What I Wish My Pastor Knew About … Responsible Engineering and Technology

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Introduction

As an engineer, it strikes me as odd sometimes that many Christians I know will expend a great deal of energy and passion arguing about theories of science, while at the same time unquestionably accepting nearly every new technological development that comes along. Perhaps you know Christians to whom mentioning the age of the earth or evolution can trigger heated debates. On the other hand, for these same people, mentioning nuclear power or the need for sustainable energy technologies usually results in blank stares or shrugs. This seems interesting to me because, while scientific explanations of history can be fascinating (as other essays in this collection have no doubt demonstrated), they rarely impact our daily activities in the way that technology does. After all, technology shapes our lives from the moment we crawl out of bed in the morning (perhaps from our visco-elastic "memory foam" mattress, made from a material revised and adapted for this purpose only within the last 10 years) and step into the shower (where we enjoy an almost immediate flow of water obtained from a massive water treatment plant via a complicated piping system and heated by a water heater powered by natural gas). Consider the impact that ubiquitous electronics technology has each day on how we spend our time (think televisions, computers, digital music players, cell phones, ATM's). So, as an engineer, I sometimes wish that my pastor would encourage people to better appreciate the substantial benefits technology (and therefore the exciting work of engineers) provides, while at the same time encouraging people to be more careful about the technologies they buy and use.

A second observation: I have occasionally felt distressed because my occupation seems so un-related to the ministry of the church. Teachers can contribute directly to church ministry by using their skills in Sunday school. Musicians can contribute to worship, accountants can keep the church's book, nurses can run church-sponsored clinics, and even lawyers can offer their services to aid the church's work. But, what can a mechanical engineer contribute to church ministry? I don't know of any churches that do

any manufacturing as part of their ministry. The fact is that most engineering work is done in secular industries for the purpose of making a profit. It has taken me a long time and some significant effort to overcome this impression that engineering does not contribute to ministry, and I would like my pastor to emphasize the ways that engineering and technology fit into our Christian calling (even if not in the church setting) so that I can better appreciate the connection between faith and my work.

So, this essay is my attempt to provide pastors with some background on the engineering mindset based on my personal experience and to highlight some features of technology that Christians ought to be aware of in order to better live lives that honor God and serve our fellow man. Specifically, I would like to debunk some stereotypes about engineers (while possibly reinforcing others) by sharing my own occupational journey. Next, I would like to help pastors and fellow Christians begin the process of critically reflecting on how technology works by discussing two prominent myths about technology that are prevalent in the American cultural context. This will involve identifying some Christian faith-based values that can help direct the activities of Christian engineers and also help Christians respond obediently in our choices as citizens and consumers of technology. Finally, I would like to offer some advice to pastors for encouraging responsible participation in technology among their parishioners.

Engineering Stereotypes – My Story

It is has long been my contention that few people besides those who are already engineers actually understand what engineers do. Unlike doctors, lawyers, and teachers, most people don't interact with engineers professionally on a daily basis. Unfortunately, the Dilbert stereotype has come to represent the typical engineering personality type and to define the nature of engineering work (if you are not familiar with Dilbert, go to http://www.dilbert.com/ and check out the comic strips). Frankly, I don't know many engineers who are "Dilberts". The vast majority of engineers share a lot of traits with

other professionals. But, there are also some tendencies that I think many engineers have in common, which sharing my own personal journey into the world of engineering and technology will help illustrate.

In high school I was good at and interested in math and science. I also liked to take things apart to see how they worked (although I had considerably less success at putting them back together again). An affinity for math and science along with a practical interest in understanding how things work, or in solving practical problems, is very common in engineers. During my junior year in high school at a career day event I heard a chemical engineer talk about his job developing and analyzing more effective paint formulas. It clicked for me during that presentation: engineering was a possible way to connect my math and science talents with a useful occupation. This is once again a typical story for a proto-engineer, choosing engineering as a way to apply science and math for practical purposes. Fortunately, following my initial profession of interest in engineering, I was encouraged by everyone around me to pursue this path. To this day, I am grateful for parents, teachers, and counselors who encouraged me to use my gifts in what is typically considered a male profession.

