



Delight in Creation

Scientists Share Their Work with the Church

8 Responsible Engineering and Technology

by Gayle Ermer

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As twenty-first century Christians in North America, technology shapes every moment of our lives. We crawl out of bed each morning, perhaps from a visco-elastic “memory foam” mattress, and step into the shower, where we enjoy an immediate flow of hot water made possible by a massive water treatment plant, a complicated piping system, and a gas-powered water heater. Subsequent hours are marked by the ubiquity of electronics technology via televisions, computers, digital music players, cell phones, and ATMs.

Most of these wonderful conveniences were developed by engineers. What does an engineer do? The movie *Apollo 13* shows a real-life example that you may recall. To save the lives of astronauts in the damaged spacecraft, the engineers at mission control have to design a carbon dioxide filtering device. In addition to filtering the air, the device has to fit into a specified space, and it has to be constructed from the limited set of materials available to the astronauts in the ship. Engineers love this type of problem, where they have to meet stringent technical requirements while getting the job done. Engineers love to make stuff work, and work more efficiently, in creative new ways.

As a North American Christian who is also an engineer, my life is shaped by technology every day. Not only do I use technology, but I design new technological devices that improve the lives of others. And yet, I have occasionally felt distressed because my occupation seems so unrelated to the ministry of the church. Teachers can contribute to church ministry by using their skills in Sunday school. Musicians can play or sing in worship, accountants can keep the church's books, 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. In fact, 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 appreciate the connection between my faith and my work.

In this chapter, I would like to help other Christians better appreciate the substantial benefits of technology (and therefore the exciting work of engineers), and to see how engineering fits into a Christian calling, whether or not it is used directly in a church setting. I also want to encourage

Christians to be more discerning about the technologies they buy and use by discussing two prominent myths about technology and by identifying Christian values that can help us in our choices as citizens and consumers of technology. I'll begin by sharing my own occupational journey to address some stereotypes about engineers.

Engineering Stereotypes: My Story

Unlike doctors, lawyers, and teachers, most people don't interact with engineers professionally on a daily basis. Your closest contact with an engineer may be through the popular comic strip *Dilbert*. Unfortunately, the Dilbert stereotype has come to represent the typical engineering personality type. 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 some unique tendencies that many engineers share, which my own personal journey into the world of engineering and technology will help illustrate.

In high school I enjoyed 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). At a career day event during my junior year in high school, I heard a chemical engineer talk about his work developing and analyzing more effective paint formulas. It clicked for me during that presentation: engineering could be a way of connecting my math and science talents with a useful occupation. Fortunately, I was encouraged by everyone around me to pursue the path of my professional interest. 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.

I enjoyed most of my engineering courses in college and found them to be analytically challenging, as I expected. But my 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 design process requires creativity along with analytical ability. Although I had never thought of myself as a creative person, 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 field to mechanical engineering because I liked 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 degree in engineering alongside the other forty-two members of my senior class, who all happened to be men. The percentage of women in engineering has increased since then, but still hovers around 15-20%, far lower than the percentage of women graduating from medical school or law school.

I chose my college because of its engineering program, but fortunately it was also a Christian college. My professors helped lay a foundation for later reflection. They prompted me to consider engineering as an aspect of my Christian calling that allowed me to integrate my work into my Christian life and to view engineering work as kingdom work. I know other Christian engineers who did not study in such an integrated environment and who tend to separate their professional activities from their religious activities. They experience engineering merely as a way to earn a living or to put themselves in a position to evangelize. They miss the joy of doing engineering in service to God as a ministry to the community.

Based on two-and-a-half decades working with engineers and engineering students, I can say that I share many traits with the typical engineer. Of course there are many different kinds 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 them. 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. However, contrary to some stereotypes, I find that most engineers, like myself, are socially well-adjusted and reasonably good at communicating with others. Work in the industry is not about people tinkering by themselves in garages or crunching numbers on computers in solitary cubicles. Nearly all engineering design is performed in teams and requires healthy group interaction to successfully complete projects. I do have at least one characteristic not shared by many engineers: an interest in philosophy and theology, which are topics that 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 vocation and has shaped my work as a college professor.

