
# PERSPECTIVES on Science and Christian Faith

*Special Issue*

Journal of the American Scientific Affiliation

VOLUME 53, NUMBER 4 DECEMBER 2001


# Asking the Right Questions

*Christian Faith and the Choice of Research Topic in the Natural and Applied Sciences*

**Does God Care About Our Research?**

**What Are the Christian Foundations for Doing Science?**

**What is Historically Important to Consider?**

**What Discipline Perspectives Guide Us?**

**What Areas Need Research?**

**What Are Important Future Directions?**

**PROCEEDINGS** from a Conference of Graduate Faculty and Students


*Sponsored by*

INTERVARSITY GRADUATE FACULTY MINISTRIES

*Funded by the John Templeton Foundation*

*Perspectives on Science and Christian Faith*




***Perspectives on Science and Christian Faith*** (ISSN 0892-2675) is published quarterly for $30 per year by the American Scientific Affiliation, 55 Market Street, Ipswich, MA 01938-0668. Phone: 978-356-5656; Fax: 978-356-4375. E-mail: asa@asa3.org; http://www.asa3.org

Periodicals postage paid at Ipswich, MA and at additional mailing offices. POSTMASTER: Send address changes to: *Perspectives on Science and Christian Faith*, The American Scientific Affiliation, P.O. Box 668, Ipswich, MA 01938-0668.

## Manuscript Guidelines

The pages of *Perspectives on Science and Christian Faith (PSCF)* are open to contributions dealing with the interaction between science and Christian faith in a manner consistent with scientific and theological integrity. Papers published in *PSCF* do not reflect any official position of the American Scientific Affiliation.

1. Address all manuscripts (except Book Reviews) to: Roman J. Miller, Editor, 4956 Singers Glen Rd., Harrisonburg, VA 22802. E-mail: millerrj@rica.net Submissions are typically acknowledged within 10 days of their receipt.
2. Authors must submit **3 paper copies** (double spaced) for review purposes (an original and two copies) and **1 electronic copy** submitted on a DOS formatted floppy disk or as an email attachment. Typically 2–3 anonymous reviewers critique each manuscript submitted for publication.
3. Use endnotes for all references. Each note must have a unique number. Follow *The Chicago Style Manual* (14th ed., sections 15.1 to 15.426).
4. If possible, include graphics (electronic file preferred) that enhance the theme of the paper. Figures and diagrams not in electronic format should be clear, black and white, line ink drawings or glossy photographs *suitable for direct reproduction*. Provide captions separately.

**ARTICLES** are major treatments of a particular subject relating science to a Christian position. Such papers should be at least 8 manuscript pages in length, **but not more than 6000 words**, excluding endnotes. An abstract of 50–150 words is required. Publication for such papers normally takes 9–12 months from the time of acceptance.

**COMMUNICATIONS** are brief treatments of a wide range of subjects of interest to *PSCF* readers. Communications **must not be longer than 2700 words**, excluding endnotes. Accepted Communications are normally published 6–9 months from the time of acceptance.

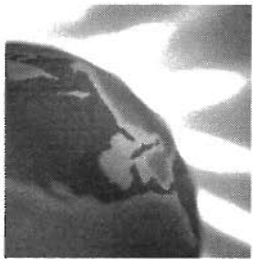
**NEWS & VIEWS** are short commentaries on current scientific discoveries or events, or opinion pieces on science and faith issues. Lengths range **from 200 to 1500 words**. Submissions are typically published 3–6 months from the time of acceptance.

**YOUNG SCIENTISTS' CORNER** contains varied autobiography submissions as well as notices of special interest to science undergraduate and graduate students and young science professionals who are entering the workforce. Submissions are encouraged and typically published 3–6 months from the time of acceptance.

**BOOK REVIEWS** serve to alert the readership to books of interest and provide a valuable source for reference. Readers are encouraged to review books in their scientific fields which have implications for the Christian faith. Guidelines for book reviewers and a list of books available for review are available from the Book Review Editor: **Richard Ruble, 212 Western Hills Dr., Siloam Springs, AR 72761 or E-mail: ruble@tcainternet.com** The viewpoints expressed in the books reviewed, and in the reviews themselves, are those of the authors and reviewers respectively, and do not reflect an official position of the ASA.

**LETTERS** to the Editor concerning contents of *PSCF* may be published unless marked not for publication. Any letter submitted for publication is subject to editorial review. Letters selected for publication will be published within 6 months.

**ADVERTISING** is accepted in *PSCF*, subject to editorial approval. Please address inquiries for rates or further information to the Managing Editor. The ASA cannot take responsibility for any orders placed with advertisers in *PSCF*.



# Why Publish These Proceedings?

Have you ever wanted to meet John Suppe (Princeton University professor and authority on structural geology and plate tectonics), Colin Russell (United Kingdom Open University professor and insightful interpreter of science history), William Dembski (Baylor University philosopher, mathematician and reflective spokesperson of Intelligent Design), or Calvin DeWitt (University of Michigan professor and enthusiastic advocate of environmental ethics)? By reading this special issue of *Perspectives on Science and Christian Faith*, you can meet the four persons described above as well as eleven additional scientists who are making notable contributions to science and are faithful representatives of Jesus in their scientific and research activities. Within these pages you may catch a glimpse of the energy, passion, and concerns gleamed from a national consultation on "Christian Faith and the Choice of Research Topic in the Natural and Applied Sciences" organized by InterVarsity Graduate and Faculty Ministries, held October 13–15, 2000, at the University of St. Mary's of the Lake, Mundelein, Illinois.

On Friday evening, a few minutes before the opening session of the conference, I was full of anticipation as I sat in the nearly empty conference room. After the conference participants and presenters entered the room, Terry Morrison opened the meeting with a welcome and prayer. Then he introduced John Suppe as the first presenter to discuss, "Why does God care about this issue?"

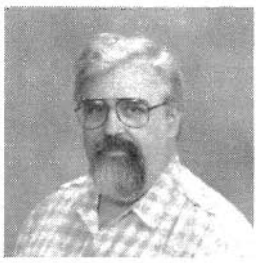
What's the issue? The next hours unfolded the details through speaker presentations, open discussion periods, and vivacious interchanges among small groups. I marveled at the energy, passion, and concern reflected in this gathering.

During the forty-five hours that spanned the opening and closing points of this conference, presenters and participants (invited graduate students and postdoctoral researchers) formed an organismic Christian community. Individual participants sought out seasoned presenters for questioning or for further discussion of presentation ideas. Participants prayed together, pondered and discussed issues, debated critical points, listened to stories, gained new understandings, enlarged their perspectives, and strengthened their Christian commitments.

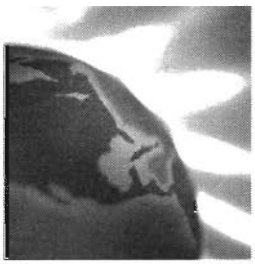
Will interactions that characterized this briefly formed but vibrant Christian community continue after Oct. 15, 2000? Will the thoughtful presentations continue to challenge and inspire long after the closing conference session? We hope so. Within this journal issue, we are delighted to share these insights with our readership, thereby enlarging the dialogue in the Christian community.

Enjoy this special issue of our journal. Open your heart to the challenges of others. Reflect on the significance of your own calling and participation in science research. Be aware of the larger Christian community that carries many of the same concerns and passions that you do in your science work. Jesus, the Lord of science, invites you to reflect his grace and to build God's Kingdom through your research. ☆

**Roman J. Miller**
*Perspectives on Science and Christian Faith*
*Editor*
*Eastern Mennonite University*
*Harrisonburg, VA*



*Jesus, the Lord of science, invites you to reflect his grace and to build God's Kingdom through your research.*



# Introduction

## Why Ask These Questions?

*How can I make Jesus the Lord of my research and teaching?*

Christians want to respond to the call to let Jesus Christ be Lord of every sphere of life. Scientists, who are believers in him, struggle to understand what this means in their vocation. InterVarsity's Graduate & Faculty Ministry is called by God to serve these fellow Christians and to encourage their growth in vocational discipleship. Young scientists and engineers just entering their professional lives but also more seasoned investigators ask, "How can I make Jesus the Lord of my research and teaching?" One of the seldom asked but deeply felt issues is, "Assuming Christ is Lord, does he really care about my choice of research problems?"

With the support of the Templeton Foundation and of the American Scientific Affiliation, we here present the proceedings of a conference called to respond to this question. The conference, *Asking the Right Questions: Christian Faith and the Choice of Research Topic in the Natural and Applied Sciences*, was held October 13–15, 2000 at the Center for Development in Ministry, University of St. Mary's of the Lake, Mundelein, Illinois. Few of the talks closely followed a prepared manuscript, so audio tapes of the talks and discussions were reduced to the written word. We hope that the following pages give some of the feeling of the conference as well as much of the content.

The conference purposes were twofold. The first was to have a group of practicing scientists explore the issue of research questions/topics/problems thoughtfully and prayerfully in order to develop some general guidelines for the selection of a research project. The second was to take steps to build a fellowship of scientists who could give guidance to other Christians who are wrestling with this issue. This group might continue to relate about this and other issues and work together toward publishing something more definitive in the future.

Each speaker was asked to build his or her remarks on six assumptions or bases for the conference:

1. The Creation Mandate: We are stewards answerable to God for our use of his creation, our minds, and other resources.
2. The scriptural injunction: "Do all things that we do to the glory of God."
3. The example of Jesus: He "went about doing good."
4. The need to resist the strong temptation to choose research questions only in areas most easily funded or trendy.
5. The rising concern about technical developments in our day and the lack of ethical directions for them.
6. The lack of guidance for Christians in making choices in this area.

Of course, the most significant question that a Christian can ask on this issue is: "Does God really care what I research?" If the answer is yes, then we need to determine why he cares. We need a biblical and theological base to our questioning as well as a sociological and personal base. ☆

**Terry Morrison**
*Conference Organizer*
*Director of Faculty Ministries*
*InterVarsity Christian Fellowship*

**Session I**

# How Does God Guide Our Decisions?

"Asking the right questions in research" is the topic we've been given. So, why should we be working on this question? How do we do our research from a Christian point of view? Is this really a Christian question at all? Is this question something that is played out at the level of "Who am I going to marry?" or at the level of "What am I going to do this afternoon as soon as I can extricate myself from this faculty meeting?" My experience has been the latter. Asking the right questions in research usually involves ordinary, mundane Christian decision-making.

These are questions of "spiritual dimensions of everyday choice." It's a subject on which there have been approaching a thousand books published. It's a late twentieth-century phenomenon, and particularly a North American phenomenon. I was talking to someone from Singapore the other day who said, "Well, all the books on this seem to come out of the United States." Actually, it probably goes along with Daytimer schedule books and "to do" lists.

While there is certainly a cultural aspect to this, I think decision-making is actually also very much at the heart of Christianity. So I think it's fair to ask a second hard-nosed question, "Why should we spiritualize our mundane choices about anything, and certainly about work?" Is there some real basis for this or is it a crazy kind of thing that Christians get into occasionally? Is it reality or self-deception?

I became a Christian in 1978 just about the same time Charles Harper (see p. 225) was a student in my class. Then I didn't know much about asking the right questions. However, I've learned a little bit over the years. I've found that self-deception is indeed a very central issue. "Who's kidding whom" is really something that comes into play. If I have really set my heart on something, but at the same time desire God's will, I find it extremely difficult to find out what the will of God is for me in that specific situation. Self-deception is a key issue in this. I think it's particularly true for intellectuals like ourselves; it's very easy for us to rationalize.

My brother, who is a philosopher of science, says that philosophers are very good at rationalizing whatever they hold to for very nonrational reasons, and that most formal philosophies are the development of that rationalization.

Another way to phrase our question might be, "Is my Christian decision-making simply a very thin Christian veneer over the way we all do things in science?" I know in my own work that I think a lot rationally and analytically—about science and how it works, how it develops, what its dynamics are, where things are going, and where intellectual insights can be gained. In speaking seriously of Christian decision-making, we're claiming that it is not just putting some veneer over our analytical, rational, and normal human emotional and cultural ways of making decisions. Does this Christian aspect of decision-making really penetrate the interior or is it just on the outside? I think that's a serious question.

I would say from my own experience that many major aspects of Christian decision-making in science are very much like

*Why should we spiritualize our mundane choices about anything, and certainly about work?*

**John Suppe**, *Ph.D. Yale University, is Blair professor of geosciences at Princeton University. He has been a visiting professor at National Taiwan University, Cal Tech, University of Barcelona, and Nanjing University. His discipline is structural geology and tectonics. He has been a Guggenheim Fellow and guest investigator of the NASA Magellan Mission to Venus, has served as associate editor of the* American Journal of Science, *and is a member of the National Academy of Sciences.*

Session I

the decision-making of all my colleagues who are not Christians. But some aspects of my decisions about my science and my group's science are really quite different from the way my colleagues make decisions. I don't think that I'm deceiving myself in thinking there are some fundamental differences. Yet, self-deception is a tremendous issue with which we have to deal. For this reason, I think it's useful to look in the mirror of Scripture where we can see ourselves more clearly.

*The decision-making of Jesus is very much Trinitarian.*

## Three Biblical Models of Decision-Making

### 1. Jesus' Example

While many biblical principles deal with decision-making, I want to look at three different human models beginning with Jesus as the prime model of the godly life. We know a lot about Jesus from the Gospels. We see Jesus making decisions in many different ways. So how does he go about doing that? One thing that impressed me as a new Christian, and still does today, was that Jesus says that he does nothing and says nothing on his own authority. This is an incredible thing. How do we make decisions as individualistic Americans?

When we look at Jesus as a model of decision-making, we find something really different. The Gospel of John is more straightforward than the synoptic Gospels in this, although you will find it in the synoptics as well. In John, Jesus repeats himself over and over again. Eventually you start to get it as you read through John a few times. He says many, many times that he's not speaking on his own. What he says and how he says it is from the Father. It's not on his own authority at all. He is really conformed to the will of the Father. He says, "My food is to do the will of him and complete it" (4:34). We can look at that in many different aspects and facets and with many different subtleties and nuances. But basically what I see there is Jesus talking about how he decides what to say and do.

Nothing is done apart from the Trinity. There is no individualism here. Jesus is submitting to the Father. A very interesting dynamic occurs between the Father, Son, and the Holy Spirit. There's sharing authority, giving authority and glory, and submitting in various different ways. As a model for Christian decision-making, the decision-making of Jesus is very much Trinitarian. It's not monist. Many have tried to make Christianity into a monist religion. But I think the Trinity is the essence here.

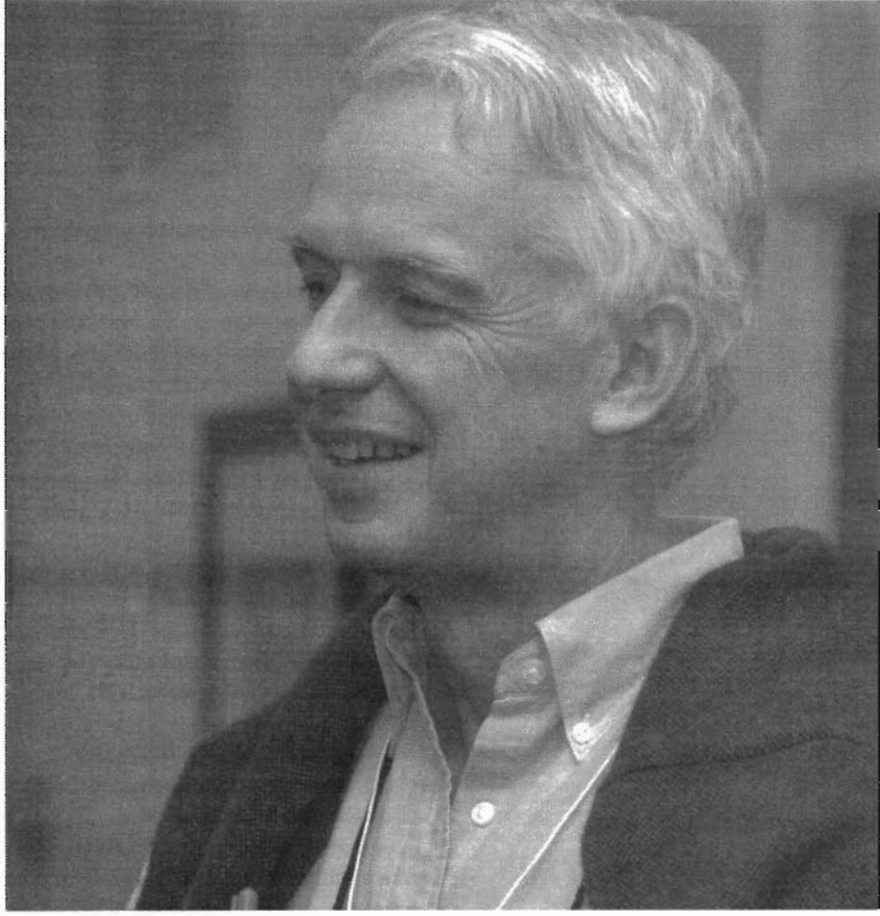
We are adopted as daughters and sons in Christ. So should we be acting and speaking on our own authority? Of course, Jesus spoke with authority. People noticed that he spoke with authority. But this was not on his own authority—he was conformed to the dynamic of the Trinity.

I think about this when I'm sitting in a faculty meeting with other faculty members in my department. How do I speak in this faculty meeting? Am I speaking on my own authority? As a new Christian, reading through Proverbs was a wonderfully practical and tremendous education for me. I know that Jesus read Proverbs. Certainly, Proverbs and other biblical principles were part of his decision-making. But there's a specificity to the situation, to what you actually can say. There's a contingent reality of what's going on in the faculty meeting, and it's not just a case of deciding what to speak based on biblical principles, but rather there is a dynamic of being part of the Body of Christ, in the fellowship of the Trinity, not speaking on our own authority.

### 2. Paul's Example

Our next model is Paul. We know a lot about Paul. He's a very interesting character. Let's focus on his decision-making about mission strategy. In the New Testament book of Acts, Luke is talking about traveling across Turkey. The whole world is open to the Gospel there. Paul clearly has a desire to preach the Gospel where it's never been heard before. But in a sense, that's easy for him. There are many virgin mission fields.

In contrast to Paul, consider a man who used to run my computer system who is now a missionary. He read *Operation World* by Patrick Johnstone. You may know this book as a guide to prayer. It has informa-



tion about the state of the church in every country in the world. My friend found a country where there are no known Christians and that was good enough for him. He didn't agonize over God's direction. He knew the great commission, and this place had no church. So he didn't have the problem that Paul had, deciding which country to go to. It was very simple for my friend. In fact, now there is a church—a persecuted church—in this country today. It's exciting.

But in Paul's case, we see a very curious thing. He's going through different potential mission fields, and the Spirit keeps closing the doors and does not allow Paul's team to go into certain areas. Finally, they get to the point where Paul has a dream of seeing a Macedonian saying, "Come over here to Macedonia." Everyone agrees that the Lord is specifically showing them that the place is Macedonia. So they go across and have a fruitful time there. This is a case with a dynamic similar to what we saw with Jesus and the Trinity. Through a dream, Paul has an interaction, a communication involving the Spirit. Although Paul is the leader, a whole mission team is also involved.

I view this as another model for Christian decision-making in science. There are so many aspects of the universe that we can study. We're working on the perimeters of knowledge. Many things have been studied, but there's still an enormous amount out there to be discovered. We have lots of choices in what we can do, each in our own scope. We ask, "Should I go into this or should I go into that?" We have different opportunities. We have different skills. How do we actually decide what to do? We've got to make a decision. Is this something that I make on my own or do I do this as a Christian together with the Trinity and the body of Christ in some way?

In my own decision-making in science since I've become a Christian, this kind of Macedonian model has been fairly common. There have been many cases in which I have made serious decisions in my science that are not just rationally looking at the science and opportunities, but where I actually have felt that the Lord wanted me to go and do something specific. I did it and I didn't really see any particular reason for doing it, but it was fruitful. I could tell you many stories about that, but I'll share only one.

I used to do a lot of work in Taiwan about 20 to 25 years ago. Taiwan is a geologically new mountain range, sort of like the Alps, growing up offshore of China. It's like having the Swiss Alps just 150 km offshore of South Carolina. We learned a lot about the mechanics of mountain building—the basic understandings were actually developed and tested there. It was a very successful time. But this was long ago. I had not been to Taiwan for ten or fifteen years. (I tend to like to work on one thing for a while and then go and work on other things.) I had no plans to return.

But a very large 7.6 scale earthquake occurred in Taiwan about a year ago. The epicenter was within a kilometer or so of an area on the fault that I had studied in detail. But I still didn't have any particular desire to go back and start a new research project there. I was very busy with other projects. However, I prayed about this. The Lord really showed me that I should return. I was invited to go and I did. The motivation was obedience, not scientific vision. As a result of my trip, some unexpected and tremendous new things have developed scien-

*Through a dream, Paul has an interaction, a communication involving the Spirit.*

Session I

*While there is a fear of randomness in Christianity today, the biblical view in both the Old and New Testaments is that God is in control of chance completely.*

tifically. We are making some very exciting new discoveries.

This is an example of decision-making in science that is perhaps in the Macedonian model. In fact, I would say that most of the major discoveries I've had in science have been handed to me as a gift. They were like a feast in the presence of my enemies, probably. I could not have made career plans that would have led to any of the significant things in which I've been involved. It's particularly in the context of Christian decision-making that they have played out. And the fruit is not all scientific. There also have been students and collaborators who have some into the Kingdom.

### 3. The Eleven Apostles' Example

Here's another New Testament model that I find quite interesting: Acts 1. This is a challenge even if you're making your decisions in a biblical way. For instance, in your church, how does your board of elders actually make decisions? Do you remember this situation? The disciples had just lost Judas. They needed an apostle to replace him and somehow they had to choose between two candidates. It's not quite clear how they chose the two, but there must have been certain criteria. We don't know what the politics were. The basic problem was that they were choosing an apostle and there were lots of things they didn't know.

Similarly in a lot of decision-making in science, we don't know the consequences of setting a particular course. Certainly Paul didn't know the consequences of his going to one mission field or another. We cannot predict the future effectively. In this case, they didn't know who was God's apostolic choice. So they ended up praying and then casting lots. This is chance. You just flip a coin. That's it. There was a clear sense that this method would show the group God's will. While there is a fear of randomness in Christianity today, the biblical view in both the Old and New Testaments is that God is in control of chance completely. We see this played out in this example. It's a challenge to our modern sensibilities.

## Conclusion

I think these models are examples of biblical ways of going about deciding things. They do not represent the ways my colleagues make decisions in science. This is finding out God's will in highly specific situations. All of the cases we've looked at involve the claim of transmitted information.

At the basic level, the most fundamental claim of Christianity or Judaism is that God communicates. The theological knowledge claims of Christianity are not things that you can deduce from first principles. Philosophical theology does not arrive at these knowledge claims. They can only be sustained through a claim that information is transmitted. This communicative aspect is essential.

I find these New Testament models really striking. They are really quite different from business as usual, and they illuminate the communicative nature of God. There is submission, sharing of authority and glorification, and interaction that occurs in communication. So, "Why does God care about our research?" – It's the very essence of God's character, the Trinitarian God. ☆

Session I

# How Does God Lead Us to Our Calling?

Following John Suppe is one of God's little jokes for me. I was his student long ago at Princeton when I was studying geological engineering. At the time, he was on a spiritual quest and I was, too. John is quite a wizard of tectonics. When he looks at the ground, he sees with x-ray vision everything that is going on underneath. But when I look at the ground, I just see the ground. He used to take us on field trips to really lovely, interesting places.

I can remember going with his class to Lake Champlain where there's a famous fault—the Lake Champlain Fault. We had our backs to the beautiful lake with the sun shining on it, and we were supposed to be investigating this "gouge" and interesting stuff in the fault. I just couldn't stand it. I'd wander away from the class, face the lake, and think spiritual thoughts about my future calling. I always felt a little guilty about my behavior.

John also took us to these cliff-like outcrops. As he was lecturing on the detail in the crystal structure in the tectonic joints of selected outcrops, I started climbing the outcrop. I love rock climbing. This day the outcrop was wet and mossy. I fell down. My feet went right splat into a mud puddle, and the mud went flying all over the professor! I'm sorry, John, for my behavior. I never did properly apologize.

