free of illness. And we know that hope is deeper than having enough food on the table.

Not for a moment are any of those things irrelevant. On the contrary the UN should be praised for its bravery in setting out this list of goals. But they demonstrate a limited understanding of human flourishing.

A quick search of entire Agenda 2030 document reveals that there is no mention of compassion, love, sacrifice, generosity, selflessness or faith.

The SDGs do a great job of articulating humans' material needs and laying out plans to meet those needs. But they make the mistake of thinking human flourishing comes from the fulfilment of those needs alone. They forget that humans are more than material inputs...

Many commentators have criticized the SDGs for being too long and extensive. They say they try to do too much. On the contrary, I would say they don't go far enough. The transformation of society comes from more than just good health, education and food.

So Christians must not ignore the SDGs or treat them with the same suspicion that the UN treats its so-called FBOs (faith-based organiztions). Rather we must accept the challenge the SDGs offer and go beyond it. We are called to bring good news to the poor, to bind up the broken hearted, to proclaim freedom for the captive and the SDGs provide an excellent starting point. But they can't be the end point.

Satisfaction, contentment and peace in the human heart comes from much more than having our material needs met. Paul learnt to be content with whatever he had because it was deeper than just the food on the table. So when we bring aid to developing countries let's not stop at thinking providing food, education and health is enough. It is a brilliant start but human beings are worth more than that. [34]

Guidelines for both emergency aid and development include these: [35]

- Ensure participation of the affected population in the assessment, design, implementation, monitoring, and evaluation of the assistance program.
- Conduct an initial assessment to provide an understanding of the...situation and to determine the nature of the response.
- Respond when needs of an affected population are unmet by local people or organizations due to their inability or unwillingness to help.
- Target assistance based on vulnerability and need, and provide it equitably and impartially.
- Aid workers must possess appropriate qualifications, attitudes, and experiences to plan and effectively implement assistance programs.

ENGINEERS AND DEVELOPMENT

Engineering involvement in international development

In many regions of the world people will not survive without:

- Food supplies
- Clean drinking water
- Adequate shelter
- Medical help

Deeply impoverished regions also need:

- Adequate sanitation
- Source(s) of energy
- Education
- Source(s) of income
- Infrastructure help

The engineering profession is in a unique position to address several of the world's needs and has a responsibility to provide some level of help to meet the deepest human physical needs. Christian engineers can understand the problems, can address some solutions, and are motivated by the love of Christ.

International needs, particularly in the developing world, are often needs that engineers are able to address:

- Access to clean water
- Keeping buildings warm
- Buildings that can withstand earthquakes
- Emergency shelter
- Remote power for villages
- Irrigation systems for large farms
- Remote health care access

- Communications across large distances

Engineering involvement may take various forms:

- Sometimes local volunteers
- Sometimes donating funds
- Sometimes short-term projects
- Sometimes long-term relationships

There are a number of ways that engineers can be involved in the area of international development:

- Working directly for a Christian development organization (like World Vision)
- Working directly for an international development agency (like USAID)
- Working on a project for a development organization
- Working on a project for a missionary on the ground
- Working on a project requested by a church in a developing nation

HUMANITARIAN ENGINEERING

Many engineering students are motivated by the possibility of directly helping others technically.

A recent branch of engineering conceived by Carl Mitcham and others is known as Humanitarian Engineering (HE). Humanitarian Engineering refers to the application of engineering solutions to community and global physical needs. "Humanitarian engineering is research and design to directly improve the well-being of poor, marginalized, or under-served communities, which often lack the means to address pressing problems." [36] HE is "the artful drawing on science to direct the resources of nature with active compassion to meet the basic needs of all -- especially the powerless, poor, or otherwise marginalized." [37]

In the past few years, a number of universities have begun formal programs in the field of Humanitarian Engineering. [38, 39, 40, 41] Carl Mitcham describes Humanitarian Engineering (HE) as the joining of humanitarianism with the discipline of engineering. [42] HE is "design under constraint to directly improve the well-being of under-served populations," [43] or "the artful drawing on science to direct the resources of nature with active compassion to meet the basic needs of all- especially the powerless, poor, or otherwise marginalized." [44]

Requirements for working in HE would be altruism, active compassion for those on the margins of wealth and power, innovation, and engineering know-how. Passino gives us this insight: "Humanitarian Engineering requires skills beyond the technical skills: cultural understanding, intentional trust, appropriate technology, and, often, language." [45]

Kevin Passino of Ohio State has developed a course and an online (downloadable) textbook introducing the concepts of humanitarian engineering: [46]

Passino makes a case for HE based on a summary of Catholic Social Teaching:

- All humans are made in God's image.

- Consequently, all humans have dignity.
- Consequently, all humans have rights.
- It is the duty of those who have to help those who have not.

The Biblical case for development for HE would come for Matthew 24: "Lord, when did we see you hungry, naked, or in prison?" Answer:" Inasmuch as you have done it unto one of the least of these, you have done it unto Me."

The 10 Principles of Humanitarian Engineering (according to Passino): [47]

1. Focus on People
   - Individuals are unique and infinitely valuable, talk to them, respect them, have solidarity with them
   - Try to understand suffering, have empathy and compassion
2. Relate, Listen, Ask, Cooperate, Empower
   - Build relationships, trust, community participation, inclusiveness, multidisciplinary teams, and cooperation
   - Do needs, resources, capacity, and aspirations assessment via active listening
   - Empower people
3. Understand Social and Physical Context
   - Understand people, communities, culture, and history
   - Understand built and natural environment, resources, and institutions
4. Be a Professional Humanitarian Engineer
   - Have competence and good conduct
   - Create the best design that meets all constraints (performance, reliability, cost, environmental, social, use of local materials, etc.) in the social and physical context and keeping the people firmly in mind
5. Build Technological Capacity
   - Empower the community to create its own solutions, and be a mentor
   - Science, technology, engineering, and mathematics education empowers students and communities
6. Ensure Long-Term Positive Impact
   - Design for reliability in extreme conditions
   - Build technological capacity for operation and maintenance
7. Understand Impact on/from Social Context
   - Understand people and power relations
   - Understand role of education, health, and economic development
8. Design for Sustainability
   - Minimize resource use and pollution impacts
   - Focus on life-cycle design and design for the environment

9. Assess Outcomes
    - Determine deployed technology effectiveness and side-effects
    - Establish basis for later improvement or scale-up
10. Promote Human Dignity, Rights, and Fulfillment
    - Focus on human dignity, rights, and fulfillment, along with other ideas from social justice
    - Try to reduce inequalities in technological capacity, promote inclusiveness, and eliminate marginalization of people

Ethical considerations include:

- Who determines the need?
- Who provides aid?
- Who received aid?

Engineers Without Borders

Engineering professionals have a major role to play in poverty reduction..." Helping people stay alive is a professional and personal obligation." [48]

Engineers Without Borders (EWB) is an organization specifically geared to providing international assistance using engineering skills. EWB was founded in 2000 by Dr. Bernard Amadei, a civil engineering professor at the University of Colorado. Amadei, who has worked in developing countries, "helps engineers across the world develop skills and reach out to work with communities across the globe believes that crossing barriers – geographical, cultural or disciplinary – is the key to a better world." [49]

Project teams have implemented footbridges, solar panel systems, and water wells in multiple countries.

> *A few people who came to help me with some landscaping work at home were from Belize and they told me about the needs of young people in their village. Two years later, when on sabbatical, I received an email from them asking for help, so I decided to go," recalls Amadei who at the time, had a flourishing academic career at the University of Colorado, Boulder, USA. In the village of San Pablo, Belize, he had a change of heart and mind. "It was my first experience with the developing world and my first exposure to poverty. It really shocked me," says Amadei who grew up in France before migrating to the US in 1982.*
>
> *In San Pablo, Amadei saw girls as young as eight whose sole job was to carry water from the river to the village. As a civil engineer he knew a pump was the logical solution but the challenge lay in operating a pump where there was no electricity and fuel was not affordable. "The problem was moving water from A to B, something engineers come across all the time but the context was different," he says. Finally Amadei, along with a team of twelve and some help from private donors and a waterfall in the area, managed to create natural power using the force of the waterfall and use that to pump water to villages. Between this and fulfilling his duties*

as a Professor at the University of Colorado, the process took over a year. [50]

"It was the first time my need to help people and engineering came together and the students decided they wanted to continue doing more practical, meaningful engineering. That's how Engineers without Borders came about," he explains. Since, Amadei has dedicated himself to creating an engineering community that has the skills and the compassion to bring about needed change across the globe. [51]

Details on EWB:

EWB Mission: Partner with communities and develop leaders to build a better world.

EWB Vision: A world where every leader is equipped to build and every community is built to thrive.

EWB Purpose

Our student and professional volunteers' partner with underserved communities at home and internationally to build a more sustainable world. These community-driven partnerships address essential needs with climate conscious infrastructure while cultivating engineering and leadership skills in our partners and volunteers. [52]

Engineers Without Borders uses a 4-part process known as PMEL (Plan, Monitor, Evaluate, Learn):

- Plan
- Build
- Learn
- Apply

Guiding questions for Humanitarian Engineering projects - [53]

1. Does the engineering work promote the good of all people independent of their nationality, religion, class, age, or sex?

2. How might the engineering project be related to the protection and promotion of human rights?

3. Is the product, process, or system being engineered likely to help meet a humanitarian crisis such as those typically associated with war or natural disasters?

4. Is the engineering work addressed especially to meet some fundamental human needs (i.e. those for water, food, and shelter)?

5. Is the engineering work oriented toward benefits for those otherwise underserved by engineering either in the advanced or the developing regions of the world?

6. In what ways might the engineering work be more compatible with not-for-profit enterprises than for profit enterprises? How might such engineering and construction work that did seem more compatible with the pursuit of economic profit be either supported by alternative means or recast so as to be compatible with economic motives?

7. What is the likelihood that the engineering product, process, or system will be sustainable?

SELECTING DEVELOPMENT PROJECTS

Deciding what truly counts as a humanitarian engineering project is not always easy. Efforts to clarify understandings in this regard within the CSM (Colorado School of Mines) undergraduate Humanitarian Engineering Minor program have led to the formulation of a set of four guiding criteria.