Soon after completing my bachelor's degree, I became interested in teaching engineering. Through the influence I have on future engineers, my impact on technology can go well beyond my own small contributions. As a professor, I worry that some of the lessons students receive from an engineering education can hinder successful professional practice. One of the impressions that students can get in science and engineering coursework is 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 answer that can be discerned 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 they might need to apply intuition as well as numerical analysis. Another problematic lesson that might be absorbed from engineering work is that everything can be "engineered"—that is, that all problems can be solved using the engineering design process. Students, and indeed all of us, need to be able to identify such myths when it comes to the faithful use of technology.

Critical Reflection on Technology

While most Christians are not engineers, they live in a society that is profoundly influenced by many different types of technology. We tend

to take for granted all of the ways that modern life in the industrialized world is reliant on technological systems. We depend on technology to transport people and goods from place to place safely, to provide sanitary living conditions, to protect people from the extremes of the weather, 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 twenty-first 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 considering only the hardware misses all of the processes and ways of thinking underlying the production and deployment of infrastructure and goods. The book *Responsible Technology*, edited by Stephen Monsma, is a classic text that attempts to articulate an approach to technology and engineering from a Christian perspective. The book presents a more inclusive definition of technology: technology is a human cultural activity. It includes all of 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 requires having a clear understanding of our relationship to technology in the context of our relationship to God. As Christians, we understand that humans are capable of creating technology only because God has gifted us with that ability. Creativity is one way in which we reflect the image of God. Although we cannot create from nothing, 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 to “be fruitful and increase in number; fill the earth and subdue it” (Gen. 1:28). God intends for us to cultivate the earth and develop it responsibly as we creatively participate in the unfolding of his creation.

However, the biblical story and everyday observations remind us

that technology, like all human cultural activities, has been corrupted by sin. Technological failure can have catastrophic consequences—think Chernobyl or the forty thousand-plus lives lost each year on American highways. Technology can be intentionally misused, as demonstrated by the terrorists on September 11, 2001. Technology can distract us from achieving our purpose in life—think about all of the time we now spend browsing the web and text messaging. Technology that protects us and provides for many of our needs can distract us from our dependence on God.

In order for Christians to make good choices related to how we use and constrain technology, we need to confront two myths about technology that have permeated our culture.

The Myth of Never-Ending Progress

In this myth, the progress of technology will continue and eventually solve all our problems. 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 for scientific reasoning and human invention. It was reinforced throughout the industrial revolution when mass production of goods contributed to dramatic improvements in the lives of the middle class. Throughout the nineteenth and twentieth centuries, dramatic technological advancements occurred.

Based on this history, it's 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 so far. 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 faster and cheaper computing.

Disappointed expectations are not the only consequence when a myth proves untrue. Accepting the myth of progress can inhibit our ability to recognize that new technology always brings problems along with benefits. Being overly confident in technological solutions can distract our attention from the economic, political, and spiritual forces that need to be considered in addressing humanity's ills. If our motives or social systems are corrupt, then technology alone cannot provide the ultimate fix. Our current system for food production and distribution is a classic example. Technologies to increase crop yields and 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 receiving adequate nutrition. 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.

The Myth of Neutral Technology

In this myth, technology is “value-free,” merely a neutral tool. This myth says that technological artifacts are not good or bad in themselves, but that users determine their worth. Richard Stengel's *Time* magazine editorial from June 15, 2009, 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.”

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. Obviously, 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, like 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, 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 its evaluation. Yes, individuals can use almost any object to kill or injure someone, but most objects, like ballpoint 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.

As with every other aspect of life in this fallen world, technology is complicated by all sorts of human motives. Real life engineering design problems are rarely affected by only technical constraints. The *Apollo 13* example is unusual in this regard, since the engineers didn't have to consider non-technical factors like costs or marketability. Nearly every other engineering design opportunity comes with the whole set of human factors that must be considered 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 that embodies 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. A Christian perspective calls for principled advancements and refinements that go beyond the mere technical considerations of efficiency and cost effectiveness. Where should Christians look for guidance?

