



## How Dialogue on 'Ingenuity in Nature' Increases Enthusiasm for Engineering and Science in Traditional Religious Communities

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## **Abstract**

The perceived conflict between science and traditional religious beliefs appears to be one reason why some young people shy away from pursuing careers in engineering and other STEM fields. A three year grant from the BioLogos Foundation, to help traditional religious communities appreciate the ingenuity displayed by our evolving universe, is assisting in alleviating this unfortunate trend. Engineering students and faculty members work together to develop, and deliver, seminars in local schools and churches that demonstrate compatibility between science and religion, with emphasis on the role that engineering can play in this ongoing dialogue. The project team has committed to conduct 250 of these seminars over the life of the grant, with an anticipated total direct audience of approximately 12,500 people.

Religions and religious denominations often take a simplistic view of origins based largely on a particular interpretation of creation accounts offered by the special revelation of sacred scriptures. The project team is currently working to complement this view with up-to-date information from science and engineering. Most denominations recognize that the general revelation of nature also has an important role to play in providing information about origins. One way that science and religion constructively interact occurs when religion allows current scientific discoveries to inform its interpretations of scripture. The application of concepts from the field of engineering has proven useful in helping religious groups engage in this kind of interaction with science. In the process, appreciation for ingenuity in nature and enthusiasm for engineering appear to be increasing in participating religious communities.

Among several other outcomes, preliminary survey data indicate that a strong majority of participants either “agree” or “strongly agree” that their participation in the aforementioned seminars not only “helps me appreciate the ingenuity that underlies our universe,” but also “increases my enthusiasm for science or engineering.” Engineering students who serve on the project team have also acknowledged significant benefits as a result of participating in this project. Among other outcomes, data from a separate survey indicate enhancements in their communication skills, their ability to lead in the midst of contentious issues, and their understanding of personal mission and purpose. They also experienced an increased enthusiasm for engineering and science, which should not be underappreciated when considering the challenge of completing a rigorous undergraduate engineering degree.

## **Engineering Insight on Life’s Big Questions**

The world is a crazy place. Lots of wild things happen, both amazingly good and extraordinarily bad. It is enough to make one wonder if anyone is actually running this show. That is a good question. In fact, that is the right question. The answer to this question greatly influences how people live their lives, and who they become. The universe seems engineered specifically to make us curious about many things, especially such “big questions” as the existence of God, and life after death. This is one of the reasons why education is so valuable. School should satisfy the

human thirst for knowledge of the world and what it's all about, in addition to giving people a skill that enables them to earn a living.

But many academic institutions today focus solely on making people employable, without much regard for life's bigger questions. Young people discover their talents and pursue careers that can be roughly divided into either the sciences or the humanities (the study of human culture such as language, literature, philosophy, religion, history and art). Their choice is likely to depend on their comfort level with quantitative areas such as mathematics. But once they decide, they find their education quickly veering off in one direction, often to the exclusion of all other subjects. This is unfortunate since life's big questions beg for input from all areas of thought. Both science and the humanities have important things to say about human origins, for example. And solving the riddle of human origins appears to be the key to answering many of our biggest questions. Near the middle of the twentieth century, British scientist and novelist C. P. Snow described the disconnect between science and the humanities in his now famous book, *The Two Cultures and the Scientific Revolution*. He wrote that the intellectual life of all of western society is split into these two cultures (science and the humanities) that have a terrible time trying to communicate with each other, and that this is a major hindrance in solving the world's problems.<sup>1</sup> The tragedy here is that humanity needs these, and all, fields of study to be in productive dialogue, not only to help solve the world's problems, but also to help answer life's biggest questions. It may turn out that these two objectives are very much related.

