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**RESILIENT AND SUATAINABLE INFRASTRUCTURE – THE ROLE OF  
CIVILIAN AND MILITARY ENGINEERS**

**Engineering and faith commitments:  
A reformed Christian’s perspective**

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**BRIEFING PAPER**

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*The thesis of this paper is that our deepest faith commitments (worldviews) should and do both inform and affect our understanding of the engineering profession and our strategies for educating the engineers of the future. I begin by discussing interesting characteristics of engineering work (responsibility, hard work, and responses to failure) and examine the reasons for them. Thereafter, I examine my own faith tradition, the reformed branch of historical Christianity, to find that (a) we finite engineers sit at the nexus of creation and redemption in a fallen world and (b) to educate engineers for a life of service addressing engineering grand challenges, a liberal arts and sciences education that goes far beyond mere technical knowledge is needed. This paper represents an invitation for readers to test its thesis using other worldviews.*

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**Introduction**

I routinely include a semester-long project in my “Design of Thermal Systems” course, a 4<sup>th</sup>-year undergraduate engineering class at Calvin College, Grand Rapids, Michigan, USA. The projects are organized around a single, one-sentence question such as “What would it take to get Calvin College off the grid?” “What would it take to make Calvin College carbon-neutral?” “What would it take to make houses in Grand Rapids, Michigan net-zero for energy?” or “What would it take to implement an energy efficiency fund at Calvin College?” Typically, the project supplies 30% of a student’s final mark in the course.

Over the years, I’ve noticed several interesting features of the students’ efforts on these projects. First, at some point during each semester, students come to me for advice on an aspect of the project in which I have little expertise. They are often aghast that I cannot assist. In that moment, they realize the project is no longer an assignment; it is a responsibility. Second, most students spend significantly more than 30% of their study time for the class on the project. Third, when things go horribly wrong, students are emotionally devastated, sometimes to the point of tears.

Practicing engineers have similar experiences regarding their professional work. Thoughtful engineers understand that engineering work is more than a “job,” it is responsibility to society. They invest a significant portion of their lives, some inordinately so, into their engineering activities. And, unfortunate failures can cause emotional trauma to the responsible engineers (Berkes, 2016).

In this paper, I want to explore why engineering work has these characteristics. And, I will suggest that our deepest faith commitments (our worldviews) provide a lens through which we can understand how and why we engineers do what we do. Finally, I will reflect on how we can best educate young engineers to be self-aware and understanding of how their deepest commitments affect their professional work. I will use my own particular faith commitment, the reformed branch of historical Christianity, as an example, with the implicit invitation for readers to think about their own religious traditions and how they can and do inform their own understanding of engineering work.

## Why?

### Why do engineers feel responsible for their work?

To understand why we engineers view our work as more than a sequence of technical assignments, it is essential to understand the fundamental nature of the profession. The Ghana Institution for Engineers code of ethics states “It shall be [a member’s] duty to interest [his or her self] in public welfare, and to be ready to apply their special knowledge for the benefit of [hu]mankind” (GhIE, 2012, Section 1.2). At our best, we engineers create amazing and useful things that meet real-world needs by conceiving with our minds and hands and then testing and fabricating for service in the real world (Heun, 2004). Fundamentally, engineering is a service profession. Its products are redemptive, improving society in ways big and small. *Engineers move from assignment to responsibility because service is paramount.* Engineering responsibility comes in many forms, including public safety, welfare, environmental, fiscal, etc.

### Why do engineers work long hours to make things good and right?

As we serve society by creating useful things, there is a sense in which a part of us remains in the things that we create. No one else would have completed your design in exactly the same way as you. Engineers are literally “in-vested” into their designs. Colloquially, we might say we pour ourselves into our designs. Because of this investment, our designs say something about us to society at large. [1] When the thing you build reflects who you are, you want it to be fitting, you want it to be right, you want it to be good, and that takes time. Engineers *spend* themselves, *exhaust* themselves, on projects with long days and, during “crunch time,” even longer nights! *Engineers spend many days and nights in hard work because the work of their hands reflects who they are.* In this way, engineers are no different from other creative artists: sculptors, playwrights, and painters, for example.