I'm going to pursue three themes. The first describes my particular context; why I see the need for professionally developed, sophisticated, and highly accomplished Christian minds in the sciences; and why this is a vital, important need corresponding to a great opportunity for engagement with our global culture. The second theme indulges in personal story and tells you about my own calling. I hope that my testimony in relation to my calling will illustrate a spiritual point about the caregiving of God. For the third theme, I want to switch gears a little bit and speak as a strategist and talk about a variety of strategic opportunities for future Christian leadership within the sciences. I want that to follow the discussion of calling because I think calling is a great spiritual mystery, and ultimately where our careers go in the grace and providence of God is a mystery. However, that should not keep us from strategic thinking and strategic planning.

*Ultimately where our careers go in the grace and providence of God is a mystery.*

## The Need for Christians in Science to Engage with our Global Culture

The context of my work in the John Templeton Foundation is mostly focused on the aim of healing the deep and painful breech between the cultures of the great faiths, including Christianity but not exclusive to it, and the cultures of the sciences. This involves demonstrating not only a potential for consonance between a spiritual view of the world and the scientific view of the world, but also, wherever possible, a positive or constructive dynamic interaction between the life of faith and commit-

**Charles Harper, Jr.**, *D. Phil. Oxford University (Balliol College), is executive director and senior vice president of the John Templeton Foundation. He formerly was a research scientist in the department of earth and planetary sciences at Harvard University, an associate of the Harvard College Observatory, and a National Research Council Research Fellow. He received a diploma in theology from Oxford in 1988 and a certificate of special studies in management and administration from Harvard University in 1997. Dr. Harper served as a volunteer in Pakistan and Thailand in development disaster assistance in refugee affairs and in Oregon with Youth for Christ as a counselor in a home for delinquent boys. Presently he is involved in the creation of a major new evangelism- and discipleship-supporting charitable foundation, "Geneva Global Research."*

**Session I**

*Evangelical Christianity is a populist activity which unfortunately also carries aspects of anti-intellectualism. To speak as Christians in the academy, we have to overcome this perception.*

ment and the life of science. This is a tremendous challenge in our modern western world, and increasingly it will be so in the whole world. A scientific world view is seen by many intelligent people as incompatible with a faith commitment. This is a serious issue that needs to be remedied and healed. Part of our Christian service to the kingdom is to work on demonstrating that this incompatibility is a caricature and an unnecessary one.

As an evangelical, I have a hope to recover the other side of the great two books tradition. Evangelicals are very good readers of the "book of Scripture" and are devoted to that tradition. However, I think we are very poor readers of the "book of nature." We miss that God is revealed through the study of nature and that we can celebrate God's greatness, his majesty, and his care through our view of nature and partly through modern scientific research.

My work encompasses a very broad range of different specific programs including cosmology and metaphysics on the one hand, to spirituality and health care on the other. My work largely is being a talent scout. I'm constantly looking for talented people to be involved in programs. This is a challenge! There is a paucity and dearth of really good people that have the right talent, the right training, the nuance, the sophistication, the desire, and the availability to engage in these kinds of tasks. I am very keen for the evangelical community to produce Christians in the world of science who can rise to this task and work creatively at this interface—healing deep wounds and breeches.

## The Need for Excellence in Science

There's a need for excellence in science. One can't be a diplomat for faith in the world of science with the problem of ignorance or lack of sophistication or distinction in the sciences. There is a need for humility to speak across these very deeply distinctive boundaries, for an intellectual curiosity, and for the subtle ability to engage in a constructive diplomacy at the highest levels in the sciences.

I think that one of the most encouraging movements within evangelicalism is the movement for rediscovering the "Christian mind." The "Christian mind" is a counter to an unfortunate, anti-intellectual tendency that is common to American culture in general. Evangelical Christianity is a populist activity which unfortunately also carries aspects of anti-intellectualism. To speak as Christians in the academy, we have to overcome this perception. So that is a general challenge.

A more particular challenge is a counter to what Mark Noll of Wheaton College has described as the "catastrophe of fundamentalism." In his book, *The Scandal of the Evangelical Mind*, Noll writes a very good chapter on the sciences. The whole book, however, is very important because it paints a historical picture in analysis of what he calls the "catastrophe of fundamentalism." The sense or recognition of the scandal of the evangelical mind is well understood by the secular critics and those who despise the Christian faith. This is something Christians have to deal with—the scandal of the evangelical mind and its strong perception in the academy.

To be successful, the Christian mind requires a spiritual engagement. It's not just a mind of purely intellectual matter. It's also a spiritual mind. It has to engage in cross-disciplinary development to form a rich spiritual, intellectual, and scientific perspective. That's a challenge for anybody. It's a very significant challenge for training and preparation. It takes time, effort, and discipline. It doesn't come naturally.

## The Need for Broad Humane Learning

In the sciences, there's a tendency to be extremely specialized. There is no particular reward within the sciences for broad humane learning. But to develop a Christian mind that is engaged with the sciences, I believe very firmly that we need this broad humane learning. We need to know and engage with the intellectual trends of our day. We need to read the journals of opinion that circulate the intellectual debates. We need to have a subtle understanding of humane learning across the disciplines that has the character of excellence. We need to demonstrate the effectiveness of the Christian mind for engaging difficult and strategically vital areas in the academy. So the Christian mind is an intellectual mind, a spiritual mind,

and an energetic and strategically-focused mind as well.

There's a dynamism—a huge energy that's characteristic of the greatest leaders of Christianity (you see it in the Apostle Paul). Sir William Grenfell was a famous medical doctor missionary in Labrador who wrote thirty-four books over his lifetime. He was a hugely energetic and dynamic Christian who described the Christian mind this way: "What Christ demands is a reasonable faith as he demands the service of our reason. We cannot drift to heaven like dead fish down a stream." The task of the Christian mind is one of huge energy.

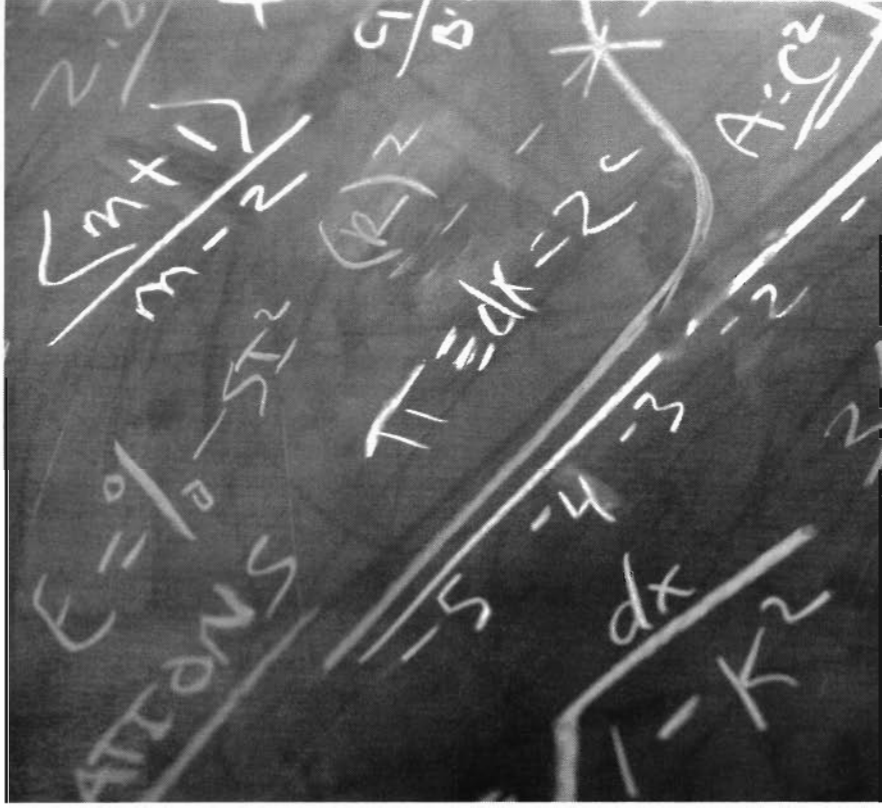
## Hearing God's Call

On the issue of calling and gifts, I'm certainly not an expert on the theology of calling nor do I want to suggest that I have anything particularly profound to say. But I recommend a very important book entitled *The Call* by Os Guiness. It gives a very thoughtful approach to the extremely serious issue of calling. William Temple, the great Archbishop of Canterbury, once wrote that to make the choice of career or profession on selfish grounds without a true sense of calling is "... probably the greatest single sin any young person can commit. For it is the deliberate withdrawal from allegiance to God of the greatest part of time and strength." The greatest part of the service that we can give to Christ is in our profession—what we do with our time and energy.

Theologically we have a tradition that our God is a God who calls. He called Noah. He called Abraham. He called Isaac and Jacob. He called the prophets. He called King David. He called John the Baptist, and he called all of humanity to himself in the personal call through his Son Jesus. And he called Mary to be the great vessel of his great salvation. He called the disciples and apostles individually. And so he calls each by name, even you and me. So calling carries a great mystery because it's personal. The great God of the cosmos, the Creator of the universe through the Incarnation personally meets us, and then our calling through the Spirit comes to each one of us.

Calling fulfills our fundamental restlessness. As Augustine said in his famous saying, "God made us for Himself, and we'll be restless until we find ourselves in Him." It's vital that we find what God plans for us by his grace. We need to pursue it, to discover it, and to open ourselves to it. I think calling in many ways is part of a dance, a dance of freedom, a dance of development. I personally don't believe in ontological determinism—that the future is determined. I think that the dance of God's grace is a dance of freedom, that God works with changes and with faults that we make, that God works with new scenarios. In many ways, our will, our prayers, and our aspirations are places where God meets us and communicates with us. What we ask for, what we pray for, what we aspire for earnestly, God can fulfill, and in the fulfilling he meets us personally. Through our calling, God can give us a mysterious wisdom and faithfulness. Our necessity is not to balk or despair or give up in pursuing calling.

Paul Brand is a Christian writer who wrote a book with Philip Yancey called *Fearfully and Wonderfully Made*. You can read a nice biography of Brand's life by Dorothy Clark Wilson called *Ten Fingers for God*. He was raised by parents who were missionaries in India, and he wanted to give his life to being a medical doctor in India. In fact, later in life he became quite a distinguished medical doctor at Vellore Christian Medical College in South India. He developed some extremely simple but important



*The greatest part of the service that we can give to Christ is in our profession – what we do with our time and energy.*

**Session I**

*God gave [Paul Brand] a deep and profoundly frustrating situation in his calling. It seemed that God was blocking his calling, but precisely through that painful experience, God was preparing his calling.*

treatments for lepers that helped them to use their fingers and toes and their eyesight. The reason that he was so successful in pioneering leprosy work was because of a frustration that God gave to him in what he perceived to be his calling. He had wanted to train as a medical doctor. Every direction to get into medical school for him was blocked, supernaturally blocked. As he kept aspiring to go to medical school, he had to work as an ordinary laborer, a bricklayer, and a carpenter in London. Finally he got into medical school and ended up going to India.

It turned out that the skills he had learned as a common laborer were precisely what he needed as a medical scientist to figure out the problem with people who had leprosy. Most researchers had been working on the treatment of the skin, on pharmacological treatments. But he realized that the loss of the pain response allowed people to hurt themselves. If you have a blister on your foot, you'll limp carefully to relieve your pain. But if you don't have pain, you won't limp because you don't know it's hurt. Or if you're in the kitchen and you put your hand on a hot surface, your hand will burn because the pain response doesn't work to stimulate you to remove your hand. Brand developed a whole variety of prophylactic tools to go on the hands, fingers, legs, and feet of people with leprosy to avoid the degenerations related to the loss of a pain response. All of his ability to do that was based on his experience as a workman. God gave him a deep and profoundly frustrating situation in his calling. It seemed that God was blocking his calling, but precisely through that painful experience, God was *preparing* his calling. I think that's important.

## The Christian Culture in which I Was Raised

My story parallels that of Dr. Brand. I grew up in a suburb north of Chicago. My mother was saved in the early 1960s in the Billy Graham movement. When I was five years old, we started attending a Bible Church, which I think is still in existence. A now famous fundamentalist leader in America was our youth pastor and used to give evangelistic chalk talks in my backyard to which my parents would invite their friends. This places me culturally within the spectrum of evangelicalism. But it gets more interesting. My parents became deeply engaged in radical fundamentalism of an extreme right wing variety. I went to their school and church. Growing up, I thought that that's what Christianity was all about—a rather extreme form of Christianity.

I'll give you one example. I have a sister Paisley named after the Rev. Dr. Ian Paisley of northern Ireland, who was considered by our church to be a noble and profound Christian leader. That was the model—to be like the Rev. Ian Paisley—to scream and yell and give death threats to your enemies in an inter-religious war such as in northern Ireland. Our church was involved in extreme tax dissent. Some people went to prison. There was even serious discussion of political assassination. There was survivalist activity in basements. There was engagement with the Theonomy movement—a very extreme form of Christian Americanism. You name it. I saw it.

In science, this form of Christianity supported Dwayne Gish and the Creation Research Society. As a young boy, I was taken to Moody Bible Institute and instructed in the teaching of the so-called creation science. I met Gish, and my mother made sure that I read the creationist literature very carefully. In politics it was Carl MacIntyre blaring on the radio. In education the paradigm was Bob Jones University. When I went to Princeton, my mother wept. That is the context of my youth. As you might imagine, this led to some confusion when I entered the gates of sophisticated academe and tried to begin to think Christianly.

I don't want to be snide. I am deeply grateful for the gift of the Gospel and the deep impression of its eternal and all-encompassing seriousness. Fundamentalists are serious Christians and that's a virtue. I'm also deeply grateful for a sense of militancy with respect to the ebb and flow of the secular *Zeitgeist*. One aspect of being a fundamentalist that I think is very important is precisely this militancy. Fundamentalists free themselves from slavish

conformism to conform to the world. And despite its flaws, that militancy and seriousness of disposition can be very precious and important for a Christian.

## My Calling

But for me a very serious transformation was in order if I was to learn to think Christianly. I was led into considerable turmoil spiritually and intellectually. Fortunately when I was an undergraduate at Princeton, a wonderful Scots theologian, Earnest Gordon, from the great Princeton evangelical Presbyterian tradition, introduced me to Christian humanism, particularly through the Russian Christian writers, like Dostoyevski, Tolstoy, Berdyaev, and several others. God also assisted me in direct ways during this tumultuous time of my life. I remember falling away from faith and entering an eastern spiritual quest—a Zen Buddhist quest. It led to a very important despair in my life that God answered with a vision of the cross and a healing, not a serious amazing healing such as from a broken leg or something like that, but a real one and a profound transformation of grace that changed my life in a big way. It set me on a different course. In that experience, just a year after taking John's course in college, I promised to follow God and put Jesus and his Lordship first wherever that might lead.

*I was led into considerable turmoil spiritually and intellectually.*

The first test for me in this mystical exploration of calling had to do with prudence and money. I had followed my father's advice to become a geological engineer because there was good money in it. He thought that if I went to a good college and if I took a reasonable, practical degree in engineering and geology, then the combination of prudence and money would lead to a fulfilled life. That's a pretty ordinary, reasonable, and sensible perspective for a parent to have.

When I graduated, I had a great job offer equivalent to vast sums of money in today's dollars. In fact, it's taken me decades to come close to it. But God provided a strange thing. There was a crisis in Cambodia that brought many refugees across the Thai border. An enterprising freshman at Princeton went to New York, talked to the International Rescue Committee, and persuaded them to take about forty undergraduates over for a summer to work in the refugee camps. As soon as we were dumped in Thailand, the newspapers announced reports that the Vietnamese army was marching on Bangkok and that Thailand was about to fall. All of the parents went into total screaming alarm. Now this is an organization trying to deal with refugees and orphans—not little, spoiled brats whose parents are concerned about their problems. But anyway, what God gave me as a volunteer in this situation of profound human misery and need is a real experience of the goodness of grace, the goodness of a different kind of life, the goodness of working in a kind of Christian service in a context which wasn't normal, which wasn't prudent, which wasn't pursuing money, which was just very, very different. For a young person in that kind of experience, I just tasted the goodness of the Gospel. That was very transforming for me; that gave me a taste that I never will forget. I needed that taste for a long time for the more difficult challenges in pursuing my calling.

## God Blocked My Way

The interesting thing is that I wanted to stay there working in disaster and refugee affairs and working in these emergencies. But God blocked me like he blocked Paul Brand and made me return to the United States for a previous commitment I had made to a Christian ministry in the National Parks. I don't know if this ministry still exists, but it used to exist for seminary students. If you were a seminary student, you would go to a place like Yosemite for the summer, and you'd be responsible with a team of people for leading worship services. There was one in the wintertime at a place called Timberline Lodge in Oregon. And because of Dean Gordon, a great Presbyterian theologian, I was given this responsibility. He said, "You go and do this" even though I wasn't in seminary. So I ended up with this awful responsibility of leading worship services.

Trained as a fundamentalist, I thought that leading a worship service meant that you stand up in front of people and yell at them for 45 minutes, sing a hymn, and then you go home. I really did. I mean, the yelling was supposed to be good yelling, but it was basically yelling, so I had to figure out how to yell good. I didn't know what to do so I just started reading the New Testament to understand what they were yelling about because they were always yelling about the Bible and pounding it on the table in my church tradition. I'd start at seven o'clock in the morning and finish at midnight. I read the whole New Testament through weekly because it was sort of an emergency situation for me. This led to a very deep confusion.

I didn't know quite what a calling was like. Was it irrational? Was it mapping this experience that I had now, or was it more like intellectual sophistication that I had experienced in college with the culture of Princeton University? Was it an accommodation to the intellectual rules and the doubts of that culture? Was it sophisticated accommodation to a kind of liberal spirituality that really didn't take things seriously but mapped the cultural forms in a more culturally sophisticated way? I was on the

Session I

*My yearning ... was to find a way to return to places like Thailand or Somalia or some other disaster relief area and to work in a direct Christian ministry ...*

proverbial horns of the dilemma so I prayed fervently that God would provide some clarity and wisdom and some means of progress.

## God Provides Direction

There was a bookstore in Portland, Oregon, where I often went and bought boxes of books. I discovered this funny writer called C. S. Lewis which, of course, was an answer to prayer. I started reading his books and I thought, "You know, there are some answers here." I had known about C. S. Lewis before—maybe somebody had written to me suggesting that I read his books. I read all of his essays, which was very helpful.

God's other provision of grace was through InterVarsity. Another Christian counselor of mine said, "You know, you should really go to this thing called the Urbana Convention."

I said, "Urbana Convention, what's that?"

He said, "Well, there's this group called InterVarsity and they do this great convention, it's a real good thing and you should go."

That conference totally changed my life, one hundred percent. While there I picked up a little brochure that described John Stott's London Institute for Contemporary Christianity which had a theme on how to develop a Christian mind. I read that brochure and thought, "That's for me."

But my yearning through all of that time was to find a way to return to places like Thailand or Somalia or some other disaster relief area and to work in a direct Christian ministry, not to engage so much with the intellectual life, but to work for an organization like World Vision. I applied to them, and they said, "Thanks very much, but we don't need your services."

So I thought, "Hmm. How can I work this one out?" Well, they needed technically skilled people. I had been learning about Oxford University because I had been reading C. S. Lewis and I thought it sounded like an interesting place. I discovered that they offered a one year masters course in hydrology. I thought this would be super. I'd study hydrology for a year, I'd have the skills I'd need, and World Vision would take me back into the field. I also took language courses, first aide, EMT courses, and other things to do with emergency logistics, and I learned to fly an airplane. I wanted to make sure that World Vision would take me. I was pursuing my calling, or so I thought. But that very pursuing of what I thought was my calling is what God eventually used, though first he blocked my way and had me do other things. Oxford University wrote and said: "We've canceled this course in hydrology. But we actually like your undergraduate thesis on planetary-scale tectonic processes using isotopes."

My thesis initially had to do with struggling over fundamentalist issues concerned with the age of the earth. I wanted to figure out once and for all the question about the age of the earth. Was Dwayne Gish right or wrong? So I said, "Fine, I'll study isotopes and I'll use my thesis as a way to work through this problem." I got into all sorts of interesting things that had to do with isotopes, and I quickly learned that the methods were reliable. Actually you can date the earth as a planet, and you can date rocks in five or ten different ways. It's pretty clear and straightforward. So I answered the question posed by the fundamentalist experience.

God used that answer to prepare me for my profession. In fact, the main thinker I worked with to do my undergraduate thesis was the same guy I ended up doing research with at Harvard for five years. Amazing! In any case, I was invited by Oxford to come in and do highly theoretical thesis work in planetary sciences. They even got me a nice scholarship. But I thought of it as an absolute catastrophe. I was incredibly unhappy. After working in a place like Thailand on the Cambodian border, I didn't want to go and sit in the library for five years. But I did feel that this was a sort of strange mystery—a strange thing that God was working out. He kept blocking all other options. It was amazing. It was grace because God could have opened other options. However, I don't think I would have followed my calling without God blocking other options.

It was a fourteen-year odyssey of tremendous, agonizing pain. Post docs and

scientists know exactly what I mean. You do a Ph.D. and then you do a Post Doc. Then you work for grants and then you work in institutes. You're part of that rat race. You work in places where at three o'clock in the morning half the cars are still in the parking lot. Right? When you're part of that rat race, with the tough standards of peer review and the often unethical behavior in the process of the adjudication of grant proposals and you are living grant to grant—when you do all that stuff as a Christian, it's tough. It is seriously demanding of your time. It's all-absorbing. It's very easy to accommodate, to make compromises of those things that have to do with spiritual nurture and cultivation of your spiritual life, just to get along, to make that next grant, and then the next grant, and then another one. It's just very, very difficult, very challenging. God has to see us through this if we're to become serious research scientists.

*That very pursuing of what I thought was my calling is what God eventually used, though first he blocked my way and had me do other things.*

We've become professionals. We're part of that culture and we know it. We become possible interlocutors between the kingdom, the evangelical world, and the world of sciences. But it's tough to get there. It's painful. For me it was incredibly painful. It involved working typically from 8 a.m. until 2 a.m., six or seven days a week for a decade. And it just kept getting worse and not better. I went from the challenge of writing a thesis to another challenge of writing a research paper, and then got into writing for highly competitive grants. Many of you know this. Many of you are right in the middle of it right now.

For me, it led to very serious despair. I thought that it was a total waste at the end. I thought that I had made a mistake in my calling, that I had been stubborn and foolish and stupid, and that God had just decided to let it crash for me. I had worked at NASA for some years and I worked at Harvard for five years, and my wife and I were starting to have kids. You know that on academic salaries, it becomes very difficult. Grants can get sketchy for times. You can get involved in projects and then it can become controversial. You're trying to get a grant and you may go for two, four, or six months without a grant. As you hustle to propose another program, you also have the angst, the risk, the worry about making your mortgage bill, staying in the profession, getting a job. You apply for jobs all over the place, and you paste up rejections all over the wall.

So I started to hedge my bets. I thought, well, you know there's a great other world out there in business. I'll take some business courses at the night school at Harvard and I'll see if I can make it maybe as a business consultant. I really liked business training, and I'm deeply grateful. In fact, God taught me a lot from studying business. It's incredibly helpful to me in my current position. But that led to more torment because I kept applying for these consulting jobs which I would almost get, and then get a letter saying, "We wish you well, but we don't think the fit is right." But God was preparing me for the next step. God provided the perfect calling for me.

## My Current Calling

I don't know if it will be my final calling, but my current calling is working in religion and science. God took this varied preparation with all of the frustrations and used it just perfectly. I work in cross disciplinary work. I used to have to work for months and months pounding my head in areas that I knew nothing about such as astrophysics, cosmology, or fundamental physics. My training was in planetary material science. I learned to jump from field to field and access fields very quickly. And that's what I have to do now. I have to do it constantly. It was extremely painful when I learned to do that. But now I have to access things in biology and health care and in fundamental physics and astronomy—things in which I have no training. But I feel very comfortable running around and getting the gist of what's going on in a field as I talent scout for the top people. So, one of the most frustrating aspects of science for me was actually a blessing of training that the Lord provided.