In the mid-1990s, writer John Brockman asserted the ascendancy and predominance of science by publishing provocative interviews with several big-name scientists in his book, *The Third Culture: Beyond the Scientific Revolution*. These scientists had been successful at popularizing their work by writing in a manner that captured the attention and imagination of the public.<sup>2</sup> In a sense, they represented a new integration of science and the humanities, since they were able to harness the power of compelling literature to promote scientific research and discovery. More recently, psychologist Jerome Kagan, in his book, *The Three Cultures: Natural Sciences, Social Sciences, and the Humanities in the 21<sup>st</sup> Century*, argues that a third culture (the social sciences such as sociology, political science, economics, psychology, and anthropology) has emerged. He helps to explain why all of these cultures have difficulty talking to each other, but emphasizes that they each makes important contributions to the understanding of human nature. He concludes, for example, that the evidence from all three cultures has led him to question the popular belief that human behavior is mainly determined by biological processes.<sup>3</sup> This is an important example of how multiple fields of knowledge illuminate the human condition and human identity, which helps to answer some of life's biggest questions.

In fact, it was the social science of psychology that originally birthed the concept of affordances (relationships that provide capabilities), which is important when discussing ingenuity in nature. The history and usefulness of affordances are explained briefly in a later section. A *fourth* culture, consisting of engineering and technology, has adopted the concept of affordances to help clarify the intricacies of product design and reverse engineering (disassembling something to figure out how it works). It is the contention of the authors that the field of engineering has important points to contribute to these conversations. Engineering is often confused with science, or taken to be one of the sciences, but this is an incorrect view that clouds an important distinction. While science is knowledge of the physical world gained through observation and

experimentation, engineering is the practical application of this knowledge to solve problems or create valuable products for public use.

Like the popular science writers of Brockman's book, *The Third Culture*, engineers are also in the business of bringing scientific discoveries to the public, not in literary form, but in physical form, by way of useful products. In this manner, engineering already serves as a kind of mediator between science and the general public. Engineers learn of a scientific discovery and ponder the question, "What do we make of this?" However, this question can be considered in both a literal sense, and a figurative sense. Engineers earn their "bread and butter" by physically making a valuable product based on scientific principles. But engineers with a more philosophical bent find themselves wondering how scientific discoveries impact life's big questions. This naturally leads to the potential for engineering to serve as a kind of mediator between science and the humanities in addressing these questions. Perhaps it's time to make room at the table for a fourth culture: engineering and technology.

Books like biologist Richard Dawkins' *God Delusion*<sup>4</sup> and more recently *The Magic of Reality: How We Know What's Really True*<sup>5</sup> paint a picture of STEM fields that is necessarily in conflict with belief in God. They seem to be written in order to convince people that religious faith should be seen as unreasonable if one is scientifically enlightened. Having taught engineering at a Christian University for 23 years and spoken with many students and parents about these issues, it is clear that this kind of polemic material also has the effect of discouraging young people from pursuing studies in science and engineering. Most people naturally tend to avoid conflict, and the idea that science and faith don't mix provides one more reason for the spiritually-minded to choose a different major in college. In his book, *Where the Conflict Really Lies*,<sup>6</sup> philosopher Alvin Plantinga argues persuasively that it is not science and faith that are necessarily in conflict, but rather the worldviews of naturalism and theism. Theologian Alister McGrath agrees with this assessment as described in his book, *Science and Religion: A New Introduction*.<sup>7</sup> These works help to dispel the myth of conflict between science and religion that seems to be so prominently promoted by the popular media.

Never-the-less, the perception among many young people is that the typical American church is out of touch with today's scientific and technological society. This is one of the theses asserted by David Kinnaman, President of the Barna Group, in his book, *You Lost Me: Why young Christians are leaving church...and rethinking faith*.<sup>8</sup> Kinnaman reports that 52% of youth group teens in one survey aspired to science-related (medical and health professions, engineering, science, technology, and veterinary medicine) careers, but that only 1% of their youth pastors addressed issues of science in the past year.<sup>9</sup> Another Barna survey of youth with a Christian background provides an interesting confession of their thoughts on these issues. 52% agreed that Christians are too confident that they know all the answers. 41% agreed that churches are out of step with the scientific world in which we live. 34% agreed that Christianity is anti-science. 34% agreed that they have been turned off by the creation-versus-evolution debate. 29% agreed that Christianity makes complex things too simple. And 26% agreed that Christianity is anti-intellectual.<sup>10</sup> Perhaps the church could do a better job of helping young people sort through issues of science and faith. A group of faculty and students at Oral Roberts University think the field of engineering has an important role to play in addressing this need, as described below.

