Enhancing Science and Engineering Programs to Equip and Inspire Missionaries to Technical Communities

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Abstract

Enhancements to science and engineering curricula are being considered in light of theologically-significant scientific discoveries, as well as the applicability of the field of engineering to the formulation of a coherent cosmology and worldview. In addition to the inclusion of these ideas in existing science and engineering courses, a new "Science and Faith" course is currently being developed in an effort to better equip and inspire science and engineering graduates to serve as "everyday" missionaries in their chosen fields.

This new course will focus on the knowledge and skills necessary for graduates to engage in fruitful dialogue with seekers from high-tech and highly-educated societies. Students will receive training in science-related apologetics, including the attitude and behavior of the Christian apologist. They will gain an understanding of the importance of God's general revelation, and how recent developments in science and engineering might contribute to the veracity of a Christian worldview. The latest developments regarding design evidence, creation/evolution, and natural theology will be discussed and evaluated. Various Christian positions on the relationship between science and scripture will be investigated. An extended design argument, based on evidence from many fields of knowledge and forming a cumulative case for the Christian worldview, will also be discussed and evaluated.

Given that complex design is largely the domain of the engineer, it is recognized that engineers have an important role to play in the current science/theology dialogue. The Apostle Paul's assertion that God's invisible qualities can be known, "being understood from what has been made" (Rom 1:20, New International Version [NIV]), may refer to knowledge obtained through a kind of reverse-engineering of the cosmos. Indeed, the systems engineering mindset has proven to be extremely useful in complex fields such as microbiology. A compelling argument can be made that the universe is so readily and profitably reverse-engineered, that it must have been engineered in the first place. The idea that many features of the universe strongly suggest (through a consilience of evidence) that the entire cosmos is an engineered system will be investigated, including possible purposes for such a system. The concepts of constrained optimization and engineering tradeoffs will also be introduced to assist in wrestling with the problem of evil from the Christian worldview. It is hoped that as a result of this initiative, students will graduate full of ready answers (1 Peter 3:15, NIV), and inspired to live a life of purpose and mission for the glory of God.

Keywords: science and theology, apologetics, missions, engineering education

In recent years, the problem of the origin of life, which essentially reduces to the problem of the origin of biological information, has become intimately connected to the problem of the origin of the cosmos. This is due to discoveries of the fitness or fine-tuning of the universe for life, and the recognition of the enormous amount of information that must have been present at the beginning. Thus any discussion about the origin of life and the cosmos is difficult because the subject is so vast. It branches across literally every area of science, especially such fields as biology, chemistry, physics, astronomy, cosmology, and earth sciences. The dialogue is also relevant to nearly every area of culture, such as education, politics, religion, and sociology. In order to be an expert in the entire subject of the origin of life and the cosmos, one would need a very diverse background in almost all of science. Actually, one would quite literally need to have the mind of God. This realization should motivate Christians to want to learn as much as possible in order to strengthen one's faith and become a

more effective witness. Engineers are in a unique position to contribute to these ideas because engineering necessitates a practical knowledge of many areas of science. Engineers can also better relate to the difficulty of dealing with the design tradeoffs inherent in a system as complicated and intertwined as the universe. As a brief description of the undergraduate course to which this work refers, this paper will not attempt to scrutinize every detail, but will give an overview of current research and dialogue while discussing critical issues at a deeper level. Initially, some pertinent ideas are presented from various fields of science. Such information is important since recent scientific discoveries appear to be particularly applicable to these issues. This is followed by an in-depth discussion of the value of natural theology for apologetics and evangelism.

Cosmology and Astronomy

A discussion about the universe naturally begins with cosmology. No scientist would deny that the universe at least appears to be several billions of years old. Evidences from astronomy, radiometric dating, and the fossil record all seem to point to this same conclusion. Interpretations of the Bible greatly affect whether one considers age to be actual or only apparent. This article will attempt to be unbiased regarding creation models, allowing the evidence to fall where it may. However, the apologetic value of various models will be investigated. Thus for example, the Big Bang will be discussed as a possibility. If the Big Bang is historical, it is far from being evidence for atheism. Obviously there are huge philosophical questions regarding why something exploded out of nothing. The general acceptance of the Big Bang theory could be considered favorable to the Christian worldview because the theory necessitates a beginning. Interestingly, the name "big bang" was originally a negative referred to astronomer Fred Hoyle, who said, "The big bang theory requires a recent origin of the universe that openly invites the concept of creation" (Heeren, 2000, p. 152). Possibly even more important is that the Big Bang must be the most finely-tuned event in history. An engineered explosion such as a fireworks shell is a simple analogy, but fireworks do not come close to representing the complexity, order, and precision of an expansion resulting in a universe beautifully

arrayed with galaxies, solar systems, planets, moons, comets, and other bodies spinning so conveniently (for us) through space and time.

In general, three essential factors are required to achieve design outcomes in engineering: a) the mathematical form of nature, b) universal physical constants, and c) boundary conditions (Bradley, 2005). For example, to determine how gravity affects an object, the following must be known: the form of the gravitational equation (Newtonian: $F = Gm_1m_2/R^2$), the gravitational constant ($G = 6.67*10^{-11}$ N-m²/kg²), and several boundary conditions (m_1, m_2, R). From the perspective of a human engineer, only the boundary conditions can be altered. The other two can only be analyzed and hypothesized, but they must have been determined sometime in the past, somehow. Science currently estimates that there are 26 universal physical constants (Baez, 2000). This number might change, depending on if a future theory is able to define one constant based on others or if a natural process is discovered requiring a new, unrelated universal physical constant. The overall purpose of the search for a Theory of Everything is to reduce all of these constants and equations into one tidy equation. Some hope this will explain the order behind the universe, but even if it is successful, it is not a true threat to theism. It will only push the questions back another level. Models and equations can explain a lot, but they can never explain their own existence or comprehensible order.