My business training, which was an emergency parachute for a career that I thought was going down the tubes very badly in terms of risk for my family, turned out to be absolutely what I needed to fulfill my calling in working in an administrative role developing academic programs. There's an important aspect to being an entrepreneur and to know the standards of cost effectiveness, management, organizational dynamics, accounting, law—all the things for which I had no preparation. But it was God's grace in taking what seemed to be a disaster and using it as his preparation for my calling.

That's been a long, shaggy dog story about my life, but it's a testimony to say that God works with people in profoundly mysterious ways to work out a person's calling. Often it seems devastating or painful, or it seems as though it's a waste. But God has this mystery of grace to work our calling through what we cannot see. Often the most painful blockages in our careers are precisely God's training for the utilization of his grace in other contexts, contexts that we do not see.

So what are the spiritual lessons from this and many other similar experiences that Christians have had? One, I

**Session I**

*The task, as [Malek] put it, of the Gospel, the Christian life, and the Christian mind in the academy is to produce scientists of great distinctions who can demonstrate the relevance of a theistic point of view.*

think, is leaving father and mother and following Christ. This is one of the painful lessons of the Gospel. It's not that we don't love our father and our mother, but our parents represent that prudence, that good sense, that "normalness" that the kingdom of God just doesn't live with. So we have to leave that prudent world behind.

Living life for the kingdom is a wild and crazy adventure. Look at the life of the apostle Paul, or all the apostles and the early missionaries of the Church. It's a wild and crazy adventure. It's not a normal prudent, solid life. It's a different life. And it doesn't conform too easily to what people expect us to do if we're responsible, thoughtful, good citizens. To some degree, it involves a certain frenetic fanaticism—being a lunatic. (In fact, the most famous lab in my field—at Cal Tech—was called the "Lunatic Asylum"!)

God cannot steer a parked car. If we're vigorous in pursuing the kingdom, then God can use these blockages, these opportunities, these experiences. But following vigorously is vital. So Christian calling is a mystery. And the choice of a research direction to some degree must include this aspect of spiritual mystery. We can't figure it out, plan it in advance, write it down, analyze it. It is a spiritual mystery, and God works in different people in different ways.

## The Need for Strategic Thinking

Now I want to switch to this issue of strategic thinking. We have to use strategic prudent thinking. But the spiritual mystery is the deeper thing. Charles Malek wrote on the subject of engagement with the modern university. He published a book with InterVarsity called *A Christian Critique of the University*. He has some comments on the problem of the failure of creationism. The creationism movement has not produced great distinguished scientists who would be most persuasive in our culture—people of the Nobel level, and others approaching that. The task, as he put it, of the Gospel, the Christian life, and the Christian mind in the academy is to produce scientists of great distinction who can demonstrate the relevance of a theistic point of view. Now I do not think that what the Christian movement needs to do is to create cadres of distinguished partisans pursuing hugely controversial agendas as in the great conflict of Darwinism, as if the task of the Christian intellectual is to kill Darwin. I think this is a deep and profound mistake. Rather, I think that our task is a more difficult one, and that's to develop cadres of great and distinguished highly accomplished scientists who have the respect of their colleagues on the basis of their scientific distinction and can speak from that authority, and can speak from that distinction. I think if we encourage young people to leap into battle, as it were to kill philosophical dragons within the sciences, we disgrace the cause of the Gospel. I think this is important and should be faced straightforwardly because it's a big issue within the evangelical world.

What are some of the distinctive opportunities that we might look at strategically for engagement as Christians in the sciences? One I think is obvious from looking at the state of the world. There's a statistic which is quite shocking. Half of the population of today's world, three billion people, live on less than $2.00 a day! There's tremendous need out there. The power of science, of technology, and the enterprise that it undergirds, the progress of civilization in terms of wealth-creating techniques and devices and ways of organizing life has brought wealth to some parts of the world, but has left massive parts of the world behind. Because the concern for the poor and others—that *agape* (demonstrative love) vision—is central to our Christian mission. I think it's unavoidable that we should think about our calling as scientists. We are people involved in the undergirding of the creation of wealth. We should be pointing some of our activity and some of our calling, our commitment, toward changing this circumstance. That would be a distinctive Christian contribution. I think that some of our distinctiveness could focus on very grave crises. I was deeply motivated in January 1999 by the cover of *Newsweek* and an Op Ed by George Will. Due to the AIDS epidemic in Africa, it's projected, by the year 2010, that there will be between ten and possibly forty million orphans in Africa! This is a huge crisis. And I think it's distinctively part of the Christian vision, the

Wilberforcean vision of evangelicalism, to think about addressing some of these great issues.

Science and technology can be an important part of this because education is part of the core of what we do as scientists and technologists. We're involved in education. When a society prospers, when it creates wealth, it has behind it depth of education. And so our commitment to education is very important. There are other great heroes in our world, for example, Norman Borlaug, who won the Nobel Peace Prize in 1970 for his work on the Green Revolution. There are amazing things that can be done through science and technology in these areas that directly interface with great human suffering. A 1997 article in *The Atlantic Monthly* about Borlaug claims that his work probably saved the lives of several hundred million people.

A dedicated Christian scientist can go into fields that have the kind of impact that address huge human problems and save hundreds of millions of lives. We can do that today, not the same as Borlaug's Green revolution, but in other ways. There's very important work in parasitology, for example. There aren't vaccinations for some of the diseases that affect billions of people around the world. In the area of environmentalism, I think of the Mediterranean littoral where there has been severe deforestation over thousands of years. How could we reforest gigantic tracks of the world and make such a challenge economically viable, and scientifically workable? This might be a task even for agricultural genetic engineering. Will Christians take on massive, world-changing projects and use the power of science and technology in innovative ways to massively solve environmental problems?

## Develop a "Faith of Fools" Attitude

Frederick T. Gates was an advisor to John G. Rockefeller. Gates was involved in generating what became Rockefeller University through the philanthropy of John D. Rockefeller. At that time, in the beginning of Rockefeller's formal philanthropic activity, it was felt that if you gave money for basic research, you were probably doing something a little ethically tainted since there were hospitals full of people on iron lung machines and full of desperately ill people. It was thought that if you were a philanthropist you needed to respond to that direct human need. It did not seem right to put a lot of money into laboratories and scientists and libraries and basic research. Why support "egg heads" when such immense immediate needs were calling out for attention?

Gates responded to this by saying "we have the faith of fools." He believed that basic research over a long period of time would fundamentally change the nature of the world. And he was right. We believe that now. We know that medical research changes the world profoundly. Nobody knew that in the day and age of polio when Gates commended massive long-term investments in basic scientific and medical research. But who of us is worried about polio now? It's not part of our world. But a generation before mine, polio killed children quite commonly. Every person knew somebody that died of polio and they knew people who were crippled by the disease. The development of vaccines against polio was profoundly transformative. The idea of deep medical research that transformed the world was an important aspect of "the faith of fools." The "faith of fools" is the idea that the future can and should be profoundly different through the fruits of research. I think Christians have to think this way. We have to listen to the wisdom of Frederick T. Gates and think outside of our usual box. We have to research and invent ways that profoundly transform the world. This is part of our challenge of the "Christian mind."

> *We need a cadre of subtle interlocutors ... who can speak profoundly [as scientists] from a religious tradition.*

It is our responsibility and task to think through these things. It could be via research in forgiveness and reconciliation, understanding conflict resolution, or changing the world through making forgiveness a normal part of life for everyone. It may be something to do with biotechnology or nano-technology or the humane aspects of medicine. It may be by researching *agape* behavior. To have this "faith of fools" about what scientific research could do to transform the world is part of our task.

We also need a cadre of subtle interlocutors. We need more interlocutors in the sciences and in many other areas, who can speak profoundly from a religious tradition. In our case, we need people from the evangelical tradition who can speak profoundly as scientists. My dream is that this kind of activity would connect with Christians like you coming out of places like MIT to bring great ideas that will transform the world in beneficial ways but may not necessarily be profitable. What can we do? What can come out of our work? We need a new generation of people deeply devoted and innovative in the sciences, and deeply devoted and engaged in spiritual life. What can people like that do working with Christian organizations, with Christian capitalizers, to transform the situation of ten-million AIDS orphans in Africa; or to combat deforestation problems in Haiti? What could we do in a profoundly transformative way to change our world with the kind of dynamism that you see in the economic sector? Could we ever have that kind of dynamism between the life of faith and the Christian mind and the sciences and technology? ☆

**Session I**

# Discussion Session

***Audience:*** *How do the two ideas – God cares about my research topic and God guides my decisions – work together in life?*

***Harper:*** *God inspired a deep spiritual yearning and hunger early in my life that He later blocked by a rather long discipleship in the sciences, which seemed like a spiritually barren desert. But through that desert, God later provided the opportunity for the hungers to be met.*

*Let's face it. Work in cosmology or planetary science doesn't have much to do with disasters and poverty in Africa. But because I now work in philanthropy, there are lots of opportunities. Interestingly in our current economy, the new wealth is creating awesome opportunities for philanthropy. Many people have recently made a hundred million dollars. People are developing and looking for philanthropic ways to use large amounts of money for the service of the Kingdom. So, philanthropy has become a very interesting opportunity.*

*My preparation and calling, which has to do with science and religion, are now my main job. I am also involved in some other things that really have to do with needs in the Third World situation. I praise God for that. Sometimes he brings back the things he had formerly blocked.*

Derek Gingerich is a graduate student studying botany at Cornell University.

***Suppe:*** *I encourage reading Christian biographies. It is helpful to see how God takes believers through things and uses these experiences in his service. The Lord may wait until you're 40, 50, 60, or 70 years old to use you in very fruitful ways. As a new Christian at age 36, I came to the point fairly quickly where God showed me my call. I was relieved! I felt he was calling me to be a witness on university campuses. However as a baby in Christ, I had no idea what this meant. Then I started to have the humbling experience that simply being a Christian faculty member physically present on a university campus was something that God uses profoundly. As I matured in Christ, he started using me in other ways.*

Jennifer Wiseman is a postdoctoral researcher in astronomy at Johns Hopkins University.

***Audience:*** *I have two questions. First of all, if we have to go through a long cycle before we get into what God is calling us, we will lose time. It almost looks like the wilderness journey of the Israelites. I know that God didn't plan to spend forty years to get there but somehow it worked that way. So I wonder, is there something you think we can do so we don't need to go around the full cycle?*

*My second question deals with funding research. Sometimes the agencies that give you money decide what they want you to do. Let me give you an example. We wrote a proposal to NIH because I wanted to do some work with parasites. They said the proposal was viable but they didn't fund it. Instead they gave an option. If we would give an evolutionary explanation to the parasite project, they would fund the proposal. This was not our idea, and we were uncomfortable with it. It seemed they wanted proof that we were evolutionists. What can we do as Christians to counteract such funding pressures that divert from our original research direction?*

***Harper:*** *In terms of science, I think the issue of shortcuts is pretty important. We all know that the process of becoming an authority in the sciences doesn't have a shortcut – except maybe for 25-year-old Albert Einstein! But that is extremely rare. To become a master in an area of science, to speak with authority in the major journals, and to make breakthroughs in sciences require a long and serious discipleship. Only people who are gifted with the ability to do the hard work can be successful in that way. I think that there are no shortcuts. If we are to have science careers for the Kingdom, it will never be a short process.*

*In terms of funding, when you are in research you can't really control it. A young super bright Christian at Yale University is running a parasitology research lab there. He is trying to develop a vaccine against a common parasite infestation that doesn't kill people but harms them by causing a loss of physiological vitality that allows other diseases to be expressed. This problem affects maybe half of the world's population. The medical drug treatment costs about $30 a year per person to control this particular kind of parasite. But there are two problems with this medical treatment. First, if the drug was used very widely, parasitic resistance would develop. Secondly, that is much too much money for people who live on less than $2.00 a day. So there is a need for a vaccine.*

*I think Christians can use leverage to accomplish an end. In the last few years, we have seen the whole issue of malaria vaccine development*

*hit the news because Harold Varmus and some others started talking and writing publicly about it. Some opinion journals picked up the idea that it was an ethical mandate for Americans to start funding basic research for malaria vaccine development though drug companies didn't have an interest in it. This concern has been picked up by the Gates Foundation, for example, which has just invested millions in this project. Many institutions are following suit. It has now become a mainstream cause.*

*If Christians are savvy in a Wilberforce sense, they can begin to exercise this kind of leadership. Wilberforce was an Englishman who was most known for his work to stop the English slave trade. He gathered men and women around him who worked and prayed with him. He campaigned and played politics supremely. On his deathbed, he actually saw his effort come to a successful conclusion. He cleverly but wisely used public, political, and personal resources to bring about a major civic transformation. Unfortunately, evangelicals today are not notable for thinking and acting that way.*

***Audience:*** *Charles, when you said that sometimes the Gospel calls us to turn our back on prudence or to leave our parents and do what is required, that resonated with my own life. Given the demands of the Gospel, I wonder how you find the balance between what you called "slaying philosophical dragons" on the one hand and "subtle interlocutors" on the other?*

***Harper:*** *You are really talking about the issue of Christian boldness in the sciences and the question of whether this is consistent with what I said in my concern about Christians wanting to jump forward and slay the dragon of Darwinism. I'll try to give you a thumbnail sketch of my own views on this.*

*When Christians look at the sciences, particularly from outside the details of evolutionary biology, paleontology, etc., we see it as a philosophical construct that tangles with Christian belief. When we see evolutionary biology as philosophy, we rightly wish to attack that philosophy for its materialistic pretensions. I think the critical mistake is the subtle assumption that a particular philosophy must follow from the science. While it is prudent for Christians to attack a particular philosophy, it is imprudent to assume that by attacking science then the philosophy is defeated. I don't know if I am making that clear, but if you are inside the sciences you realize that evolution is fundamentally different from Marxism or Freudianism. Evolution is based on a huge base of data from people studying trilobites and dating rocks and doing molecular experiments. Since evolution has this gigantic base of factual data, it is very different from some 19th century, explain-it-all wacky philosophy cooked up by some hare-brained Hegel student brooding on Wagner and world revolution. But evolution then becomes philosophically interpreted. Interestingly when evangelicals look at science from the outside and see people like Stephen J. Gould, Peter Atkins, Richard Dawkins, or Daniel Dennett philosophically interpreting science in the public sphere, evangelicals accept the interpretation as science. That's the trap, in my view. I think that evangelicals should make their own narrative of what science means. We need narrators of the sciences in terms of the book of nature, the glories of God. We have people that interpret science through the lens of philosophical atheism. So some of the public believe that is what science means. The tragedy is when we misjudge bad philosophy to be faulty science and then attack the science wrongheadedly. We need to narrate the story of science to the public in interpretive terms of the glory of God with respectfulness to the proper respect due to the carefulness and thoroughness of the detailed science which has been done and with proper humility to recognize where Christians have made poor judgments in the past with respect to promoting what is clearly embarrassing nonsense. We, therefore in my view, should not be in a responsive mode doing battle with bad philosophy, but in a pro-active mode narrating science and offering high quality philosophically sophisticated alternatives to the science = atheism choir. That's my little philosophical vignette.*

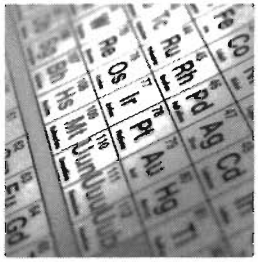
***Audience:*** *When it comes to choosing a research topic, I wonder if there might not be a more mundane factor. I'm thinking about the commitment you were talking about of 14–16 hour workdays, especially for a married person. God created marriage for companionship. I blurted out in an interview with Texas A&M a year after I got married, after they described expectations close to that, that much of my life wasn't for sale. I didn't get the job. What do you think about a Christian spending so much time in research so that her/his family seldom sees him?*

***Suppe:*** *A lot of the fourteen-hour workday in research science is certainly self-inflicted. We are workaholics and have a passion for these things. We keep upping the ante. I think that is part of the nature of people who are self-selected for scientific research. So if you don't fit that mold then obviously it is much more painful. But for someone that really fits that mold it can be a very exciting thing.*

*Similarly the highest levels of corporate America select only certain personality types. To a very large extent, top universities select certain personality types. A trait of this personality type is the tendency not to work very well with others. That's why we have all these problems with faculty meetings! Just trying to find anyone who could be a chairman of a department is really difficult. So I think part of that problem is really just a nature of our culture. For example, I was on sabbatical one year at Cal Tech, which has a culture that is really "macho engineering." It is really very distinctive, very different from the culture at Princeton. There are similar realities in university life.*

*Even before I became a Christian, I started to realize that being a workaholic is actually a little bit crazy! The human character is to have your mind and desires go so much faster than your feet. I started to realize that I have a family to enjoy. By not working so much, actually I accomplish more. So this is something I encourage young faculty members to do. Work less and perhaps work smarter.*

***Harper:*** *A spiritual calling is not going to be comfortable. I have certainly experienced certain tensions. As a Christian, you have to draw boundaries and you have to be distinctive about not going over them. But if you have a calling and a ministry in the academic life and if you are not an Albert Einstein, then you really do have to put in long hours. I think working long hours is an unavoidable necessity. Spiritual calling to a more conventional form of ministry, like evangelism, involves a similar sacrifice. Billy Graham has spoken of his family life as being a disaster and I think it was. His kids never saw him. So while the problem is a painful thing with which we struggle, I don't think it is unique to the academy.* ☆





Session II

# What Are the Essential Biblical Principles?

*How does the Christian in science think about God's involvement with his or her science?*

Is there a separating line between the natural and supernatural for a biblical Christian? The interesting thing is that biblically there is no such thing as "nature," which could then have something above it or outside it. There is only creation, which God has brought into being and sustains. Perhaps in the idiom of today the question could be: "Is the cosmos self-sufficient?" or "Is the cosmos explainable totally in terms of matter, energy, in time and space?" Or to quote that great "philosopher" Carl Sagan: "Is the universe all there is or ever was or ever will be?" We believers ask, "Does God interact with matter and energy, in time and space?" Or put differently, "How does the Christian in science think about God's involvement with his or her science? Does God only intervene to fix what 'nature' cannot do, that is, to do miracles?"

Let's look at some of the evidence from God's own revelation. In Genesis 8:22 (NIV), Noah is building an altar to the Lord in thanksgiving for his deliverance from the flood. The Lord responds to this offering, while acknowledging "every inclination of his heart is evil from childhood," meaning the sinfulness of human kind. God goes on to give this promise.

> *As long as the earth endures, seedtime and harvest, cold and heat, summer and winter, day and night will never cease.*

Then in Jeremiah 10:12–13 (NIV), God tells Jeremiah to tell the people:

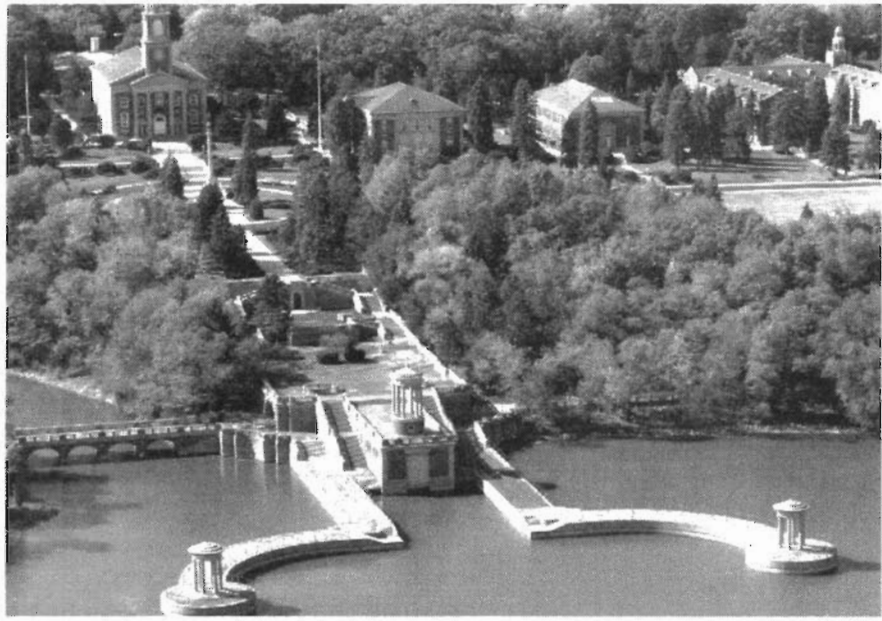
> *But God made the earth by his power; he founded the world by his wisdom and stretched out the heavens by his understanding. When he thunders, the waters in the heavens roar; he makes clouds rise from the ends of the earth. He sends lightning with the rain and brings out the wind from his storehouses.*

These two passages together tell us that not only does God know that the earth will continue in predictable patterned behavior but that God causes that predictable patterned behavior. He is the one who continuously brings about the actions of matter and energy in time and space.

In Jeremiah 31:35–36 (NIV), God identifies himself thusly:

> *This is what the Lord says, he who appoints the sun to shine by day, who decrees the moon and stars to shine by night, who stirs up the sea so that its waves roar – the Lord Almighty is his name: Only if these decrees vanish from my sight," declares the Lord, will the descendants of Israel ever cease to be a nation before me.*

**Terry Morrison** *was born in Pittsburgh in 1936 to a recent immigrant from Northern Ireland and his young wife, a descendent from the Mayflower folk. Terry's educational degrees include a B.S. from the University of Pittsburgh, a M.S. from the University of Illinois and Ph.D. in Chemistry from Syracuse University. Terry taught Inorganic Chemistry at Virginia Commonwealth University and was a Chemistry Professor at Butler University. In 1974, he joined the InterVarsity Christian Fellowship staff and directed staff work in the Middle Atlantic and Great Lakes Region and later served as an international director connecting InterVarsity USA with student work around the world. Currently, Terry is a director of the Faculty Ministry program of InterVarsity and is a board member of the Au Sable Institute of Environmental Studies. His is also big fan of British mysteries written between the wars (1920–1950).*



View of University of St. Mary's of the Lake, Mundelein, IL, the site of this conference.

The Lord indicates—by the present tense character of the verbs—that he is the actor behind matter and energy behavior in time and space. He calls the patterned behavior "decrees." He has said that the creation is to exhibit a certain behavior and that it will continue that behavior until he indicates a change.

Going now to the New Testament, in Colossians 1:16, 17 (NIV), we are told that the Lord Jesus, the "Son," is the "first born over all creation."

> *For by him [Jesus] all things were created: things in heaven, on earth, visible and invisible, whether thrones or powers or rulers or authorities; all things were created by him and for him." He is before all things, and in him all things hold together.*

Similarly, in the letter to the Hebrews (NIV) in the first chapter, verses 1–3 says:

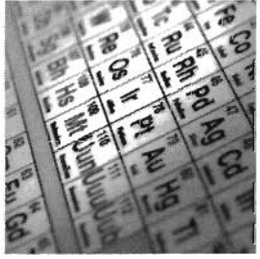
> *In the past God spoke to our forefathers through the prophets at many times and in various ways, but in these last days he has spoken to us by his Son, whom he appointed heir of all things, and through whom he made the universe. The Son is the radiance of God's glory and the exact representation of his being, sustaining all things by his powerful word.*

These two passages indicate that the Lord Jesus is the Creator, Sustainer of the universe. It is his word and character that keep creation in being. We could say that the "laws of science" simply describe the decisions and actions of our Lord. He is the "glue" that holds it all together. So the biblical perception is that God, for and by his Son, creates and sustains in being, i.e., gives character and behavior patterns to everything that exists—matter, energy, time, and space. He is the Lord of science.