## **Do Religious People belong in STEM Fields?**

Because of this apparent conflict between science and religion, the question may be raised, “should those of religious faith be involved in the STEM fields at all?” This is a valid question. The integrity of scientific research is at stake if many of those involved are influenced by beliefs which have the potential to corrupt proper and effective scientific methods.

There are two avenues which can be surveyed to lend some insight into this question, those being historical progress and modern progress within the STEM fields. Historically, many of the greatest thinkers were associated with the Christian faith, prominent figures such as Copernicus, Galileo, Kepler, Newton, and Boyle, just to name a few. Charles Townes won the 1964 Nobel Prize in physics for research leading to the creation of the laser. Soon after that, he published an article entitled “The Convergence of Science and Religion,” where he wrote about the similarities between science and religion, encouraging their interaction for mutual enlightenment.<sup>11</sup> Looking at a survey of the 100 years of Nobel prizes awarded between 1901 and 2000 yields some insight. 65.4% of the Nobel Prize Laureates during this period claimed affiliation with some form of Christianity. Looking more closely, it is seen that 72.5% of Nobel prizes in chemistry, 65.3% of those in physics, and 62% of those awarded in medicine were received by scientists who adhered to some form of Christianity.<sup>12</sup> The purpose of bringing forth these statistics is not to diminish the validity of those not associated with a faith in God. This data is meant only to affirm the legitimacy of those thinkers of faith who coincidentally desire honest and thorough progress in the STEM fields. Thus far, this only addresses Christian thinkers in science, while there are many more people of other faiths also intimately involved in the advancement of science.

Based on this data, it could be argued, that the STEM fields have benefited greatly and will continue to benefit from the involvement of religious individuals. It shows minimal signs of suffering from their involvement. What needs to be addressed now is the false contention between faith and science. The fallacy that the truly inspired scientists are those that have rejected the idea of a God should be exposed. There needs to be a great deal of effort given to reaching out to youth within religious faiths. Not to try and “fix” their worldview based on one’s personal belief system, but to foster a curiosity about the universe, that they may be taught how to explore and think critically, coming to their own conclusions, and refraining from coercion.

## **How Engineering Contributes to the Conversation**

In January of 2013, a three-year \$160k grant was received from the BioLogos Foundation<sup>13</sup> to fund a project entitled, *Science and the Wisdom of God: An Interdisciplinary Project to Help Christians Gain an Appreciation for the Ingenuity Behind our Evolving Universe*. The principal investigator for this project is a Professor of Engineering at Oral Roberts University, former Dean of the ORU College of Science and Engineering, Director of the ORU Center for Faith and Learning, and the primary author of this paper. He has gathered a team of faculty with experience in engineering, science, history, education and theology to assist with this project. He also directs a group of about ten undergraduate students (mostly engineering majors) who regularly conduct research on the role of engineering in the science and faith dialogue.

The project team has committed to make at least 250 presentations over the duration of the grant to help support Christian groups in reconciling their biblically-based faith with the findings of mainstream science. How can expertise from the field of engineering assist in this goal? Much of the science and faith dialogue focuses on the question of design in nature. Design is the specialty of the engineer. Engineers know how to design complex systems, and they recognize instances of affordances in nature.<sup>14</sup> They are adept at reverse engineering analysis,<sup>15</sup> which has been found to be extremely useful in the recently exploding field of systems biology.<sup>16</sup> They recognize engineering design principles in the layout and fine-tuning of the universe for life.<sup>17</sup> Previous research has also shown that an engineering mindset is helpful in evaluating various worldview options.<sup>18</sup> In addition, encouraging students to make connections between engineering and human spirituality is seen to be an important aspect of a whole-person education.<sup>19</sup> Although ORU is a Christian institution, students are encouraged to wrestle with these issues and come to their own conclusions based on the evidence from all pertinent fields of study.