Regarding the finely-tuned physical constants, Christian de Duve (2008), a biochemist, Nobel laureate in medicine states,

> We live in a biofriendly world. Were it otherwise, we wouldn't be around. The question is, therefore, how biofriendly is it? Physicists have addressed this question and have come to the conclusion that if any of the fundamental physical constants were a little smaller or a little larger than they are, the universe would be very different from what it is and unable to produce or harbor living organisms. (p. 169)

How have physicists come to this conclusion? The primary method is called "counterfactual variation" (Eschenmoser, 2008) where physical constants are varied and it is determined if the results are still

favorable for life. One can determine the amount of variation that results in conditions unfit for life, and therefore one is able to determine how "finely-tuned" the dials on each of the physical constants are. In biology, this process is more difficult and subjective, but it is a relatively simple process for cosmology. Types of fine-tuning, other than universal constants, include specific conditions for quantities such as distances, and timing. As of 2006, astronomer Hugh Ross (2006) listed 93 constraints that are usually considered instances of "fine-tuning" in the universe. All of these conditions had to be embedded into the rapid expansion of a singularity if the Big Bang is historical.

How incredible are the instances of fine-tuning in the cosmos? The expansion rate relative to the gravitational pull caused by the density of the universe must be accurate to the order of $1:10^{60}$ (Holder, 2004). If this ratio had been altered by such a small magnitude, the universe would have either collapsed rapidly back in on itself, or expanded so fast that galaxies would have never formed, prohibiting life as we know it. The ratio of gravity to the electromagnetic force is vital for star variety and therefore element variety and stars with long life spans. This precision is on the order of $1:10^{40.7}$. Of course, many more examples could be listed, but the overall point is that the biofriendly behavior of the universe is teetering on an incredibly sharp knife edge.

Besides fine-tuning, another type of evidence for design is presented in the book, *The Privileged Planet*. In their book, Gonzalez and Richards (2004), explain how several traits combine to make Earth an ideal location for discovery of the universe. It makes sense that God would want His existence to be confirmed through investigation of His creation. The atmosphere is dense enough to block the correct amount of harmful radiation, while remaining transparent enough for observation of the sky. Earth's single moon regulates the tides and stabilizes Earth's rotation, but it also provides only minimal obstruction of the night sky. The correct ratio of size and distance between the moon and sun make the two bodies appear the same size in the sky. This may only be coincidental, but it did provide an opportunity for scientists to test Einstein's theory of relativity based on the bending of light due to the sun's gravity. Possibly most importantly, this solar system is located near the outer edge of a spiral

arm of the Milky Way Galaxy. In this region, harmful chaos is minimal, while beauty of the night sky is still impressive. The gas and dust in this region is diffused compared to others, which means that approximately 80% of the universe is unobstructed from Earth's vantage point.

Physics and Chemistry

It is difficult to separate cosmology and astronomy from the fields of physics and chemistry. Orbits are obviously based on the laws of physics. Fusion inside stars not only affects large-scale astronomical behavior, but it also determines the elemental composition of the universe. Besides typical fusion reactions, the rapid transitions that occur during the nova or supernova of most stars' deaths are the source of almost all of the heavy elements in the universe. The most important elements for the existence of life are probably hydrogen, oxygen, and carbon. Carbon is important because of the incredible variety of compounds made possible by its four valence electrons. The most notable importance of hydrogen and oxygen is that they constitute water, a substance incredibly fit for life.

Hydrogen, oxygen, and carbon conveniently rank one, three, and four in prevalence in the universe. This situation results from the behavior of fusion within stars. Early reactions start with hydrogen atoms and then produce deuterium (mass 2), tritium (mass 3), and alpha particles (mass 4), but no stable mass 5 exists. This limits the creation of heavy elements and was once considered one of God's "mistakes". In actuality, the lack of a stable mass 5 necessitates bigger jumps of four which lead to carbon (mass 12) and oxygen (mass 16). Otherwise, the reactions would have climbed right up the periodic table in mass steps of one (until iron, which is the cutoff above which fusion requires energy rather than creating it). The process would have left oxygen and carbon to be no more abundant than any other element.

One might wonder why beryllium (mass 8) is not more prevalent. This is because beryllium reacts easily to make carbon due to carbon's energy resonance level. Beryllium and helium have very nearly the exact same combined energy level as an excited carbon atom. If the resonance level of

carbon was 4% lower, essentially no carbon would form. If it was 0.5% higher, it would rarely hold together (Gingerich, 2008). Fred Hoyle predicted this situation based on an anthropic assumption. When it was later confirmed, Hoyle (an agnostic) seemed to be unnerved, leading to some interesting quotes such as the following:

> A commonsense interpretation of the facts suggests that a superintellect has monkeyed with physics, as well as with chemistry and biology, and that there are no blind forces worth speaking about in nature. (Hoyle, 1981)

Another agnostic scientist struck by how the universe is so well-suited for life was Lawrence J. Henderson, the author of *The Fitness of the Environment* (1913). The central claim of the book is summarized in the first chapter, "Fitness there must be, in environment as well as in the organism" (p. 6). Among other topics, Henderson studies the fitness of water extensively.

Water's most famous trait is that it expands into the solid state, causing ice to float rather than accumulate on the ocean floor. A short list of some of water's other impressive properties includes the following: A very high specific heat maintains relatively stable temperatures in oceans and organisms. Its thermal conductivity is four times that of any other common liquid, helping organisms distribute heat. On the other hand, ice's thermal conductivity is low, making it a good thermal shield. Water has the highest latent heat of vaporization of any substance – more than five times the heat necessary to raise the same amount from freezing to boiling. This allows water vapor to store huge amounts of heat in the atmosphere, and it also helps humans dissipate heat through sweat. Water's high vapor tension enables the atmosphere to hold more water, and thus it enables precipitation. A low viscosity allows blood to flow through small capillaries. Water has unequaled solvency properties, enabling blood and the oceans to transport all of the necessary contents for life (Denton, 1998). Jeffrey P. Schloss (2008) also notes that some of the traits of water are optimized at various temperatures. At body temperature, the specific heat of water is lowest and water's viscosity (decreasing with temperature) is optimized

with the solubility of hydrophobic molecules (increasing with temperature). In short, every property of water seems to be ideally suited for life.

This situation should be amazing to an engineer. How can a simple substance containing only three atoms exhibit all of these functionally impressive qualities? Many of these qualities are caused by water's hydrogen bonding and strong polarity (Gingerich, 2008), but this is an oversimplification. That every property is suited for life seems too incredible to be a coincidence. God's design process for water must go very deep, including the design of forces, masses, sizes, and other quantities all the way down to the quantum level. This must be engineered in a way that accounts for the behavior of all of chemistry, not just water. The problem is of such high order that it suggests the action of a calculating intentionality.