- *One, there must be a need that originates with the people directly benefitting from any proposed work.*
- *Two, whatever need is involved should be related to a basic human need, although it is also possible to include higher level needs such as education and economic development.*
- *Three, good communications is essential, preferably with the people directly benefiting from the work and/or commonly through and NGO intimately familiar with the local context.*
- *Four, the need should be one that can benefit from engineering skill and knowledge.* [54]

Sustainable Engineering

While sustainability often gets a bad rap because of political mis-use, the engineering concept of sustainability is solid and explores the interactions between society, the environment, and the economy. All three must be in balance for long-term survival of any project.

"Communities are complex adaptive systems consisting of multiple subsystems and parts (e.g., individuals, institutions, and infrastructures) that are interconnected, are driven by some purpose, follow certain rules, and interact with each other and with the surrounding environment." [55]

As a result, projects must deal with complexity and uncertainty.

No two development problems/projects are the same.

Sustainable engineering involves systems thinking, causal analysis, risk analysis, resiliency analysis, and good project management techniques. The project management approach includes phases of initiating, planning, executing, maintaining, controlling, and closing. [56]

In addition, we will need to consider project lifecycle, project quality, and project impact.

Sustainable engineering will integrate community participation, data collection and analysis, problem identification, continuous reflection-in-action (How are we progressing?, What have we learned?, What needs to change?), and critical and creative thinking.) [57]

In the traditional approach to development problems, each problem is addressed

> *by an expert in that particular field (water, sanitation, economy, health). This tends to miss the interconnection of the issues, to miss common root causes, and to miss possible feedback mechanisms.* [58]

A multi-disciplinary, muti-pronged approach is preferable.

Consider starting with problems that are easiest to address ("low-hanging fruit").

In addition to problems and vulnerabilities, analyze the resources and "capacity" present in the community. Human capacity can include skills, values, attitudes, relationships, and behaviors.

Consider using a project design framework built upon those tools used by established development agencies (e.g., CARE, Mercy Corps). One example is the ADIMEE process: [59]

- Appraisal
- Design
- Implementation
- Monitoring
- Evaluation
- Exit strategy

Realize that, in addition to a technical solution, people's thinking often needs to change. (Take sanitation practices seriously.)

Unlike high-tech design where the resulting solution involves optimizing something, design for development involves producing a "good-enough" solution.

The ultimate goal is for communities to reach a point where they can:

- Address their own problems
- Be self-sustaining
- Adapt to stresses and changes
- Supply basic needs
- Provide for basic livelihoods

The goal is that the community becomes more stable, prosperous, safe, and peaceful.

CHRISTIAN HUMANITARIAN ENGINEERING

A particular subset of humanitarian engineering (HE) is Christian humanitarian engineering (CHE).

As defined by William Jordan, CHE is "the practice of engineering with the intentional goal of improving the well-being of underserved populations as part of our Christian calling to transform the world." [60]

> *If you see your engineering skills as capable of helping to improve lives, you'll be motivated to help poor people as this is intrinsically the right thing to do. Evangelism will also result, but this is not the only goal.*

CHE is often directed towards indigenous Christian groups.

CHE may involve working on projects that will directly benefit people who are in unreached people groups (an example of engineering as mission). [61]

Results:

- Show concern for the whole person, physical and spiritual
- Meet needs in Jesus' name
- Demonstrate God's love
- Serve others as Jesus served
- Extend God's shalom

CHE in practice may not look that different from general HE. The issue may be mindset and motive.

"We need to be motivated by service as well as profit. We serve best by finding out what people want and helping them work to realize their dreams, not by going into a country and telling villagers what they need". [62]

According to Dr. Stephen Offutt of Asbury seminary, Christian development projects are "holistic, designed with an understanding that the human condition is both physical and spiritual." [63]

Bill Jordan and his Baylor students have worked on projects in Kenya, Tanzania, Rwanda, Honduras, and Haiti.

Probably the major organization working in Christian Humanitarian Engineering would be EMI (Engineering Ministries International). EMI teams a staff of engineers and architects with international volunteers to tackle problems around the world. Their website states: "EMI is a Christian non-profit made up of architects, engineers, surveyors, and construction managers. Since 1982, our worldwide mission is to develop people, design structures, and construct facilities which serve communities and the Church. Together, we are designing a world of hope." [64]

GUIDELINES FOR DEVELOPMENT

Da Costa lists 12 "musts" for modern international development: [65]

1. Development must be total, much more than economic
2. Development must be original, country-specific
3. Development must be self-determined to avoid dependency
4. Development must be self-generated, with active participation and cooperation
5. Development must be integrated, with multiple linkages
6. Development must respect the integrity of the environment
7. Development must be planned and monitored

8. Development must be directed towards a just and equitable social order
9. Development must be democratic, responding to the choices of the whole population
10. Development must not insulate less developed regions into "reservations"
11. Development must be innovative
12. Development planning must be based on a realistic definition of national needs

Development Efforts and Sin

It is always possible for sin to enter development work: [66]

1. Wrong motives: does pride lead us to encourage development so that we can add it to our CVs and point to something achieved?
2. Wrong audience: do we talk only to those we find it easy to communicate with in our terms? Do we talk enough to the people we are trying to help, understanding properly what they really need and how far their maintenance skills can be stretched without breaking? Is God part of our conversations?
3. Wrong personnel: do we involve to the greatest possible extent engineers and technicians of the beneficiary community? Are we prepared to recognize that God puts engineering skills into other hands than ours?
4. Wrong approach: do we pray for guidance in project choice, definition, execution, and USE? Are we guilty of the "We've always done it that way" syndrome?
5. Wrong relationship: having been part of a development, do we move quickly off to the next one, or do we maintain a relationship with the community concerned, returning in person or sending a local representative as and when we can to support them?
6. Wrong history: do we record the problems encountered in such a way that the lessons learnt will not be forgotten in another project to which they are relevant?

APPROPRIATE TECHNOLOGY

Any project carried out overseas must take into consideration the major aspects of the local culture. The project will likely fail without this piece.

> *Designing equipment to fit a different culture is more than putting an engineer and blueprints on a plane. Participation by artisans in the target country is essential. Only persons with a thorough knowledge of the local economy and culture can determine whether a design can be sustained in a developing nation...By and large, these projects are scaled to the village, neighborhood, or personal level, where they will have the best chance of benefitting individual lives.* [67]

Appropriate technology (AT) refers to the application of technical solutions that fit with the local resources and culture. Many international workers have reported that American agencies and engineers have developed elegant solutions for small villages but within months after leaving them the project was abandoned by the villagers since they felt no "ownership" and no cultural connection to the machinery.

Appropriate technology is "an optimized technological solution to a set of local conditions which includes problem-solving capabilities of indigenous people and a sensitivity to environmental and cultural impacts." [68]

> *Back in 1973, in his book Small is Beautiful, economist E. F. Schumacher noted that donations of high-tech equipment aren't the key to improving living conditions. Many nations don't have the expertise or resources to use the equipment. Why, for instance, export the technology to build an energy-generating dam to a country whose people have neither the education to build or operate it, or an immediate need for it? More likely, they could use equipment to build a rudimentary irrigation system to meet their more pressings need for survival.* [69]

> *An approach deserving the title, "Appropriate Technology," should (1) encourage exchange and contact with the modern sector and with industrial nations only to the extent that such contacts favor the use and the development of local resources and talent; (2) free people from dependence on foreign resources; (3) be characterized by small units of decentralized production; (4) create jobs by adopting techniques that guarantee the extensive use of manual labor; (5) recognize that different countries and peoples have different cultures, priorities and values, and that all technological development in that country should be integrated with those cultures, priorities, and values; (6) be able to function within the capacities, materials and resources locally available; (7) usually be characterized by its simplicity and low cost; (8) have sufficiently flexible guidelines and regulations to allow for adaptation to new conditions or unforeseen difficulties; (9) be compatible with the local ecology; and (10) seek to assure that relevant research will lie in the direction of leading to new initiatives that are both constructive and independent.* [70]

In addition, AT involves tools and techniques that:

- Require only small amounts of capital
- Are relatively labor-intensive
- Are small enough in scale to be affordable
- Can be understood and maintained by the local community
- Can be produced locally
- Are flexible enough to be adapted to other locations [71]

Typical AT projects include:

1. Water supply
    - Rain collection
    - Irrigation methods
    - Shallow wells
    - Deep wells
    - Pumps
    - Water purification

2. Basic energy
    - Run a pump
    - Run a projector
    - Provide some light at night
    - Charge a laptop
    - Sources: solar panels, hydro turbines, wind generators, biomass
3. Village industry
    - Simple manufacturing
    - Wood and metal products
    - Locally available materials

Guidelines for AT: [72]

- Western-style industry cannot be suddenly thrust upon a developing nation or village. Development must be accomplished step by step.
- Conversion to technical industrial practice often displaces the individual artisans of the country (because their training and processes are inconsistent with modern machinery and synthetic materials).
- There must be a careful analysis of what is necessary vs. what is possible, especially with regard to the continuation of the project.
- Realize that any development-no matter how beneficial- requires change, often in a culture that has almost never undergone change.
- Avoid rules and programs that are too rigid.
- Understand that every situation is different.
- Materials and parts should be imported only if absolutely necessary and economically viable.

Aims of AT practitioners:

- Identify needs
- Identify losses, inefficiencies, and bottlenecks
- Provide simple and inexpensive solutions
- Arrange for local maintenance and continuation
- Disseminate information about solutions

Sources of solution ideas

- Traditional practices modified
- Older techniques revived
- Modern techniques reduced in scale
- Do-it-yourself techniques
- Innovative new techniques

Appropriate Technology initiatives involve:

1. cost of development and implementation (+travel)
2. probability of implementation and/or sustainability limitations (failures)
3. risk of community non-acceptance
4. likelihood of unintended consequences
5. payoff in great fulfillment (or disappointment) [73]

Results of AT:

- Sustain life
- Produce local goods
- Provide employment
- Produce community services

STUDENT PROJECTS

An ideal way to introduce students to international needs and the possibilities of applying their talents to help meet those needs is to develop senior design projects based on global humanitarian needs.

Jordan lists the following criteria for successful student projects: [74]

> *Successful projects do not just happen. If the project is to be successful there are some things that need to be done before the project can be implemented. They are:*
>
> *1. Have contacts in the country who are interested in having us do the project and who can act as a resource.*
>
> *2. Know enough details about this project so that the design work can be done during the academic year at our university.*
>
> *3. Raise enough money to pay for travel to the country and to purchase the needed equipment.*
>
> *4. Have someone from our university handle logistics on the ground in the other country so that the faculty member and students can concentrate on the engineering project and not get overwhelmed by just surviving in that country.*

A clear understanding of the need and someone "on the ground" who really understands the needs and the culture are critical to any project.