How, then, do we as Christians in science think and act as we do science or applied science? To say it another way, how should our faith *function* in our work? I believe it functions by our always being aware that our Lord is present in us and in the work we do. He delights in the character and behavior of matter, energy, time, and space. And the Lord delights in us as we study science. Our work is part of our worship of the God we serve who is Creator and Sustainer. We can work "doxologically." All of it can be praise. We can react to what we observe in science as wisdom did in those days of creation. Proverbs 8:30b–31 (NIV) says:

> *I was filled with delight day after day, rejoicing always in his presence, rejoicing in his whole world and delighting in mankind.*

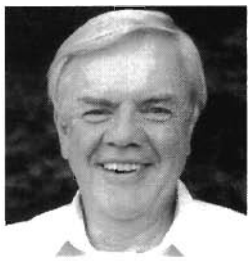
Thus there is no separation between our church-spiritual life and our university-professional life. All of it can be lived in joyful worship, humble, obedient service and complete faith. As we offer our work to the Lord in worship, he is delighted with us. ☆





**Session II**

# What Is the Role of Worship?



*God asks us in our work to mirror back to him his love to us and his care for us and for the whole world.*

God asks us in our work to mirror back to him his love to us and his care for us and for the whole world. As a prelude to a reading from the Scriptures, I'd like to read from a small book in which I've written these words:

> I have been in love with the Creator since my childhood and have been inspired and awed by God's creation for over 50 years. I gained an early appreciation for God's creatures from caring for and keeping the animals in the backyard zoo of my childhood and youth.
>
> I am now a teacher. I have taught thousands of college and university students (and nearly every other person I've met), helping them to develop a profound sense of awe and wonder for God's world. Like the great Teacher—my model—I also like to teach on field trips! And, I am also a continuous student, learning from the "university of creation" and from God's holy Word.
>
> One Sunday evening when I was in my teens, I overheard my uncle ask my Dad a question about me: "Shouldn't you help Cal do something more important than this—something that will help him get a job?" My Dad guided him down the basement stairs to see my birds and fish while my mom and aunt prepared the after-church goodies. Then my Dad responded to my uncle's question, softly replying that he thought I was doing just fine. You see, my Dad had told me earlier to keep going in what I loved to do; that would mean that I would do it very well, and doing it very well meant that eventually someone would even pay me for it. In this—his rendition of Matthew 6:33—he was ever so right! I now get paid for what I love to do. My profession is caring for God's creation and helping others to do so, too.
>
> Early on, some of the people I talked to about my work saw it as leading nowhere. Later, as I studied at Calvin College and the University of Michigan, many people viewed my work with curiosity. Then much later—during the early 1970s—most people saw my work as being vitally important. As my work developed, it was labeled radical (because it suggested that we might have to change the way we lived). But, as environmental fervor grew across the land, people began to see this very same work as too conservative (because I failed to take a stand, among other things, on the ecological unsoundness of pink toilet paper). In the late 1980s that same work was again seen as curious, but largely irrelevant. And today? Well, most people think it is important again. What's next? The next stage—I feel it coming—is that what I am doing and saying about the care and keeping of God's creation will again be seen as too radical (for the same reasons as before)![1]

Matthew 6:33 (NIV) is, as you know, the key passage probably for all of us, as we

**Calvin DeWitt**, *Ph.D. Zoology, University of Michigan, is professor of environmental studies in the University of Wisconsin's Institute for Environmental Studies and director of the Au Sable Institute of Environmental Studies. He is a member of the University of Wisconsin-Madison graduate faculty of land resources, conservation biology and sustainable development, water resources management and oceanography limnology; a Fellow of the University of Wisconsin Teaching Academy; and a recipient of the Chancellor's Award for Distinguished Teaching.*

seek God's will for our lives, because it tells us what we should be seeking. It says:

> *But seek first his* [God's] *kingdom and his righteousness, and all these things will be given to you as well.*

We move from here to another reference to the kingdom in the very last times, Revelation 11:15–18 (NIV):

> *The seventh angel sounded his trumpet, and there were loud voices in heaven, which said: "The kingdom of the world has become the kingdom of our Lord and of his Christ, and he will reign for ever and ever." And the twenty-four elders, who were seated on their thrones before God, fell on their faces and worshipped God, saying: "We give thanks to you, Lord God Almighty, the One who is and who was, because you have taken your great power and have begun to reign. The nations were angry; and your wrath has come. The time has come for judging the dead, and for rewarding your servants the prophets and your saints and those who reverence your name, both small and great – and for destroying those who destroy the earth."*

We should believe on the Lord Jesus Christ (as we read in John 3:16) because in believing on him, we shall have everlasting life. If we thwart his ways we deserve the judgment described in Revelation 11:18.

Who is Jesus? And why by following him can we gain everlasting life? We find this Colossians 1:15–20 (NIV):

> *He* [Jesus Christ] *is the image of the invisible God, the firstborn over all creation. For by him all things were created: things in heaven and on earth, visible and invisible, whether thrones or powers or rulers or authorities; all things* ("ta panta" in the Greek) *were created by him and for him. He is before all things and in him all things* ("ta panta") *hold together. And he is the head of the body, the church; he is the beginning and the firstborn from among the dead, so that in everything he might have the supremacy. For God was pleased to have all his fullness dwell in him and through him to reconcile to himself all things* ("ta panta") ...

Whoever believes on him will have everlasting life. However, we read in Revelation that those, who seek not the kingdom but who destroy the earth, are destroyed. Sometime you might want to reflect on not only the consequences in following Jesus, which we read in John 3:16, but also on the consequences for destroying the Lord's earth.

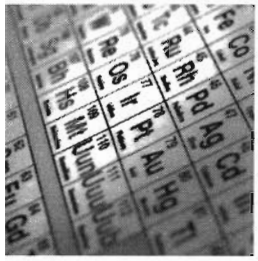
As scientists, I think it is important for us to realize that God loves us not only through the gift of Jesus Christ, through whom he reconciles *"ta panta,"* but also that God shows his love to the world in providing everything that the world needs. In our studies, in our research, in our reading of God's great second book in the context of the first book, we see this love and here it begins.

In the hymn, "Oh, Worship the King," a rendition of Psalm 104, God's love is expressed in many, many ways. In the first verse, we are already reverencing the King and the kingdom we seek. The first two lines of the hymn tell us how difficult, how impossible, it is to describe this care:

> *Thy bountiful care, What tongue can recite?*
> *It breathes in the air. It shines in the light.*

It is too bad that we sing these words so fast, because we might want to ask: "How does God's love breathe in the air?" Many

*Sometime you might want to reflect on not only the consequences in following Jesus, which we read in John 3:16, but also on the consequences for destroying the Lord's earth.*



**Session II**

*God loves the world, and we, as scientists, have the opportunity to bask not only in God's love for us, but also to bask in the love that God shows in the very things we study.*

of us have studied the atmosphere. We breathe ourselves. We study respiration and photosynthesis. But what's remarkable, of course, is that God's bountiful care "breathes in the air." Carbon dioxide, which is being released from us right now, is soon going to be absorbed by plants outside and those plants in return will be using that carbon dioxide to make the substances which fuel the rest of life, using the process of photosynthesis. They will be producing oxygen, which in turn will be fueling our lives as well as the respiration processes in plants.

The atmospheric circulations, which are driven by the differential heating of the surface of our spherical planet at its 23½° angle in relation to the sun, create these differentials of pressures and temperatures. This not only reflects the movement of the sphere, but also the connections with the carbon dioxide we breathe out and the carbon dioxide which is taken in by the vegetation that covers such a large part of our earth.

In the next two lines we see:

> *It [Thy bountiful care] streams from the hills. It descends to the plain,*
> *And sweetly distills in the dew and the rain.*

Every once in a while as a scientist, there are some things that just bowl me over. Stuff I know, but I really didn't know. We all learned that water is the universal solvent. This question struck me a couple years ago: "Why doesn't water taste like a big, massive pea soup, if this universal solvent has been working over all of these years to dissolve everything?" Of course, there may be many components to the answer. But one thing is that through the remarkable process of transpiration of plants, which is occurring all across the globe, water is being pumped from the soil below and into the atmosphere. It is not being pumped up with all of its dissolved materials, but is being pumped pretty much as pure water. Evaporation is taking place across all the surfaces of the earth and all the surfaces of the city and the rivers and the lakes and it, too, is coming up leaving the solutes behind.

God loves the world, and we, as scientists, have the opportunity to bask not only in God's love for us, but also to bask in the love that God shows in the very things we study. We know from the Scriptures that we are made in the image of God. Being made in the image of God is something that brings us to reflect God's love in a dynamic way. Perhaps it is best for us to say that we are made to mirror God's love for the world. We are mirrors of God; we are images of God, dynamic reflections of God who cares for the world. In our research, the question that should always be with us is this: "Is the work I am doing in or to God's creation reflective of God's care for creation, God's care for the world, God's care for people and for all creatures?"

Perhaps if I can be so bold as to give a commission to you, I ask you to look through the hymn book, which often is the synthesis of a great deal of theology, and reflect on the hymn texts. Sometimes if the Sunday sermon is not going too well, you can pull out the hymnal and reflect. Think on this one, for example:

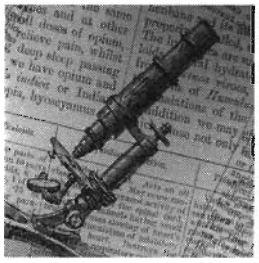
> *Joy to the world, the Lord has come,*
> *... Let heaven and nature sing ...*
> *He makes His blessings flow as far as the curse is found.*

There are hymns and carols that pull everything together. This is one of them.

Let's conclude by reviewing. God loves the world. Our failure to love the world by destroying it has consequences. But seeking the kingdom and mirroring God's love for the world also has its consequences, which are far more glorious. Our love should mirror God's love so that his bountiful care is expressed. Our principle publication in science should not be in our papers, but it should be in our lives and in the land's care. ☆

## Reference

[1]Calvin DeWitt, *Earth-Wise: A Biblical Response to Environmental Issues* (Grand Rapids, MI: CRC Publications, 1994), 7–8.



Session III

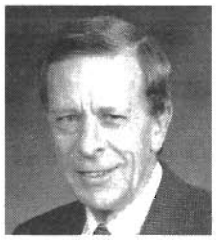
# What Lessons from the Past Aid Our Choice?

In considering how a twenty-first century scientist chooses his or her research topic, it may seem bizarre to go back to the past where conditions were unimaginably different. Yet in fact the past has much to teach us, and there are sound Christian reasons for sometimes glancing back over our shoulders to see how God has shaped history. There are patterns in history which have a habit of repeating themselves. So our problems are not necessarily new *in principle*. After all, serious historical studies have revealed much of the intimate connection between science and Christianity. Nor is the past necessarily a long time ago; as someone has said, "History finished last night!" Yet, of course, the past has gone, and we should not hanker after an imagined golden age nor try to put the clock back (unless, as C. S. Lewis once said, it's actually wrong). But a *balanced* approach to the past and the future can be of great help in looking at some of our contemporary problems.

When we focus on the question of choice of research topics, there is surprisingly little written about it, either in Christian or secular literature. Possibly this is because there often has been little choice anyway, or because in the past research students were not recruited as now, or simply that the initial choice may not be seen as a particularly interesting topic, certainly not in comparison with what the subsequent research actually showed. For a Christian, some of the matters discussed below are likely to be of greater importance than they might be for non-Christian colleagues. In general, the biblical principles of guidance would need to be thoroughly explored.[1]

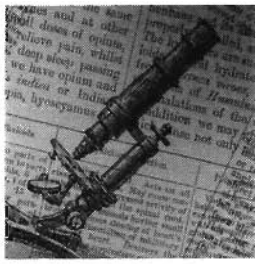
A close examination of a number of cases, historical and contemporary, does seem to disclose certain factors that drive the choice along certain lines. We may call these *determinants of choice*, and in the following account seven have been identified as specially important. Others may exist, but the list seems to be fairly inclusive. We shall illustrate them with modern examples as well as from two well-researched lives of the past.

One of these was Edward Frankland, an English chemist who lived from 1825 to 1899 and who was, in his time, reckoned to be at the very front of his profession in Britain. He discovered (and named) the chemical "bond," was the founder of organometallic chemistry and a pioneer in chemical education, and contributed massively to the monitoring of drinking water supplies in the expanding Victorian cities. He was the first professor of chemistry at Manchester and then worked in London, finishing his career at what is now Imperial College. He was knighted in 1898. Interestingly—if sadly—he initially professed the Christian faith encountered in his youth at Lancaster, but gave it up for apparently complex reasons and spent his later years in the company of Huxley and other agnostics seeking to ridicule the Church and all that it represented.[2]



*A balanced approach to the past and the future can be of great help in looking at some of our contemporary problems.*

**Colin A. Russell** *is emeritus and visiting research professor in the history of science and technology, The Open University, UK, and a senior member of Wolfson College, Cambridge. He holds a Ph.D. and a DSc from the University of London. He is an organic chemist who entered history of science via history of chemistry. He previously served as president of Christians in Science, president of the British Society for the History of Science, and chairman of the Historical Group of the Royal Society of Chemistry. He received the Dexter Award from the American Chemical Society in 1990 for "outstanding contributions to the history of chemistry." He is currently a trustee and member of the managing committee of the John Ray Initiative (concerned with Christianity and the environment), and a member of the Council of the Royal Society of Chemistry.*





The other example is Michael Faraday, probably the greatest experimental physical scientist of all time, a founder of electromagnetism and pioneer in other branches of chemical and electrical studies, working all his scientific life at London's Royal Institution. He lived from 1791 to 1867, and maintained a robust Christian faith for all his days, belonging to an obscure, and now extinct, denomination known (from one of their first leaders) as the Sandemanians. They placed loyalty to Scripture before any other allegiance.[3]

*Fields of science discovered almost by accident have proved the most powerful determinant for future directions in research.*

## Determinants of Choice

Seven determinants of choice will be introduced in roughly the historical order in which they first appeared. Of course, it was rare for any one them to have acted alone.

### 1. Fascination for the Topic

From time immemorial, people have studied nature for the sheer fascination it exerts: "Just because it's there." A youthful delight in flowers, insects, or small animals has turned many a person to become a life-long naturalist. A preoccupation with Greek ideas of circular motion undoubtedly helped to determine the direction of Copernicus' revolutionary ideas on cosmology. And in more recent times, every research supervisor knows well how sheer intellectual satisfaction with a given topic can drive even apparently unpromising students to perform splendid work. Few of us will have taken researchers on board without some indication that they were likely to find the topic of great inherent interest. A geology researcher I knew once confided that he felt it so unfair that he should receive a salary for something that others would willingly pay to do if they had half a chance. This is science for its own sake, a disinterested search for knowledge.

It was a major factor in the life of Edward Frankland. While studying in Germany, he encountered a school of thought that believed it was possible to isolate organic radicals (like methyl and ethyl). He declared, "I was also smitten with the fever" and thereafter engaged in such single-minded pursuit that he discovered, not transient "radicals," but a whole new range of compounds which he called "organometallic" and one of the fundamental theories of chemistry, the theory of valence.

Michael Faraday's first science was chemistry—in his circumstances there was little alternative. But when he was invited by the editor of a journal to write a historical paper on electromagnetism, such was its fascination that he moved right into electromagnetic research himself. That kind of story can be repeated endlessly as fields of science discovered almost by accident have proved the most powerful determinant for future directions in research.

### 2. To the Greater Glory of God

It was Francis Bacon who gave us one of the main aims for studying nature: It should be "to the glory of God." Most of those who worked in the Scientific Revolution undoubtedly shared that motivation. This includes Copernicus, Kepler, Newton, and countless lesser lights. How far this ideal determined which area of nature they studied is more problematical. It may be that Copernicus forsook medicine for astronomy for precisely the reason enunciated in Psalm 19:1: *"The heavens declare the glory of God."* Kepler certainly argued that astronomers should not pursue the glory of their own intellect but the glory of God above everything else.

Perhaps the least specific of all the seven determinants, a longing for the glory of God has surely helped in the selection of research topics in the sense that it enabled people to exclude that which was evidently *not* for God's glory. And it has sometimes given general encouragement to pursue scientific objectives which look as though they might disclose something new of the grandeur of the universe (as astronomy) or the evidences of design and purpose.

Amongst our Victorian predecessors, Edward Frankland's developing agnosticism would find no room for "the glory of God." However, in his Inaugural Lecture at Manchester, even he would argue the special case for chemical research because "the chemist experiences a peculiar delight & inexpressible feeling of love to the beneficent Author of creation." Whether he meant it, or was simply playing to the gallery, it is hard to say, but the very fact that he articulated such a sentiment suggests at least that

it was a credible one to cite. His older colleague Michael Faraday said little of his faith in the arena of public science, but a much underlined verse in his Bible says it all: *"Let us not be weary in well-doing"* (Galatians 6:9). And when his theological musings on the structure of matter led him eventually to his field theory, Faraday was (in the words of one commentator) "quite literally at play in the fields of the Lord."[4] Today many modern students have had their steps directed to certain research areas by convictions that, somehow, such studies may be truly to the greater glory of God. In our secular society, it is a consideration we cannot possibly ignore.

### 3. Social Benefit

Francis Bacon's other reason for studying nature, as well as being for "the glory of God," was for "the good of man's estate." Science was seen for its potential for social improvement. As the utility of science became more and more obvious, this became one of the commonest motives for pursuing it, and also for the selection of research topics. Many starry-eyed youthful researchers have gone for a topic because it might lead to a cure for cancer, improved agriculture, a benefit to the environment, etc.

In Victorian times, there was a huge optimism about the power of science. Edward Frankland was a typical embodiment of that view. His research projects were often chosen for that purpose, especially in his early years in Manchester (1850–1858). Later work on water analysis, which helped to avert a national disaster through contaminated and infected drinking water, was at least partly an expression of that belief. Similarly much of Faraday's research was for the common good: gas-lighting, collaboration with Davy on the miners' safety lamp, consultant work on mining disasters, advice on lighthouse matters for Trinity House, and much more. His desire to benefit humankind sprang from his clearly articulated belief that "the gifts of God" are given "for our good."

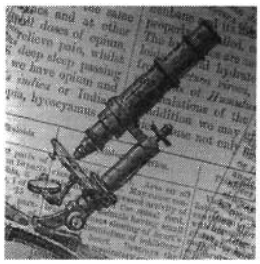
Two examples from the twentieth century must suffice. Ray Gambell has told how, as a Christian he wanted to do something "useful" with his biological training, so he decided to work on fisheries' research. He is now the Secretary of the International Whaling Commission.[5] Another biologist, Oliver Barclay, having graduated at Cambridge during World War II, was led to his research topic by the plight of the wife of a medical professor. She had injured her knee but surgeons at that time did not know enough of how the joint worked to operate successfully on it. She therefore had to lose her leg. Barclay was led by this circumstance to dedicate his research to a study of the mechanics of vertebrate locomotion in general.[6] After his Ph.D., he moved into Christian work among students, becoming eventually General Secretary of the British IVF/UCCF.

### 4. Intentions of the Supervisor

However free one might imagine oneself today, the fact is that one major determinant must be the wishes of one's supervisor. Such a person often has been at the elbow of young research students but the supervisor's role is now much more closely defined than two hundred years ago, reflecting the emergence of research schools in science. For chemistry, Justus Liebig opened the doors of his laboratory at Giessen from 1825 to 1852 to a great variety of people, from those just passing through the town and wanting a week or two of laboratory instruction to full-fledged Ph.D. candidates. Similar schools appeared in France (Dumas, Paris, 1832–1838) and Scotland (Thomson, Glasgow, 1817–1852). They gradually evolved from laboratory training of bright students to conscious preparation for Ph.D., and instituted a trend for travel to centers of excellence in Europe.

Today the supervisor's wishes may be expressed as a command or as advice. It is unlikely that the (possibly apocryphal) experience of Ernest Rutherford will be repeated in our lifetimes. It is said that the young New Zealander was asked by Professor Bickerton what he wanted to do. He replied that he wished to repeat and exam-

*As the utility of science became more and more obvious, this became one of the commonest motives for pursuing it, and also for the selection of research topics.*







*The most important decision we probably have to make is our choice of director.*

ine the discovery by Hertz of the transmission of electromagnetic waves. "Splendid!" the Professor is said to have responded, "I'll be your demonstrator!"[7] When Josiah Willard Gibbs was pursuing his doctoral research at Yale in the early 1860s, his biographer notes that the direction of his studies "in those days of informality must have been largely determined by his own predilections."[8]

Those days are long gone. Therefore the most important decision we probably have to make is our *choice of director*. It is still true as J. D. Bernal had observed just before World War II:

> The professor controls a department and advises the research workers in that department; that is, in general, he suggests the research they should undertake, and assists and criticizes them in the course of their work.[9]

Elsewhere the same writer advises: "Pick your chief wisely and make yourself agreeable to him," adding that the best scientists are not necessarily the best research directors. Some may be so involved in their own work that students get seen once or so a year, while others may be so interested in the work of their students that they tend to regard it as their own. In a somewhat more cynical tone, Bernal remarks:

> Perhaps the most convenient chiefs are those amiable scoundrels who establish a kind of symbiosis with their research workers, choose good ones with care, see they are well supplied with apparatus, attach their own names to all their papers, and when at last they are found out, generally manage through their numerous connections to promote their protégé into a good position.[10]

So it is clearly crucial to select a supervisor (if possible) on the grounds of reputation or even amiability. Has he or she got a flourishing research community? This approach goes back at least to the days of Liebig when students flocked to the *guru* whose reputation was even then international. One needs also to know if the establishment is well managed and well financed. Bernal's caution is timely as instances are still well known of certain supervisors trying to acquire record numbers of research students and in fact rarely seeing any of them, a problem compounded in many countries today by government pressure for visible results.

In the case of Edward Frankland, a visit to Marburg for five months in 1847 persuaded him of the excellence of Robert Bunsen as a supervisor; so he returned there in 1848/9 to acquire a Ph.D. Bunsen seems to have only provided a framework within which to work (the hunt for radicals), and Frankland's own topic was determined partly at least by the accident of some of his own early discoveries. He chose well because Bunsen's team worked in an expanding and novel field, there was a good research atmosphere aided by fellow students like J. Tyndall and H. Kolbe, and a range of new techniques in gas analysis was available.

Faraday, in contrast, worked in the less formal period of the early nineteenth century. His supervisor, Sir Humphry Davy, could not have been better chosen, for he was a bright and rising star in scientific London. There can be no question as to how the two men came together. Faraday heard Davy's lectures at the Royal Institution and wrote to him (1812) for help in general, not as a formal research student. Later he was urged by Davy to analyze some minerals and then to work with him on the safety-lamp. In that way, his career as a chemist was begun. For the rest of his life, he was deeply grateful to his supervisor.

## 5. Personal Ambition

For some people, research topics always have been a means to fulfil a personal ambition for fame, influence, or whatever. This is surprisingly common in science today, though science's institutions may "cunningly sublimate human ambition & competitiveness into the search for new knowledge."[11] If one's ambitions are merely to get a doctorate for whatever reason, one may face a difficult decision between an important piece of work that may lead only to a dead-end, or to a safe but fairly trivial Ph.D. topic.

> The means chosen to reach the first goal of the Ph.D. may affect the possibility of reaching the second goal [subsequent

career]. Choice of an unadventurous research area may produce a dull teacher, or someone who is wedded to a safe but unexciting branch of science.[12]

Frankland was driven by a burning ambition for recognition, probably to overcome his hereditary disadvantages (for he was illegitimate). But this drive did not seem to have affected his topic choice. For Faraday, personal ambition was not relevant at all, for he had no interest in status, even declining the presidency of the Royal Society. He said: "I could not answer for the integrity of my intellect for a single year." That fitted perfectly with the biblical values enshrined in his Sandemanian faith.

### 6. Financial Gain

The thought of choosing a research project for money is distinctly odd at first sight. Centuries ago the alchemists are possible examples, and by the Victorian era, utilitarian projects could have financial rewards as well. The career of Edward Frankland is a classic, if extreme, example of science being pursued for financial gain (as well as for other motives). Setting himself up as a consultant analyst, he made analytical chemistry a major research interest, not merely advancing the science but also generating an enormous extra income. For Frankland, making money became an extreme obsession. In dramatic contrast, Michael Faraday always loved science more than money, once saying, "I cannot afford to get rich." His Bible had heavy markings on those passages warning against avarice.

In modern times, science sometimes may make a person's fortune, but it is fairly rare. When choice of a research topic has to be made, it is not often a consideration, though grants do vary. Variation between countries is more important, as when would-be researchers migrate from the UK to the USA! The main case, however, is in industrial sponsorship, where firms may compete to sponsor gifted individuals and where the area of research is already determined.

### 7. Ethically Unobjectionable

The final determinant is whether a given topic is ethically objectionable. If it is not, it may prove more attractive than one that does have ethical objections. This, unlike the other six determinants, is uniquely modern. It is a function of the modern (or even postmodern) fear of science and its effects on the environment. Such concerns can be recognized in Victorian times, though they were expressed in different terms from ours. Industrial practices were often seen as dangerous and undesirable, as in the emission of toxic gases. But that rarely, if ever, affected any choice of academic research topic. Such considerations were not relevant to the cases of either Edward Frankland or Michael Faraday. However, today many are bothered by projects that might promote abortion, proliferation of weapons, exploitation of the poor, and spoiling of the environment. This is a fairly new phenomenon in science, dating specially from the environmental crusades and the anti-nuclear lobby of the 1960s. Several, perhaps many, Christians declined to commence research that could eventually lead to the proliferation of nuclear weapons.