Biology and Biochemistry

Considering all of the evidences for superb engineering mentioned to this point, as well as the possibility that they were embedded into an expansion from a singularity, some Christians extend this logic to propose that God also front-loaded the origin of life into the original event of creation. This suggestion encounters criticisms from both science and theology, but one must at least consider the possibility that these criticisms are not insurmountable. One's faith should not be challenged based on whether God created the first living organism by natural processes or more immediately. Study of the origin of life is primarily a subject of biochemistry. It requires considerable knowledge about the components of the simplest known cells, especially DNA, RNA, and proteins. DNA is an especially challenging hurdle because it contains the codes for reproduction. A naturalistic explanation of the origin of DNA becomes a "chicken or the egg?" conundrum, and it also requires an explanation for a pathway to the excellent DNA design with limited occasions for natural selection as an explanatory method. Prior to the existence of codes for self-replication, the only type of natural selection is the tendency for certain reactions to occur more readily than others.

There are two general categories of theories for a naturalistic origin of life. Geneticists usually claim that life began with replication, while metabolists consider genetic replication to be a later function of autocatalytic-metabolic cycles. There is currently no full model for either type of theory. Most claim that RNA was an ancestor to DNA, but RNA needs its own ancestor as well, and no one knows how many steps might be necessary prior to that. TNA has been studied as a more stable predecessor to RNA, but it encounters most of the same problems because its composition is primarily only different in that it contains four carbon atoms instead of five in its sugar building block (Eschenmoser, 2008) RNA cannot be directly produced abiotically because of many difficulties. Nucleotides (the structural units of DNA, RNA, and TNA) include a base, a ribose, and a phosphate. It appears that none of these can be created abiotically. The pathways to the bases are antagonistic, all sugars are unstable in prebiotic conditions, and no source for abiotic phosphate has been found. On top of this, nucleotides themselves are also unstable. This means that these nucleotides must come later in any naturalistic explanation, after shelter from the environment has been created. There is also currently no plausible abiotic reaction scheme to assemble the nucleotides (Freeland, 2008).

A pathway to DNA and a reaction scheme to create it still would not account for the code it contains. The four bases create a four "letter" code capable of housing all the information to produce a human or any other living organism. This code could not have been synthesized randomly, since the odds become astronomical very quickly. The human genome was first mapped by a team led by Francis Collins, who said,

> When you have for the first time in front of you this 3.1 billion-letter instruction book that conveys all kinds of information and all kinds of mystery about humankind, you can't survey that going through page after page without a sense of awe. I can't help but look at those pages and have a vague sense that this is giving me a glimpse of God's mind. (as cited in Swinford, 2006, para. 7)

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The method to decode the message was discovered before the code was mapped. Triplets of nucleotides, called codons, refer to one of the 20 possible amino acids in the production of a protein. Three codons are stops, like a period at the end of a sentence (Freeland, 2008).

Although DNA is the instruction manual for reproducing life, proteins carry out almost all of the essential functions in cells. Proteins are composed of chains of amino acids. Almost half of the 20 amino acids can be reliably produced in prebiotic experiments, so natural explanations assume the others must have been invented later by metabolism (Freeland, 2008). Complex proteins are folded by stacking simpler folds. There are a limited number of configurations – probably somewhere between 1000 and 6000 possible folds (Denton, 2008). Biologist Michael Denton explains why the discovery of this "periodic table" of folds is exciting:

> The discovery that this elegant set of atomic architectures represents a set of natural forms determined by physical law (and therefore that many of their genetic properties are 'antecedent' to biology) not only is profoundly beautiful and intellectually attractive in itself, but has far-reaching consequences. It implies, aside from the question of the actual biological fitness of the folds, that protein-based life is an integral part of nature and may be properly designated an *emergent property of matter*, (p. 276).

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This builds on the argument that the universe is improbably fit for life.

Denton (2008) also lists some of protein's impressive abilities: "architectural diversity, marginal stability, robustness, and possession of a hydrophobic core," (p. 270). Architectural diversity refers to the variety of folds, which is obviously vital for the variety of processes necessary for the life of a cell. Marginal stability and robustness might seem like opposites, but this seems to represent an engineering trade-off. Slight energy variations can cause simple adaptations, which are vital to such processes as the intake of oxygen into hemoglobin. On the other hand, proteins assume their folded form without energy input, which makes them very robust. The hydrophobic core is a useful feature that acts as a reaction chamber excluding the presence of water. It also provides the ability of proteins

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to stack to make assemblies like filaments and microtubules. Scientists have a lot to learn about proteins because current research can only test, not predict, how combinations of amino acids will fold or how this sequence determines the protein's function. Regardless of the results of future research, it is hard to deny the evidence of great engineering design in proteins.

The origin of life is a difficult problem, but explaining the variety of life's forms is an equally perplexing proposition. The theory of evolution has resulted in a major conflict in society since Darwin wrote *The Origin of Species* in 1859. Christians believe in varying amounts of power for the roles of mutation and natural selection in creating the current variety of species. Some place almost no power in evolution, claiming that God created every species almost exactly as it appears today. Others claim that God used evolution to create every organism from the origin of life to the first man. To either prove or falsify the theory of evolution is very difficult. A reasonable proof would require a logical evolutionary pathway to every organism along with evidence that these pathways were taken. Science and the fossil record cannot demonstrate this goal. To disprove evolution as an all-encompassing theory would only take a single example of an organism that could not possibly evolve in reasonably small steps. One of Darwin's quotes that has become a favorite of those opposed to evolution is, "If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down" (Behe, 2006). However, such arguments are usually condemned as arguments from ignorance. Scientists often use the evolutionary landscape (Freeland, 2008) as a metaphor for evolutionary pathways, where fit organisms are on top of hills. An un-evolvable organism would be situated on top of a tall tower, but proving that there are no stairs hidden behind a back door is very difficult.