In conducting these 250 seminars, churches and schools are contacted by project team members to explore their openness to the idea of a presentation on science and faith. A description of the seminar is provided, and many groups accept and appreciate our offer to serve them in this way. A convenient date is set and the standard presentation is modified based on the interests and age of the audience. Some seminars are delivered by individuals, and some are delivered by a portion, or all, of the project team. Some seminars are 30 minutes long, and some are 3 hours in duration. Some constitute a series over multiple days. Significant time for discussion and Q&A is provided at the end of each seminar. A survey instrument is used to assess the impact of the seminar. Overall, the seminars have been very well received, as evinced by survey data presented in a later section of this paper. The following section provides examples of the kind of material that is presented in these seminars.

### **Ingenuity in Nature**

According to Mechanical Engineering Professor Robert L. Norton, a machine is defined as “a system of elements arranged to transmit motion [and energy] in a predetermined fashion.”<sup>20</sup> While it may seem unusual, or even defined by some philosophers to be “unscientific,” to consider the application of this definition to the universe, this is exactly what recent evidence from science is suggesting. The universe appears to be finely tuned, or engineered in a machine-like fashion, for life.<sup>21</sup> In other words, the motion and energy transmitted through the expansion associated with Big Bang cosmology has resulted in structures and mechanisms which are necessary for, and even conducive to, the emergence of complex life. The constants of physics, laws of nature, and initial conditions of the universe all appear to have been predetermined, or calculated, for the existence of life. Of course, there are other interpretations, such as the multiverse hypothesis,<sup>22</sup> but this inherent ambiguity is consistent with a system that appears to have been engineered to engender trust, or faith in a Creator. Certainly, there are differences between this kind of cosmic engineering, which seems to be an ongoing process, and human engineering, but the evidence suggests some kind of intentionality, intelligence, and exquisite engineering expertise behind the universe.

Furthermore, engineers who study the evidence for fine-tuning recognize an underlying ingenuity associated with the universe and life processes. Ingenuity is defined as “skill or

cleverness in devising or combining,<sup>23</sup> and this is what is observed in natural systems. Life-friendly chemical elements are manufactured within stars and somehow ingeniously combine, eventually resulting in complex life. It is now obvious that mutation and natural selection play an important role in these processes, perhaps even to the extent of common ancestry. But where do the laws of physics and biology come from that allow such a symphony of life?<sup>24</sup> Physicist Walter Thirring, in his book, *Cosmic Impressions: Traces of God in the Laws of Nature*, writes, “Chemical forces are able to create the most astounding things out of atoms as if by magic. Life continues this process and takes it to the extreme.”<sup>25</sup> A theistic worldview posits that such ingenious and creative forces are the action (either directly or indirectly) of a master design engineer who “holds all things together.”<sup>26</sup>

Engineering Professor Walter Bradley provides insight into the difference between cosmic and human engineering. Human engineering consists of specifying the boundary conditions under which the laws of nature operate to produce a purposeful outcome. Cosmic engineering must involve specification of not only the conditions under which the laws of nature operate, but the laws themselves and the universal constants that scale the “building blocks” of matter and energy and the fundamental forces in nature to provide the purposeful outcome of a habitable universe for life, and life itself. Dr. Bradley contends that for someone to choose to believe that there is a naturalistic explanation for the precise fine tuning of all of these factors is to “believe in a miracle by another name.”<sup>27</sup>

The primary author of this paper has recently published a chapter on the applicability of affordance-based reverse engineering techniques for answering some of the deeper questions associated with the origin of complex natural systems.<sup>28</sup> The concept of affordances was first introduced in ecological psychology by J. J. Gibson to represent any capability that a creature possesses simply by virtue of its relationship to its environment.<sup>29</sup> This idea was extended to engineering, first by Donald Norman in his book, *The Design of Everyday Things*,<sup>30</sup> and later by Jonathan Maier. Maier claims that affordances are a fundamental and unifying principle in product design and reverse engineering.<sup>31</sup> In more complex systems, he explains how part-to-part affordances are recognized when one part of a system provides something to another part of the system in supplying a capability to the end-user. From this perspective, the universe is full of life-friendly affordances that are indicative of meaning and purpose.<sup>32</sup>