The Bible is our primary 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 understand it today, with its emphasis on scientific knowledge, 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 the construction of the temple are praised for their excellent work, though these artifacts are examples of technology employed for God's service, rather than for human flourishing in general. The story of Noah building the ark is often cited as the first example of human "engineering," but 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.

We cannot rely on specific texts from the Bible 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 for broader principles that can guide our technological choices. The book *Responsible Technology* identifies some of these principles 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 list below briefly describes the 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.

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. The stewardship norm reminds us that sustainability needs to be taken seriously in technology development. Until now, most consumer products have been designed with very little regard for their effects on the natural environment. There has been little emphasis in North American on designing for recyclability or reduced energy use. Fortunately, trends are shifting as we become more aware of the need to reduce our environmental footprint amid the prospect of global climate change. As stewards of creation, Christians should be encouraged to consider the sustainability of our church buildings as we balance our economic and environmental values. Are we willing to spend more on a new building to make it greener? The Ecological Intelligence movement has begun developing scoring systems for determining the carbon footprints of various products. Perhaps we as individuals and as communities 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 disproportionate access to computers experienced by the poor and certain ethnic groups. In a society that assumes basic computer skills, those without access to knowledge and equipment are at a significant disadvantage. We need to consider what new technologies, as well as government regulations or business incentives, might be needed to address this problem.

Technological behavior that honors God requires that we balance the design norms appropriately and anticipate the consequences of our choices. This task is difficult because we are, individually and collectively, both finite

and fallen. Given the complexity of the problems, we often need to assume some risk and move forward with only partial information. However, we participate in God's redemption of the technological sphere when we help shape technology toward serving others in the name of Christ.

A Christian Response to Technology

A few months ago, I was talking with one of the youth leaders at our church about a recent pool party 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 iPod as a gift from my spouse. I have come to love this little device for the ability to listen to my favorite music while walking or running. But lately I have begun relying on my ear buds to shut out the rest of the world while shopping and traveling on airplanes. Have I carefully considered the implications of this individualistic behavior on my potential for engaging and encouraging others?

After the closing of our church about a year ago, our family spent six months visiting over a dozen area churches. Regardless of the worship style, liturgy, or level of formality, every single church we attended had one or more projection screens in the sanctuary for multimedia display. Have churches carefully considered the impact of this technology on worship, or is this an example of a technological "keeping up with the Joneses?"

To begin considering these questions, Christians can look to Paul's advice to the Romans: "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" (12:2). What does it mean to be "in the world, but not of the world" with respect to technology? Some Christian families and communities have carefully considered the consequences of integrating various types of technology and have deliberately chosen to limit their involvement, which can be a courageous, counter-cultural practice.

In addition to lifestyle choices, Christians can demonstrate faithfulness by encouraging more Christian young people to become engineers. We desperately need better technology to address many of the pressing issues facing global civilization today. Most of us 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 we do not often remember 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. Idealistic, creative, young Christians have the potential to impact the world for Christ in significant ways by becoming engineers and scientists, as well as pastors and doctors. This kind of encouragement within the Church would not only help young people find their callings, but would remind professional engineers like myself of the value of our career choices and the ongoing responsibility we have to use our skills in ways that reflect our Christian faith.

Further Reading

- Monsma, Stephen V., ed. *Responsible Technology: A Christian Perspective*. Grand Rapids, MI: Wm. B. Eerdmans Publishing, 1986.
- Winston, Morton E. and Ralph D. Edelbach. *Society, Ethics, and Technology*, 3rd ed. Belmont, CA: Thomson-Wadsworth, 2006.
- Swearingen, Jack C. *Beyond Paradise: Technology and the Kingdom of God*. Eugene, OR: Wipf and Stock, 2007.
- Petroski, Henry. *To Engineer is Human: The Role of Failure in Successful Design*. New York: Vintage Books, 1982.
- "Greatest Engineering Achievements of the 20th Century." National Academy of Engineering (<http://www.greatachievements.org>).
- "Grand Challenges." National Academy of Engineering (<http://www.engineeringchallenges.org>).