Guidelines for international humanitarian (IH) student projects: [75]

> *Team formation*
>
> - *Students should be self-motivated to tackle an IH project.*
> - *Self-selected teams may be appropriate, if united by their motivation.*
> - *IH projects may call for teams with interdisciplinary skills.*

Project Selection

- *Partner with individuals knowledgeable about the problem context.*
- *Ideally, partner with individuals already involved with the problem.*
- *Carefully scope projects for feasibility in consideration of the obstacles* involved.

Funding

- *Prepare for higher costs than traditional domestic projects.*
- *Consider philanthropic churches, community groups, and individuals.*
- *Students and their communities may be willing to help fund an IH project.*

Obstacles Identified

- *Plan for international travel which is often critical and difficult.*
- *Partner with knowledgeable individuals for help with travel logistics.*
- *Insure students have an adequate awareness of special design constraints. Travel, contact with individuals, and supplemental lectures and research can help.*

Deliverables

- *Encourage or require delivery of a working design or actionable recommendations to provide motivation, satisfaction, and community rapport.*
- *Avoid assuming that high-technology is required. Creative adaptation and synthesis of low to medium technologies may be appropriate.*

Mentoring &Teaching

- *Seek mentors with problem-related expertise, particularly if faculty lack it.*

Beyond seeing an application of their engineering education, academic benefits from participation in IH projects include:

Allowing students to view the nature of the world today through participant interaction with multiple foreign cultures and institutions.

Sharpening an appreciation for Christian/Western culture and institutions by instructive comparison and contrast with other countries.

Encouraging critical self-assessment of Western culture, such as the comparatively high consumption of resources and prioritization of material pursuits at the expense of relationships.

Experiencing cultural and societal immersion and actively contributing to improving conditions in the host country, when appropriate.

Motivating students to study and apply their gained knowledge through the commitment to the client and providing a context for theory... [76]

For deliverables to achieve the desired high impact on quality of life, several common pitfalls should be avoided. The design must be rugged and durable enough to have

a high potential of surviving local conditions. Additionally, it is important that any required maintenance and parts will be available, preferably in-country. A final consideration is whether the benefactor can realistically afford to implement the project deliverables. If these and other potential barriers to success are overcome, there is realistic potential of the project having a high impact. [77]

Example Projects

Some of the projects in the area of missions/development that our students (at LeTourneau) have tackled in the past few years include:

- Lower limb prosthesis (local parts - cost <$50) (Kenya)
- Stream-powered power generation system (South America)
- Parachute deployment system for flying "car" (ITEC/Maverick/Ecuador)
- Solar chimney for power (Mongolia)
- Small-plot irrigation system (Senegal)
- Modified medical aircraft for missions support (Burma)
- Rapid assembly emergency shelter (Haiti)
- Well-drilling system (Senegal)
- Solar desalination system (Africa)
- Vertical axis wind turbine (Asia)
- Ruggedized wheelchairs (Guatemala, Kenya)
- Disaster relief multi-purpose emergency stove (Caribbean)
- Remote aircraft for missions agriculture (Asia)
- Transport system for medicines (Burma)
- Remote airfield construction vehicle (Burma)
- Fruit dryer for villages (Africa)
- Universal portable power source (Burma)
- Installation of a solar power system in Asia
- Hand-held non-invasive hemoglobin meter (Burma)
- Inexpensive portable surgery table (Africa)
- Similar types of projects have been undertaken for many years at Baylor, Calvin, Dordt, and Messiah.

FINANCIAL APPROACHES TO POVERTY

The "10-40 window" contains not only the largest number of unreached people, but also some of the poorest people in the world.

International development deals with poverty —

The goal is not a utopian dream to end all the poverty in the world but to provide real and lasting help to individuals and communities.

Poverty alleviation must begin with an understanding of poverty. Poverty is more than unequal distribution of wealth. People living in poverty sense the brokenness and hopeless more than the lack of resources. [78]

Financial approaches to poverty

Goal of many projects- to create a source of income for the community

Models:

- Externally funded (kick-start)
- Locally funded
- Start-up loans

Typical types of businesses in Africa:

- Energy production
- Brickmaking
- Agriculture, livestock
- Local arts and crafts- carving, baskets, clothing, musical instruments

Microfinance

Microfinance involves providing very small loans to individuals to begin producing something. This has proven successful in many cases.

> *Microfinance refers to the financial services provided to low-income individuals or groups who are typically excluded from traditional banking. Most microfinance institutions focus on offering credit in the form of small working capital loans, sometimes called microloans or microcredit. However, many also provide insurance and money transfers, and regulated microfinance banks provide savings accounts...*
>
> *Microfinance seeks to address the needs of the unbanked by fostering economic justice and financial inclusion for all.* [79]

Kiva is a nonprofit organization that provides loans for projects around the world. [80]

Richard Stearns tells the story of a couple in Zambia who received a small loan form World Vision to purchase cloth to sell for tie-dying. When he returned four years later the couple had not only paid off the original loan but started ten other businesses. [81]

Microfinance does have some problems:

In one region of Africa unscrupulous lenders flooded the region with loans or charged exorbitant interest. [82]

Unless people learn a few principles of business (pricing, inventory, savings...), their enterprises may not last.

The best source of start-up funds has been from within the community, rather than from outside.

Business solutions to poverty (Polak)

Paul Polak, who disagreed with the concept of microfinance, founded IDE International Development Enterprises in 1981 to bring about his "Out of Poverty" approach.

> *Because of his roots in rural America and his study of psychiatry, two questions always came to mind for Polak: "What makes poor people poor?" And "what can they do about their poverty?"* [83]
>
> *The nearly three billion people living on $2 a day are not just the world's greatest challenge—they represent an extraordinary market opportunity. The key is what Paul Polak and Mal Warwick call Zero-Based Design: starting from scratch to create innovative products and services tailored for the very poor, armed with a thorough understanding of what they really want and need, and driven by what Polak and Warwick call "the ruthless pursuit of affordability."* [84]
>
> *The common vision of poverty is perhaps one of crowded cities in India, Mexico or Africa. While these perceptions are valid, it might be surprising for some to learn that many of the world's poor are farmers subsisting on the equivalent of a dollar per day.*
>
> *Since many of those that fall under this definition of poverty—approximately 800 million—are farmers, Paul Polak has proposed that the way out of poverty is very simple: increase the amount of money that a farmer can make on his own land.* [85]

Paul Polak's concepts:

- Business is better equipped to eradicate world poverty than nonprofits or governments.
- Promising governmental and philanthropic efforts to end poverty have not reached scale because they lack the incentives of the market to attract massive resources
- We must talk to people about what they believe would help them advance out of poverty
- Big business and its models only help if they produce products that the poorest can actually afford.
- Establish actual businesses with a business plan and a profit margin.
- "We do need growth to end poverty, but that it must happen in the remote areas where these farmers live and work. It also must happen in the slums of the large cities, not just in the suburban areas."
- Set specific goals for revenue and for poverty alleviation. "Recovery programs must be well defined and aimed at specific targets. They cannot be broad-based industrial programs lacking a defined purpose." [86]

Paul Polak worked hard and realistically to create solutions to some of the world's most challenging poverty.

> *Below are his twelve steps to Practical Problem Solving:* [87]
>
> *Step 1: Go to where the action is*
>
> *Step 2: Talk to the people that have the problem and listen to what they have to say*

Step 3: Learn everything you can about the problem's specific context.

Step 4: Think big and act big

Step 5: Think like a child

Step 6: See and do the obvious

Step 7: If somebody has already invented it, you don't need to do so again.

Step 8: (part 1) Make sure your approach has positive measurable impacts that can be brought to scale

Step 9: Design to specific cost and price targets.

Step 10: follow practical 3 year plans.

Step 11: Continue to learn from your customers.

Step 12: Stay positive: Don't be distracted by what other people think.

Here's an example from EWB:

In Afghanistan, an alternative fuel source to wood was needed because forests had been clear-cut in that country's successive wars. Engineers Without Borders designed a simple press to make fuel briquettes out of paper and sawdust, and was instrumental in rescuing 20 children from a prostitution ring by employing them in the fuel business.

"With a limited amount of funding — about $10,000 — we were able to build a business from the bottom up," said Amadei. [88]

Business as Mission (BAM)

C. Neal Johnson, author of *Business as Mission* [89], defines BAM as "a for-profit commercial business venture that is Christian-led, intentionally devoted to being used as an instrument of God's mission to the world...and is operated in a cross-cultural environment..." [90]

Such business enterprise has the potential to generate new wealth and resources in developing countries through a combination of creativity, risk and work, to provide important goods and services, and to build networks of human relationships. These natural fruits of honest, competent business activity also provide opportunities for a broad range of mission activities, addressing spiritual needs hand in hand with social, economic and environmental needs. [91]

Objectives of a BAM entrepreneur:

- Create jobs and provide dignified work for poor or marginalized communities.
- Profitably introduce essential goods or services into an impoverished community.

- Model good environmental stewardship, including the wise use of natural resources.
- Transfer skills and training, spinning off new businesses and encouraging entrepreneurship.
- Through skilled and honest business leadership, become a respected and influential voice in the community.
- Model biblical principles and sound business ethics.
- Become a witness of Jesus in word and deed in the context of everyday life.
- Disciple newer Christians through the organic relationships arising from business activity.
- Strengthen the local church, helping to establish new church plants or providing economic stability for believers.
- Use some of the business's profits to fund community or church projects [92]

CONCLUSIONS

International development is a clear fit for both mission organizations and engineers. The goal must be simply to help people with the love of Christ.

International development may not change a nation, but it may change a village or a community.

International development doesn't have to be a publicized success. It simply has to help. A project might be considered successful if it is useful and not abandoned and done in the name of Jesus.

The Engineer of 2020 Report (2004) included this phrase: "We aspire to a future world where engineers are prepared to adapt to changes in global forces and trends and to ethically assist the world in creating a balance in the standards of living for developing and developed countries alike." [93] (The focus of international development is to improve the living standard of the poorest people without necessarily lowering the standards of the developed world.)