What about instances of bad design in nature? This project includes consideration of the difficult and perennial problem of evil and suffering, especially in biological systems.<sup>33</sup> Actually, a reverse engineering approach readily addresses this problem by considering the possibility that the system of life has experienced damage or corruption during its history.<sup>34</sup> Again, a theistic worldview might suggest that this occurred when the system voluntarily strayed from its original purpose. It is common knowledge that engineered systems are susceptible to damage or corruption when used in unintended ways. Even so, a good engineer will foresee this possibility and perhaps plan for a redemptive solution that somehow draws good out of evil and suffering. Such a solution is provided by Christian theism, for example.

Another class of examples of ingenuity in nature involves the recognition of engineered solutions to problems in the natural world. Sometimes, natural solutions are discovered only after human inventors have already independently devised a strikingly similar solution. An example of this

was published last year with the discovery and analysis of the plant hopper's utilization of interlocking spur gears to synchronize leg motions during its explosive hop.<sup>35</sup> Spur gears have been used by human engineers for millennia, but it is thought that last year's discovery was the first time that spur gears were found in nature. Of course, this solution is probably the result of environmental pressures involving mutation and natural selection, but one should take care not to miss the bigger point. Regardless of how these natural systems came to be, they exhibit fabulous engineering, in terms of efficiency and ingenuity, when compared to examples that human beings have to offer.

The information storage capacity of the DNA molecule is another example of an ingeniously engineered solution in nature. The exploding field of engineered biomimicry testifies to the ingenuity that underlies the natural realm.<sup>36</sup> This ingenuity, and the fact that natural systems are so readily and profitably reverse engineered by humans, strongly suggests that such systems were engineered in the first place.<sup>37</sup> The implication is that of a caring and calculating intentionality that resonates strongly with a theistic worldview in which humans are created in God's image. Thus, many Christians have found the above information very encouraging to their religious faith, leading to an increased enthusiasm for the fields of science and engineering.

## Results and Conclusions

Although the number of theists in America appears to have declined slightly in recent years, a Harris Poll administered at the end of 2013 found that "a strong majority (74 percent) of U.S. adults say they believe in God."<sup>38</sup> Perhaps one of the reasons for the decline is that religious institutions have neglected to clearly articulate the relation and relevance of religious faith to scientific and technological understandings, which underpin the more materialistic worldviews that pervade the further developed countries of the world. This project attempts to translate information from the academy to the church in order to help rectify this situation. In the process, it is believed that enthusiasm for engineering and science will increase among both adults and young people. Survey data indicates that demonstrating the underlying ingenuity behind nature, as exemplified above, has been moderately successful in accomplishing this goal.

Thus far, as a part of this grant-funded project, 79 presentations have been made to community groups, churches and Christian schools with a total audience of 2,500 people. A diverse selection of 23 of these groups was anonymously surveyed in an attempt to assess the impact of the presentations and drive improvements for the future. The presentations typically close with lively question and answer sessions between speaker(s) and audience. A total of 600 people completed and returned surveys at the end of the presentations. Of these respondents, when given the options on a 5-point Likert scale, 42% agreed, and 17% strongly agreed that the presentation had increased their enthusiasm for engineering or science. 30% were neutral on this issue, while 11% either disagreed or strongly disagreed. Even higher scores were received for the statement regarding ingenuity. 75% of respondents either agreed (48%) or strongly agreed (27%) that the presentation helped them appreciate the ingenuity that underlies the universe.