So, I enrolled in a college which offered an engineering program and enjoyed most of my engineering courses. I found them to be analytically challenging, as I expected. But my engineering educational experience also opened my eyes to aspects of engineering that I had not anticipated. Through my engineering design projects I began to comprehend that engineering is more than just applied science. The engineering design process requires creativity along with analytical ability. Although I had never viewed myself as a creative person (I reserved that label for artists, novelists, and the like), I came to appreciate that creativity channeled for practical purposes is the key to addressing technological problems. As I progressed in my studies, I refined my choice of engineering field to mechanical engineering based on the scale of technology involved. The

systems I wanted to design were generally bigger than breadboxes but smaller than bridges, especially those with parts that moved. In 1986, I graduated with a Bachelor of Science in Engineering degree alongside the other 42 members of my senior class, who all happened to be males. The percentage of females in engineering has increased since then, but still hovers between 15 and 20 percent, far lower than the percentage of women graduating from medical school or law school. I continue to wonder why it is that so few women are attracted to the engineering profession and why women seem be so much less involved in technology in general than men are.

Fortunately, the college that I chose because of its engineering program was also a Christian college. My professors there challenged me to connect my Christian faith with my work in technology and engineering. I am not sure that their efforts bore much fruit at the time, given my maturity level, but they did lay a foundation for later reflection. It was the prompting of my engineering professors to consider engineering as an aspect of my Christian calling that allowed me to integrate my work into my Christian life, to view engineering work as kingdom work. Sadly, I know Christian engineers who seem to completely separate their professional activities from their religious activities. They experience engineering as merely a job, a way to earn a living or put themselves in a position to evangelize. They miss the joy of doing engineering in service to God as a ministry to the community.

Reflection based on approximately 25 years of working with engineers and engineering students reveals that I share many traits with the typical engineer. Of course, not every engineer exhibits these traits to the same extent, since there are a wide variety of people involved in engineering work, but there does seem to be some commonality. I see these traits as being partly innate and partly acquired through the engineering education process. In other words, engineers self-select for the field because of certain tendencies, and then have some of these tendencies reinforced through engineering

practice. In my experience, engineers tend to be quite logical, swayed in their decisions by evidence and data. They also tend to be quite critical or judgmental, which reflects their desire to continually improve things. Engineers are quick to identify problems because they want to solve problems. They also tend to be impatient with inefficiency in any form. Surveys suggest that engineers are generally conservative in their approach to life. I think this is true because engineers are always concerned about risk and consequences. They are unwilling to try something new unless they have some confidence (preferably based on data) that it will work. But, contrary to the Dilbert stereotype, I find that most engineers, like myself, are socially well-adjusted and reasonably good at communicating with others. Engineering work in industry is not about people tinkering by themselves in garages or number-crunching on computers in solitary cubicles. Nearly all engineering design is performed in teams, and requires healthy group interactions to successfully complete projects.

I do have a characteristic not shared by many engineers: an interest in philosophy and theology, whose topics strike many engineers as irrelevant, at least to their daily work. This willingness to explore foundational assumptions about the meaning of life has been crucial to my ability to connect faith and work and likely explains why I was asked to write an essay like this one.

Soon after completing my bachelor's degree, I became interested in teaching engineering. In teaching, my impact on technology can be enhanced well beyond my own small contributions through the influence I have on future engineers. As an engineering professor, I worry that some of the lessons students get from an engineering education can be a hindrance to successful professional practice. One of these is the impression that students get in science and engineering coursework that there is one correct answer to every problem. In textbook examples, even if there is more than one possible solution, there is always an optimum (best) answer that can be arrived at with effort. Most non-engineers

realize intuitively that life is messier than this assumption conveys. Engineers may need to be reminded periodically that most decisions require guesswork and that sometimes intuition as well as numerical analysis should be applied. Another problematic lesson that might be picked up from engineering work is that everything can be "engineered," that is, that all problems can be solved using the engineering design process. Some of the problems with this assumption will be addressed in the next section of this essay.

Critical Reflection on Technology – Two Myths

The previous paragraphs provided some information about engineers (admittedly based only on my biased experience). While most Christians are not engineers, they still live in a society that is profoundly influenced by many different types of technology. 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.

Many people associate "technology" solely with electronic devices. Although computers are very visible examples of 21st century technology, they are only a subset of the artifacts and systems that surround us and impact our activities. A slightly broader definition of technology encompasses all built and manufactured things. But, calling just the "hardware" technology misses all the processes and ways of thinking underlying the production and deployment of infrastructure and goods. The book *Responsible Technology*, a classic text which attempts to articulate an approach to technology and engineering from a Christian perspective, presents a more inclusive definition: Technology is a human cultural activity. It includes all the processes of conceiving, designing, building, producing,

implementing, using, maintaining and refining objects and systems for practical uses. This definition appropriately directs our attention to all of the interactions between individuals and cultural organizations within which technology is embedded.