REFERENCES

1. Ref- Southwick, N., "A volunteer's guide to international development," https://www.gooverseas.com/blog/a-volunteer-guide-to-international-development
2. Amadei, B., *Engineering for Sustainable Human Development*, ASCE, 2014.
3. Stearns, R., *The Hole in our Gospel*, Thomas Nelson, 2010, p. 150.
4. Stearns, p. 57.
5. Stearns, p. 60.
6. Stearns, op. cit.
7. Stearns, p. 105.
8. Stearns, p. 104.
9. Stearns, p. 201.
10. Stearns, p. 202.
11. Stearns, op. cit.
12. The Lausanne Movement, First Lausanne Congress, *The Lausanne Covenant*, 1974.
13. *The Lausanne Covenant*, p. 12-13.
14. *The Lausanne Covenant*, p. 63.
15. Suggested by Phil Skellie, initial director of CAMA Services, 2005.
16. Engineering for Hope https://www.engineeringforhope.org/
17. Corbett, C., and Fikkert, B., *When Helping Hurts*, Moody, 2009, p.133.
18. Spitters, D. and Ellison, M., *When Everything is Missions*, Pioneers USA, 2017, Foreword.
19. Lupton, R., *Toxic Charity*, HarperOne, 2011.
20. Ibid.
21. Corbett and Fikkert, op. cit., p. 100.
22. Corbett and Fikkert, p. 101.
23. Corbett and Fikkert, op. cit.
24. Corbett and Fikkert, p. 136.
25. Corbett and Fikkert, p. 140.
26. Bryant Myers, quoted in Corbett and Fikkert, p. 59.
27. Winston, B., "Let Them Eat Laptops," Int'l. J. *Communication* 1(2007) Feature, p. 170-176.
28. Lynn, M., Gailey, R., and Reese, D., *Development in Mission*, Abilene Christian University Press, 2021.
29. Ibid.
30. Ibid.
31. United Nations, *Sustainable Development Goals*, https://sdgs.un.org/

32. Ibid.
33. Dutta, S.,"The SDGs and India," in *Sustainable Development Goals*, *Drishtikone* (EFICOR) (2000), p. 12-14.
34. Farley, H., "Ambitious, but limited," *Christianity Today*, Sept. 24, 2015. https://www.christiantoday.com/article/ambitious-but-limited-the-sustainable-development-goals-lack-a-christian-perspective/65692.htm
35. Sphere Project, "Minimum Standards of Disaster and Rehabilitation Assistance" (2004), quoted in Corbett and Fikkert, p. 106-108.
36. Wikipedia definition
37. Mitcham, C., and Munoz, D., *Humanitarian Engineering*, Morgan and Claypool, 2010.
38. Colorado School of Mines: https://humanitarian.mines.edu/
39. Purdue: https://engineering.purdue.edu/ENE/Academics/Undergrad/MDE/PlansofStudy/humanitarian-engineering
40. Ohio State: https://global.engineering.osu.edu/humanitarian-engineering-overview
41. Oregon State: https://humanitarian.engineering.oregonstate.edu/
42. Mitcham and Munoz, op. cit.
43. Ibid.
44. Ibid.
45. Passino, K., *Humanitarian Engineering*, Bede Publishing, 2016, p. 692.
46. Kevin Passino website https://ece.osu.edu/humanitarian-engineering-book
47. Passino, p. 692.
48. Amadei, op. cit.
49. Engineers Without Borders website https://www.ewb-usa.org/
50. Aneez, Z., "Engineering with mind, heart, and soul," *The Hindu*, May 27, 2014. https://www.thehindu.com/features/metroplus/society/engineering-with-mind-heart-and-soul/article6053284.ece
51. Ibid.
52. Engineers Without Borders, op. cit.
53. Mitcham and Munoz, op. cit.
54. Ibid.
55. Amadei, B., *A Systems approach to Community Development Projects*, Momentum Press, 2015.
56. Amadei, 2015, p. xi.
57. Amadei, 2015, p. 2.
58. Amadei, 2015, p. 6.
59. Caldwell, R., *Project Design Handbook*, CARE USA, 2002.

60. Jordan, W., "Christian Humanitarian Engineering," Am. Scientific Affiliation Annual Conference, 2013.
61. Ibid.
62. Maurice Albertson, quoted in Mitcham and Munoz, op. cit.
63. ARDF, "What is 'Christian' International Development?" https://ardf.org/blog/what-is-christian-development-2018
64. EMI website https://emiworld.org/
65. Da Costa, J. F., "Twelve 'musts' for development," *UNESCO Courier*, 32(11) p. 10-11, 1979.
66. Waller, D., "Sustainability - The Development Engineer's Viewpoint," *CEA Perspective*, Summer 2007.
67. Valenti, M., "Appropriate technology: Designing to fit local culture," *Mechanical Engineering*, June 1991, p. 64-69.
68. Le Sieur, H., *Appropriate Technology and Scaling Considerations for Developing Countries*, USAID, 1979.
69. Zuspan, W., "Appropriate Technology," *Drexel University News*, 1986.
70. Ramon, J. and Bube, R., "Appropriate technology for the third world," *J. Am Sci. Affil.* Vol. 37(2), June 1985, p. 66-71.
71. Darrow, K., and Saxerian, M., *Appropriate Technology Sourcebook*, Volunteers in Asia, 1986, p7.
72. Ramon and Bube, op. cit.
73. Farison, J., Appropriate Technology Panel, Christian Engineering Education Conference, 2004.
74. Jordan, W., "Using appropriate technology and social entrepreneurship to help transform poor communities," ASEE Annual Conference, 2008.
75. Green, M. and Wood, K., "Service-Learning Approaches to International Humanitarian Design Projects: Assessment of Spiritual Impact," Christian Engineering Education Conference, 2004.
76. Ibid.
77. Ibid.
78. Corbett and Fikkert, p. 49-51.
79. Finca, "Microfinance," https://finca.org/our-work/microfinance/
80. Kiva.org https://www.kiva.org/about
81. Stearns, op. cit.
82. Greer, P., "Microfinance," *Mission Frontiers* July-Aug. 2011, p. 9-10.
83. De Gier, "Out of Poverty: What Works?" Vision.org https://www.vision.org/review-paul-polak-out-of-poverty-what-works-924
84. *Review of The Business Solution to Poverty* by Polak and Warwick, https://paulpolak.com/books/

85. De Gier, op. cit.
86. Polak, P., *Out of Poverty*, Berrett-Koehler, 2009.
87. Makezine, "Twelve Steps with Paul Polak," https://makezine.com/article/science/energy/12-steps-with-paul-polak/
88. Macmillan, L., "Engineering for Humanity," *Tufts Journal*, November 2008 http://tuftsjournal.tufts.edu/2008/11_2/features/03/
89. Johnson, C.N., *Business as Mission*, IVP, 2009.
90. Ibid.
91. Poverty Cure, "BAM-Objectives of the BAM Entrepreneur," https://www.povertycure.org/learn/issues/entrepreneurial-spirit/business-mission
92. Ibid.
93. National Academy of Engineering, *The Engineer of 2020 Report*, 2004, p.51.

CHAPTER 27: EXAMPLES OF CHRISTIAN ENGINEERS

INTRODUCTION

In this chapter we want to highlight four engineers who clearly saw their work as a ministry for God, accomplishing great things with their talents:

- R.G. LeTourneau
- Wilson Greatbatch
- Herb Jacobsen
- Ken Crowell

Three of the four served in the military. Three created companies to manufacture their creations. All four faced struggles in carrying out their work. All were humble before the Lord, knowing that He had orchestrated what they accomplished.

R. G. LETOURNEAU

R. G. LeTourneau completed only an eighth grade formal education but became one of the most prominent inventors in our nation's history. LeTourneau developed numerous earthmoving machines, huge construction equipment, and the first jack-up offshore drilling rigs.

Robert Gilmour (R.G.) LeTourneau was born November 30, 1888 in Richford, Vermont. At the age of fourteen he headed out to make a living, first in Duluth, Minnesota, then in Portland, Oregon. He began by working in an iron foundry.

> *He moved from Vermont to Duluth, Minnesota, then to Portland, Oregon, where he began to work as an apprentice ironmonger at the East Portland Iron Works. While learning he foundry and machinist trades, he studied mechanics from an International Correspondence Schools course that had been given to him, though he never completed any course assignments. He later moved to San Francisco, where he was employed at the Yerba Buena Power Plant and learned welding skills and became familiar with the application of electricity. In 1909, he moved to Stockton, California. During this time, LeTourneau worked at a number of jobs including wood cutter, farm hand, miner and carpenter's laborer, acquiring a sound knowledge of the manual trades that would prove invaluable in later life.* [1]

In 1911 LeTourneau became partner (half-owner) in the Superior Garage, where he also worked as an automotive mechanic. During World War One he did not serve because of a neck injury. Instead, he worked as a maintenance assistant at Mare Island Naval Shipyard in Vallejo, California, where he received training as an electrical machinist.

He returned to Stockton to find that the garage business had failed. He then repaired a Holt tractor and used it along with a scraper to level a 40 acre plot. This began a decade of work as a dirt-moving contractor.

> *The year was 1919 and as a Christian, he felt the tug to be doing more for God. He went to his pastor, Reverend Devol, for advice. RG thought that anyone who was wholly committed to Christ had to become a pastor or a missionary to truly fulfill the great commission. After deep prayer with his pastor, RG LeTourneau was shocked to hear Rev. Duvol say the words that guided him for the rest of his life, "God needs businessmen too." This was a revelation to RG. He immediately began to consider his business to be in partnership with God.* [2]

While operating his equipment day after day, R.G.'s mind was racing with possible alterations that he wanted to try: using motors to drive the wheels, using telescoping buckets, adjusting the tilt of the blades, adding reducing gears, replacing wheels with tractor treads,... [3]

In 1933 he began manufacturing earth-moving equipment, establishing a factory in Peoria, Illinois in 1935. His initial breakthrough was in the use of rubber tires on heavy earth-moving machinery and using an all-welded, instead of riveted, frame.

Additional factories were later established in Toccoa, GA, Vicksburg, MS, and Longview, TX (including a small steel mill). The plant in Longview later sold to Marathon Manufacturing, the Rowan Corporation, Joy Global, and Komatsu Mining.

During WW2 the military needed 400 bases and 100 airfields. 70% of those were built with LeTourneau equipment.

In 1946 R.G. and his wife Evelyn flew over the former U.S. Army Harmon General Hospital grounds in Longview, Texas and concluded that this was the ideal site to train local employees, particularly former GI's. The training center became LeTourneau Technical Institute, then LeTourneau College, then LeTourneau University.