Michael Behe's *Darwin's Black Box* (1996) is one of the most famous books exposing the difficulties facing the theory of evolution. Behe's most famous concept is called irreducible complexity, for which Behe uses the analogy of a mousetrap. The whole does not work without every part in place, so small steps are not advantageous. Behe's microbiological examples of irreducible

complexity are cilium/flagellum, blood clotting, protein transport, the immune system, and AMP generation. Cilium and flagellum are efficient propellers with all of the necessary parts corresponding to their mechanical equivalents. Blood clotting is basically an 11 part Rube Goldberg mechanism. Protein transport includes 21 steps to tackle all of the difficulties of bringing proteins through the assembly line to their correct locations by using microscopic versions of tags, delivery trucks, and so forth. The immune system contains billions of versions of white blood cells, making it ready for even synthetic bacteria. AMP is a molecule that becomes one of the building blocks of DNA. Its generation in the cell requires 13 steps, including 12 enzymes, five energy bursts (via ATP), and eight specific types of molecules (Behe, 2006).

The afterword of the 10th anniversary edition notes that as of 2006, despite great attention from evolutionist scientists, no scientific literature exists that contains evidence for how molecular evolution might have occurred in the examples Behe gives. However, it has been rebutted by suggesting, in a more general sense, that the individual parts may have served other advantageous uses before combining into their current form. In this way, evolution may still select advantageous parts without a preference towards their final purpose. This argument is reasonable, but it lacks specific examples.

The study of evolutionary mechanisms is still in its infancy. Specific, detailed examples of pathways are not common. Regardless of the power and extent of advantageous mutations in biology, the extended design argument still seems to be strong. William Dembski states that "Many of the systems inside the cell represent nanotechnology at a scale and sophistication that dwarfs human engineering. Moreover, our ability to understand the structure and function of these systems depends directly on our facility with engineering principles" (Dembski, 2008). Life contains many hallmarks of well-engineered systems, such as modularity, specificity, adaptability, and durability. Whether these traits were caused directly by the Creator's hand or by a tool in His hand is really a side issue. An efficient tool still demands an explanation.

Homo sapiens pose an even more difficult evolutionary question. Each person knows from experience the amazing capabilities of the human mind, but yet very little is scientifically known. The concepts of consciousness and free will might forever remain beyond the scope of science. Since atheism requires only cause and effect explanations, it necessarily claims that free will is an illusion. Christianity claims that an eternal spirit exists in every human. Author Roy Abraham Varghese explains the relationship of the spirit to the body like a radio to its message. He writes, "When its batteries run out, the radio can no longer transmit the messages it used to pick up. The physical components of the radio, however, are by no means identical with the messages, let alone with the person or persons from whom the messages originate" (Varghese, 2003). The spirit could not originate through any naturalistic process, so a Christian model of evolution at the least needs divine intervention at this point unless it is going to stray significantly from orthodoxy.

The Anthropic Principle

Even disregarding a Christian worldview, one can make the case that the cosmos seems to be centered on humans. Mankind is matched to creation in such a way that people are able to comprehend and predict its natural laws. At a more basic level, the ground can be tilled to produce enough food without expending too much energy in the process. The logic of days, seasons, and years provides a simple backdrop for living. The list can go on. In the end, the true purpose for creation is to provide a setting for God's redemptive plan of love and grace. Orthodoxy says that God did not need to create, but He chose to create as an act of love. In this sense, all of nature is a display of God's love. Science is a witness of His affection for us.

The innate beauty of creation is another expected trait if it has been engineered. Beauty is generally impossible to quantify. Thus, "beauty is in the eye of the beholder." This delights artists and is entirely fitting. If beauty could be quantified, it could be optimized and bottled, ironically losing its beauty. Since beauty is subjective though, it makes a definitive argument for a divine Artist all but impossible. The concept of beauty should not be dismissed from this discussion, though. Science

might describe, but never explain the view of a sunrise, the taste of chocolate, the touch of a soft breeze, the sound of birds chirping, or the smell of flowers after a rain. These all convey a purpose that naturalistic science can never appreciate. Beauty is not necessary, yet it is prevalent and good, so the very existence of beauty strengthens the case for a Creator. Certain aspects of the argument for a Creator are more forceful than others, but the strength of the theory lies in the cumulative case, not necessarily in the individual evidences.

On the flipside, as overwhelming as the task of explaining nature and the cosmos naturalistically seems, the current theory that poses the biggest potential is the multiverse theory. The strength of the multiverse theory is its nearly infinite explanatory power. If there are nearly infinite universes, then there is probably literally another one just like this one where this paper was never written. The multiverse theory can explain all of the fine-tuning and even any astronomically unlikely events for the creation of life. However, the multiverse theory still requires an ultimate cause, so it still needs a transcendent creator. The theory also suffers from its absurdity and lack of evidence. What determines the possible array of universes? Tegmark proposes a universe obeying mathematics based on fractals or non-Cantorian sets (Davies, 2008). Paul Davies suggests that some universes might not even obey mathematics, but instead obey purely teleological principles (Davies, 2008). Do the possibilities stop? What would be the cause of such a strange variety of universes in which mankind as it exists here is just one infinitesimal occasion?

Even if no alternative to a Creator is ever satisfactorily suggested, the problem of evil and pain will still bother people. This subject comes up almost every time the topic of origins is discussed. Unfortunately, evil seems to be a necessary side effect of free will. Besides this, death (and probably the uncertainty of its timing) seems to be necessary so that God can bring us fully back to a glorious state. Although pain and evil may not be good, God is a master at using it to accomplish His purposes. In his book, *Miracles*, C.S. Lewis (1947) states,

> So much for the sense in which human Death is the result of sin and the triumph of Satan. But it is also the means of redemption from sin, God's medicine for Man and His weapon against Satan. In a general way it is not difficult to understand how the same thing can be a master-stroke on the part of one combatant and also the very means whereby the superior combatant defeats him. Every good general, every good chess-player, takes what is precisely the strong point of his opponent's plan and makes it the pivot of his own plan. Take that castle of mine if you insist, It was not my original intention that you should – indeed, I thought you would have had more sense. But take it by all means. For now I move thus… and thus…and it is mate in three moves. Something like this must be supposed to have happened about death. (p. 170)

The redemption of an apparent failure is actually a characteristic of a well-engineered system, as engineer and author Henry Petroski, (2006) writes in his book *Success Through Failure: The Paradox of Design*

> Failure is thus a unifying principle in the design of things large and small, hard and soft, real and imagined…Whatever is being designed, success is achieved by properly anticipating and obviating failure. (p. 5)

The concept of God using a refining fire is throughout scripture. Isaiah wrote, "See, I have refined you, though not as silver; I have tested you in the furnace of affliction" (Isaiah 48:10, King James Version [KJV]). God can also use pain to get our attention. C.S. Lewis (1962) also states, "God whispers to us in our pleasures, speaks in our conscience, but shouts in our pains: it is His megaphone to rouse a deaf world" (p. 93). Engineering design is full of tradeoffs, and it seems that this is the biggest tradeoff (and the biggest risk) of God's plan. Despite pain and evil, God's plan still can be optimally good.