### Why are engineers devastated by failure?

Evil or corrupt actions by engineers that lead to failures are inexcusable and forbidden by professional codes of ethics (GhIE, 2012; ASME, 2012). However, not all failures are caused by evil. Engineers are finite human beings, so they can not anticipate all possible modes of failure for every design. Even when failures are caused by human finitude, engineers are distraught. I submit that *engineers are devastated by failures, in part, because such failures reflect poorly on the engineer’s ability to carry out redemptive service to society, despite having spent long hours on the task.*

## Reformed Christianity

I believe that faith commitments and religious traditions (i.e., worldviews) can inform one’s understanding of their professional life. It must be so: how can our deepest convictions not affect all aspects of our lives, including home, leisure, and work? Indeed, my own faith tradition, the reformed branch of historical Christianity informs my work as an engineer and a teacher, and I’ll use the reformed Christian worldview as an example below. Before going further, it will be helpful to review some of the key themes of the reformed “accent” of historical Christianity.

A perfect and all-knowing God created the universe. God spent God’s self on the creation and rested afterward. Everything in the universe has value because it was created by God. Humans were fashioned, in ways that we don’t fully understand, “in God’s image,” reflecting God’s character in an incomplete way. Some of the ways humans reflect God’s image include (a) we are bodily beings with a soul and spirit, (b) we are rational, moral, and volitional beings, and (c) we are creative. The purpose of the entire creation (both human and non-human aspects) is to praise God. The creation itself is known as “general revelation,” for it proclaims God’s power and might and provides all humanity with a means of knowing God and God’s goodness.

Humanity’s fall into sin separated humans from God, tarnishing the relationship. We all deserve eternal punishment for our sin, and everything is “fallen,” including societal patterns and institutional structures

such as the engineering profession. The fallenness of the creation makes life difficult and a struggle. It makes life seem capricious and unfair.

But, God provided prophets to speak truth about a coming saviour. The birth of God's son Christ Jesus fulfilled the prophesies, providing the clearest indication of God's grace toward the fallen creation. Christ Jesus' death and resurrection repaired the relationship between humanity and God. Between Christ's first and future second comings, the entire universe remains tainted by the fall. God sent the Holy Spirit to abide with us until Christ's return, thereby sustaining the universe. The Father (God), the Son (Jesus), and the Holy Spirit comprise the holy trinity.

Reformed Christians say that God is sovereign over all the universe by virtue of being its all-powerful creator. [2] God has entrusted humans to steward God's creation. Our work as stewards means that we are to both protect and unfold [3] the creation today, even as we prepare for the second coming of Christ.

Although we don't know for sure, most evidence in the Christian Bible supports the idea that Christ's second coming will usher in a renovation of the current Earth, with continuity, not discontinuity, being the predominant theme between the before- and after-second-coming worlds. [4]

Because the entire universe is today tainted by the fall, everything is open to critique, and Reformed Christians like to say we are "reformed and always reforming." Thus, change (even if difficult) is an acceptable and preferred response to new evidence; we continually need to do better by the creator. [5] Humans have the freedom to ask big questions and seek big answers. Some answers to big questions are found in the Christian Bible which is God's "special revelation" to humanity and the guide to holy living. Its major themes are creation, fall, and redemption. Other answers are found in the creation itself, God's "general revelation."

All of this means that reformed Christians are concerned not only with the evangelical agenda of saving souls and winning others to Christ but also with being good stewards of both the human and non-human portions of God's creation. People are worth more than their souls, and the Earth, indeed the entire universe, has intrinsic value beyond its usefulness to the humans who inhabit it. We need to be busy with the project of stewarding the Earth, of fixing its ills, for such activities have eternal consequences. In summary, we have reason to believe that our actions today matter for the future, matter for all time. [6]

## Echoes in Reformed Christianity

Ideally, our deepest faith commitments will comport well with our professional lives as engineers. It seems to me that the example of the reformed Christian worldview provides a useful lens through which engineering activities can be understood.

### Creation

Reformed Christianity helps us understand that one way engineers reflect God's character is that they create useful objects for service in the physical world. God created, so we engineers create. In distinction to the creator who made the universe *ex-nihilo* (out of nothing), we humans create from what we find around us. [7] Thus, our creative tendencies can be traced back to our being created by God in God's image.