In 1956 LeTourneau designed a mobile sea platform for offshore oil exploration. His jack-up offshore oil rig became the workhorse of Zapata Oil, the firm run by George H.W. Bush.

> *The "Scorpion" rig was something to see. It stood 186 feet long and 150 feet wide on three huge legs, each 140 feet long. All of the steel and most of the components had been made at LeTourneau's main plant in Longview. Actual fabrication was done on the banks of the Mississippi River at LeTourneau's Vicksburg plant.* [4]

Over the course of his career R.G. LeTourneau received 299 patents. Between 1942 and 1945 he developed 78 inventions. He is credited as the inventor of:

- The scraper machine (1923- his first patent)
- Two wheel tractor -1946
- Tournapull -1948
- Bulldozer with pneumatic tires- 1953

- Electric wheel- 1955
- Excavating machine -1956
- Tree crusher -1958
- Earthworking scraper -1965

Other inventions included dredges, cranes, rollers, dump wagons, bridge spans, jungle crushers, housemovers, logging equipment, overland trains, loaders, and concrete castings.

Between 1953 and 1961 LeTourneau established a ministry work in Peru (which he named Tournavista). After successfully building a road through the jungle, he received a sizable plot of land, where his family built a farm, an airstrip, a school, a ranch, and a church. He also established Christian camps in New York and Indiana.

For many years R.G. flew almost every week to various cities to speak with businessmen and share his testimony.

His key ideas:

- Everyone needs Christ, including successful businessmen
- Laymen can serve the Lord as well as ordained clergy
- Life is not about work vs. worship but serving God in everything we do

R.G. LeTourneau also developed a remarkable concept of stewardship:

> *In 1935, with the gigantic profits pouring out of the manufacturing business, at the gentle suggestion of his wife Evelyn, they transitioned to a 90/10 split with the Lord. 90% went to the Lord and 10% went to RG and Evelyn. LeTourneau was fond of remarking, "It's not how much of my money I give to God, but how much of God's money I keep for myself." With the money, they established the LeTourneau Foundation to manage the administration of donations. By 1959, after giving $10 Million in donations to religious and educational works, the LeTourneau Foundation was still worth some $40 Million.* [5]

R.G. LeTourneau died June 1, 1969 in Longview, Texas at the age of 80. His Impacts expanded from the amazing equipment to the talks and testimonies and eventually to the university.

> *Dr. Dale Lunsford, President of LeTourneau University describes LeTourneau like this: "Through bottomed-out economies, personal catastrophe, bad business partners, short deadlines, breakdowns, hard decisions—and repeatedly facing off against real mountains-he knew who God was, so he knew who he was."* [6]

WILSON GREATBATCH

Wilson Greatbatch was an electrical engineer who became one of the leading inventors of medical equipment.

Wilson Greatbatch was born September 6, 1919 in Buffalo, New York. As a boy he was interested in radio technology and experimentation with electronics.

"He began attending church to receive a prize. When his Boy Scout troop offered the boys ten points for each service, Greatbatch regularly sat under gospel preaching." [7]

Greatbatch enlisted in the US Navy during World War Two, serving in both the Atlantic and Pacific operations as an aviation chief radioman. Under fire, he made an agreement with God to live for Him if God spared his life. Unlike most "foxhole conversions," this one was real. He became a serious student of the Bible and sought the Lord's direction for all his major decisions from then on. "When he reflected on his war experiences … in 2008, he said, 'A lot of people died, but I was spared. Apparently, God had other plans for me.' " [8]

Following the war, Wilson Greatbatch attended Cornell University to study Electrical Engineering. He continued at Cornell working on electronic instrumentation in animals at Cornell's Animal Behavior Farm. He later completed a Master's degree from the University of Buffalo in 1957.

In 1951 at Cornell he learned about the problems of heart conduction: irregular beats and total heart blocks. In 1951 at Cornell he learned about the problems of heart conduction: irregular beats and total heart blocks. (Heart block is the condition where the contraction of the heart's upper chambers (right and left atria) fails to trigger contraction of the heart's lower chambers (right and left ventricles)).At that time the only solution was a large external device (about the size of an early television) to deliver a high-voltage electric shock. The device burned the patient's skin was so painful that many patients would disconnect themselves and risk death rather than endure the shocks.

In 1956, while working as an assistant professor of electrical engineering at the University of Buffalo, Wilson Greatbatch was experimenting with a transistor circuit for heart sound recording when he made a simple mistake. Instead of grabbing a 10 K ohm resistor he picked up a 1 M ohm resistor and soldered it into his circuit. The result was a repeated pulse about one second apart –the exact sound of a heartbeat.

> *"It was no accident, the Lord was working through me… The oscillator required a 10 KΩ resistor at the transistor base. I reached into my resistor box for one, but I misread the color coding and got a 1 MΩ resistor by mistake." When he plugged in the resistor, the circuit started to "squeg" with a 1.8 millisecond pulse followed by a 1 second interval during which the transistor drew practically no current. "I stared at the thing in disbelief," Greatbatch said. He immediately realized that this small device could drive a human heart.* [9]

His employer, Taber Instrument Company, was not interested in developing a pacemaker or tackling the risks involved. "I put it to the Lord in prayer and felt led to quit all my jobs and devote my time to the pacemaker," Greatbatch said. [10]

Working in the barn behind his house Greatbatch spent the next two years miniaturizing and perfecting the circuit. He drew out his savings and enlisted the help of his wife, Eleanor, in setting

up and testing fifty pacemaker circuit designs built by hand. After successfully providing a pulsing beat to a dog, he worked with a local surgeon, Dr. William Chardack of the Buffalo Veteran's Hospital, to implant a pacemaker into a human patient who needed one.

> *In 1960 the team implanted Greatbatch's pacemaker in ten human patients, including two children. The following year, Greatbatch sold the licensing rights to Minneapolis-based Medtronic, which had developed an external pacemaker, and went on to serve the company as a consultant for many years.* [11]

The following year he established Mennen-Greatbatch, Inc. in Clarence, New York to make heart monitors and pacemaker parts.

By 1970, after several years of success with pacemaker circuits, Wilson Greatbatch was convinced that the weak point in pacemakers was not the circuitry but the battery. Zinc-mercury batteries lasted only a couple of years, then had to be replaced, requiring another surgery and a new pacemaker. He sold his interest in the pacemaker company and began development work on lithium iodide batteries for pacemakers, which could last at least ten years. Wilson Greatbatch Ltd. eventually produced 90% of the batteries for pacemakers.

Throughout his life Greatbatch continued exploring and inventing. He eventually held over 300 patents. His later work involved a solar powered canoe, alternate energy sources, intracellular electroporation as a treatment for AIDS, methods of combatting viral infections, and fusion energy.

Reflecting on the value of learning from failure and from failed experiments, Greatbatch told an audience at a graduation: "I don't think the good Lord really cares whether you succeed or whether you fail, but I think He wants you to try, and to try hard, and that's all that's required of you. My most abject failure may be part of some grand success in His sight and may not take place in my lifetime. So I should not fear failure, but at the same time I should not crave success..." [12]

Wilson Greatbatch died September 27, 2011 at the age of 92 in Amherst, New York. Nearly a million pacemakers are implanted in heart patients throughout the world each year.

Wilson Greatbatch was a follower of Christ who acknowledged that God gave him the ideas for his devices. He spoke at local meetings of the American Scientific Affiliation and at Science and Faith conferences. He served with the Gideons in Western New York and supported Houghton College, a Christian school, where he also served as an adjunct professor.

When asked about his legacy for future generations, Greatbatch once said: "If you want to know what I want to be known as: it is as one of the Lord's smaller people." [13]

HERB JACOBSON

Herb Jacobson studied electrical engineering and headed to the mission field in 1949 as an engineer with HCJB radio in Ecuador.

Herbert Paul Jacobson Jr. was born October 5, 1925 in Minneapolis, Minnesota. He became a Christian at age 8 and began moving towards missions at age 18.

> *"At 8 I accepted the Lord, and at 18 I considered serving Him overseas," Herb recounted. "But my capabilities and gifts didn't coincide with typical missionary work. At university—through Inter-Varsity Christian Fellowship—the Lord gave me a solid conviction that He wanted me on the mission field."* [14]

He attended the University of Minnesota, studying electrical engineering and graduating in 1947.

Herb joined the Navy and worked as a radar technician. One day during a submarine exercise he picked up a Gospel radio broadcast from Quito, Ecuador.

For a short time he worked as a radio engineer while taking courses at Bethel Seminary (three semesters). In 1949 he studied Spanish in Medellin, Colombia. In Medellin he met Norma Peterson, who was preparing to work as a missionary nurse. They married the following year.

Later in 1949 he came to Quito, Ecuador to continue his language learning and began working at radio station HCJB ("Heralding Christ Jesus' Blessings"), which broadcast to all of South America.

Herb's work included:

- Locating land for the international transmission site in Pifo, Ecuador
- Designing the 50 KW, 100 KW, and 500 KW transmitters
- Designing antennas for the broadcasts
- Repairing computers

In 1990 Herb returned to the United States to work at the HCJB World Radio Center (Global Technology Center), which had been established in 1986 in Elkhart, Indiana. The Technology Center continues today as the mission organization SonSet Solutions.

In 1996 Herb Jacobson received a patent for a power supply modulator circuit for radio transmitters. The description reads:

> *The present invention relates to a power supply modulator for a radio transmitter having apportioned input impedance and buffered switching of power modules. A series arrangement of power supply modules, conventionally disposed in a diode cascade, includes individual inductors to apportion the input impedance of the switching power supplies. The switching sequence of the power supplies is controlled by a FIFO buffer, with the sequentially adjacent power supplies being disposed physically remote so that current transients and thermal loads are more uniformly distributed.* [15]

After 41 years in Ecuador and 24 years at the technical center, Herb Jacobson served HCJB for 65 years. He continued working at the Technical Center on digital radio technology until shortly before he died. He was widely read in all of science and one of the world's experts in radio engineering.

Herb Jacobson died October 8, 2014 in Elkhart, Indiana at age 89. Millions have heard the Gospel through radio thanks to his work.

KEN CROWELL

Ken Crowell was an engineer and Bible student who established a major corporation to bless Israel.

Kenneth Eugene Crowell was born June 1, 1932. He became a Christian as a young man.