Of those who returned surveys, 293 people chose to include optional comments in response to the presentations. 50% of these comments were neutral but constructive, 45% were positive or appreciative and only 5% were negative. More comprehensive results can be found in a paper presented at the Faith and Science Conference at Evangel University in Springfield, Missouri on



June 24, 2014.<sup>39</sup> In addition, anecdotal evidence suggests that these kind of public presentations, which had been going on for several years before the awarding of the grant, may be partly responsible for the recent growth in engineering enrollment at ORU. This is evidenced by the fact that several current engineering students have offered personal appreciation to the primary author for such presentations, as influential in their decision to pursue a career in engineering. In addition, it has also been influential in strengthening their religious faith, as evidenced by the following unsolicited and unedited student testimony (It should be noted that the statements below do not represent an ORU position on origins, since ORU does not take an official position on exactly how, and exactly when, God created everything. It is merely an example of the positive impact of the current grant project.):

I was raised believing that six-day, young earth creation was the only position that a good Christian could really take. Sure I knew there were some Christians who didn't take the six days literally, but these Christians couldn't know where to start taking the Bible seriously, and would be free to accept homosexuality and whatever else they wanted to believe (the typical slippery slope argument). What's more, I was taught that the real science was actually on the side of creationists, and all that fake science propaganda saying otherwise was just coming from atheists wanting to suppress the truth.

However, as I began to look into the cases presented by both sides, I found there were many compelling evidences for an old earth and an old universe in cosmology, geology, biology, paleontology, and archaeology. Furthermore, the creation "science" that I was finding seemed prolific with problems and substantially lacking in supporting evidence. Additionally, I simply could not maintain the position that science supported young earth creation with 97% of scientists accepting evolution,<sup>40</sup> and creation scientists that would openly admit that no amount of evidence would convince them of an old Earth because they were absolutely sure their interpretation of Scripture was correct.

Studying science and coming to the conclusion that I agreed with the scientific consensus, I was left at somewhat of an impasse for I still was not sure how well Scripture could be reconciled with many of these well-supported scientific theories. At the same time I was facing many other questions about my faith, and desperately looking for stronger reasons to substantiate it, while being told that it was wrong to question such things. This began to make it seem as if there were no good reasons to base faith on, and I didn't see how it could be good to hold a belief that wasn't supported with good reason.

When I went to college I heard a professor that I held in high regard presenting inflationary Big Bang cosmology and some arguments for God from the fine tuning of the universe. Seeing this exceptionally intelligent, Christian professor who accepted the Big Bang helped me to recognize that scripture really could be compatible with all of this science that young earth creationists rejected. Furthermore, once I was open to the idea, I found that this story of cosmology that I found immensely fascinating could even bolster my faith in God. Seeing not only the apparent fine tuning, but also the sheer beauty in the model, was something that I couldn't help but feel pointed to a creator with immeasurable wisdom and foresight.

Although this student testimonial is merely the response of a single individual, it was included as representative of many students who have shared similar sentiments with the authors. This anecdotal evidence, taken in conjunction with the positive quantitative results, presents a picture of the powerful impact of this project in the local community.

Finally, this project has also had a significant impact on ORU undergraduate students who serve as members of the project research team. Most of these students are engineering majors, as well as members of the ORU Honors Program. As honors students, they enjoy a small amount of monetary compensation for their research efforts. Weekly meetings are held under the direction of the primary author during the academic year to present research findings and develop presentations and publications. Students often co-author publications, this paper being one example, and sometimes assist in making presentations. Over the last six years this group has produced hundreds of presentations, 19 conference papers, 5 journal articles, and 4 book chapters. In producing these publications, 21 different undergraduate students and 8 different faculty members served as co-authors. In 2012, current and previous students on the research team were surveyed. All respondents strongly agreed that participation in the group assisted them in communicating on issues of science and faith. In addition, all respondents agreed that participation assisted them in solidifying personal integrity (wholeness), and resulted in a greater sense, and understanding, of personal purpose.

More details on the work of this research group and further results of the survey can be found in a paper presented at the Spirituality and Honors Education Symposium at Indiana Wesleyan University on May 29-31, 2012.<sup>41</sup> The work of this group appears to be meeting an important need by helping those with a theistic worldview to reconcile science and religious faith. As described above, concepts from engineering have an important role to play in this regard, and as a result, both young and old alike are appreciating the remarkable ingenuity in nature, and experiencing a newfound enthusiasm for the fields of engineering and science.

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