One can, of course, rationalize such fears away, even arguing from such implausible proposals as that of Asimov that "sending men to the moon just *might* lead to a cure for cancer." Or it is possible that one evil can overcome another; some would say that includes using GM products to destroy the global poppy crop that produces heroin. In extreme cases, one can also invoke the freedom of science and reject ethical objections altogether. However one reacts, there is no doubt that this is another strong determinant in the way we choose to do our science.

## Three General Rules to Remember

### Rule 1: We can never predict the outcome of research with certainty.

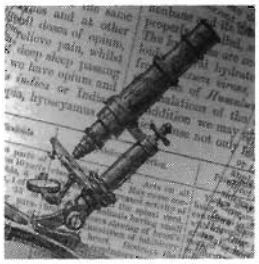
For all of our diligence in selecting the "right" research topic, we can never be sure of the outcome, how useful or innovative or even harmful it may be. Michael Faraday is supposed to have countered a question as to the utility of his electromagnetic research with the question, "What use is a baby?" In each case, one cannot tell the future and has to be prepared for surprises. In connection with the research by Comroe and Dripps on cardiovascular and pulmonary diseases, it has been pointed out that over 40% of the work on which their advances were based was *not* clinically oriented at the time and the kind of outcome was quite unpredicted.[13] Some highly academic research on the mesomorphic state of certain aromatic compounds led to the large-scale production of liquid crystals and a large new industry. The oft-quoted example of Fleming and penicillin was, however, only a chance result in one sense, for it was the culmination of twenty years of searching.[14] As Pasteur said, "Chance favors the prepared mind."

### Rule 2: We need to sit down before the facts.

The noted agnostic T. H. Huxley once wrote:

> Science seems to me to teach in the highest and strongest manner the great truth which is embodied in the Christian conception of entire surrender to the will of God. Sit down before the fact as a little child, be prepared to give up every pre-conceived notion, follow humbly to whatever abysses Nature leads, or you shall learn nothing.

One may question his almost Hegelian spelling of Nature with a capital letter, but in other respects he was entirely right. In choosing our research topics, we do well to





remember that the openness that he advocates is a Christian virtue. Whatever our subject of investigation may be, such "theology of humility" will stand us in good stead.

### Rule 3: We must explore, discuss, and pray.

This should surely be the final word to anyone with a Christian commitment facing the difficult decision that we have been discussing. Explore the issues, discuss them with like-minded companions, and pray actively about them. Above all, don't drift! ☆

### Notes

[1]This paper is based upon a lecture entitled "Choices of research problems in the past and their consequences" given at an IVCF Conference, "Asking the Right Questions," at Mundelein, IL, in October, 2000.

[2]C. A. Russell, *Edward Frankland: Chemistry, Controversy and Conspiracy in Victorian England* (Cambridge: Cambridge University Press, 1996).

[3]G. Cantor, *Michael Faraday, Sandemanian and Scientist* (Basingstoke: Macmillan, 1991).

[4]M. Berman, *Social Change and Scientific Organisation, the Royal Institution, 1799–1844* (London: Heinemann, 1978), 162.

[5]R. Gambell in R. J. Berry, ed., *Real Science, Real Faith* (Crowborough: Monarch, 1995), 174–81.

[6]Personal communication.

[7]R. McKeon, *Rutherford* (London: A. & C. Black, 1964), 23.

[8]L. P. Wheeler, *Josiah Willard Gibbs* (New Haven and London: Yale University Press, 1962), 27.

[9]J. D. Bernal, *The Social Function of Science* (1939, reprint; Cambridge, MA: MIT Press, 1967), 37.

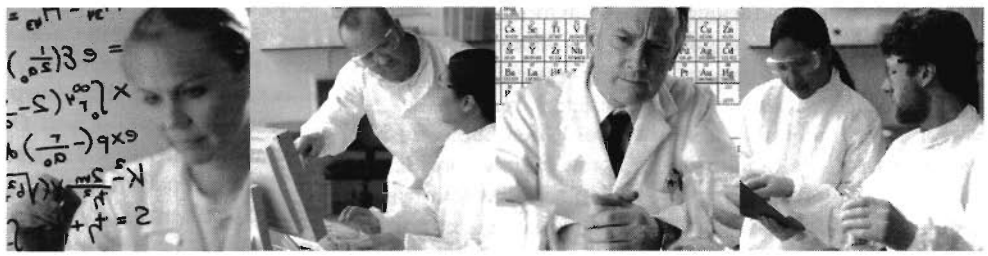
[10]Ibid., 84.

[11]J. Wren-Lewis, cited in Morley, *The Sensitive Scientist* (London: SCM Press, 1978), 93.

[12]Morley, ibid., 93.

[13]Hanbury Brown, *The Wisdom of Science* (Cambridge: Cambridge University Press, 1978), 116.

[14]Hilary Rose & Steven Rose, *Science and Society* (Harmondsworth: Penguin, 1970), 214–5.



## Discussion Session

Amy Hsiao is a graduate student in materials science at Carnegie Mellon University.

***Audience:*** *Beyond your list of topic determinants for research, most of us face two additional questions: (1) What topic will be funded by a research grant? You need to put your own personal fascination aside and think about what can be funded. It is a little disturbing to be completely driven by what the "powers that be" determine to be worthy of funding. (2) What do our peers think is important? We are often completely driven by peer review, which is an important good. What kind of paper will get peer agreement so it is accepted in the journal world and therefore funded? Is this driving force too strong, when a Christian is completely driven by funding considerations?*

***Russell:*** *If the thing is in itself good, I don't think that is a problem. Is it?*

***Audience:*** *No, as long as we are free to consider other elements on the list that you gave us, e.g., having a fascination for the topic, determining social benefit and considering the ethical dimension. Sometimes these things are pushed aside with the overwhelming issue of peer review and funding. That concerns me. My husband, e.g., is in biomedical engineering research. He chooses to do a human-based study in a particular field because he doesn't want to do animal research which could cause the animals to suffer. However, he knows in the back of his mind that in his particular field he could get funding more easily if he did animal research. It's difficult to balance these other factors and not just funding.*

***Russell:*** *I take your point, but would add that funding applications can sometimes be more successful if they are imaginatively presented. I recall once asking a large funding authority "If this proposal is at all interesting, how could I present it in such a way that you would be most favorably inclined to look upon it?" They indi-*

*cated several strategies, including an emphasis on currently fashionable trends in methodology, reference to themes and possible applications of great contemporary interest, collaboration with other institutions, etc. One must always be strictly honest and truthful, but a sanctified imagination can make all the difference between a mundane and a sparkling application.*

***Audience:*** *How should a postdoctoral student go about choosing a research topic? You said we should choose a supervisor rather than a topic. I am wondering about Faraday as an example of this; his advisor was Davy. He might not have been a really appropriate advisor in some areas. What about ethical considerations? Would you recommend that someone choose a supervisor based on his or her Christian faith or ethical record? Or should the choice be based on someone who is doing some really interesting work?*

***Russell:*** *I think you want a combination. I would never say choose a supervisor just because he or she is a Christian. Equally, I wouldn't say, choose someone who gets 300 research students and lots of Ph.D.'s each year, but whose ethics were highly debatable. You need to have a balance.*

***Audience:*** *Historically, do we have models of communities of believing scientists?*

***Russell:*** *Faraday wasn't in one. There are plenty of eminent Christians today who are. I am the immediate past president of Christians in Science in the UK, where many of the leading scientific figures in Britain are members. In Victorian times, James Clerk Maxwell, George Stokes, Lord Kelvin, just to name three in physical science, were all people who thought very biblically and Christianly. There were lots of lesser lights.*

*When Darwin's theory came out, the Christian church interacted with it, although parts of it got terribly upset. Incidentally, the parts that got upset were not all the evangelicals. It was often the liberals in the Anglican Church who didn't have a clearly defined faith. Many evangelicals saw that it resonated with what they believe. But that's another story. Your point was about community for believing scientists. Around 1865, 650 Christians signed a document called "A Declaration by Members of the Physical Science Community." These people were not all evangelicals, but all Christians. They said, "We have nothing to fear from science." They were people who were primarily active in chemistry and physical science but were concerned with the biological sciences to some extent. Often in Victorian times, there was a great divide between physical and biological sciences. More physical scientists were Christians than biological ones.*

***Audience:*** *You mentioned that there are a lot of passages in the Bible that have wrongly been taken scientifically in the past and there is significant danger in that. On the flip side of that, are there passages that you think should be taken scientifically or at least more scientifically than they have been? Is there a source of more specific research inspiration in the Scriptures, not just in a Christian sense, but in very disciplinary sense?*

***Russell:*** *I don't think there are any passages in the Scriptures which should be interpreted as though they were scientific descriptions of the universe. I don't think that's what Scripture is about. It has something far more important to tell us. As Galileo said when he was up before the Inquisition, about the authority of Scripture: "I am persuaded that the purpose of the Holy Ghost in giving us the scriptures is not to tell us how the heavens go, but how to go to heaven."*

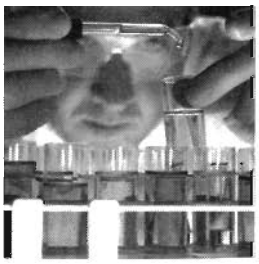
*But I think there are other ways in which Scripture does have a lot to say to us about what we do with the world in which we live and how our responsibility for it has to be exercised. I'm not just thinking of environmental activity or general care of our neighbors, but of care for posterity as well. Although Christians don't always agree, I think Scripture has a view on scientifically relevant issues, like abortion. In the UK, a big issue is genetically modified crops. For Christian reasons or otherwise, I think the cause is lost in Britain. Scripture probably has some things to say on such issues but it needs very careful, very responsible, exegesis to find it. One old hymn used to say, "God has yet more light to show forth from His Word." I'm sure the Bible isn't just a closed book that is finished. It still has much to say to us as individuals and as a community.*

***Audience:*** *Is there scriptural exegesis that is best left to theologians, or should Christian scientists be involved with it?*

***Russell:*** *I don't think anything is best left to theologians, except perhaps in theology. Why make it an either/or? Why can't we sit down together? This is one of the things that I feel is so important. Theologians do their own thing and scientists do their own thing. And we rarely actually interact. I am involved with the John Ray Initiative where we are trying to do that by getting real theological input and yet real scientific input too. It's hard work. The language is different. The cultures are different – theologians are much more polite! My point is don't make it either/or. Let's have the two together. And then you may get somewhere, provided both accept the authority of Scripture.*

***Audience:*** *Someone had misgivings about this conference because we didn't have theologians here. It could be useful to have philosophers here with their own methodology and discourse. Might there be other folks who could help frame the questions that scientists have to frame? Do we get specialized help from other people in addition to the theologians?*

***Russell:*** *Well, I think you have a point. For instance, one obviously has to develop historical approaches. I do feel, passionately believe, that the history of science has an enormous amount of light to shed on contemporary problems. I went into science history because I thought it had relevance to the science/religion debate. I didn't know how it would work out, but that's one of the things that made me make the jump. History has a great deal to tell us, so we could stop making the mistakes of the past. For example, Galileo was persecuted because he dared to say that the earth went around the sun rather than the other way around! If the church had known that, they would not have applied all sorts of bogus criteria. They would not have failed to see that Galileo's comment about Scripture was right and that it isn't the truth of Scripture that is at stake; it is what kind of truth it is. We may not be professional theologians but that should never prevent us from thinking theologically. It may mean much wider reading and study, but everything in life, including science, will be enriched.* ☆





**Session IV**

# What is the Perspective from Bioscience?

*"Jesus' call to us is ultimately to be good members of the kingdom no matter what our profession is."*

Let's see if there are some uniquely biological spins that we can put on the questions we need to ask. First, let me remind you of the basics and how they apply for biologists. I think we would agree that our main motivation ultimately is what I'll call the "kingdom mandate." Matthew 6:33 (NIV) says:

> *Seek first his kingdom and his righteousness and all these things will be given to you as well.*

Hallelujah! That's what we like to sing. That's the kingdom mandate. Jesus' call to us is ultimately to be good members of the kingdom no matter what our profession is. And though that may seem obvious, the "real rub" is to discover what the kingdom mandate means to me as a Christian biologist. What should it look like? How do I flesh it out? It's a great starting principle. We would all agree that the ultimate goal is to be good subjects of the King. I'd like to suggest a few ways in which being a good member of the kingdom of God interfaces with how I run my life as a biologist. While these things are not in rank order, I would like to describe some very basic biblical principles.

**Jeff Hardin,** *M.Div., International School of Theology, Ph.D. Biophysics, University of California-Berkeley, did his postdoctoral work at Duke University. In 1991, he joined the faculty of the department of zoology, University of Wisconsin-Madison, where he is currently an associate professor. His research into the morphogenesis of early embryos has resulted in recognition as a Lucille P. Markey Scholar in the biomedical sciences and a National Science Foundation Young Investigator. Dr. Hardin also has been recognized for teaching as a Lilly Teaching Fellow, and has received awards for his use of technology in teaching. He is a co-founder of the University of Wisconsin Teaching Academy. With Wayne Becker and Lewis Kleinsmith, he is co-author of* The World of the Cell *(Benjamin-Cummings).*

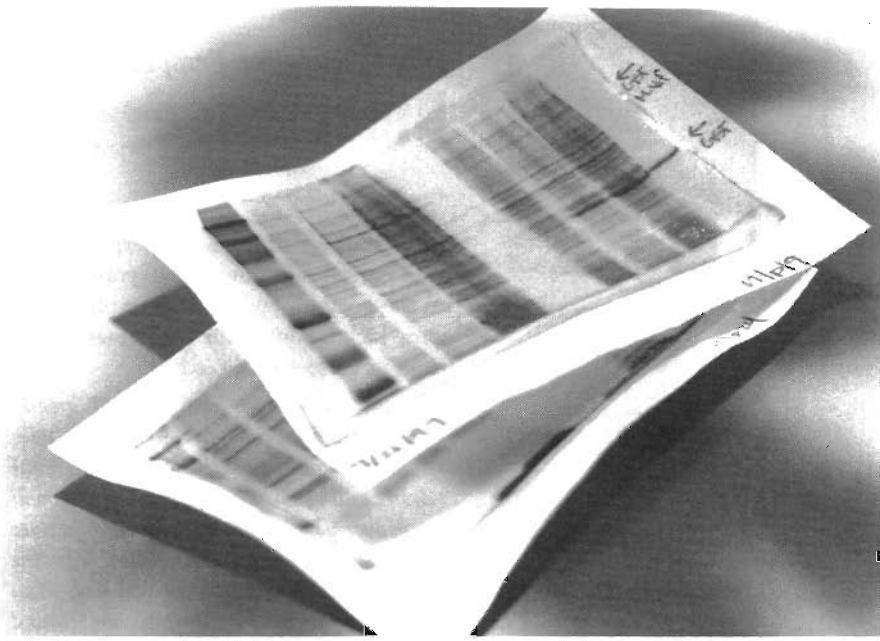
## Doxological Fascination

For me, seeking the kingdom as a biologist means that I do what I do with "doxological" fascination. By that I mean *bringing glory to the King.* So we need to ask ourselves, "Does our research encourage us to praise the Creator and revel in his creation?" I don't believe that God wants us to see biology as drudgery. Now admittedly there are some unpleasant things that we do as biologists, but at ground level we need to be excited about biology as an act of worship. So in that sense, bringing glory, doxology, and fascination means being really fired up about what we are studying and being motivated to try to unlock the secrets of our research.

Let's look at Psalm 19. We talked about Frances Bacon using a two-book metaphor. Where does that two-book metaphor come from? One place is in this passage:

> *The heavens declare the glory of God. The skies proclaim the work of his hands. Day after day they pour forth speech; night after night they display knowledge. There is no speech or language where their voice is not heard. Their voice goes out into all the earth, their words to the ends of the world. In the heavens he has pitched a tent for the sun, which is like a bridegroom coming forth from his pavilion, like a champion rejoicing to run his course. It rises at one end of the heavens and makes its circuit to the other; nothing is hidden from its heat (Psalm 19:1–6, NIV).*

In this first strophe of Psalm 19, the Psalmist is saying, "You know what? The universe is cool!" You really get the feeling that he is reveling in it. He is luxuriating in how awesome the creation is. And in that sense, God's creation is a book. It reveals something about its Creator that we can



only get through it. In verse two, it says: *"Day after day they pour forth speech."* "Pour" is from a Hebrew word that means to bubble up from the ground. Remember how the crude oil bubbled up from the ground in "The Beverly Hillbillies"? Well, that's what this idea is. The creation is bubbling forth praise of the Creator. That needs to be the bedrock upon which we do our biology. Francis Bacon said: "Let no man think or maintain that a man can search too far, be too well studied in the book of God's word or in the book of God's works."[1] Interestingly, Darwin quotes these words in his preface to the *Origin of Species*.

Francis Collins, who is a believer, heads the NIH's portion of the human genome project. He said this about the same idea:

> The work of a scientist involved in this project [the human genome project], particularly a scientist, who has the joy of also being a Christian, is a work of discovery which can also be a form of worship. As a scientist, one of the most exhilarating experiences is to learn something ... that no human has understood before. To have a chance to see the glory of creation, the intricacy of it, the beauty of it, is really an experience not to be matched. Scientists who do not have a personal faith in God also undoubtedly experience the exhilaration of discovery. But to have that joy of discovery, mixed together with the joy of worship, is truly a powerful moment for a Christian who is also a scientist.[2]

To Francis Collins, unlocking the secrets of the human genome is an act of worship. So that's one of the things that seeking the kingdom as a biologist means.

## Stewardship of Creation

Seeking the kingdom also means that we need to be part of the overall biological enterprise of Christians being stewards of creation. By that I mean *caring for the world of the King*. One of the justifications for this comes from Genesis 1:27–28 (NIV):

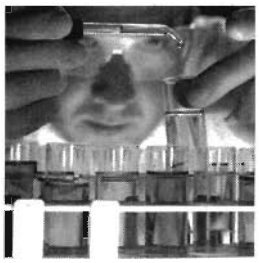
> *So God created man in his own image, in the image of God he created him; male and female he created them. And God blessed them and said to them, "Be fruitful and increase in number; fill the earth and subdue it. Rule over the fish of the sea and the birds of the air and over every living creature that moves on the ground."*

Clearly human beings have dominion. If, as Christian biologists, we are going to be concerned about practical application of knowledge from basic biological research, then we need to be concerned about this dominion issue. We have a responsibility to fill the earth, and I think we have done a good job of that as a human species, to a degree. But, in addition, we have a role to care for the earth. One of the things that we want to ask is, "In what ways can Christians who are biologists uniquely speak to this issue of stewardship?" In particular, in Genesis 1 and 2, we have the good news of God creating a very good world, but in Genesis 3 we have the bad news. And the bad news is that the effects of the Fall have tarnished, in many ways, God's original intent for the creation. This means that part of the stewardship mandate now is to exercise a restorative function with regard to creation. Stewarding creation means caring for the world of the King and trying to undo, in some sense, the physical results of the Fall of the whole creation.

*Stewarding creation means caring for the world of the King and trying to undo, in some sense, the physical results of the Fall of the whole creation.*

## Healing Restoration

Now we can move to another idea, which I think is part and parcel of a uniquely Christian biology. We need to think about ways in which Christian biology can address healing restoration. By that I mean *caring for the people of the King*. If we take a look at Genesis 3:16–19 (NIV), we learn something interesting. The Fall has happened. The



Session IV



# Bioscience

*Does my research topic encourage or discourage God's values and work out his principles?*

eyes have been opened. The serpent has just been cursed. He now has to crawl around on the ground, and he is going to get into some kick boxing with the human species. Then in verse 16 we read:

> *To the woman he said, "I will greatly increase your pains in childbearing; with pain you will give birth to children. Your desire will be for your husband, and he will rule over you." To Adam he said, "Because you listened to your wife and ate from the tree about which I commanded you, 'You must not eat of it.' Cursed is the ground because of you; through painful toil you will eat of it all the days of your life. It will produce thorns and thistles for you, and you will eat the plants of the field. By the sweat of your brow you will eat your food until you return to the ground, from it you were taken; for dust you are and to dust you will return."*

The effects of the Fall encompass both the creation and human beings as part of the creation. One of the results seems to be some reproductive difficulties for the human species. A distinctively Christian view makes biology part of the healing process.

## Ethical Reflection

Christian biology also involves ethical reflection. People of the kingdom need to *live by the rules of the King*. If we go back to Psalm 19, we get a nice taste of ethics. The first six verses have to do with the book of God's creation. But then the Psalmist goes on and switches gears in verses 7-11 (NIV). He says:

> *The law of the Lord is perfect reviving the soul. The statues of the Lord are trustworthy, making wise the simple. The precepts of the Lord are right, giving joy to the heart. The commands of the Lord are radiant, giving light to the eyes. The fear of the Lord is pure, enduring forever. The ordinances of the Lord are sure and altogether righteous. They are more precious than gold, than much pure gold. They are sweeter than honey, than honey from the comb. By them is your servant warned; in keeping them there is great reward.*

The Psalmist ties the book of God's creation to the book of God's Word. For him these are inextricably linked. And so the Christian biologist needs to maintain that inextricable linkage. God's Word shows what right living ought to look like. So I think Christian biologists need to ask, "Does my research topic encourage or discourage God's values and work out his principles?" That's a very general question. And yet I think it is one we don't often ask. This is where I believe the Bible provides some unique insights. For example, in the account of the Fall in Genesis 2, recall that the command was given: "*... you must not eat from the tree of the knowledge of good and evil ...*" From the creation narrative, we get the sense that human sinfulness requires restraints on knowledge. So the Genesis narrative prefigures the Pandora's Box problem. We should ask, "Is human ethical behavior sufficient to restrain the implications of human knowledge?" That's where biblically based ethical reflection can be pretty powerful. This includes looking at inappropriate uses of technology.

I am a developmental biologist. Reproductive technology is a booming industry. We manipulate human embryos very frequently. How should we feel about that? Livestock cloning has become a routine process. I live in Madison, Wisconsin. There is a company there that routinely clones cows. The first reported cloning was in 1997. That is how fast this technology is moving. In the UK and continental Europe, genetically modified foods are a big thing. How do we feel about that? Are there inappropriate technologies that we should totally avoid? If so, then clearly there are going to be some things that are ethically out of balance for us as believers and as biologists.

I mentioned Francis Collins, director of the Human Genome Project. Are there any things that we should be ethically troubled by as biologists that are going to come out of the Human Genome Project? Well, I think there might be. Collins mentioned his daughter having some reservations about pre-natal genetic diagnosis. Well, we're going to get better and better at doing that. We will have genetic tests for many conditions that are completely debilitating from birth. We also have tests for genetically predisposed conditions that may only manifest

themselves later in a person's life. How should biologists handle that? Unless we think biblically, we are not going to come up with correctly framed answers to these kinds of questions. But as Christian biologists, I think these answers need to be part of how we choose what kind of research we decide to do.

*We should ask, "Is human ethical behavior sufficient to restrain the implications of human knowledge?"*

Let me give you an example. I am in the Zoology Research Building on the Madison campus and next door to me for a long time was a good friend of mine. He works on the biology of what happens after fertilization. Once you fertilize an egg, the two nuclei move together and fuse in a movement known as pronuclear migration. He studied this and is, without doubt, the world's expert on pronuclear migration. He studied things like sea urchin embryos and mice, which do not create ethical problems. He studied rhesus monkeys—we're getting a little warmer now. Eventually he started studying leftover material from human in vitro fertilization clinics. In the United States, it is legal to perform research on this material. If the embryos were fertilized for the express purpose of experimentation, that research, if federally funded, is prohibited by federal law. But you can use private funds to do research on leftovers in this way. So he did some experiments on leftover human embryos, investigating various properties about them.

He had obtained these human embryos from a fellow at the University of California at Irvine, who ran an in vitro fertilization clinic. Typically in obtaining oocytes from women, you superovulate the woman by giving her fertility drugs. The woman releases multiple oocytes, which are collected and fertilized. Typically all of those are not re-implanted into the woman. The man from UC Irvine took the leftovers and shipped them out without informing the women from whom the oocytes were obtained. He saw no ethical problem with that. Of course, other people did.