After he completed high school, Ken was drafted and served in the Army during the Korean War (1952 to '54). During this time he learned helicopter maintenance. He returned home and married Margie, who was his lifetime partner in ministry.

For five years Ken worked as a draftsman for the Aero Jet Corporations and managed a Bible bookstore in Placerville, California. During this time he began sensing that God could use him in mission work.

Ken Crowell studied at Multnomah Bible College and at Western Baptist Seminary in Oregon. He worked for several years as a test engineer and technical advisor at Tektronix, Inc., manufacturer of oscilloscopes, all the while sensing a pull to ministry in Israel. [16]

> *About three months prior to graduation from Western Seminary, Ken received a call from Motorola wanting him to fly to Chicago for an interview. Motorola was working on a project in Israel and needed an engineer. Ken went for the interview and after he returned home, Motorola sent him an envelope containing the job offer. The job was for a three-year project.* [17]

> *Ken first came to Israel with Motorola in 1969. He and his wife Margie saw how natural it was to open their home for spiritual dialogue and Bible study with Jewish company employees. Ken began to contemplate the prospects of establishing his own enterprise in the country. What could be done, he wondered, if he were to have his own company, free form any policy restrictions? A place where God's word could be shared freely throughout the course of each day? A company where the management was comprised entirely of qualified believers who manifested genuine love and concern toward each employee?* [18]

Ken returned to the U.S. at the end of three years and worked for Motorola in Florida.

> *Ken noted that antennas made for Motorola's hand-held radios might offer a niche for a business since development of these antennas was not getting much attention. He also noticed that expertise in radio frequency (RF) antennas was not being taught in engineering schools, with the result that this skill had to be taught on the job.* [19]

Ken Crowell left Motorola and established a small antenna manufacturing firm in Florida. He petitioned the Israeli government for permission to transplant the company to Israel, in the Galilee region. By 1978 he received the charter that allowed him to proceed.

In 1979 Crowell moved his family to Tiberias, Israel with the purpose of manufacturing parts for Motorola and blessing the land of Israel.

Galtronics was started with three major goals:

- To be a Christian witness
- To provide local employment, especially for Messianic Jews
- To bless the land of Israel

> *Since they did not have the money they had planned on, they began the new Israel-based company on a shoestring. Ken's first factory in Israel was in Margie's kitchen*! *His workbench was an x-ray table that had been discarded. It was there had he assembled antennas for Motorola's walkie-talkies. To cure the black, sticky PVC plastic used to make the antennas, he baked them in Margie's oven. This regularly smelled and smoked-up the house. Finally Margie gave an ultimatum: Ken could have antennas or cookies, but not both*! *Fortunately the mayor of Tiberias helped them secure a suitable manufacturing building.*
>
> *The Lord had groomed Ken for five decades for the work that He had for him. In what seemed like rapid fire order, the 1980s were a time for the harvest and the blessing of Israel.* [20]

Galtronics, Inc. became a leading producer of flexible ("rubber ducky") antennas for mobile radios and, later, antennas for the global cell phone market. The firm has won numerous national awards for quality and production. Messianic Jews, secular Jews, Palestinians, and American Christians worked side-by-side in the factory as a model of cooperation and brotherhood. Many in the plant came to Christ, and a multi-ethnic church was established in Tiberias.

> *The Crowells also saw the firm as a modern-day parallel to the biblical city of refuge, and, as such, offered employment to hounded converts from both Muslim and Jewish backgrounds, impoverished Arab villagers, needy Jewish immigrants (especially from the USSR), and handicapped individuals of both races.* [21]

Over the years Galtronics expanded into the "Gal Group" of companies, including:

- The Galilee Experience -a sight-and-sound experience of the Galilee region for tourists
- Galcom - manufacturer of fixed-tuned radios
- Galadon- maker of communion grape juice from local farms

In 1989 at a missions conference (IFMA- Interdenominational Foreign Missions Association) Ken met two others with a vision for special radio ministry, Allan McGuirl of Gospel Recordings and businessman Harold Kent. Together they launched Galcom International to manufacture (in Israel) "Go-Ye" radios. These are solar powered fixed-tuned radios (tuned to major shortwave Gospel broadcasting stations) for distribution to unreached people. Over a million of these radios have been distributed in 140 countries.

Along with Tom Treseder and Rudolph Geigy Ken was part of developing Mega-Voice, a solar-powered audio player that holds the Bible and Bible stories. Over six hundred thousand of these are in circulation.

The company name, Galtronics, did not originate from Galilee but from the Hebrew word "Gal"

meaning to commit, to roll onto, from Psalm 37: 5: "Commit your way unto the Lord, and He will bring it to pass." [22]

> *Asked what he learned through all his experiences, Ken said, "I would say seek the Lord to know what He wants you to do as an emphatic, to know exactly what you ought to do and then Gol al Adonai, roll it over on Him and do it as you are led."* [23]

Ken Crowell died January 25, 2012 in Israel. Between Galtronics, Go-Ye radios and Mega-Voice players he impacted hundreds of thousands of people worldwide.

OTHER EXAMPLES OF CHRISTIAN ENGINEERS

Dr. Walter Bradley – Taught mechanical engineering at Texas A&M (chair) and Baylor. Worked with establishing CRU's faculty leadership ministry. Co-author of The Mystery of Life's Origin. Began appropriate technology studies at Baylor.

Fred Brooks (dec.) – Software engineer. Managed development of the IBM 360 family.

Dr. Richard Bube (dec.) – Taught electrical engineering and materials science at Stanford. Author of seven books on photovoltaics and photoconductivity.

Dr. Cullen Buie – Professor of mechanical and biological engineering at MIT.

Dr. Stuart Burgess – Mechanical engineering professor at Bristol and Cambridge. Expert in joint biomechanics.

Dr. Graeme Clark – Engineer and medical researcher. Developer of the cochlear implant.

Gen. Charles Duke – NASA astronaut. Part of Apollo 16 mission in 1972.

Dr. C. Daniel Geisler (dec.) – Professor of electrical engineering and neurophysiology at Univ. Wisconsin. Researcher in hearing mechanisms.

Pat Gelsinger – Computer engineer. Design manager for the Intel 486. Founder of several high-tech start-ups.

Dr. Roger Gonzalez – Taught Biomedical Engineering at LeTourneau. Developed low-cost lower limb prosthetic. Founded LIMBS International. Director of Leadership Engineering at UT El Paso.

Don Hastings – Antenna engineer. Designed several antenna systems for HCJB in Ecuador.

Dr. Otto Helweg (dec.) – Engineering dean at North Dakota State. Special consultant on water resources to government of Uganda.

Jim Irwin (dec.) – Aeronautical engineer at NASA. As an astronaut on the Apollo 15 mission, walked on the moon in 1971.

John Kiker (dec.) – Mechanical engineer/USAF/ As a NASA engineer designed the "piggy-back" transport system for the space shuttle.

Dr. Robert Marks – Electrical engineering professor at Baylor. Director of the Bradley Center for Natural and Artificial Intelligence.

Clarence Moore (dec.) – Radio engineer. Designed the quad antenna system for HCJB radio in Ecuador. Founder of Crown International audio company.

Ken Olson (dec.) – Pioneer in computer design. Founder of the Digital Equipment Corporation.

Dr. Rosalind Picard – Director of the Affective Computing Research Group at MIT.

Nate Saint (nephew of the martyred pilot with the same name) – LeTourneau graduate. Designer of the PackNPlay for Graco. Founder of Iron Mountain LLC.

Dr. Leo Setian – Taught electrical engineering at John Brown U. Author of multidisciplinary text on field theory.

Karsten Solheim (dec.) – Engineer for GE. Invented the PING golf club and founded the company to manufacture them.

Gary Starkweather (dec.) – An engineer for Xerox Corp. and Microsoft. Inventor of the laser printer.

Dr. Aldert Van Der Ziel (dec.) – Taught electrical engineering at University of Minnesota. Author of the classic text on Noise.

Prof. Bill Zuspan (dec.) – Dean of Freshman engineering at Drexel University. Founder of Appropriate Technology program at Drexel.

REFERENCES

1. "R.G. LeTourneau," https://tractors.fandom.com/wiki/R._G._LeTourneau
2. Giants for God, "R.G. LeTourneau," http://www.giantsforgod.com/rg-letourneau/
3. LeTourneau, R.G., Mover of Men and Mountains, Moody Press, 1967.
4. Craddock, V., "R.G. LeTourneau had 'Mystic' Touch," https://www.sfasu.edu/heritagecenter/9931.asp
5. Giants for God, op. cit.
6. Peel, B., "Lessons about overcoming obstacles from R. G. LeTourneau," https://www.patheos.com/blogs/missionwork/2015/10/4-lessons-about-overcoming-obstacles-from-r-g-letourneau/
7. Hill, M., "Wilson Greatbatch, Presbyterian Elder and Pacemaker Inventor Dies," https://theaquilareport.com/wilson-greatbatch-presbyterian-elder-and-pacemaker-inventor-dies/
8. Ibid.
9. Mouton, B., "Dr. Wilson Greatbatch," https://boycemouton.com/downloads/DR_GREATBATCH.pdf
10. Adam, J., "Innovative Lives: Making Hearts Beat," https://invention.si.edu/innovative-lives-making-hearts-beat-wilson-greatbatch
11. Holmes, C., "Wilson Greatbatch, 1919-2011," *Memorial Tributes*, National Academy of Engineering, v. 18, p. 113-116, 2014.
12. Lemelson Foundation, "Wilson Greatbatch, 1996 Winner, https://lemelson.mit.edu/award-winners/wilson-greatbatch
13. Hill, M., op. cit.
14. Reach Beyond, "Herb Jacobson Honored for 65 Years of Ministry," https://reachbeyond.org/content/news/read/veteran-engineer-redefines-retirement-honored-for-65-years-of-ministry
15. Jacobson, H., "Power Supply Modulator Circuit for Transmitter," U.S. Patent 5736906, 1998.
16. Goheen, W., *The Galtronics Story*, Wipf and Stock, 2004.
17. Kersey, K., "Used by God to Bless Israel, Pt.1," https://www.godsotherways.com/stories/2019/6/12/man-with-a-vision-from-god-blesses-israel-part-1
18. Otis, G., and Brink, G., "Tentmaking Today: Entrepreneurial Tentmaking," *Strategic Times Journal*, May-June, 1990, p. 6-8.
19. Kersey, K., "Used by God to Bless Israel, Pt. 2," https://www.godsotherways.com/stories/2019/6/12/used-by-god-to-bless-israel-2
20. Ibid.
21. Otis and Brink, op. cit.
22. Mitchell, C. and Stahl, J., "US Pioneer Ken Crowell Dies, Leaves Legacy in Israel," Charisma News,

https://www.charismanews.com/us/32732-us-pioneer-ken-crowell-dies-leaves-legacy-in-israel