A Christian worldview appears to be quite capable of accommodating this diversity of evidence. Some people disagree because the supernatural seems irrational to them or possibly because of the implications. However, the full picture of the cosmos discovered by science displays an impressive system of precision, order, and purpose. Engineers cannot rival the efficiency and

complexity found in nature. The full picture, including astronomy, chemistry, physics, biology, and all other sciences, creates a consilience of evidence pointing towards a transcendent Engineer. Since engineers tend to be very rational, every Christian engineer needs to be competent to discuss this topic if he or she is going to be a successful witness among other engineers, scientists, or educated skeptics.

Apologetics: Communicating Truth

Unfortunately, the worldviews carried by people color their perceptions of reality. It is not enough for the Christian apologist to use science, reason, and philosophy to demonstrate the viability of the truth claims in Scripture. The method of presentation is critical. To this end, Christian engineers who understand the science of design and its fitness for understanding the natural world benefit greatly from some exposure to apologetic techniques. With this in mind, the content of a missions-oriented Christian engineering course may effectively fall into two categories: (a) foundational knowledge and worldview and (b) apologetic techniques for effective transmission of truth.

The New Testament writer Jude (1:3b) encourages the first century Church to "…contend for the faith that was once for all entrusted to the saints" (1:3b, KJV). Dembski, (2001) explains that,

> The very idea of contending for the faith rings foreign to our modern and postmodern ears. To contend for something, after all, presupposes we have something worth contending for—that the faith is something definite and precious, all too easily lost, and therefore in need of being vigorously preserved. I want therefore to begin this essay by showing that it is legitimate to think of the faith in these terms, that is, as something definite, precious and worth fighting for. (p. 31)

In the last two hundred years, firmly held beliefs in many areas of study seem to have been turned upside down:

1. Physics—Newtonian mechanics → relativity theory and quantum mechanics.
2. Biology—systems are designed → systems are the product of naturalistic mechanisms.

3. Sociology—Marx proposed that economic forces govern history.

4. Psychology—Freud proposed that psychic forces beyond our control govern our personalities.

5. Arts—the absence of any stable reference points have been celebrated.

Because of these changes, many young people wonder if faith in God should be something fought for or just left to be interpreted in ever changing ways. Sean McDowell uses a simple illustration in teaching his students about the objective reality of faith in Christ. He places a jar of marbles in front of them and asks, "How many marbles are in the jar?" After some guesses he tells them the correct answer and asks, "Which of you is closest to being right?" They all agree on one of the guesses. Then he passes out Starburst candies and asks, "Which flavor is right?" They all recognize this as an unfair question. He affirms this and asks, "Are religious claims like the number of marbles in a jar or are they a matter of personal opinion, like preference for flavors of candy?" After this door is open he then explains that Christianity is based on objective fact. While many people reject the historical resurrection of Jesus, it is not the type of claim that can be "true for you but not true for me." He then proceeds to the objective Christian views of creation, nature of the triune God, nature of man, and authenticity of the Bible (McDowell, 2007).

Much foundational knowledge about the nature of God may be observed by scientific study or general revelation. Heie, (1999) proposes a view of God's redemptive plan that includes not just individuals but the whole creation. This view gives Christian engineers a purpose for engineering beyond secular achievement. We are, in Heie's view "to be *agents for knowledge,* for greater understanding of all aspects of the created order, that we may live in proper relationship with that order." (para. 22) By establishing the moral requirement that engineering education focuses not just on the most profitable solution, there is room to instill a true foundation of ethical responsibility rather than an afterthought piled on for public image protection.

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The Cumulative Case

There is a point however, when explaining the natural data in a common sense way leads to the need for additional (special) revelation like Scripture. If this transition is approached wisely, there arises a compelling cumulative case for the Christian worldview. Geivett, (2006) suggests that it be presented in the following order:

1. Cosmological evidence—universe was caused by an agent with great power and intelligence.
2. Design evidence—fine-tuning and complex functionality suggest plan and purpose for humans.
3. The human condition—tension between positives and negatives raises important questions.
4. The need for additional revelation—the expectation of a remedy for the human condition.
5. The arena of religious traditions—which revelation is most consistent with previous data?
6. The evidence of miracles—Jesus' resurrection solidly confirms our expectation of a remedy.
7. Making the truth believable—a devotional experiment to break the chains of habitual unbelief.
8. Religious experience—rational trail of evidence culminates in a genuine experience of God (pp. 302-315).

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Once the evidence (from science) for a Creator has been presented, a study of the positive and negative aspects of the human condition naturally leads to unanswered questions, and the need for additional revelation. This leads to a comparison of the evidence in support of various world religions and possibly inspired writings. Hopefully, the investigation culminates with a devotional experiment in which the seeker opens up to a personal relationship with the Creator.

Throughout the process of delivering truth the apologist must be sensitive to the reception, or good answers may fall on deaf ears. Paul, in reaching out to the skeptics of his day proceeded in a similar fashion:

1. Evidence from nature (Rom. 1:19-21).
2. Human condition (Rom. 1:23-25).

3. Relating to the religious traditions (Acts 17:3).
4. Made the truth believable and wrapped it in the language of the culture (Acts 17:22).
5. Special revelation. (House, 2007, pp. 64-75)

Comment [t6]: I moved the citation here.