I am troubled by the fact that we as Christian biologists don't talk about these kinds of things in a coherent manner. I don't remember a single discussion that I have been in about these kinds of issues. Typically, we are very reactive about these sorts of things. So when we pick research topics we need to ask before we get into those situations, "Do I want to put myself in a position where I might find myself in an ethical quandary of this sort?"

## Cultural Reformation

The fifth thing that needs to be part of our kingdom mandate as biologists is what I'll call "cultural reformation." By that I mean *spreading the message of the King*. Here we have a very Calvinist idea. Although I don't come from that tradition, I resonate with it very strongly. This basically boils down to fleshing out the great commission. Matt. 28:19–20 (NIV) says:

> *Therefore go and make disciples of all nations ... teaching them to obey everything that I have commanded you ...*

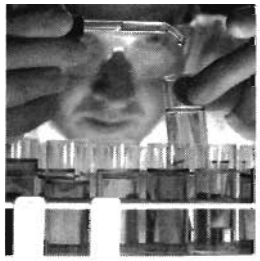
Cultural reformation is an extension—a redemptive extension—of the great commission into the culture at large. In this sense then, in choosing a research topic, I think that a legitimate question to ask is, "Does my research encourage or discourage God's values in the world generally?" These values may not be explicitly framed in a biblical sense in the culture at large. Another way to ask it is, "Can I bring, based on the research I do, God's values to the societal table?"

Arthur Holmes said:

> [I]f all truth is ultimately God's truth, then we have no reason to denigrate some areas of learning by regarding them as either worldly or as beyond help or as having little or no importance. On the contrary, such learning needs to be restored to the wholeness of God's truth from which it is torn.[3]

What I think he means is that basic research, including basic biological research, is an area where we can have a redemptive influence. In particular, by restoring the context where it is done, we can be, in some sense, God's agents of redemption within the biological community. Charles Harper calls people doing that "subtle interlocutors," that is, when opportunities arise in our respective fields, we take the opportunity to be agents of redemption. Thus, we can ask, "Are there particular areas that I might decide to research specifically because there may be more opportunity for this kind of redemptive influence?" I'm not saying I know the answer, but I think that's one way to think about it.

Charles Malik said: "The problem is not only to win souls, but save minds. If you win the whole world and lose the mind of the world, you will soon discover that you have not won the world."[4] And elsewhere he said: "I know of no more important question to ask than, 'What does Jesus Christ think of the university?'"[5] He means that we need to apply a Christian critique to our culture. Our "culture" is biological research, the community of scientists who engage in it, officials at the federal level who fund it, and leaders in the private sector who encourage proprietary research. That's the culture to which we need to speak.



Session IV

*What Discipline Perspectives Guide Us In Choosing a Research Topic?*

# Bioscience

*How does picking a research topic affect my spiritual formation – my ability to become a person of the King?*

One thing that we can say, as believers, is that our Christian faith allows us to provide a meaning for biology by providing a larger context for our work. Terry Morrison talked about the first chapter of Colossians where the cosmic Christ is a "glue" that holds everything together – both the material and the immaterial world. This is the ultimate cosmic context within which to do biology.

Secondly, you might be motivated to explicate the work of the Creator. If we believe Colossians 1 to be true, then in some sense we engage, as the Psalmist did in Psalm 19:1-6, in art appreciation every time we do science. Some people would like to say more, that we can actually explicate evidence for the Creator. That's a stronger kind of statement. So one possible motivation is to choose a research area with the express purpose of trying to show evidence for the Designer of the world. Now I know there are vehement differences of opinion about this, but I think it is fair game for us to discuss it here.

Finally, I think Christian faith helps us avoid (to borrow a term from our humanities colleagues) a deconstruction of people by naturalistic reductionism. We know functionally that most of us are reductionists in our day-to-day research. I certainly am. However, I am not a philosophical reductionist by any stretch of the imagination. I think there may be situations where we, analyzing the parts, can show that there is a failure to appreciate the whole. That is true in issues like the mind/body problem or the brain/mind issue and the Creation with a capital "C" that Cal DeWitt likes to describe. You can't view that atomized. You must view it holistically to fully appreciate it, and I think Christians have a unique spin on it that we can bring to the table.

## Spiritual Formation

So far we have been talking about Christian biology and ways we can do biology in select research topics, or research emphases within those topics, that make us good citizens of the kingdom of God. We know that God calls us to be more than good external citizens of the kingdom. He expects our *hearts* to conform to the kingdom. Thus, choosing a research topic needs to have our own spiritual development in mind. That may seem nuts, but in thinking about our careers, about the kind of research we want to get into, there are questions we need to ask. One such question is, "How does picking a research topic affect my spiritual formation – my ability *to become a person of the King*?"

I firmly believe that there are certain areas of biology that some of us, given our giftedness and our situations in life, probably shouldn't go into because of the demands that they would place on us. They are inappropriate for us. For example, my wife and I are a team to care for our younger son who has autism. We are trying to balance him with our older, 13-year-old son. It is inappropriate for me to do extensive fieldwork, where I am gone for eight months out of the year. In situations like that, we have to ask questions about the appropriateness of a particular research path. If I am in a competitive area that's really going to require that I spend fourteen hours a day in the lab, I need to ask, "Is that appropriate?" In my opinion, that's a great question which we should not brush under the carpet and say, "Well, you may have to make sacrifices and work hard." Although that may be true, some sacrifices may be inappropriate for us to make.

Let me suggest a few ways in which we can get into trouble. This is not restricted to biology, but certainly includes biology. Most of our career paths are prone to busyness. Pascal in the *Penseés* said: "If our condition were truly happy we should not need to divert ourselves from thinking about it."[6] In other words, we complain about being busy all the time, but you know we actually like it! It keeps us from thinking about those niggling questions in the back of our mind that are troubling us about ultimate issues. Busyness is a salve that temporarily covers that wound, at least until we rip it open again.

As biologists, we are also prone to pride and ambition like that in every other field of science. One thing the Bible frequently condemns is being a fool, that is, being a spiritually proud person. In academia, we are prone to that and get into areas of biology because they are hot and because we

get "strokes" for doing them. To me that's an incorrect motivation.

Some paths are clearly prone to self-sufficiency. I think you have to look into your own heart about this one, but there are certain areas of biology where you know this to be true. I think of people like Jane Goodall, who is out by herself. Maybe she can manage that, but you may need to ask yourself, "Will I get into trouble with that type of research?"

John Calvin said:

> For God has not granted his servants such a great benefit that each of them has been endued with full, perfect, and absolute knowledge. No doubt he does this partly to humble us, partly to keep us in zeal for brotherly communication.[7]

What Calvin was saying is that none of us has all the answers, so we need other scholars. To the extent that your biology pulls you away from interdependence—that's something to think about. That's a potential warning sign. It may not be a definitive one, but I think it's something to think about.

## Ultimate Integration

Ultimately, I think the goal for all of us is integration. By that I mean *becoming whole servants of the King*. If we are devoted followers of the King, then the ultimate goal is that we will become whole, devoted followers of the King. In that sense, we should ask, "Does my research topic fit me as a total person with unique gifts and giftedness?" In the first chapter of James, it says that if we ask God for wisdom, he will grant it to us. I think this is an area where we need deep wisdom. Ultimately, what an integrated life looks like is going to be different for each one of us. I think there is no way to legislate the integrated life. For each of us, our answer is going to be different. Part of the answer to that question is going to be, "What kind of research is appropriate for me to do?" Part of it is going to be a career decision, "What kind of job do I want so I can do a particular kind of research? Do I want a large research university? Do I want a high quality Christian liberal arts college? Do I want a secular, but smaller school? What kind of environment do I want?" No one, except us, can provide answers to these questions. However, we can kick these ideas around in community, and ultimately that's the goal. Nicholas Wolterstorff calls that "the search for shalom." I really like that idea. He said:

> The goal of human existence is that man should dwell in peace in all his relationships: with God, his fellows, with nature, a peace which is not merely the absence of hostility ... but a peace which at its highest is enjoyment. To dwell in shalom is to enjoy living before God, to enjoy living in nature, to enjoy living with one's fellows, to enjoy life with oneself. Never can there be shalom without justice. Yet shalom is more than justice ... In shalom there is delight.[8]

Whatever we ultimately choose to do as biological researchers, I think God wants us to delight in shalom. He wants us to love doing our research. He wants it to seem like it's not fair that we should be paid to do it. I believe that's what he wants. The task for all of us is to ask the questions to help us get to that end point. That, I think, is the struggle for us. Clearly the answers to these questions are going to be different for each one of us. Are there some things that should be distinctive about Christian biologists? What should we look like, if we consider ourselves Christian biologists? Things I've said are not really earth shaking, but they are good starting points for us to flesh out the particulars. ☆

## Notes

[1]Francis Bacon, *The Advancement of Learning*, I.3. (1605) quoted in the frontispiece to Charles Darwin *On the Origin of Species*, 6th ed. (1859). Bacon's work is available online at: http://www.uoregon.edu/~rbear/adv1.htm Darwin's is available online at: http://www.literature.org/authors/darwin-charles/the-origin-of-species-6th-edition/index.html

[2]Francis Collins, "The Human Genome Project," in J. Kilner, R. D. Pentz, and F. E. Young, eds. *Genetics Ethics: Do the Ends Justify the Genes?* (Grand Rapids, MI: William B. Eerdmans, 1997), 96.

[3]Arthur Holmes, *All Truth is God's Truth* (Grand Rapids, MI: Eerdmans, 1977), 27.

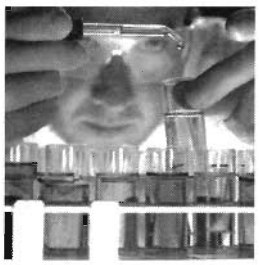
[4]Charles Malik, *The Two Tasks* (Westchester, IL: Cornerstone Books, 1980), 32.

[5]Charles Malik, *A Christian Critique of the University* (Downers Grove, IL: InterVarsity Press, 1982), 24.

[6]Blaise Pascal, *Penseés*, in *Pascal* (*Great Books of the Western World* 33), R. M. Hutchins, ed. (Chicago: Encyclopedia Britannica), 203 (reprint 1952, Pensée 165b).

[7]John Calvin, preface to *Commentary on Romans* quoted in E. Harris Harbison, *The Christian Scholar in the Age of the Reformation* (New York: Charles Scribner's Sons, 1956), 152.

[8]Nicholas Wolterstorff, *Reason within the Bounds of Religion*, 2d ed. (Grand Rapids, MI: Eerdmans, 1984), 114.

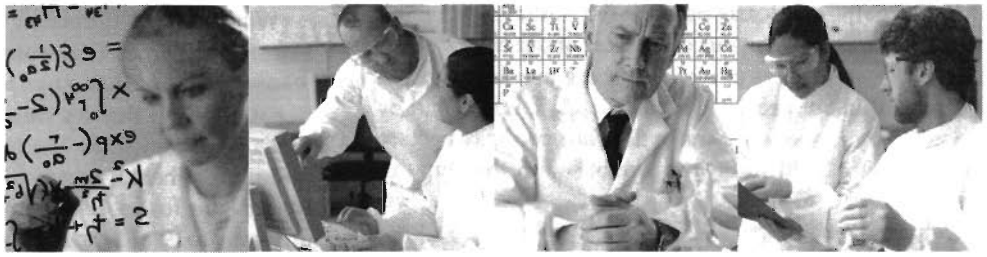


Session IV

*What Discipline Perspectives Guide Us In Choosing a Research Topic?*

# Bioscience

## Discussion Session



Lee DeHaan is a graduate student studying plant genetics at the University of Minnesota.

Martyna Elas is a postdoctoral researcher investigating radiation oncology at the University of Chicago.

***Audience:*** *You said that God wants us to delight in our topic of research. How compatible is "delighting in research" and "the long, hard painful road to research" that Charles Harper referred to earlier?*

***Hardin:*** *I don't mean to imply that every waking moment of every day is a delightful experience for me. After filling out the sixth recommendation for a premedical student who wants to go to medical school in one day, I am not exactly delighting in my work, although writing recommendations is part of my job. I agree with Charles when he described "a process." The process may be a little bit labyrinthine and varies for different people. I know people for whom everything seems easy. I look at them and really fight envy. For some of us "to delight" is more difficult than for other people. No job is perfect, and so you are going to have to make compromises.*

*Joy, a postdoctoral fellow, and I were talking yesterday about the decisions she is facing. In her words, "I really like research, I really like teaching, and I don't see many jobs where you can combine those in a nice way. It's going to make me sad to give something up." I think part of the nature of the beast is having to make some compromises. You must weigh the bedrock things that are personally important to you.*

***Audience:*** *I have a controversial issue and question. I want to focus on the issues involved with animal research, but I have been in an isolated science community. At the same time, I have been in a pretty conservative church. These two communities are basically opposite. How can people who struggle with ethical questions of animal work bring their concerns to the members of their church? What biblical information becomes part of the decision making?*

***Hardin:*** *In my personal situation, I don't work with anything that my university considers to be an animal. I work on a little nematode worm, which was the first higher animal whose genome was sequenced. It was the template for what they did with the human genome. We know a little about these tiny worms, but they are not furry, they don't have backbones, and so the university considers them biological material. I used to work with sea urchins, which the university considered as seafood rather than as animals! Are there people here that have extensive work with animals? A lot of us, right? So a good question is, "To what extent is that appropriate stewardship?"*

***Audience:*** *We don't want to be cruel to animals but we just need to use them to provide solutions for human life. Should we use animal life to help other animal life?*

***Hardin:*** *Some would say to hold humans as higher animals is "speciesism" as Peter Singer from Princeton has said. It is not a total given in our society that humans are considered to be higher animals, therefore justifying the use of other animals in research. Are there other thoughts on research use of animals?*

***Audience:*** *I basically agree with what you are saying. The thing that gives me great pause is pain research that uses animal models. That seems very difficult to do. While I think it needs to be done, I could not have joy in doing that research.*

***Hardin:*** *There are no easy answers in that situation. Without arguing from the creation mandate for the ethical use of animals in research, it becomes difficult to justify that research.*

***Audience:*** *Can you justify sacrificing animals for educational purposes rather than for research?*

***Hardin:*** *When gaining knowledge requires the sacrifice of the animal, the issues become much more intense for biologists. This is an area where we are really different from physical science people.*

***Audience:*** *I do research with animals as experiments but they are sacrificed at the end. To be honest, the idea that it's going to help someone else is nice and certainly it leads to grants etc. but that's not particularly why I am doing it. I*

*am a mathematician and a modeler so I am very removed from the idea of helping someone else. I am having a hard time justifying what I do for that reason. In this area of research is it warranted to kill animals?*

***Hardin:*** *Good question. What do you think?*

***Audience:*** *I can speak to that because we sacrifice a lot of mice and rats. And we sacrifice them before the experiment even begins. At one point, I did have a problem killing these poor little mice. A lot of them are very cute, especially the brown ones. In this work, I came to realize and understand more what it meant to have dominion over the animals. I see a "care versus cosmetics" dichotomy. I don't think I can ever do research on an animal so that someone can wear mascara. I don't necessarily think it's bad that we have cosmetic products but they are not necessary in the same way as understanding about medical, physiological, or immunological processes. But it is sufficient justification that something we do in our lab can result in better scientific understanding so that someone else can develop something that can help people breathe better.*

***Audience:*** *I don't work on animals but when I have a mouse in my kitchen I don't think twice about killing it. Most people consider a pest like a mouse not nearly as significant. However, there is a minority being more and more vocal about the sanctity of all life.*

***Audience:*** *For Christians, is there a difference between a mouse and a monkey? But what is our stand on it? I'm not expecting it to be the same for everybody. I think that with a science background we've seen more differences between animals than the animal rights groups.*

***Hardin:*** *Some people would say the level of sentience is important.*

***Audience:*** *But, for us, is the issue dominion?*

***Hardin:*** *Yes, but you could still argue that dominion is exercised differently over beings that have different levels of sentience. I think one could make that argument. You are not going to find anything about primatology in the Bible, so I think that you have to argue from principle.*

***Audience:*** *I used to do experiments that required sacrificing a lot of rats. We used to isolate enzymes from their livers. I am not sure I could have done the same work if it was on chimpanzees. I would need a stronger reason for using chimpanzees as opposed to rats, or be more careful about minimizing the suffering.*

***Hardin:*** *I think those are all extensions of this issue of dominion.*

***Audience:*** *If animal use in research is an issue and a problem, then who is developing new alternatives?*

***Audience:*** *For some things, you are not going to have an alternative. In other cases, there are alternatives. For example, many people have developed recombinant DNA technology – splicing the gene into bacteria and then just growing bacteria and harvesting the enzymes so that you are sacrificing bacteria rather than mammals.*

***Hardin:*** *Charles Harper said that we don't want to put out a bunch of people who are trying to slay philosophical dragons. And yet he called for us to raise up a cadre of "subtle interlocutors." I am not sure exactly what he meant by that, but let's think about this question without trying in a Quixotic fashion to slay windmills that don't need to be killed. Are there explicit ways in which Christian biologists should think about their research topics that would help to fulfill this idea of what I call cultural reformation? Are there areas we should go into that will contribute in some more explicit sense to the praise and glory of God and in some sense be saltier and brighter to our society? I can think of several areas that we could kick around. One is the Intelligent Design movement. If you subscribe to the view of Michael Behe that irreducible complexity is out there, one possibility is to show that some things are irreducibly complex. You could investigate something with the express purpose of doing that.*

*We could discuss the area of neuronal function. We had a lively discussion around lunch today about brains and minds. What is the nature of a mind? Is there a soul out there? Should we get into mind/brain research with the express purpose of trying to explicate that interaction in a way that is consistent with Christian thinking?*

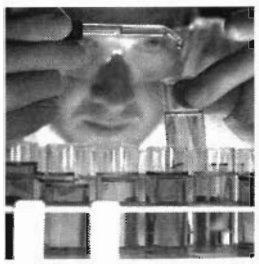
*Environmentalism is another important area. Should we forget about Gaia but talk about God's world instead? Should we specifically encourage Christians to work in those areas? If you are an advanced graduate student, you have the opportunity in choosing a postdoc to get into an area that could potentially impinge on these kinds of ideas. What do you think about that? To what extent should we think about "apologetic" biology? Is that appropriate?*

***Audience:*** *I certainly think it could be, but I think it is also useful to have a perspective of what's gone on in physical sciences in the last forty years. Probably forty or fifty years ago, there was a lot more hostility to Christianity in the physical senses than there is now. What changed that? Did we find, when we examined the big bang theory of cosmology, that there's real evidence for God? It wasn't that. One of the changes in the physical sciences was a growing sense that this universe is really neat and it is okay for us as scientists to admit that fact! So non-Christians in the physical sciences can see how you can be a Christian. They can see how it might yet make sense to be a Christian. This decrease in hostility to Christianity has been due partly to an awareness that the physical universe is really neat and our knowledge as physicists and cosmologists has a limit. I think that same sort of thing could happen in the biological sciences.*

***Hardin:*** *It sounds like a "wait and let it shake out" approach.*

***Audience:*** *You can accelerate that process by constantly pointing out in private conversations and writing just how wonderful all this stuff is! It's okay as scientists to talk about wonder!*

***Audience:*** *I think the physical scientist may have embraced a little bit more humility than biological scientists. Physical sciences have had their entire world view reshaped by things like the big bang and varied views on cosmology. I think biologists*



Session IV



# Bioscience

*have yet to go through that kind of humbling process where the way they explain the world has been completely turned around.*

***Audience:*** *Colin Russell was describing that in terms of going into a research topic with preconceived notions. I think that it is okay to study what the world is studying if we are yearning and praying for God to reveal himself through that. If we're studying species or whether God uses evolution as a process, God is going to reveal that to us in his work. I am not so sure that we have to set out to disprove things as much as to continue proving what is true about God's creation.*

***Audience:*** *What about that term, "subtle interlocutors"?*

***Audience:*** *I took it to mean not just as showing scientists where they are wrong but also showing other Christians where scientists are right. When I went to a creationist meeting, I felt uncomfortable because there wasn't a humble appreciation that said maybe we don't understand all of this or an acknowledgment that there is truthful work in science. Certainly evolution, even if you don't agree that it is totally right, has shown us truth that you wouldn't probably have ever come to otherwise about the changing of life.*

***Audience:*** *Only truth can glorify God. If our goal is something other than finding truth about God's creation then we're going to find something other than truth. Whatever that is simply cannot glorify God because it is not true. Only that which is true about God's creation can reflect him.*

***Audience:*** *Sometimes we ask, "Should we slay dragons or be those subtle interlocutors?" This is asking the wrong question. The question is not either/or, it is probably both. Jesus said we should be as "wise as serpents, harmless as doves," which implies this second idea. The apostle Paul talks about the warfare that deals with principalities and powers that exalt themselves against God. The Christian is responsible to tear those down, which involves "slaying the dragon." I think God gifts us in different ways. There are some very good dragon slayers around, and I am grateful for them. And there are some others who are more subtle, and I am grateful for them.*

***Hardin:*** *Is it possible to be a dragon slayer within the system? Let's use Phillip Johnson, a law professor at Berkeley, as an example. One thing that gives him an advantage in many ways is that he stands outside the system. He's like a prophetic voice crying in the wilderness. And that makes some biologists really mad, I guess. But suppose you are in the system. You've got to apply for grant money to maintain your lab's funding. You have to go up against the machine. Do you rage against the machine? Is that a good tactical move or not?*

***Audience:*** *About a year ago someone asked me, "I want to research this mind/brain question because I believe for theological reasons in mind/brain dualism. What should I do? Should I hide that fact or should I try and find a professor that will support me in that?"*

*I thought about that question for a while and tried to answer that person by saying, "It depends on your aim. Is your goal to learn more about God's creation and hope that along the way you'll find some good evidence for dualism?" Then you would be perfectly fine going to a professor of neuroscience who doesn't believe in dualism and find a research topic that interests you both and let the evidence come where it may. If, on the other hand, you focus your effort to prove dualism, you don't want to go work for the average professor neuroscientist. You probably want to locate a niche for yourself.*

***Audience:*** *Will you define the term "interlocutor" for me?*

***Hardin:*** *I think "interlocution" is essentially dialogue. If you become the top gun in your field, you have a platform from which you can gently raise issues because of your credibility.*

***Audience:*** *That fits in with the idea, that if you are involved in this kind of work, it is important to the glory of God to be good in it and earn those credentials. The "subtle" part of the term suggests not to be niggling, but just to be aware of appropriate ways to do dialogue. The appropriate way is to follow the method of science, have a thesis in mind, and then proceed in ways our society and others allow us to function. But you always have to know in the back of your mind that this is the direction you are going. That's being subtle.*

*A number of years ago an undergraduate Christian student who I happened to know applied to our medical school for admission. When he did not get admitted he came to see me about it. I happened to be on the admissions committee, so it was a bit complicated but I couldn't reveal everything to him. In the interview process when he was asked, "Why do you want to be a physician?" his response had been, "Because God told me to do it." The committee*

Randy Kerstetter is a postdoctoral fellow researching biology at the University of Pennsylvania.

Chinedu Njoku investigates veterinary preventive medicine as a postdoctoral researcher at Ohio State University.