23. Ibid.

CHAPTER 28: SUMMARY AND CONCLUSIONS

ENGINEERING

Regardless of the discipline, engineering is defined as the practical application of science and mathematics to the benefit of mankind. Its history traces back hundreds of years, paralleling the development of modern science. Various disciplines, along with formal education, developed more recently: electrical engineering (1880s), chemical engineering (1880s), biomedical engineering (1960s), computer engineering (1970s). To the basic math and science foundation modern engineering adds certain "soft skills," what the National Academy of Engineering has termed "six habits of mind": communication, collaboration, creativity, systems thinking, ethical thinking, and optimism (including learning from failure). [1]

Engineering is certainly an appropriate vocation for a Christian. Robert Sloan commented that

> *Engineering is the practice of taking ideas, conceptions, and information and translating them into some kind of ordered reality... Engineers take all that can be known, confront a problem, and then try to bring an order to it. They bring organization and functionality. It's beautiful and artistic, and at the same time, it works. It contributes towards the flourishing of life in the world. That's what engineers do, and from the text of Scripture, that's what we're called as human beings to do.* [2]

FAITH

We have seen that real faith is not a blind leap in the dark but rather a deep trust based on evidence. Christian faith ("saving faith") is specific trust in the Person of Jesus Christ and His action of dying on the cross as substitute and payment for my sins.

Faith is not the enemy of reason but a different category altogether. It is, in fact, reasonable to trust in the God of the Bible if the evidence leads there. Just as we can't boast about grabbing a life-saver thrown to us to keep us from drowning, there is no merit to us in putting our trust in Jesus. It is the least non-zero thing we can do, and even it originates from God.

CHRISTIAN TRUTH

The Christian message begins with an infinite Creator, triune, holy, and loving and the observable fact that all humans sin and fall short of His holiness. The Son of God came to bring eternal life. (John 3:16). All of history then falls into a "grand narrative" of four parts: (1) God's Creation, (2) our Fall into sin, (3) Christ's Redemption, and (4) Restoration (begun now and completed when Christ

returns).

CHRISTIAN LIVING

The Christian life encompasses several dimensions: relating to God (trusting in God, abiding in Christ, waking in the power of the Holy Spirit); relating to self (knowing our purpose and value, avoiding sin, including greed and impurity); relating to others (showing compassion, kindness, humility, gentleness, patience); making Christ known; applying God's truth in all of life; seeking justice for the oppressed.

Christian growth and Christian living are built upon Bible study, prayer, worship, and fellowship. The Bible is uniquely inspired ("God-breathed"). It was originally written in the language of men with the style of the writers yet stating exactly what God wanted to convey, perfect and without fault.

God has made communication with Him possible through prayer and instructs us to "pray without ceasing." We are very good at asking for things and may express our deepest concerns in prayer, but we are not as good at praising Him, listening to Him, or confessing our sins.

WORLDVIEWS

All thinking people try to make sense of their world, and the framework they accept or develop is their worldview. Our society has drifted from a worldview of Theism towards Naturalism (materialism, practical atheism) and Pantheism (think eastern mysticism). While Naturalism could account for personal pleasure and need for community, it could not adequately account for the existence of compassion, truth, and love.

In terms of cultural worldview we have moved from Pre-Modernism to Modernism (emphasizing humanity, science, and progress) to Post-Modernism (no single truth, no overriding narrative to life and history).

EVIDENCE

Evidence pointing to the truth of the Christian message falls into categories: Historical, Philosophical, Scientific, and Miraculous. Recent evidence includes new findings about the cell and the universe and new discoveries in archaeology. [3] No single piece of data makes the case, but when all the pieces are added together the conclusions are powerful.

Critics argue that nothing has been found to validate the wilderness wanderings of Israel of their conquest of Canaan. Since the tribes were on the move in a wasteland, it shouldn't seem surprising. On the other hand, they usually ignore the vast amount of material that has been discovered, including dozens of ancient cities.

The single remaining argument that critics can make involves the issue of pain and suffering ("How could a good God allow a world with so much pain and suffering?") The Bible, however,

does not shy away from discussing the reality of pain and suffering in our fallen world. For the pure naturalist there is really no possible purpose behind anything that happens.

WORK, PROFESSION, AND VOCATION

The work that we do as engineers is clearly significant and not meaningless. There is no separation between "secular" activities (including our daily work) and "sacred" activities (worship, prayer). Instead, all parts of life should be lived to the glory of God.

Engineering is one of several "vocations" or "callings" from God that provide a salary and bless the recipients. When seen from the Biblical perspective, engineering, like all vocations, fits into a much larger picture:

- Our lives extend beyond the present.
- Our choices are real and significant.
- Our work matters to God.
- We can fit into God's grand plan of redemption.
- We can contribute to God's shalom.
- We can show love to God and our neighbor through our work.

GOD AND THE ENGINEERS

While God can be described as a Builder, an Artist, a Counselor, and a Story-Teller, we can identify with the idea of God as the ultimate Engineer. God engineered all of the universe, our planet, and our bodies. God communicated at times in technical language. Human engineers engage in three primary activities that mirror God's engineering throughout Scripture: design, problem-solving, and creativity.

We actually have a divine mandate to develop the earth (Gen. 1:28). Engineering addresses the physical needs of humanity, and parts of engineering are involved with restoration and remediation, physically restoring a broken (fallen) world.

We see the effects of our fallen nature in faulty designs, greedy businesses, engineering disasters, and ethical failings. Christian engineers can bring both a reality check and a divine perspective to an engineering project.

ENGINEERS AND GOD

Engineers possess both advantages and disadvantages in their relationship with God. We can appreciate His logic, standards, and design. We may struggle with our need to understand everything and to fix everything.

Engineering can be practiced as an act of love to God and to our neighbor (1) by offering it to the Lord as an act of worship, (2) by following Biblical principles throughout the work, (3) by

meeting human needs, (4) by demonstrating common grace, (5) by promoting ethical practice, (6) by seeking human flourishing, and (7) by showing wise use of technology.

SCIENCE

Science is foundational to engineering but, unlike engineering, does not specifically result in design of a process or product. There is no "warfare" between science and faith. Instead, God authored "two books" to reveal Himself, Creation (Nature) and Scripture (The Bible). Since the same God wrote both, they cannot contradict each other.

Modern science grew out of a Biblical worldview. Many of the earliest scientists were believers in God, and some were clearly Christians.

Modern physics has arrived at several mind-boggling ideas. Some concepts are almost incomprehensible, but not necessarily impossible or illogical (electron particle- wave duality, Heisenberg uncertainty, black holes...). In a similar way we shouldn't be surprised to find areas in theology that are very hard to grasp (the Trinity, Jesus as fully God and fully man, free will and God's sovereignty).

False Science

Science moved us away from worshipping nature. The danger today is worshipping science. Scientism is the idea that science can explain everything.

Scientism runs into multiple difficulties: (1) It is a philosophical position, rather than experimental science. (2) It can lead to a false understanding of science. (3) It ignores the limitations of science. (4) It does not allow for its own definition.

MATHEMATICS

Like the physical sciences, mathematics is foundational to engineering. Mathematics is a language that engineers must speak fluently. Similar to what we have seen in science, many of the major mathematicians were believers in God. Mathematical thinking is one way in which humans demonstrate the image of God.

God is in no way dependent upon logic, but God acts and communicates logically. The "law" of non-contradiction is fundamental to theology and to human communication.

"Chance" is purely a mathematical description used where we don't have complete knowledge of outcomes. It cannot cause or create anything. Nothing is unknowable to God.

Mathematics is used to model nature, and the amazing part is how repetitive various patterns appear in nature and how well mathematics can describe the natural world.

DESIGN

Design is a primary activity of engineers, and engineers should be able to recognize design. Rather than purely random, the universe in many ways has the appearance of being designed. Such an observation leads many to wonder if that leads to a cosmic Designer.

Back in 1996, Carl Sagan declared that there were really only two requirements for life to exist: existence of a sun (star) and being the right distance from that sun. The conclusion was that "since those two conditions were so easily met, there must be literally billions of planets in the universe that could support life." [4] Since then scientists have concluded that there are dozens, if not hundreds, of conditions required for life, including the size of the planet, size and placement of a moon, mass of the universe, sunlight, water, and fundamental forces. [5]

Engineering design typically involves a process which begins with problem definition and involves choosing among multiple candidate solutions. Engineering design may involve creativity, conformance to standards, knowledge of components, test and measurements, weighting factors, and simulation.

If human design copies God's design we might look not only at reliability, maintainability, and robustness but ponder what part mercy, peace, justice, and blessing play in our designs.

ETHICS

Christian engineers should be the most ethical of engineers since we serve a righteous God. The principal concepts and codes of ethics either arise from or are consistent with Scripture. Engineers must "hold paramount" the safety and health of the public.

Engineering ethics encompasses multiple areas: general morality (forbidding theft, lying, and deliberate harm), the Code of Ethics, and reasoned approaches to ill-defined ethical problems. Classical ethical theories include virtue ethics (Aristotle), duty ethics (Kant), and utilitarianism (Mills).

Ethics and Poverty

God has special concern for the poor, and providing help for the poor is taught in Scripture (but modern socialism is not). The engineer in modern society needs to find a way to alleviate the burden of poverty without crossing the line into Marxist approaches. The real issue is not income inequality, but rather the fact that many cannot meet basic needs.

The Bible suggests multiple causes for poverty, which require multiple different solutions. Among the causes are famine, drought, war, refugee status, natural disasters, social collapse, sickness, disability, theft, exploitation, lack of skills, wasteful living, and sloth.

Poverty is associated with a fallen world, with lack of skills, lack of things, and a flawed culture. Besides providing emergency help through agencies like the Salvation Army, engineers can apply their efforts towards job creation and training and designing affordable appliances and

transportation.

Ethics and the Military

Engineers are inherently realists rather than idealists, and a realistic look at the world shows us the existence of threats and conflicts throughout the globe. Christians need to find an operating point that includes loving our enemies and protecting the innocent under attack. Traditionally, believers have adopted one of two positions: "just war" or "Christian pacifism." There is not a universal agreement on this issue.