Besides his form of reasoning, Paul used great wisdom in relating to the people's common understanding. He talked of how some of the pagan poets called humans children of God. He also appealed to common sense and was therefore received to an extent by the greatest philosophers of the day (McGrath, 2004). Similarly, Jesus was gentle and wise in his presentation. His method as identified by Heeren, (2002) is as follows:

- Determine how far they are along their spiritual journey (Matt. 7: 6)
- Not "take-it-or-leave-it"; ask another question; make them think (Matt. 21:23-27)
- Give an answer but don't let them label you an extremist (Matt. 22:15-22)
- Broaden the issue to the more important one (Matt. 22: 23-33)
- Find common ground (Matt. 22: 31-32)
- As soon as they are ready point to Jesus for a decision (Matt. 22:41-46), (pp. 21-23)

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Apologetic Systems

Since the first century, Christian apologetics has been greatly refined to the point of entire methods of apologetics being studied and classified. House, (2007) gives three basic types:

1. Classical apologetics (Natural Theology)
    - Step One: Arguments for undeniable first principles (laws of logic, self-existence, existence of truth, reality, meaning, morality)
    - Step Two: Traditional theistic arguments for existence of God (cosmological, teleological, ontological, and moral)
    - Step Three: Empirical and historical evidences for Christian truth claims (miracles; the life, death, and resurrection of Jesus Christ; truthfulness of Scripture)

2. Evidentialist apologetics
    - Step One: Use evidences to demonstrate God's existence and the truth claims of Christianity
    - Nature of evidence: Historical, archaeological, rational, scientific, and experiential
3. Presuppositional Apologetics
    - Assumption: Assumes truth claims about God and Christ as revealed in Scripture
    - Procedure: Demonstrate that only Biblical presuppositions make sense of reality and attempt to show unbeliever that his or her presuppositions are irrational. Last of all reveal that only Christianity provides proper foundation for life and thought. (pp. 64-75)

By carefully planning for the presentation of truth to a person's mind and emotions we are actually employing a discipline called systems engineering in which the whole is considered rather than isolated parts.

One benefit of systems engineering for the Christian apologist is that it gives a framework to analyze the value of belief systems. In this way skeptics may be witnessed to in stages. In *Mere Christianity*, C.S. Lewis, (1943) shared the idea of modular belief systems. In other words, someone may have a worldview that is 90% wrong, but 10% right. Acknowledging this not only provides common ground for further discussion, but also requires that each element of the total worldview be examined individually. Then the elements are reassembled into the whole so that the clearest picture may be obtained. Instead of force feeding a skeptic with the truth I have discovered, why not put each worldview to the systems test?

Kenneth Samples, (2007) proposes nine tests for evaluation of various worldviews:

1. Coherence Test: Is a particular worldview logically consistent?
2. Balance Test: Is a worldview properly balanced between simplicity and complexity?

3. Explanatory Power and Scope Test: How well does a worldview explain the facts of reality ("power"), and how wide is the range of its explanation ("scope")?
4. Correspondence Test: Does a particular worldview correspond with well-established, empirical facts, and with a person's experiences in the world?
5. Verification Test: Can the central truth-claims of the worldview be verified or falsified?
6. Pragmatic Test: Does the worldview promote relevant, practical, and workable results?
7. Existential Test: Does the worldview address the internal needs of humanity?
8. Cumulative Test: Is the worldview supported by multiple lines of converging evidence that together add increasing support for its truth-claims and extend the breadth of its explanatory power?
9. Competitive Competence Test: Can the worldview successfully compete in the marketplace of ideas? (pp. 201-276)

Why Engineers Make Good Apologists

After listing these criteria, Samples (2005) evaluates various worldview competitors to Christianity on the basis of these nine tests. In particular, Naturalism, Postmodernism, Pantheism, and Islam are evaluated. By studying the basic inconsistencies in each major worldview competitor, an apologist is able to refrain from becoming defensive or dogmatic. Patience is critical when expecting major shifts in thinking, and the Christian who knows why he or she believes what is true can be more understanding and flexible when immaturity is displayed by potential converts. The apostle Peter exhorts Christians to "…in your hearts set apart Christ as Lord. Always be prepared to give an answer to everyone who asks you to give the reason for the hope that you have. But do this with gentleness and respect" (1 Peter 3:15, Today's New International Version, 2005). Christian engineers are particularly well equipped to give reasons to those who do not believe in Christ. They understand that engineers and scientists may require more than the average amount of evidence, and possibly from a broader range of sources to be convinced of any particular proposition (Halsmer, 2006).

Frezza and Caulfield, (2005) further suggest that engineers generally share a set of beneficial traits (listed below) to understanding and defend the Christian faith. Several of these traits are also identified in Samuel Florman's (1987) book on *The Civilized Engineer*.

1. Believe in scientific truth—truth that can be verified by experiment.
2. Understand that scientific truth is not enough, that there is a point where application of truth to human objectives comes into play.
3. Are at home in the world—share in the understanding of the extent to which the forces of nature have been comprehended, the structure of the universe revealed, and this brings some measurement of contentment.
4. Are humble before the unknown, and stand in awe of the unknowable.
5. Believe in hard work, demanding it of themselves and of all new engineers.
6. Pledged not to engage in just wishful thinking—e.g., that sermons and poetry alone are not an adequate foundation on which to build human society.
7. Prudent in the undertaking, yet willing to make decisions knowing that something may go wrong.
8. Learn from theirs, and other's experience, including an ability to learn through failure.
9. Willingness to accept responsibility. (pp. 201-276)

After showing the extreme likelihood of God's existence for a multitude of reasons, this apologetic of systems engineering may be further extended to learning about the nature of God through the natural world He created. Such questions as "How can God be all powerful and still give me free will?" may be addressed in exciting new ways. With the systems approach, one may deal with this question as a matter of partitioning viable systems. If the whole of creation is represented by a huge orchestra with God as the conductor, there is predetermined music to be played but each musician makes choices about the act of playing. While each musician playing separately may sound good, the whole orchestra must be coordinated for it to create beautiful music.