*interpreted that this was a person who could not think for himself, which was not an unrealistic interpretation for the admissions committee. The student hadn't really thought about it so he did this three times. Later I had the opportunity to sit down and share with him and said, "There might be some other ways for you to answer that question that wouldn't violate your faith." Is looking at other ways of answering that question being a "subtle interlocutor?"*

**Hardin:** *Yes, that's getting closer. Sociologically speaking, I don't see a lot of evangelical Christians explicitly moving into origins type research. One of the reasons that you might not want to do that is because these issues come up again and again if you are in that area. Is that a cop out? That's what I am asking. Should someone explicitly go into that area only to show that the "primordal ooze to Albert Einstein" scenarios have real insurmountable holes in them?*

**DeWitt:** *Restoration ecology is an area, at least in my own experience, that opens up communications. In our work at Au Sable on Puget Sound, we're engaged in a very major prairie restoration project that includes providing college level courses and doing research in restoration. The project opened up channels for communication as reflected in various questions: "Why would you want to restore a prairie?" or "What's bad about agricultural land that we want to have this come back?" One student who took one of our courses last summer said, "I'll have to get out of here pretty soon because I am soon going to become a Christian otherwise." While the project was not explicitly done as something out of a Christian calling, everyone was working from a sense of calling. It was contagious. A lot of people had never thought about what it means to restore creation.*

**Hardin:** *Trying to find cultural resonance is a good thing no matter what field we are in. Are there fields where there's more resonance? That's a tough question to answer because the culture keeps changing. I teach a course in embryonic development at the University of Wisconsin. I begin my opening lecture with the history of embryology and I quote from a Hebrew poet named David. In Psalm 139, David muses about God's omnipresence that includes the womb. With this example, I am trying to draw out resonance with people because anybody who has had a child has a sense of wonder about the process.*

*Here is a related question. Are there any areas that are ethically off limits for Christian biologists? I would personally argue that there are certain areas of biology that could be considered as "Pandora's box" areas of biology. Once the lid is off, bad things are going to happen. I think that cloning is one of those Pandora's box issues.*

**Audience:** *I think there's a responsibility on both sides. I feel like saying we don't go into cloning humans because it's a sanctity of life issue, but I feel that we have been here before with in vitro fertilization. Perhaps, we conceived something that God didn't intend to conceive. What do we do with the result? Shouldn't we be careful to see embryo creations as things that God has allowed to come into being?*

**Hardin:** *I think most people say that if you clone a human being, the result is also a human being.*

**Audience:** *What if you created a human being without a brain? It has been proposed here.*

**Hardin:** *Researchers have put human nuclei into enucleated pig oocytes. Someone at the University of Wisconsin is doing experiments involving nuclear transplantation across species lines, however human material is not being used in that situation.*

*Since the human genome project is moving forward, there is no reason to think that one could not do germ line transformation of human beings or genetically engineer humans. Usually genetic engineering is justified as a therapeutic intervention to correct a genetic deficit that is transmissible. Are you going to repair that genetic defect so the repair is transmitted in the germ line? What about that? Are there areas like these where we should say "no"?*

**Audience:** *Will it make a difference if we say "no"? And how do we as a community discuss this? Some Christians may believe that it is not a problem? Do we make a decision as a group that some things are off limits for Christians? Maybe we could spend some time just proving something else is right.*

**Hardin:** *An area where Christians disagree is using human embryos that are left over from in vitro fertilization to produce human embryonic stem cells. The University of Wisconsin is a main center for distributing human embryonic stem cells. What do I do with that as a faculty member? Do I go to those doing it and say, "I think it's a bad idea." How do I engage them?*

**Audience:** *We have difficulty in weighing intangibles and tangibles together. We have real benefits and we have potential benefits. We have real harm and potential harm. We don't have a good way of weighing real benefit against potential harm.*

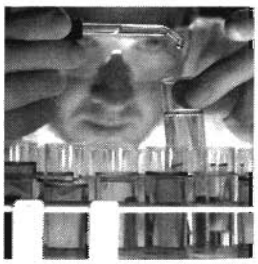
**Hardin:** *With stem cells the discussion is almost always potential benefit. However, that seems to be a weak argument, since there has been no demonstrated actual benefit.*

**Audience:** *You don't realize the benefits unless you research it.*

**Audience:** *The Christian Medical and Dental Society has a well established mechanism ready for dealing with ethical questions. If you go to their web site it will show something already worked out. Perhaps we as Christian biologists should participate fully in a group that has already dealt with some of these issues so we can work on others in the future.*

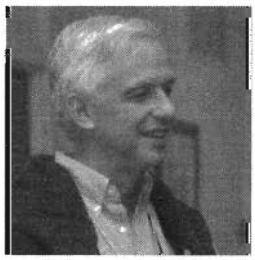
**Hardin:** *Should this kind of forum be replicated? Our gathering is unique in my experience. We have people at different levels in their careers that include the full spectrum from professors to postdoctoral researchers to graduate students.*

**Audience:** *It's encouraging that other people are searching and asking how to live your faith and what direction to take. I have things to share when I go back to my research laboratory.* ☆



Session IV

# What is the Perspective from Physical Science?



*Can we predict the future growth of the physical sciences and of my subdiscipline in particular?*

Let's begin by thinking about two questions that impact our future as researchers. First of all, can we predict the future growth of the physical sciences and of my sub-discipline in particular? Secondly, will my research be of use to anyone else or will other people read my papers? After that we'll consider a few Christians in the physical sciences.

From a historical perspective, consider that the growth of research in the physical sciences has increased exponentially continuously since 1700. This steady exponential growth is shown by many indicators such as numbers of scientists, numbers of scientific journals, books, and budgets (See Figure 1).

But the growth of sub-disciplines is less steady. The beginning or formation of a new sub-discipline, such as plate tectonics or string theory shows a very rapid rise in the number of published papers. Most of the significant papers in the history of the sub-discipline are published early during the rapid growth phase as illustrated below in the development of the field of supergravity. Sub-disciplines typically follow their rapid growth period with a plateau period. The rapid growth and subsequent saturation typically occurs within a fraction of one's career (See Figure 2).

This understanding of the transient influence of a particular sub-discipline has many implications. For example, if you continue to do research within a sub-discipline decades after its saturation, you're going to have a tough time with funding and you will find it difficult to provide meaningful research and career opportunities for graduate students. Also, intellectually it's less fruitful. If you remain working too long in some sub-discipline, I think that you'll find that you are becoming less creative after awhile, since you've made your most significant contributions earlier. But I don't think you should be jumping fields all the time. You need to invest in a field long enough that you can really make a good contribution.

I've worked on a lot of different things over the years, but I've tended to have logical transitions from one sub-discipline to another. I remember the day I defended my Ph.D. thesis. My professor at Yale took me aside and said, "Don't work on this all your career. Work on it for awhile, but then go off and do some new thing." I've certainly done that. It makes science much more exciting. I'm working on things today that I never would have thought of ten years ago. And in many ways the Lord has led me into these new opportunities.

I've often worked on things that other people aren't working on. I've had the opportunity to work on potential new fields and then find interesting new things. The

**John Suppe**, *Ph.D. Yale University, is Blair Professor of Geosciences at Princeton University. Has been Visiting Professor at National Taiwan University, Cal Tech, University of Barcelona and Nanjing University. His discipline is structural geology and tectonics. He has been a Guggenheim Fellow and guest investigator of the NASA Magellan Mission to Venus, has served as associate editor of the American Journal of Science, and is a member of the National Academy of Sciences.*

field then becomes interesting to other people because they have certain skills that allow them to build upon what you have done. When you see a really useful paper published, you say "Oh, I can take this, and put it together with what I know and do some interesting research." A lot of research is done that way. Papers that spark—that are attractants in a sense—get you excited and redirect your research. That's an important phenomenon in science.

Generally the efforts of a single researcher make little impact. Figure 3 shows the number of citations accumulated between the years 1981 and 1997 for 800,000 papers that were published in major journals in 1981. The graph indicates that most papers are not very useful to other scientists. About 45% are never cited. A quite useful paper receives more than one hundred citations during its lifetime, however only about 1% of papers fall in this category. Some of the most cited papers deal with useful technique, theory, or definitive observation. Thus, there are different roles that contributions play. Scientists need to be doing something that is useful to people, something that we can take and use, not just in practical ways, but also in some broader intellectual ways. It's really useful papers that get cited a lot.

Let's switch gears and consider some Christians who have made an impact in the physical sciences. One example is the group of evangelical isotope geochemists (Larry Kulp, Karl Turekian, Wally Broecker, Paul Gast, Heinrich Holland, and Charles Harper) who made many of the most significant contributions to this subfield. While their research had fundamental, scientific, and societal impact, their work was rejected by many of their fellow evangelicals. For example, the publication of *The Biblical Flood* by Whitcomb and Morris was a direct response to the geologic influence of Larry Kulp in the evangelical community.

Significantly, after gaining success in their work, some of these scientists left their faith or church community. I don't know why. Certainly the world of a successful research scientist is an all-consuming one. Obviously, there are tremendous temptations resulting from scientific success. But some of these geochemists remained strong

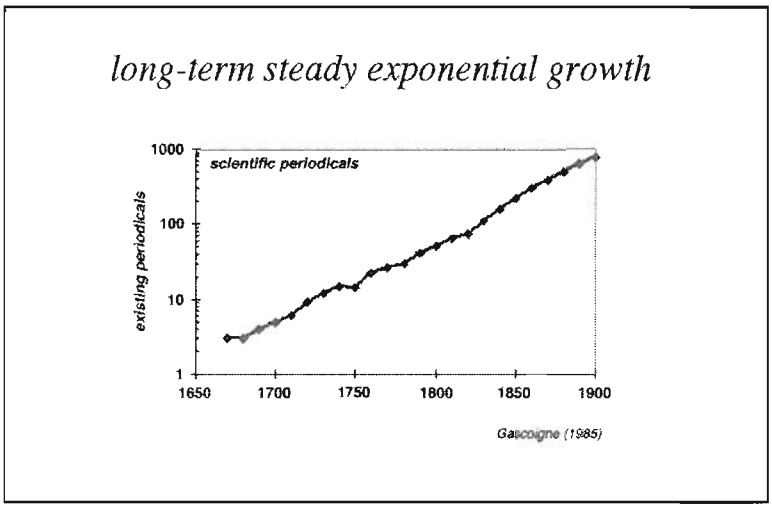



*Figure 1.* Exponential Growth.

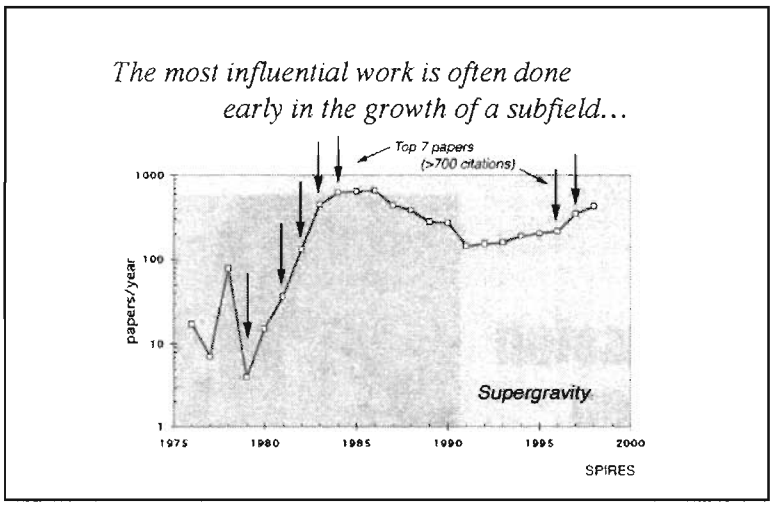



*Figure 2.* Influential Work.

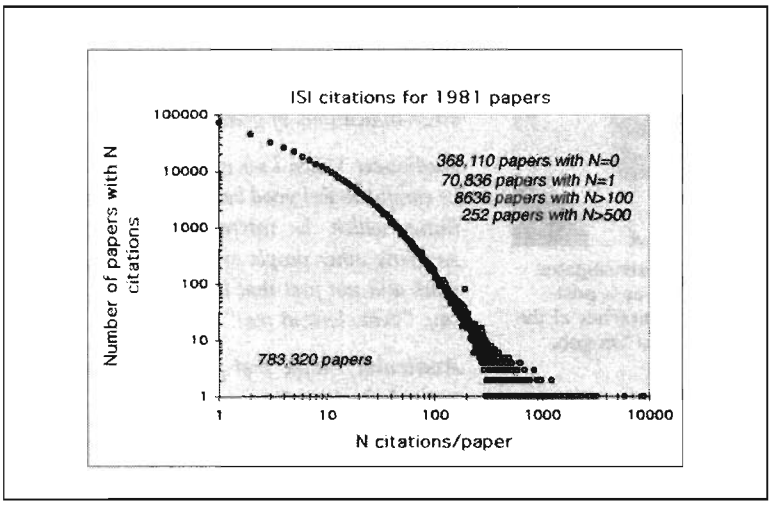
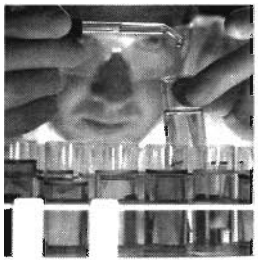



*Figure 3.* Paper Citations. Data from S. Redner, "How Popular Is your Paper? An Empirical Study of the Citation Distribution," *Eur. Physics Journal* B4 (1998): 131–4.



Session IV



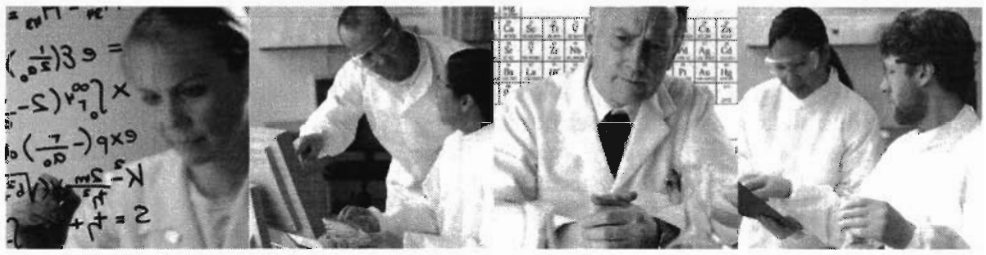
evangelical Christians, but have repudiated fundamentalism.

Influenced by the work of John Whitcomb, Henry Morris, or Phillip Johnson, who strongly advocated a young earth theory or anti-evolutionism as a biblical issue, some churches have reacted negatively to science and actually have attacked science. A number of scientists, who have been hurt by the negative church reaction, have tried to distance themselves from the Church and the Christian faith. Even people who kept their faith have had some very bad experiences.

In my experience, I have not gotten flack for my faith from my non-Christian colleagues, but from conservative Christian colleagues. I think it is fair to say that these young evangelical geochemists were really naive about the nature of evangelical Christianity in their failed attempts to teach geology to the church. Conservative Christianity contains an element of populist anti-intellectualism that is really part of American culture rather than specifically Christian. Of course, culture and religion are very much intertwined.

For these problems to get resolved, it is important to develop a working Christian intellectual community. A lot of the pressing issues of Christianity are intellectual ones that cannot get solved in conservative seminaries or evangelical congregations. They cannot be solved fundamentally at a pastoral or counseling level. The intellectual underpinnings of any solution, I think, must be cross disciplinary arising from orthodox Christian intellectuals. Christian intellectuals from secular research universities and academic institutions have much more freedom to deal with issues of Christian faith and the intellect than do professors at conservative seminaries. ☆

## Discussion Session



Cindy Roy investigates cell biology as a post-doctoral reseracher at the University of Oregon.

***Audience:*** *How ought we regard the citation rate of our papers?*

***Suppe:*** *That's a very controversial subject that's been discussed a lot. But there is a very strong correlation between the citation rate and other indications of great science.*

***Audience:*** *When I see my paper cited, I need to be careful to feel good because I produced something which is interesting and useful in spurring other people on to producing truthful work and not just that it lifts my day up and I say, "Wow look at me!"*

***Audience:*** *People that publish the loudest get noticed the most too.*

***Suppe:*** *There are certainly aspects of that. If you are well known, then people tend to read you a lot, so then you get cited a lot more. Robert Merton has called this the "Matthew effect" – to those who have, more will be given!*

***Audience:*** *Where are the Christian communities that will help prevent Christians in science from losing their faith?*

***Audience:*** *A notable example has been the Society of Christian Philosophers here in the U.S. Against much opposition, they wrestled with truth, so to speak, from a Christian point of view, out of the general phenomena of philosophy. Because their work was good and because they supported each other, they have built a community of stability that has made philosophy for Christians a totally different experience, then say biology for Christians. But we don't have many other disciplines that have made that kind of development.*

***Audience:*** *Has the success of that group been due to the work of a couple of particular people?*

***Audience:*** *Yes. Usually two or three names are cited as the pioneering people. One was a faculty*

*person at Wheaton who did exceptionally good work and spawned a lot of good students. Another source was the Christian Reformed community at Calvin that developed a number of significant thinkers. Another person whose background was different and was an adult convert to strong faith made a significant contribution. These are the people who were so good and recognized by their peers that they became leaders in the field. A couple of them were presidents of the American Philosophical Society and were so highly respected in spite of being Christians, that they paved the way for others to follow.*

***Audience:*** *The Council of Christian Scholarly Societies, a newly formed organization composed of about eleven or so different professions, have a goal of getting the rest of the disciplines to follow the philosophers' development. I hope we can make some movement there.*

***Suppe:*** *It may have been easier for philosophy because it's sort of a subject to itself. There is an organization for Christian geologists but they tend to be tied up with the evolution/creation controversy.*

***Audience:*** *I think the ragged impact of the Christian geologists group is because some of the more noteworthy Christian geologists have not been visibly involved. At the 1999 annual meeting of the Geological Society of America, several very big names in the geological community stepped forward at the creation/evolution session to identify themselves as Christians. It was a big surprise to a lot of the younger members of the community who said, "Where have you been? Why have you been keeping your head so low?" On one hand it was good news to see that the young geologists weren't alone. On the other hand it was like "Thanks for nothing." Some who are already in the field have not been "stepping up to the plate" yet. Perhaps that will change after that particular session which I thought it was very much a community cleansing experience.*

***Audience:*** *I think it is critically important to raise the intellectual level in these debates. In the UK we have tried to do that with our scholarly journal, Science and Christian Belief. We turn down seven out of eight papers we get! We're hoping to increase the number of issues a year because it's really top quality stuff. It's actually making a visible impact. And I would encourage the American Scientific Affiliation (ASA) to do the same.*

***Suppe:*** *Some people including many of the evangelical geochemists were frustrated with the ASA in years past because they tried to be a mediator between these different Christian camps in a way that anyone could speak. But unfortunately there was not a strong commitment to the truth and pursuing the truth. Within the intellectual world, I think we need to be able to argue for the truth in persuasive ways and pursue it.*

***Audience:*** *One of the difficulties I hear younger researchers share in relation to what you're talking about is that they feel so constrained to invest themselves so deeply in their research. If they have a church or family, that's just about all they can do, so they feel that reading widely is out of their reach. I don't know of any good way around it, but perhaps we need a mentoring or "buddy system" to pass on wisdom and knowledge to each other.*

***Audience:*** *Have you watched younger people move up through geology or other sciences who have thought about their career in a calculating way? Is it important to encourage a young person to be aware of the trends in papers and the growth of subdisciplines?*

***Suppe:*** *I don't know. Intuitively some people recognize that there are hot fields and that time is of the essence. Some fields have a culture, like isotope geochemistry or theoretical physics, where you jump onto things and you completely mine them out quickly. In theoretical physics when you file a paper, you know when it's published to the second on the electronic database. Some fields have a culture that feeds on riding these rising tides and then jumping off, and moving on to the next rising tide.*

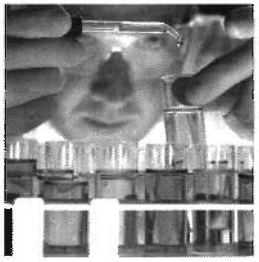
***Audience:*** *A lot of us resonated with what you were saying about finding yourself doing a particular thing while not being aware of consciously choosing to go down a particular path. Providence leads you to a fruitful result. Then you look back later and say, "Wow! Thanks! That's really cool."*

***Audience:*** *Although I'm getting a better grasp about fruitful directions for a career, I don't trust myself to be able to pick a specific direction.*

***Suppe:*** *I think you probably can pick the direction very well. A lot of growth in science comes from new technology or new theoretical ways of looking at things. I think astronomers have been tremendously good at investing in technology. Technology brings new data, and data drives a lot of sciences.*

*I have a graduate student from Italy who's working as a structural geologist on the deformation in the earth. As you might imagine, earthquakes are actually the quanta of structural geology – most deformation goes on in earthquakes. But earthquakes are just recorded in catalogs, and nobody studies most of them. I've had a vision for a long time that if you could bring together earthquake seismology and structural geology, you could see and discover many tremendous things. A fundamental problem with earthquakes is that they're poorly located. That's been really improving a lot lately. So I talk to graduate students about what the possibilities are. This student from Italy said, "I could never study this in Italy because these fields would be located in two completely different institutes. I want to work on this here." While it's taken a long time for her to develop the technology to map faults in 3-D using tens of thousands of small earthquakes, she's now starting to get some fabulous results. This is a kind of strategy to follow in science.*

***Audience:*** *Some say the nature of science has changed and there will be no more scientists of the magnitude of Maxwell*





# Physical Science

**Session IV**

Todd Pedlar is a postdoctoral researcher at Cornell University who studies nuclear physics.

Scott Jackson is a graduate student in neuroscience at Cornell University.

*and Faraday because of the incremental nature of science. Do you find that credible?*

***Audience:*** *I think it is more because of the over specialization we have today that you won't become a Faraday or a Maxwell, because these guys were very, very broad in what they did.*

***Audience:*** *A frequent suggestion is for conservative Christianity to produce these stellar personalities in the intellectual realm to galvanize the academy and establish a credibility for Christian scholarship that it has lost. Is that an absurd strategy?*

***Audience:*** *It sounds like wanting an academic conquering Messiah.*

***Audience:*** *Sometimes a Christian may be jealous of our secular larger-than-life figures like Stephen J. Gould. A lot of paleontologists would say that he has done a service to the community by providing information for the public. But in terms of actual research contributions, he's not working in the lab much these days.*

***Audience:*** *People said the same about Carl Sagan.*

***Audience:*** *Carl Sagan's the astronomy equivalent. So do we want to create a Christian Stephen J. Gould?*

***Suppe:*** *He's not only a phenomenal scientist but he's a brilliant essayist. Gould has made really outstanding contributions in research. Actually I have the impression that campus ministries often don't want professors who are great intellectuals, but want great spokesmen for their programs who draw crowds.*

***Audience:*** *To increase the glory of our side?*

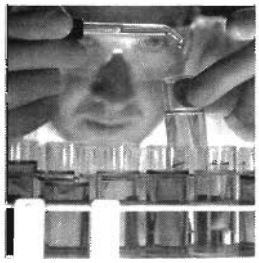
***Suppe:*** *Perhaps, but some serious intellectual issues, which have arisen out of this tremendous growth of knowledge since 1700, have not yet been confronted by conservative Christianity. This is true not just in science, but also in history and in other fields that have experienced exponential growth in the last few centuries. For example, consider the problem of the natural and supernatural. What is the legitimate role of the supernatural? What is the epistemology of Christianity in light of all of these things that we have learned? How is God acting in the world? Last night I was claiming that God communicates, which is supernatural by most people's accounting. I think we have to think about what the Bible is, what is its relationship to other knowledge that we have? How do we know these things as Christians? We tend to have this wall around the Bible. The Bible is a remarkable book that plays a legitimate supernatural role. But I think many of these debates have to do with our understanding of how we know what we know as Christians. I don't think we have a very articulate way of dealing with this. Our misunderstanding of science has a lot to do with a fundamental misunderstanding of how God acts in the universe. That's a really central part of Christianity. Augustine and his friends set up a kind of Christian intellectual think tank in North Africa where they dealt with issues of how to bring together classical Jewish/Christian views of the universe with some of the intellectual perspectives of the pagan ancient world. Their synthesis served the Church very well. This activity is very important to the Church.*

***Audience:*** *How would you evaluate the harmfulness of the great divides, such as the origins question, that separate Christians?*

***Suppe:*** *Many Christian intellectuals, Christian geologists, Christian paleontologists, Christian biologists are isolated, walled off from the church, and are viewed with suspicion there.*

***Audience:*** *Should we not grapple with these intellectual questions within the church? Some of the Christian scientists you mentioned were trying to do this but got shot down by the church – to the detriment of their faith. So how do we resolve the conflict within the church independent of what the outside world says? In the area of the creation/evolution controversy, is it the responsibility of Christian geologists to shut down the opposition?*

***Suppe:*** *The issue is not just the science. It is also the interpretation of the Bible and having a mature understanding of Christian epistemology. Refuting "bad" science is not enough for the church. This is biblical theology at a fundamental level. We also must work out our Christian epistemology at the level of biblical interpretation.* ☆



Session IV

# What Is the Perspective from Applied Science?

The primary motivation for choosing a research question must not be to seek personal recognition or funding. All of us that are doing research, even persons new to the profession, know that funding is an issue. However, I'm advancing the thought that funding should not be the dominant issue. I've seen many examples in the last twenty-five years where funding drove decisions for a number of individuals. I think that approach didn't work out well, either for themselves or, for that matter, for the field.