Our position on military involvement should carry over into our employment in the defense industry. We also need to be careful not to be seduced by the "coolness factor" of most high-tech weaponry. As followers of Christ we cannot love war and destruction. Weapons systems need to be the last resort, the deterrence factor, or the backup protection we hope we never have to use (like a fire protection system.)

Ethics and the Environment

God's amazing creation has been given to us to use but must be protected and handled wisely. Engineers need to apply reasonable and acceptable approaches to environmental issues, emphasizing our stewardship of the earth. In the most extreme environmentalism we would actually worship the earth and would never tamper with nature at all.

The civil engineering definition of sustainability balances three areas: environment, cost, and public acceptance.

TECHNOLOGY

Engineers both develop and apply technology. Technology is, according to Monsma, "a distinct cultural activity in which human beings exercise freedom and responsibility in response to God by forming and transforming the natural creation, with the aid of tools and procedures, for practical ends or purposes." [6]

We must not be those who shun all new inventions, not those who embrace everything blindly. Almost anything that can be used for good can also be used for evil. We need to evaluate every technology rather than blindly embracing or rejecting it.

Technology can change entire patterns of living and working (automobile, television, computer). We need to be aware of trade-offs and the unintended consequences of our technology use. We don't need more cars, more TV's, and more toys, but everyone needs access to transportation, communication, and medical care.

Theology of Technology

From scientific principles to human creativity, God made technology possible. At times God directed and used human-made objects (the ark, the tabernacle, the temple). In terms of the "Grand Narrative" of Scripture (Creation, Fall, Redemption/Restoration): We mimic God in our designing and developing. All of technology is affected by the Fall. Technology can be redeemed and used for God's glory.

The largest dangers of technology are these: Technology can blind us to God's Creation and glory and our neighbor's needs. Technology can move us towards idolatry. We need to decide what's worth making and worth owning.

Screen Technology

From television to computer to smartphone, screen-based technology occupies a greater and greater place in our daily lives. Problems arise not so much because of the technology itself but because of the content, apps, and algorithms used. Besides the addictive power of many programs, users may encounter continual distraction, information overload, separation from others, and constant comparison.

Among young people social media has contributed to peer-pressure, bullying, isolation, apathy, radicalization, anxiety, and depression.

Screen technology needs to managed and controlled: Offer the technology and its use to the Lord. Take deliberate breaks from technology. Keep life balanced, including exercise and enjoying nature. Deliberately do some "non-tech" things every day.

Brave New World of Technology

Robotics, Artificial Intelligence, and the Singularity represent the future of technology, and each has been seen as a potential threat to society. Robots will likely not bring about a huge reduction in jobs. The concept of "sentient AI" assumes that consciousness and human intelligence are strictly material. We do not expect machines to become self-aware and pose a threat to humanity.

A number of people in the sciences and technology anticipate a day in the near future when humans can upload their brains to computers and thus "live forever." Not only are the technical problems involved enormous, but such a "singularity" is a poor counterfeit for the resurrection and eternal life promised to Christ's followers.

Humans are finite, limited, and mortal, but those are not necessarily bad things. We are dependent beings. We need the Lord, and we need each other.

WORKPLACE

The majority of engineers will spend forty or more hours a week involved in their daily jobs. No job is perfect, but the workplace should be a place where engineers can use their skills, see value in their work, see good results, and see God using them at work. Day to day interaction with

colleagues presents unique opportunities and challenges. The workplace becomes the laboratory where we live out what we've been learning.

While Christian engineers desire to share Christ with all those they work with, they must keep in mind that they were specifically hired to do engineering work, not to evangelize. Personal integrity, excellent work, and loving relationships with others will open the door to opportunities to talk about Jesus.

EDUCATION

A handful of engineers will spend all or part of their career preparing the next generation of engineers in a higher education setting. The purpose of a college degree should be seen not only as job preparation and opportunity for broadening oneself but as preparation for a life of service and an opportunity to appreciate more of God's Creation and human culture. Faculty members should know their subject and wider discipline, their students, how students learn, and how best to communicate their subject.

Those Christian faculty teaching in public institutions have an opportunity to demonstrate what a Christian engineer looks like and hopefully answer some significant questions about their faith. Those faculty teaching in uniquely Christian ("faith-based") institutions have the opportunity to explore with students the integration of faith and practice and to help flesh out a reasoned Christian worldview. "Integration" may involve attitude and motivation, character formation, Christian virtues, theology of work, theology of engineering, presuppositions of the discipline, ethics, service and missions.

WORLD MISSIONS

Beginning with the Great Commission in Matthew 28, world missions has been a part of the work of the church. All believers can pray and support the work financially, and some will travel overseas for a short period or for a lifetime.

While the basic message is unchanged, modern missions makes use of current technology, cultural understandings, and workplace opportunities. Engineers have supported mission work through translation and translation assistance, radio broadcasting, building, energy support, and development of small-scale industry.

INTERNATIONAL DEVELOPMENT

Because God cares for the marginalized and poor of the world, international agencies and international mission boards have often provided physical assistance to under-developed regions. Clean water, adequate irrigation, connecting bridges, and alternative energy sources are natural projects for engineers.

Those working in international development need to keep certain principles in mind to be effective: Learn the needs directly from those involved; identify the greatest needs; understand the culture; use local assets; use local materials; promote local ownership; enhance sustainability; work alongside the local people; and address spiritual needs while meeting physical needs.

EXAMPLES

R.G. LeTourneau (designer of earth-moving equipment), Wilson Greatbatch (inventor of the cardiac pacemaker), Herb Jacobson (engineer/designer for HCJB radio), and Ken Crowell (founder of Galtronics in Israel) are prime examples of Christian engineers who used their God-given talents with great impact.

ENGINEERING AND GOD'S PURPOSES

How does the work of a Christian in engineering fit with God's purposes? Several different approaches are possible:

1. We are responsible to provide for our families. Engineering is a job (that I happen to be good at doing) that pays the bills and feeds my family (as God ordained). True, but not necessarily inspiring.
2. Engineering puts me in the workplace, which is a mission field. This is a popular evangelical viewpoint. It is certainly valid, but if we push it too far then God only cares about souls and our actual work is insignificant.
3. Engineering is a vocation, which God uses to bless humanity. Luther developed this approach in detail.
4. The engineering workplace is a venue for God to shape our character and conform us to the image of Christ. Engineering work is then a path to sanctification.
5. Engineering is part of God's restoration of the creation after the fall. This approach is popular in Reformed circles. It is certainly valid, but if pushed too far could diminish the Gospel and God's work I the lives of people.

Our safest position is to build our theology in parallel instead of in series, recognizing that each approach has some Biblical warrant and brings some insight to the question.

Ideally, the Christian engineer

- Is growing in Christ
- Sees work and life as part of God's plan
- Sees engineering as a worthy vocation to which he or she is called
- Deliberately does engineering to the glory of God, as an act of worship
- Prays about work and decisions
- Does excellent work
- Takes seriously designing to the benefit of mankind
- Acts ethically in decisions

- Desires to redeem and restore
- Shows the love of Christ to Co-workers
- Brings peace and joy to the workplace
- Recognizes the value of creation
- Thinks seriously about the uses of technology
- Helps to meet human needs

CONCLUSIONS

We have seen that these concepts are unique to a Christian approach to engineering:

- Consciously aiming to glorify God by what we do.
- Seeing engineering as a "calling" where God places us for ministry.
- Seeing engineering as part of God's "common grace" to the world.
- Finding our place in God's Grand Story; helping to restore parts of a fallen world.
- Aiming to bless the world through the technology we develop.
- Addressing the dangers of technology, including idolatry.

In our desire to grow spiritually we must not despise

- The material world- It was created by God.
- The earth- It will be renewed.
- Work -it was given to us by God.
- The body- It was created by God, and Jesus was born with a human body.
- Human culture- It is a gift from God.
- Meeting physical needs -This is part of love for our neighbor.
- Science- It can glorify God.
- Technology- It can bless humanity.
- Education -We are studying God's world.

Walter Bradley [7] has given extensive thought to three primary ways that engineers who are Christians can advance God's Kingdom:

"First, engineers are uniquely equipped to understand, share and explain the compelling evidence that the universe is designed, implying the existence of an intelligent creator to non-Christian scientists and engineers who think that science and faith are incompatible, and therefore, necessarily hostile. Second, engineers are also well equipped to help Christians within the church to understand the ways that faith and science can be, not just reconciled, but synergistic, affirming that God's revelation in His book and His revelation in His world can be harmonized. Finally, engineers are uniquely equipped to be responsive to the first commandment, to go out and subdue the earth, especially in parts of the world were this project is still far from complete, making life extraordinarily difficult."

The summation is given in Rom. 11:36: "For from Him (all of the material world, all of the physical laws, all of our talents), and through Him (all of His commands, all of His love, in the power of His

Spirit) and to Him (all praise, thanksgiving, glory) are all things. To God be the glory forever. Amen."

REFERENCES

1. Katehi, L., Pearson, G., and Feder, M., *Engineering in K-12 Education*, National Academies Press, 2009.
2. Sloan, R., "Engineering and the Christian Worldview,"2018, https://robertbsloan.com/2018/02/07/engineering-christian-worldview/
3. Metaxas, E., *Is Atheism Dead?* Salem Books, 2021.
4. Ibid.
5. Ibid.
6. Monsma, S., et.al, *Responsible Technology*, Eerdmans, 1986, p.19.
7. Bradley, W., "Unique Ways for Engineers to Bring Healing," Engineering and Metaphysics Conference, 2012.

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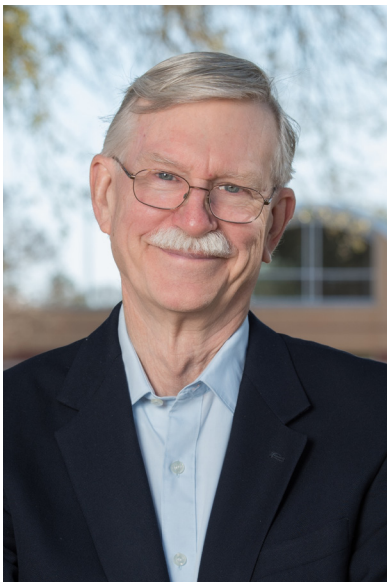

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