Making good decisions about our participation in modern life depends on having a clear understanding of what our relationship to technology should be in the context of who we are in relationship to God. As Christians, we understand that humans are capable of doing technology only because God has gifted us with that ability. Creativity is a part of the way in which we reflect the image of God. We cannot create from nothing, but we can make use of the resources of creation that God has made available to us. Technology is also one of the ways we respond to the cultural mandate of Genesis 1:28 to "be fruitful and increase in number; fill the earth and subdue it." God intends for us to cultivate the earth, develop it responsibly, and therefore to creatively participate in the unfolding of his creation.

But, the Biblical story and everyday observations remind us that technology, like all other human cultural activities, has been corrupted by sin. Technological failure can have catastrophic consequences (think Chernobyl or the 40,000+ lives lost each year on American highways). Technology can be intentionally misused (as demonstrated by the terrorists on 9/11/01). Technology can distract us from achieving our purpose in life (think of all the time spent web-surfing and text messaging). Technology that protects us and provides for many of our needs can also distract us from our dependence on God.

In order for Christians to deal appropriately with the many choices we have related to how we use and constrain technology, I think the church needs to confront two myths about technology that have permeated our culture. These myths are transmitted to us and our children through the media (especially advertising for technological goods) and via our own personal interactions with technological artifacts. I believe these myths can interfere with a responsible approach to dealing with technological issues.

Myth #1. I will identify the first as the "never-ending progress" myth. It could also be stated as the "technology will solve all problems" myth. Engineers tend to be especially susceptible to believing in this myth, since they are so immersed in the problem-solving potential of their technological endeavors. The roots of this myth extend all the way back to the enlightenment, with its emphasis on the potential of scientific reasoning and human invention. It was reinforced throughout the industrial revolution, when mass-production of goods contributed to dramatic improvements in the lifestyles of the middle class. Throughout the 19th and 20th centuries, dramatic technological advancements occurred. For a complete list of technological accomplishments during that time, you can check out the National Academy of Engineers list of the Greatest Engineering Achievements of the 20th Century.

Based on this history, it seems completely natural to assume that the solutions to each of society's problems depend primarily on future technological breakthroughs. The development of computers provides yet another contribution to the myth. Moore's Law, the observation made back in 1965 that computing power tends to double roughly every two years, has held true for a remarkably long time since then. Unfortunately, this view fails to take into account the physical limits that will eventually begin to dominate the manufacturing of ever smaller integrated circuits. There is no guarantee of another breakthrough that will allow for the development of ever faster and cheaper computing.

Disappointed expectations are not the only consequence of the falseness of the myth. Accepting the myth as truth is dangerous because it fails to recognize that new technology always brings new problems as well as benefits with it. Also, the over-confidence in technological solutions can distract our attention away from the economic, political and spiritual

forces that need to be considered in addressing humanity's ills. We need to recognize that technology's power in solving problems is limited. Ultimately, if people's hearts are not right and if our societal systems are corrupt, then technology alone cannot provide the ultimate fix. Our current food production and distribution systems are a classic example. Technologies to increase crop yields and to more effectively preserve food products give us the technical capacity to supply the world's population with food. Yet corrupt governments and factional fighting in developing countries prevent billions of people from being adequately fed. In the United States, people in many inner city neighborhoods have no access to healthy food due to the lack of quality supermarkets. The solutions to these problems lie not only in technology but in changing the economic conditions and political relationships that contribute to these situations.

Myth #2. A second and related myth that stands in the way of appropriately dealing with contemporary technology is the "value-free" technology myth. It involves the assumption that technology is merely a tool, that technological artifacts are not good or bad in themselves, but that users determine their worth. A recent TIME magazine editorial on the effect of Twitter sums up this perspective: "Historically, the most powerful new mediums have changed the way we perceive the world--and how we relate to one another. The telephone, television and Internet have done that in ways we are still processing. But technology itself is neutral. It's a tool, neither good nor evil. It's all in how we use it." (Richard Stengel in "Technology and Culture," *Time Magazine,* 15 Jun 2009).