Emergence

This property of systems, that the whole is greater than the sum of its parts, is known as emergence. In this way worldviews like postmodernism with relative truth and situational ethics may be confronted on the grounds that without engineering and coordination, a system cannot possess emergence and thus fails to be the best it could be. If a person's worldview is considered to be an emergent system, coherence between different parts of the worldview are critical to the overall harmony and usefulness of that system. If a scientist or engineer believes in absolute truth when testing scientific theories but not in personal morality, there is an inconsistency that hinders emergence. Emergence is seen everywhere. A winning formula one race car cannot be made by taking the best parts from the ten fastest cars and putting them together. Good components are only part of the solution. Engineering those components to work together makes the difference. While few answers alone provide compelling explanations for hard questions like the existence of pain and suffering, the concept of emergence may be used to combine multiple answers from many fields into a cohesive worldview in line with the Creator's intentions.

This concept of divine engineering can open up potentially rich discussion with those who have no belief in God. Since the best human engineering produces emergent systems with finely-tuned components, what can we conclude about the exquisite engineering in natural systems that makes life possible? Simple tuning only requires feedback, time and technical knowledge, yet engineering requires creativity. The generation of a system that works together well is not simply a matter of time and chance but of well coordinated and creative ideas. An extended design argument may begin with cosmology and astronomical precision and progress to the bio-friendly environment of earth, the interplay of a multitude of simple biological systems or cells, and even the efficient and robust information content of the DNA codes.

Questions and Definitions

Once enough positive evidence has been presented it is quite appropriate to point out that various questions that are tough for faith to answer point to even tougher questions for those without faith. The following examples from Heeren, (2002) demonstrate this:

- Genetic similarity to apes? (Uniqueness of Humans)
- Common Ancestry? (How life points to a purposeful Creator)
- Are humans destined for extinction? (Our creation for a relationship with God), (pp. 25-26)

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Throughout the process of dialog with skeptics it is helpful to remember some basic techniques such as the Socratic methods. These may be questions for any of the following purposes:

- For Clarification
- To Probe Assumptions
- To Probe Reasons and Evidence
- To Reveal Viewpoints and Perspectives
- To Probe Implications and Consequences
- To Better Understand the Questions (Paul, 2008, para. 4-9)

Comment [t9]: Need page number.

Apologist Greg Koukl (2004) also provides excellent examples of good questions to ask in his article entitled *"Tactics: Applying Apologetics to Everyday Life"*.

Besides these types of questions, it is essential to define terms to avoid misunderstandings. A common example of this is exactly what is meant by the term "evolution". Is it simply the ability of living organisms to adapt to their environments over time, or is it a complete worldview entailing atheism, or more likely something in between. Misunderstandings are difficult enough to set straight when the parties are perfectly honest with each other. Unfortunately, this is often not the case. The dishonesty is not always intentional but often is simply inappropriately shifting the burden of proof

through the use of logical and rhetorical fallacies. It should always be remembered that the goal is not to win an argument, but rather to assist all who are willing to come to a knowledge of the truth.

The Value of Apologetics

John David Weaver (1994) wraps up his book, *In the Beginning: Modern Science and the Christian Doctrine of Creation*, with a chapter on apologetics where he states,

> What we are seeking to do in the area of apologetics is two-fold: to meet people where they are in their search for answers to their own life; and to demonstrate the reasonableness of the Christian understanding of the world, so providing an environment where God is seen to be worthy of faith and trust. (p. 97)

The value of apologetics is not in its ability to save, since it has none, but rather as a kind of pre-evangelism tool. Philosopher Angus Menuge, (2008) stresses this point:

> Apologetics is best viewed as pre-evangelism. As John the Baptist prepared people for Christ, an apologist prepares the soil for the seed of the Gospel. Apologetics does not provide the seed, but it can remove some of the "thorns" which Jesus tells us include "the desire for other things," (Mk. 4:18-19) or in other words, man-made substitutes for the true God. The apologist works to make himself redundant, clearing away the ideologies and objections which the natural man uses to reject the Gospel, before an evangelist proclaims it. (p. 3)

Comment [t10]: Need page number.

Indeed, in Jay Richards', (2007) brief overview of the contemporary design argument, he cites the example of how the famous atheistic philosopher, Antony Flew, became converted to theism based on scientific evidence, such as the specified functional complexity of biological structures.

In addition, Christians should remember that attending to God's general revelation will help to keep us in-tune with our Creator, as C. John Collins (2003) emphasizes in his book *Science and Faith; Friends or Foes?* where he states,

> How shall we keep our hearts adoring our God?...By attending to the evidence God has given us…And a crucial part of this attending is mulling over the glory he has revealed in the natural world, and the supernatural design of which it speaks so clearly. (p. 315)

Clearly, the pursuit of science-based apologetics has much value for both believers and nonbelievers. The engineering mindset is well-suited to this endeavor as described in recent papers on the applicability of engineering design principles for worldview formulation (Halsmer, Halsmer, Johnson & Wanjiku, 2008) and the coherence of an engineered world (Halsmer, Asper, Todd & Roman, 2008). It has been the experience of the authors that when the ideas discussed in this paper are made explicit in coursework for undergraduate engineering students at a Christian university, those students become better equipped and inspired to serve as missionaries to educated people groups, especially scientists and engineers.

Conclusions

Nature readily lends itself to our investigations (science) and improvements (engineering). Through these activities, it also teaches us some very fundamental things about the significance of mankind in the universe. Thus, engineering students with a Christian worldview are in a position to play a key role in preparing the world for the truth of the Gospel. Contrary to recent, much publicized philosophies touting atheism as the logical conclusion of scientific studies, a thorough and open-minded investigation of both science and engineering suggests the influence of a caring and calculating intentionality; a transcendent engineer who's precision and provision inspire a hope that all things can work together for good for those who are willing to submit to the Master's designs.

References

Baez, J. (2000). *"How Many Fundamental Constants Are There?"* University of California, Riverside, http://math.ucr.edu/home/baez/constants.html

Behe, M. J. (2006). *Darwin's Black Box*. New York: Free Press.

Bradley, W. (2005). "The Designed 'Just So' Universe," *Leadership U.* Retrieved from http://www.leaderu.com/offices/bradley/docs/universe.html

Collins, J. C. (2003). *Science and Faith: Friends or Foes* . Wheaton, IL, Crossway Books.