Many aspects of an engineer's work can be understood through the lenses of creation and creativity. Engineers take pride in work, because a part of themselves becomes embedded in their created objects, just as general revelation teaches us that the creation contains indications of God's character. An engineer's pride in work is similar to God's repeated declaration in the book of Genesis that the created world is "good." The fact that engineers spend themselves on their work is parallel to God spending God's self on the creation. Creating is hard work, so leisure and the concept of Sabbath are important for working engineers, just as God rested on the seventh day. Of course, engineers are not God, nor are we little gods as we go about our work. But the parallels between the work of engineers and God's activity at creating and sustaining the universe are striking. We engineers design because we must; we were created in the image of the creator.

### Fall

Engineers grieve when their creations fail, similar to how God was grieved when God's creation (humanity) fell into sin. Indeed, there are times when things go horribly wrong despite the best intentions of every

engineer working on a project: a consequence was not considered, a sequence of events was not envisioned, or an extreme operating condition was not evaluated. Of course, we can never envision the full range of conditions and events that our created stuff will encounter, and failure to correctly envision the future exposes not evil but human finitude. But, by God's grace (manifest in such concepts as safety factors, building codes, and design margins), successful engineering designs anticipate *most* future conditions and *usually* function well in real-world service. In fact, you could say that engineers need to be prophetic (Van Poolen, 2004) if their creations are to achieve their redemptive purposes in a manner similar to the prophets who heralded Christ's coming that would achieve God's redemptive purpose.

### **Redemption**

At our best, we engineers create engineered objects that make the world better, that overcome the effects of the fall, that redeem the world many ways big and small, thereby echoing God's redemption of humanity in Christ Jesus. The ongoing work of maintaining created objects resembles God's sustaining work through the Holy Spirit, too. And, stewardship of the earth and its resources can be seen as a redemptive act, one in which engineers, as creators of machines that are fashioned from resources and consume resources for their ongoing operation, have a special and central role. We steward the earth in partnership with God who, in Christ Jesus and through the Spirit, sustains the universe. The sustaining work of stewardship takes on a holy significance when we realize that today's earth is also important for life after Christ's return, is important for eternity. Indeed, in this context, all occupations, including engineering, are vocations with eternal significance.

### **Deeper Understanding of the Creator**

And, if it is true that engineers reflect God's image, we ought to be able to discern something about the image that is reflected in us. In fact, because our work is so intimately related to creating, we engineers may be well suited to consider some aspects of God's response to the creation. The excitement that we feel when a successful design is unveiled or first put into production can lead us to consider God's celebration of God's creation at the dawn of time. Perhaps we can glimpse some of God's desire to maintain and sustain the good creation as we think about designing for durability over long product lifetimes. And, our reaction to design failures can lead us to consider God's reaction when elements of God's good and perfect creation are damaged or distorted. Perhaps we can glimpse God's grief when God's creation is exploited or pillaged (Heun, 2014).

### **Preparing the Next Generation of Engineers**

The above discussion raises the question of how to educate the next generation of engineers to both recognize and understand (a) the eternal significance of their work and (b) the important redemptive task it represents. I suggest that within the reformed Christian worldview, the themes of creation, fall, and redemption provide guidance.

### **Creation, Fall, and Redemption**

First, the importance of creating and creativity as a link to the creator in the reformed Christian worldview suggests that development of creativity and design skills in students should be paramount in engineering education. The impartation of technical knowledge must be only one aspect of the education process. Ample opportunity must be given for students to apply technical knowledge by practicing design and design processes. Exercises and projects should be structured in ways that allow students to express creativity while developing solutions to real-world problems. Students should be educated in and experience first-hand the tensions among competing goods that arise during the engineering design process; design norms [8] may be helpful for this purpose (Monsma, 1978).

Second, the importance of the fall and human finitude in the reformed Christian worldview suggests that engineering students should be sensitized to the effects of past engineering failures on the created world. Students should be made aware of both evil and finitude and their differing effects on the engineering design

process. Students should be educated in and have experiences with procedures and processes to avoid failures, such as engineering reviews, continuous improvement, quality control, and engineering ethics.

Third, the importance of Christ's redemption of humanity in the reformed Christian worldview suggests that engineering education should highlight the redemptive aspects of engineering design. Design challenges set before students should be constructive rather than destructive. Successful student designs should bring about higher quality of life and human development always. They should be focused on renewable and sustainable technologies rather than unsustainable practices.