The phrase "Guns don't kill people, people kill people" is a common restatement of this myth. The myth has some traction because the statement is partially true. It is obvious that a gun is an inanimate object and cannot do violence on its own. But the danger in accepting this statement as truth is that it fails to recognize that the very characteristics built into the gun make it exceptionally effective at doing harm. Some guns, for instance assault rifles, have been

designed to allow their users to do a great deal of damage in a short period of time. While the morality of the violence done may indeed be determined by the intentions of the users (we might agree that an assault rifle used for defense in war is acceptable use, while an assault rifle used to kill bystanders in a school shooting is evil), the technological object and the systems that produce and regulate it must be considered in evaluating it. Yes, individuals can use almost any object to kill or injure someone, but most objects, say ball point pens or hammers, have not been optimized for that use and are therefore rarely used for that purpose. Whether or not the gun designers included a safety mechanism to prevent accidents or a fingerprint ID system to prevent unauthorized use influences the potential uses of the weapon. In this sense, technology is always biased in its effects, based on the values that were operative in its design and implementation.

A broad definition of technology as cultural activity implies that value-neutrality is a myth. As with every other aspect of life in this fallen world, technology is complicated by all sorts of human motives. We need to recognize the biases in technology. Engineers need to think about how guns can be designed and manufactured in such a way that the Christian value of respect for human life is exemplified. A Christian perspective that values human life will call for new technology advancements and refinements that go beyond the mere technical considerations of efficiency and cost effectiveness.

Real life engineering design problems are rarely affected by only technical constraints. One example of a purely technical engineering problem that might be familiar to those who have seen the movie Apollo 13 is the scene in which the engineers at mission control were faced with the problem of designing a carbon dioxide filtering device to fit into a specified space using only the limited set of materials available to the astronauts in the ship. Engineers love this type of problem due to the challenge of satisfying the severe technical constraints and the absence of messier concerns like costs or marketability. But, nearly every other

engineering design opportunity comes with the whole set of human factors that must be dealt with along with the technical constraints. While a Christian perspective would have little influence on the nature of the Apollo 13 filter solution, it will have much more influence within the non-technical context that always needs to be considered in typical engineering work.

If technology is a cultural activity and does indeed embody human values, then what particular values should we be concerned about in engineering design? As in other areas of life, it is possible to begin with Christian values and arrive at quite different conclusions about how particular technologies should be designed and used. Where should Christians look for guidance?

The Bible is our ultimate source of revelation from God regarding the way we are expected to live. Unfortunately, I do not think the Bible speaks directly or specifically about many contemporary technology issues. The Bible was written well before the invention of engineering as we would define it today, with its emphasis on scientific understanding, structured analysis and radical transformation of materials. While engineering is not addressed directly in Scripture, examples of technology are included throughout the Old Testament. The activities of the craftspeople who participated in construction of the temple are praised for their excellence, although these are examples of technology employed directly for God's service rather than for human flourishing more generally. The story of Noah building the ark is often cited as the first example of human "engineering," but it strikes me that since God directly provides the specifications for this particular project rather than relying on Noah's ingenuity, identifying Noah as an engineer is not particularly helpful.

I do not believe that there are specific proof-texts from the Bible that can be relied on to tell us whether or not we should invest in a hybrid car or upgrade to a new cellular phone. Rather, we need to rely on the themes of Scripture and Christian theology to provide broader principles that can be used to analyze and guide our technological choices. The book *Responsible Technology* identifies some of these and refers to them as design norms.

For engineers, the norms can be used to ensure that all important value considerations are identified, considered and balanced in the design process as new technology is developed. The table below lists the norms along with brief descriptions. I would like to highlight two of these norms for application not only to engineering, but to also to consumer choices and technology regulation in general.

Design Norms for Technology	
Cultural Appropriateness	Technology should preserve what is good in culture and provide for meaningful cultural development
Openness and Communication (Transparency)	Technology information should be shared and function should be understandable
Stewardship	Technology should make frugal use of resources (financial, physical, and human)
Delightful Harmony	Technology should be pleasing to use and promote quality interactions and relationships
Justice	Technology should promote justice and respect human dignity and environmental integrity
Caring	Technology should demonstrate love and concern for individuals
Trust	Technology should be trustworthy and done in humility in response to our faith in God

The stewardship norm reminds us that sustainability needs to be taken seriously in technology development. Up until now, most consumer products have been designed with very little regard for their effects on the natural environment. There has been very little emphasis in North American on designing for recyclability or reduced energy use. Fortunately, this is beginning to change as we develop greater awareness of the need to reduce our environmental footprint amid the prospect of global climate change. Churches should be encouraged to think about the sustainability of their buildings and activities. Are we willing to spend more on a new church building to make it greener? We need to appropriately balance our economic values with our environmental stewardship values. The Ecological Intelligence movement has begun developing scoring systems for determining the carbon footprints of various products. Perhaps we should be willing to spend more time considering these estimates of environmental impact before we make new purchases.