Davies, P. C. W. (2008). Fitness of the cosmic environment. In J. D. Barrow (Ed.) *Fitness of the Cosmos for Life* (pp. 100-110). New York: Cambridge University Press.

de Duve, C. (2008). How biofriendly is the universe? In J. D. Barrow (Eds.) *Fitness of the Cosmos for Life.* New York: Cambridge University Press.

Dembski, W. A. (2001). The Task of Apologetics. In W. A. Dembski & J. W. Richards (Eds.), *Unapologetic Apologetics: Meeting the Challenges of Theological Studies.* Downers Grove, IL: Intervarsity.

Dembski, W. A. & Wells, J. (2008). *The Design of Life*. Dallas: The Foundation for Thought and Ethics.

Denton, M. J. (2008). Protein-based life and protein folds. In J. D. Barrow et al. (Eds.) *Fitness of the Cosmos for Life*. New York: Cambridge University Press.

Denton, M. J. (1998). *Nature's Destiny: How the Laws of Biology Reveal Purpose in the Universe.* New York: The Free Press.

Eschenmoser, A. (2008). Creating a perspective for comparing. In J. D. Barrow (Ed.) F*itness of the Cosmos for Life*. New York: Cambridge University Press.

Florman, S. C. (1987). *The Civilized Engineer*. New York: St. Martin's Press.

Freeland, S. J. (2008). Could one predict earth's biochemistry? In J. D. Barrow (Ed.) *Fitness of the Cosmos for Life*. New York: Cambridge University Press.

Frezza, S. T. & Caulfield, M. J. (2005). *Deus Machinator and the Implications for Catholic Engineering* Education. Role of Engineering in the Catholic University (RECU) Conference, Dayton, OH.

Geivett, R. D. (2006). David Hume and a Cumulative Case Argument. In J. F. Sennett and D. Groothuis (Eds.), *In Defense of Natural Theology*. Downers Grove, IL: Intervarsity.

Gingerich, O. (2008). Revisiting the fitness of the environment. In J. D. Barrow (Ed.), *Fitness of the Cosmos for Life*. New York: Cambridge University Press.

Gonzalez, G. & Richards, J. W. (2004). *The Privileged Planet.* Washington DC: Regnery.

Halsmer, D. (2006). *Multidiciplinary Cross-cultural University Outreach to Secular Scientists and Engineers (Why Engineers Make Good Apologists).* International Conference on Engineering Education, San Juan, Puerto Rico.

Halsmer, D., Halsmer, N., Johnson, R., & Wanjiku, J. (2008). *The Applicability of Engineering Design Principles in the Formulation of a Coherent Cosmology and Worldview.* ASEE Annual Conference, Pittsburgh, PA.

Halsmer, D., Asper, J. M., Todd, T, & Roman, N. (2008). The coherence of an engineered world. In C. A. Brebbia (Ed.), *Design and Nature IV*. Southampton: WIT Press.

Heeren, F. (2002). *How to Talk with a Skeptic*. Wheeling, IL: Day Star.

Heeren, F. (2000). *Show Me God.* Wheeling, IL: Day Star.

Heie, H. (1999). Christian Engineers as Faithful Witnesses to God's Redemptive Purposes for Creation. Christian Engineering Education Conference. Retrieved from http://engr.calvin.edu/ces/ceec/heie.htm

Henderson, L. J. (1913). *The Fitness of the Environment*, New York: The MacMillan Company.

Holder, R. D. (2004). *God the Multiverse and Everything.* Burlington: Ashgate.

House, H. W. (2007). A Biblical Argument for Balanced Apologetics: How the Apostle Paul Practiced Apologetics in the Acts. In N. L. Geisler and C. V. Meister (Eds.), *Reasons for Faith: Making a Case for the Christian Faith.* Wheaton, IL: Crossway.

Hoyle, F. (1981). The Universe - Past and Present Reflections. *Annual Review of Astronomy and Astrophysics*. *20, 8-17.*

Koukl, G. P (2004). Tactics, Applying Apologetics to Everyday Life. In F. J. Beckwith (Ed.). *To Everyone an Answer*. Downers Grove, IL: Intervarsity.

Lewis, C.S. (1962). *The Problem of Pain*. New York: Macmillan.

Lewis, C.S. (1947). *Miracles: A preliminary Study*. New York, Simon and Schuster.

Lewis, C.S. (1943). *Mere Christianity*. New York, Macmillan.

McDowell, S. (2007). Apologetics for an Emerging Generation. In P. Copan & W. L. Craig et al. (Eds.), *Passionate Conviction: Contemporary Discourses on Christian Apologetics*. Nashville, TN: B&H Publishing Group.

McGath, A. (2004). *The Science of God*. Grand Rapids, MI: Eerdmans.

Menuge, A. (2008). A Surgical Strike: Getting to the point in Christian Apologetics. Unpublished manuscript.

Paul, R. W. (2008) The Six Types of Socratic Questions. College of Engineering, University of Michigan. Retrieved from http://www.engin.umich.edu/~problemsolving/strategy/cthinking.htm

Petroski, H. (2006). *Success Through Failure: The Paradox of Design*. Princeton, NJ: Princeton University Press.

Richards, J. W. (2007). The Contemporary Argument for Design: An Overview. In P. Copan & W. L. Craig et al. (Eds.), *Passionate Conviction: Contemporary Discourses on Christian Apologetics.* Nashville, TN: B&H Publishing.

Ross, H. (2006). *Fine-Tuning For Life in the Universe. Reasons To Believe*. Retrieved from http://www.reasons.org/resources/apologetics/design_evidences/200608_fine_tuning_for_life_in_the_universe.shtml

Samples, K. R. (2007). *A World of Difference: Putting Christian Truth-claims to the Worldview Test*. Grand Rapids, MI: Baker Books.

Schloss, J. P. (2008). Would Venus Evolve on Mars? In J. D. Barrow (Eds.), *Fitness of the Cosmos for Life.* New York: Cambridge University Press.

Swinford, S. (2008). I've found God, says man who cracked the genome. Times Online. Retrieved from http://www.timesonline.co.uk/tol/news/uk/article673663.ece

Varghese, R. A. (2003). *The Wonder of the World*. Fountain Hills: Tyr Publishing.

Weaver, J. D. (1994). *In the Beginning: Modern Science and the Christian Doctrine of Creation*. Macon, GA, Smyth and Helwys Publishers.