The "reformed and always reforming" mantra gives permission to ask whether the typical, highly technical focus of engineering education is the best way to educate engineers. Indeed, an education that is broader than merely the technical aspects of "hard" science and its application in engineering is required if it is to have the above characteristics. Aspects of philosophy, social thought, local and global political structures, and diverse worldviews normally associated with the humanities and "soft" sciences become essential to an engineering education when its character is informed by a reformed Christian worldview. One educational tradition that excels in this area is the liberal arts and sciences.

### **The Liberal Arts and Sciences**

In my view (and that of my employer, Calvin College), a Christian liberal arts and sciences institution provides an appropriate structure for the type of engineering education discussed above. [9] It may seem unnatural to embed a professional degree such as engineering within a liberal arts and sciences context, [10] but in the reformed Christian worldview, all of the universe was created by God, all of life is under God's sovereignty, all is in need of redemption, and general revelation teaches us that everything in the created world has the capacity to reveal God. Thus, at their best, reformed Christians value learning and education highly and embrace the sciences and engineering. [11]

A hallmark of a liberal arts and sciences education is the freedom to ask big questions and seek big answers. "Big questions are the lifeblood of liberal arts education with its emphasis not only on the disciplines, but also on the connections between the disciplines and contextual study. ... Liberal arts education, at its best, goes beyond simply knowing about reality or simply and narrowly acquiring competence in some field" (Curry et al., 2007). Given that the merely technical aspects of an engineering education are not enough to develop engineers who understand the importance of creativity, the fall, and the redemptive aspects of engineering design, a liberal arts and sciences institution is a very attractive environment in which to educate the next generation of engineers. Indeed, if engineers are to participate in the redemptive project of solving today's big challenges (e.g., human development, climate change, and resource depletion), they will need the breadth of the liberal arts and sciences.

### **Summary**

Engineers carry much responsibility and gain significant satisfaction from work well done. In the midst of that work, it is helpful to step back and reflect on the sources of the responsibility and satisfaction. My thesis is that our deepest convictions and religious beliefs (our worldviews) can help us interpret and inform the work we do as engineers. Furthermore, I posit that examination and clear articulation of worldviews can provide guidance for the project of educating future engineers to address (Heun, 2008) the engineering "grand challenges" (NAE, 2013).

I used the example of my reformed Christian worldview to illustrate my thesis. My faith tradition suggests that creative endeavours, including engineering, are both relevant today and significant eternally. Indeed, we finite engineers sit at the nexus of creation and redemption in a fallen world. And, educating future engineers to tackle big issues will require an education in the liberal arts and sciences, one that goes far beyond acquiring mere technical knowledge.

I fully recognize that other faith traditions, when reflected upon, could similarly provide deeper understanding of engineering work and provide guidance for education. The implicit invitation presented by this paper is for readers to do so.

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## Note/s

- [1] I suspect that every engineer has looked at a manufactured or constructed object and wondered why certain design or fabrication decisions were made. These questions are akin to asking “what was the engineer like who made that decision?”
- [2] One of the documents of the Christian Reformed Church is entitled *Our World Belongs to God: A Contemporary Testimony*.
- [3] Humans “unfold” the creation when they develop new purposes and ways of using the creation for God’s glory.
- [4] There is hardly agreement on this topic among Christians. I am presenting an amillennial position wherein the “new Earth” discussed in Isaiah, 2 Peter, and Revelation is a renovation or restoration of the present earth, not something totally different.
- [5] In a way, optimization is “built-in” to Reformed Christianity.
- [6] Ideas of sustainability resonate with Reformed Christianity. See Curry (2007) for more details.
- [7] One term often used for humans is “sub-creators.”
- [8] The design norms have been given as (1) cultural appropriateness, (2) open communication, (3) stewardship, (4) delightful harmony between designed objects and the world, (5) justice, (6) caring, (7) trust, and (8) humility. The design norms have, embedded within them, inter- and intra-norm tensions. For example, stewardship can encompass both stewardship of both natural resources and financial resources.

[9] The definition of what subjects should be included in the liberal arts is a matter of some interpretation. One such list includes the arts, languages and linguistics, literature, mathematics, natural sciences, philosophy, psychology, religious studies, and the social sciences.

[10] In some quarters, the term “liberal arts” precludes education for a profession.

[11] Unsurprisingly, effective teaching, both broad and deep learning, and incisive thinking are also highly valued by reformed Christians.

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