The justice norm reminds us to be conscious of the injustices of current technology distribution. Our wealthy society has many "high-tech" options for satisfying our basic needs while the developing world has little access to these advantages (especially access to safe drinking water). Even within the United States there is concern about the "digital divide," which refers to the problem of lack of access to computers experienced disproportionately by the poor and certain ethic groups. In a society in which basic computer access and skills are assumed, those without access are at a significant disadvantage. We need to consider what new technologies, as well as governmental regulations or business incentives, might be needed to address this problem.

It is very important for God-honoring technological behavior that we balance the design norms appropriately and anticipate the consequences of our choices. This is difficult because we are, individually and collectively, both finite and fallen. Given the complexity of the problems, we often need to move forward with only partial information and by assuming some risk. But, the process of redeeming the technological aspect of our existence is possible if we become more conscious of the need to bias technology toward serving others in the name of Christ.

Conclusions

I have found many of my fellow Christians to be remarkably un-reflective about the impact of technology choices on many aspects of their lives. A few months ago, I was talking with one of the middle school youth leaders at our church about a recent youth group pool party mixer that my son had attended. She and I were both disturbed that three girls at the event had spent the majority of their time texting other friends on their cell phones rather than participating. Have we carefully considered the impact of technologies like cell phones on our fellowship practices? A few years ago I received an I-pod as a gift from my spouse. I have come to love this little device for the opportunities it provides for listening to my favorite music while walking or running. But lately I have begun relying on my earbuds to shut out the rest of the world while shopping and travelling on airplanes. Have I carefully considered the implications of this individualistic behavior on my potential for witnessing and encouraging others? After the closing of our church about a year ago, our family spent 6 months visiting over a dozen area churches. Regardless of the level of formality of worship style or liturgy, every single church we attended had one or more projection screens in the sanctuary for multi-media display. Have churches carefully considered the impact of this technology on worship, or is this an example of a technological "keeping up with the Jones's"?

So, what can pastors do to address this situation? First, they can encourage their congregations to think about Romans 12:2 "Do not conform any longer to the pattern of this world, but be transformed by the renewing of your mind. Then you will be able to test and approve what God's will is—his good, pleasing and perfect will." What does it means to be "in the world" but not "of the world" with respect to technology?

Amish and Mennonite communities have obviously carefully considered the consequences of integrating various types of technology into their culture and faith and have deliberately chosen to limit their involvement. Most of us might not agree with their conclusions, but they should be given credit for taking technology seriously and having the courage to make counter-cultural choices.

Second, pastors can encourage Christians to be actively involved in science and engineering. We desperately need more and better technology to address many of the pressing issues facing civilization today. The National Academy of Engineering has a website presenting global problems that require engineering solutions, which it refers to as "Grand Challenges" (http://www.engineeringchallenges.org/).

Idealistic Christian young people especially need to consider their part in addressing these needs. Often they can easily understand and appreciate how a missionary ministers to the world by preaching the gospel or how a doctor ministers to the world by serving in a free clinic. But they do not often realize that the missionary's travel would not be possible without a well-designed aircraft or that the doctor's early cancer diagnosis depends on the magnetic resonance imaging (MRI) machine. Young people have the potential to impact the world for Christ in significant ways by becoming engineers and scientists as well as pastors and doctors. This type of encouragement would also help to more often remind me not only of the value of my career choices, but also of the responsibility I have to use my skills in ways that reflect my Christian faith.

Further Reading

Responsible Technology: A Christian Perspective, Stephen V. Monsma, Ed., Eerdman's: Grand Rapids, MI, 1986.

Society, Ethics, and Technology, 3rd Ed, Morton E. Winston and Ralph D. Edelbach, Thomson-Wadsworth: Belmont, CA, 2006.

Beyond Paradise: Technology and the Kingdom of God, Jack C. Swearengen, Wipf & Stock: Eugene, OR, 2007.

To Engineer is Human: The Role of Failure in Successful Design, Henry Petroski, Vintage Books: New York, 1982.

Greatest Engineering Achievements of the 20th Century http://www.greatachievements.org/ National Academy of Engineers

Grand Challenges (http://www.engineeringchallenges.org/ National Academy of Engineering