I want to read a couple of verses, John 12:42-43 (NIV), that might serve to get a discussion going.

> *Yet at the same time many even among the leaders believed in him. But because of the Pharisees they would not confess their faith for fear they would be put out of the synagogue; for they loved the praise from men more than praise from God.*

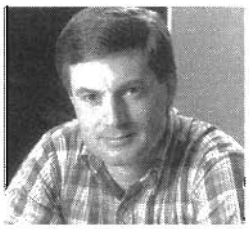
I know there are enormous pressures that all of us face. We do science research because we love the work. I consider myself extraordinarily fortunate to have worked in this field for almost twenty-eight years. But, for us as Christians, it seems to me that one of the primary motivations must be in seeking divine approval rather than the approval of other scientists in the field.

## How Christians Approach Life

I think another aspect of this discussion must be the whole way in which Christians approach life. We certainly believe that truth exists. The Scriptures tell us clearly that this truth reflects or emanates from the very character of God. Truth is a reflection of God's character and we should pursue it. In Colossians 1:10 (NIV), where Paul is praying for the Christians in Colossae, he says:

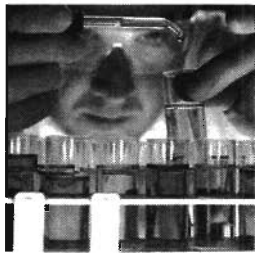
> *... that you may live a life worthy of the Lord and may please him in every way: bearing fruit in every good work, growing in the knowledge of God.*

This verse is a spectacular one, isn't it? Growing in the knowledge of God certainly should apply to our life's calling. Every aspect of our lives should be pursuing the knowledge of him, which is pursuing truth. We ought to oppose any effort to avoid the truth. Whenever we're in a position that we sense an effort is underway to oppose the truth, we have an obligation to oppose that effort. I've been in situations where supporting the truth was uncomfortable because of political pressures that had built up. However, standing for the truth is an obligation that we have, irrespective of the context. I think this has a bearing on what we choose in our research decisions.



*Every aspect of our lives should be pursuing the knowledge of him, which is pursuing truth.*

**J. Gary Eden**, *Ph.D. University of Illinois, was a National Research Council post-doctoral research associate at the Naval Research Laboratory and then was appointed a staff member of the laser physics branch. He joined the University of Illinois faculty in 1979 where he has been engaged in research in atomic and molecular laser spectroscopy, the discovery and development of visible and ultraviolet lasers, and the development of photo chemical vapor deposition. He is a fellow of the IEEE, the Optical Society of America and the American Physical Society, Editor-in-Chief of the IEEE* Journal of Quantum Electronics, *and has served as the Assistant Dean in the College of Engineering and Associate Dean of the Graduate College. Dr. Eden was the James F. Towey Scholar from 1996 through 1999 and is professor in the Department of Electrical and Computer Engineering, and Associate Vice-Chancellor for Research, as well as a research professor in the Coordinated Science Laboratory.*



Session IV

*What Discipline Perspectives Guide Us In Choosing a Research Topic?*

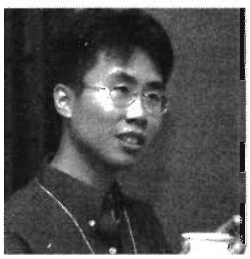
# Applied Science

During my years of doing research, I've seen a number of fads arising out of priorities set by the funding agencies in Washington. Maybe it was a momentary flurry of excitement that resulted in scientists quicky moving into a particular area. In talking with individuals who were making decisions to work in this area, it became evident that some were doing it for what I personally believe are the wrong reasons.

Let me talk about one example: high temperature ($T_C$) superconductivity. In the mid-1980s, it was discovered (by Chu and others) that some copper oxides would operate as superconductors near the temperature of liquid nitrogen, 77°K. This was a tremendous discovery. The funding agencies decided almost on the spot that they were going to put a lot of money into this area. Almost overnight, individuals who had little interest in superconductivity or some of the underlying physics that's associated with it, were sending out research grant proposals solely because they knew funding was available. Remember when cold fusion was in the news? Many purchased deuterated water, heavy water, to get in on that research area. When a funding agency sets a new specific priority, it can provide powerful motivation to a scientist to begin research in that area.

In my own field, this is often done in the Department of Defense (DOD) and sometimes by the National Science Foundation (NSF). They will set priorities, making it clear that they are accepting proposals in a particular area. It's difficult to avoid moving in that direction. If there is a natural intellectual curiosity that's drawing us to that topic, then I think that's a great thing, very defensible. ☆

## Discussion Session



Eric Forbes Y. Hom is a graduate student in biophysics at the University of California at San Francisco.

***Eden:*** *Does anything of what I've said raise any issues with you? I'd love to hear objections.*

***Audience:*** *Right now it seems that some grant agencies are "throwing seed money" at specific projects to see if they are worthy of continual funding. That doesn't seem like a bad idea because some specific projects may merit an investigative look. While it seems that some people rush into a new field because there is potential money available, are there other important factors such as a natural, intellectual curiosity that drive the direction of the research? Is it defensible for a Christian to be primarily motivated by the availability of money in choosing a research project or program?*

***Audience:*** *While this is a little far afield, I think it is relevant. I'm the director of a nonprofit organization. Some board members have located possible funding from civic clubs for proposed work that is not within our mission statement. That makes the decision simpler. Even though the money is available, we can easily decide to turn it down because we have a mission statement that directs us.*

***Audience:*** *Here's a different angle. I studied physics. I saw that it would be very hard to continue the research that I was doing initially because of personal and funding reasons. Now I do something quite different – robotics. Why not?*

***Eden:*** *If you see a new field that has genuine intellectual* ***and*** *funding opportunities, you might wish to switch to it. But if money is the sole factor that is driving the change, I think that would call for real introspection.*

***Audience:*** *I think there's an interesting tension here. You used one principle to urge us to not seek recognition and/or funding. However that seems to be opposed to the typical academic charge of faculty members needing to seek funding and to impact their discipline. To make an impact requires recognition of good work. How can this tension be resolved? How does it relate to having a mission statement?*

*Eden: I think we have a great illustration in the life of Michael Faraday. Faraday's ambition was not to be famous. What we're talking about is motivation. Some of the greatest people that I've known in applied physics and engineering are highly motivated individuals because they loved their research field. That's an apt description of Michael Faraday who did not pursue recognition, although he certainly received it. Faraday is widely viewed as one of the giants in physics. Another good example would be Isaac Newton. The motivation to pick a research topic that will catapult me to the top is quite different from the motivation to pursue a topic because of interest, and fascination.*

*Audience: How about pursuing a topic that will make me effective in mentoring students and thereby positively affect the university? While I might not have a passion for superconductivity, but by choosing that topic I may be able to satisfy academic requirements so that I can shape minds and mentor students at the university.*

*Audience: You don't want to shape student minds into doing things unwisely. It may not be right to be mentoring students in research so you can show them the "smart" way to get funds.*

*Eden: While I agree with the last comment, the goal of mentoring young people is the most important part of research for me. I'm sure that value is shared widely by others who are here at this conference.*

*Audience: If you're looking for a specific topic, you must first assess the available supervisors, since they are the ones who determine the available topics. It does not work for a Ph.D. student to say, "Here are my noble goals and here's the topic I'm going to study regardless of what the faculty are interested in." It may not be appropriate to say that I'll never go where the money is or to only study a topic of personal interest.*

*Eden: My introductory comments were based on the perspective of a supervising faculty member. A graduate student is in a different situation, where the only real option is a choice of the supervisor. If you as a graduate student have received offers to work in several different laboratories, you can go and look at the laboratories. Then if you have some concerns after talking with one of the faculty members, that enters into your choice of supervisor. You don't want to get into a situation and find out that your supervisor wants you to work on something that is either unethical or makes you uncomfortable. A graduate student does not need to feel boxed in. Is there a scenario where you feel boxed in? A couple of you grad students could tell us about it. Tell us about your choice of supervisor.*

*Audience: To some degree, I get the impression that my supervisor is an anomaly. What she does for research is based on her grad students. Her grad students' interest can change her research focus. She did her thesis on planning but she doesn't do planning any more because she doesn't have any grad students that do planning. So, to some degree, it's almost like you have free reign to do what you want to do.*

*Eden: Is she providing leadership?*

*Audience: I think so, from my perspective. She took what I was interested in and tried to mold that into a good research problem. She is interested in machine learning, robotics, and the issues of how robots behave in some environments. She does know what good research is and she can always give helpful directions.*

*Audience: I think that having a mission statement as a basis for your projects will prevent you from being tossed about by whatever is flashy at the moment. As an example of that, I was reminded of a speech given by our governor where he said that he thought we should grow hemp in our state. Two weeks later, my advisors included that in their funding application to the state legislature. In this case, the governor liked the idea, but the legislators crossed out that part of the grant.*

*Audience: Does it change what research they would do?*

*Audience: Sure. They wouldn't do hemp research unless they get money for it.*

*Audience: Would that dramatically change your lab or what you do for the next three years? What's the difference of growing hemp as opposed to sunflowers?*

*Audience: Introducing hemp is a dramatic change because you're bringing in a different species that you've never worked on before and you probably know little about it. So it's a huge change.*

*Eden: Is there an intellectual reason to pursue hemp growing or is the change proposed simply to get the funding?*

*Audience: That needs to be evaluated. There's some research on hemp in Canada and it's been somewhat disappointing.*

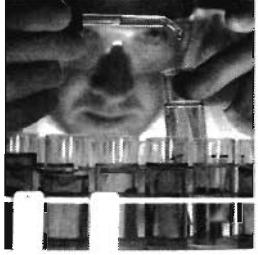
*Eden: When I was going off to graduate school, I asked a young man who had become a Christian during his graduate studies, "How do I choose in which area to work? So many things look fascinating to me and I don't know which lab to chose for my work."*

*He said to me, "I'm going to give you some advice that sounds really strange. Pick the person that you like best. Because if this person is fun to work for, you'll learn to love what he does."*

*On the other hand, if you choose a subject that you really love but work for a mentor who creates extraordinarily difficult working conditions, you'll start to be repelled by the subject because you'll associate it with the difficult individual. I'm sure it's possible to separate the mentor from the research subject, but it's a human reaction to associate them.*

*There are very good reasons for switching research topics, aren't there? We've talked about a couple. Your interests may change. My students rarely study for their Ph.D. research, the same area that was the subject of their Master's thesis. When they come to my laboratory, I tell them that I hope they will see a number of different technologies and science issues. The variety makes them more valuable and enriches their training. So, there are a number of good reasons for changing a research topic. However, if money is the sole determining factor for change, I don't think that's good for a Christian.*

*I want to be a faculty member that trains young minds. That's what motivates me. The universities, whether they are public or private, are putting enormous pressure on faculty.*



Session IV

*What Discipline Perspectives Guide Us In Choosing a Research Topic?*

# Applied Science

Jennifer Hampton is a physics graduate student at Cornell University.

Chip Kobulnicky investigates astronomy as a postdoctoral researcher at the University of Wisconsin.

*I'm amused by the ads that I see for faculty. Every single ad looks like they're looking for the top person in the country who has to be a superwoman or a superman. A lot of pressure is being put on young faculty, in particular. If the goal of the faculty member is to train young minds, then the way research topics are selected and the laboratory culture are important. All of these things together tell our students about what Christianity means to us. I think the whole package of how we run our lab, how we teach, and how we secure funding is vitally important.*

***Audience:*** *What was your earlier point about opposing efforts to avoid the truth? Have you had experience with projects where people had results that they didn't want or that were fudged? Is that what we're talking about?*

***Eden:*** *While the issue hasn't come up frequently, I'll tell you about what I have in mind. I was at a research laboratory in Washington for several years in the late 1970s. A new type of laser was discovered that has since turned out to be important for several application, including vision correction. This ultraviolet laser works well in micromachining the front of your cornea. In those early years, the characteristics of it were so spectacular that one government agency, in particular, was pouring enormous funding into it. When I was with the Navy, we often were asked to evaluate proposals that were presented to the government. I remember a few individuals coming and making presentations to program managers who had a considerable amount of funding, claiming that they could get considerably more power from the laser than all of us knew they could get. Everybody in the room knew that what was being claimed was wrong. Because of the inflated claims made by some, it hurt laser technology. It got to the point where nobody believed the numbers, even if they were correct and perfectly legitimate. So, a small number of highly placed and influential people made statements that ultimately hurt research in the rest of the field.*

***Audience:*** *I've seen situations where researchers don't want to show negative results. Rather than presenting something that's not truthful, only the positive part is represented, because most fields don't seem to tolerate negative results. Somehow a negative result is seen as wasted effort or failure. I try to teach my graduate students, at least at the level where we're working in the lab, that a negative result is a really good result, because it tells you something important about your effort.*

***Eden:*** *I couldn't agree with you more. I've said to my students, "No is a perfectly good answer. 'No' means that you have good data and the idea looked promising, but it's just not going to work."*

***Audience:*** *I'd like to hear from graduate students working on their dissertation research. The research is expected to be stupendous and make a huge contribution to the field. If it doesn't, then the thesis is not a good one and a temptation comes to fabricate results.*

***Eden:*** *Do any of you feel pressure along those lines?*

***Audience:*** *My advisor often encourages me to make the story simpler, not so complicated. Other people say the complex parts are the interesting parts of it. To what extent is it truthful to give a paper that's so complicated no one will ever read it? Or do you try to simplify a very complicated paper? I don't bother writing up and submitting some aspects of my research for publication because I get the feeling that they wouldn't be accepted.*

***Audience:*** *I don't either. However, I have found that you can include negative results if you end up with positive results also. We present our work by saying, "Here are all the things we tried that didn't work and then we found this one thing that did." Then we write papers to publish the positive but not the negative results. You must keep working until you get a positive result or else the work doesn't get published.*

***Eden:*** *Those who work in research know that you spoke correctly. There are going to be lots of failures. I think it was Edison who once said that the best way to have a good idea is to have lots of ideas. That's true. You have to have lots of ideas and then one of them works. I tell my students that you need to have a high tolerance for failure.*

***Audience:*** *Someone implied that you must almost "sell your soul" to the research project. If there's any area where being a Christian should affect how to do research, it's believing that there is more to life than the research project. A geologist, who has a wife and five children, told me that he has made very definite research choice decisions that would allow him to spend more time with his wife and family. Others who are not so careful experience divorces and family separations.*

***Eden:*** *Put that concern on the list and call it "priority."*

***Audience:*** *I have a friend from graduate school days who was getting his doctorate in math. At that time, I was very active in the InterVarsity chapter trying to get this friend to be active in a*

*Bible study. Well, in that time of his life, he couldn't participate because frankly he was over achieving and didn't have time. He was always exhausted and unhappy. I now occasionally see him thirty years later. He's still over achieving and still uptight. I expect to hear any year he's had a heart attack. His marriage has held together, but his wife doesn't see him very much. When she does, she sees an uptight, sad man. It isn't worth trading your life for research.*

***Eden:*** *I couldn't agree with you more. I think it is a tragedy to take something that should be noble, beautiful, fun and exciting and convert it into something that is a terrible burden. I've told my graduate students that my hope is that their graduate years will be some of the best years of their lives. I hope they will look back and say, "As a graduate student, I was never more free. I wasn't wealthy and I didn't get paid what I was worth. But I had a good time working in interesting research. Those were good years." From the Christian perspective, science research should be a noble calling and something that should just be fun.*

***Audience:*** *I think research is something that we don't make happen on our own. Good ideas come from God. As a Christian believer, I believe that God is the one who inspires me. Two statements summarize the wrong way of thinking for a Christian: (1) "I'm going to make it happen." (2) "I'll do whatever it takes." As believers, I don't think God wants us to live that way.*

***Eden:*** *I completely agree. One issue we didn't discuss is that before a research area is determined, one must discover the talents God has given. I am fascinated by a passage in the book of Exodus in which God commissioned the construction of the Tabernacle and told Moses that two people are to lead the work: Bezalel and Oholiab.*

> *Then the Lord said to Moses, "See, I have chosen Bezalel the son of Uri, the son of Hur, of the tribe of Judah, and I have filled him with the Spirit of God, with skill, ability, and knowledge in all kinds of crafts – to make artistic designs for work in gold, silver, and bronze, to cut and set stones, to work in wood, and to engage in all kinds of craftsmanship. Moreover, I have appointed Oholiab son of Ahisamach, of the tribe of Dan, to help him. Also I have given skill to all the craftsmen to make everything I have commanded you"* (Exodus 31:1–6, NIV).

*These verses tell us something spectacular. The last part of verse six applies to all of us because it says, "Also I have given skill to all the craftsmen to make everything I have commanded you." So it wasn't just those two gentlemen who were given skill, but it was all of those involved. I think that hits right at the heart of what we're talking about. Everyone around this table has skills of a certain kind to give as an offering to the Lord. We need to recognize that and say, "Lord, I'm excited about doing this. I recognize that I have these skills. I'm going to use what I have with joy."*

*We also didn't talk about competitive issues. I didn't hear that come up in the discussion. For example, some research areas in atomic and molecular physics might require specialized, expensive types of equipment such as an accelerator. Even a large NSF single investigator research grant will not be able to purchase an accelerator. So those kinds of research activities are better done at the national labs. Some popular research areas have so many people working in them that it is difficult for an individual to make a contribution. Those are strategic issues in research. I don't view them as ethical issues if the other considerations that we have been talking about are met.*

***Audience:*** *Referring to the last point, my thesis topic was chosen because there were too many people working in the area of my initial interest. I knew that I wasn't going to be able to do something unique. I didn't switch to something I didn't want to do; rather, I switched to another area that interested me. I don't think I made an improper decision.*

***Audience:*** *I think it's very pragmatic and I don't think it's wrong for a believer to be strategic and wise. I think it's wise to assess your talents, the environment, and the way you can fit in the research field.*

***Eden:*** *What about societal impact? Does anybody struggle with that issue?*

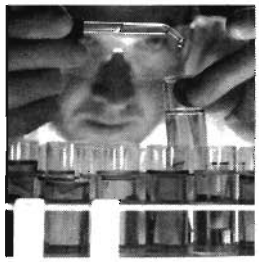
***Audience:*** *I'm in robotics research. I know my research group is already involved and will get much more involved in military things. If the military can use robots instead of people, the US soldier death rate would be lower. Just think about recent events in Yugoslavia or Iraq. If robots would have been used, more people would have been saved from the NATO side as well as in the country being attacked. Should I avoid that research topic because it's military and it's aggressive and in the end people will be killed? Or, should I say, this is actually a good thing because fewer people may die? That's the issue with which I'm struggling. I don't know what to do.*

***Audience:*** *It's really intriguing. I never even realized that was an issue. War does seem problematic if people don't want to risk their own lives. If you're willing to kill someone else, you should be willing to risk your own life also. A government that can kill others without risking their own children is a frightening idea!*

***Audience:*** *Someone spoke at an InterVarsity graduate conference a couple years ago who had developed a method for satellites to map crop development. The project was supported by a huge grant from the Central Intelligence Agency (CIA). Through that work the CIA thought they could, in a state of war, destroy all the crops from the air. The idea was so extreme that the speaker and his research group actually destroyed key data in the program so it couldn't be recreated. They almost got themselves fired. The speaker believed it was unethical to target the civilian population by destroying their food source as a means of war.*

***Audience:*** *The other day my advisor asked how we felt about taking funding from the military or the National Security Council (NSC) or the CIA. I guess someone from the NSC offered him money for research. My advisor's response was, "Well, if you want to give us money, that's fine." It's only a problem for me, if they want me to do something I don't want to do.*

***Audience:*** *Well, here's another issue. One of the research projects I've worked on could be used by a government agency to spy on private telephone conversations. Right now one of the reasons we're not so worried about people listening in on our phone conversations is because there are too many phone con-*





# Applied Science

**Session IV**

David Thompson is a postdoctoral researcher in analytical chemistry at Stanford University.

Christina Chan is a graduate student in geophysics at Ohio State University.

*versations. But, if a computer listens to a phone conversation and can determine which conversations are of interest, then everybody's conversations could be monitored. This project looks suspiciously like they plan to use it improperly even though they didn't say so. I had to think, "Do I want to have anything to do with this project?"*

***Audience:*** *What is the framework that we use to decide about our work? Practically everything can be used for wrong.*

***Audience:*** *Someone said that you can't predict how things will be used or what their impact will be, so stop trying. However, you don't want to use this reasoning to avoid getting out of something you know is a bad thing either. What's the framework we should use to decide?*

***Audience:*** *It would be nice if researchers could stay involved with the way technology gets used. If you refuse to work on a research project because you think it may be used unethically, then someone else will do the research. Maybe by working on the research project you can influence what people think about its ethical issues. That involvement may make you more useful than if you had said "hands off" altogether. Is it possible to do research and also have a say in the ethics of its use?*

***Audience:*** *I did my Ph.D. research in nuclear physics, which had nothing to do with weapons or energy. But I found myself exposed to the history and development of the atomic bomb. Maybe we can take that as an example, at least to look at what happened. Some physicists came here and developed a bomb because they were afraid that the Germans would discover it first. They were also very excited because it was a great idea. When they developed the bomb, they found that they couldn't make the decision to really use it. The usage of the bomb became a political issue and many scientists regretted that they were involved in its development. Yet, they must have seen the consequences. More recently during the cold war, many physicists, who were involved in trying to build trust between the United States and Russia, attempted to educate the public about common issues involving people in both countries. Physicists also tried to meet with scientists from the other side in order to exchange information and to build trust. They wanted to establish a working foundation that would minimize risks. Can we use that approach as a model? If we're involved in critical military research, we should try to be involved in the related decisions and we should inform the public about it.*

***Audience:*** *It seemed like the lesson from that story is that once the technology is developed, it's out of your control.*

***Audience:*** *Maybe it isn't totally out of your control.*

***Audience:*** *The scientists that developed the bomb could have changed the landscape of the decision of its use if they had gone public with the knowledge they had. The entire political process involved in whether to use the bomb would have changed completely with public awareness.*

***Audience:*** *I don't think the outcome of the bomb use decision would have changed. The exact same thing might have happened even though the way the decision was made would have been changed.*

***Audience:*** *Albert Einstein was very influential in getting the atomic bomb started. I think he had a tremendous influence by what he wrote in a famous letter. I have the impression that if serious, well-established scientists speak out about nuclear weapons, they can have more influence on public opinion than any politician can.*

***Audience:*** *I want to continue with the nuclear example. If the scientists who developed the bomb would have thought ahead and realized that they were going to regret the use of these bombs, then it would have been more effective for them to have refused to develop the bomb than to try to control the bomb after its development. If enough people refuse to work on something, it's not going to get done.*

***Audience:*** *That framework for dealing with a problem is called "relinquishment," right? It means to agree that you're not going to pursue something. It is debatable whether that's a reasonable way to solve a problem. If the US would not have pursued bomb development, another country may have developed it with a different outcome that was lot worse. It is really hard to know.*

***Eden:*** *That's right. I think a very strong argument is often made in those cases. Get out in front and know it better than your foes. What you know you can control and what you don't know you can't control. In other words, there are ways of preventing somebody else from using it if you know enough of the physics of it. That doesn't apply to this particular discovery, as far as I know, but just relinquishing it is sometimes not the best option.*

***Audience:*** *Another example that is more current might be the Internet. It's a technology that has been developed and you can't really predict*

*the consequences of the Internet for the next fifty years and the way it's going to change the world. You can speculate about it, but I say the choice is to not pull the plug against the horrible things that happen because of the Internet but to try to control it.*

***Audience:*** *One speaker said, "Step back and be in wonderment of what you're doing and think about how God is in physics or chemistry or the stars." Does that change because we're doing applied research? I step back and I see a computer. On the eighth day God created computers? In some ways I feel like I'm not looking at the creation of God.*

***Audience:*** *Computers are a human creation, but of course, God created humans.*

***Audience:*** *It's difficult to think that God holds this computer together, because it's not really the natural world. It's hard to think about it that way. So we're one step removed.*

***Audience:*** *If the computer falls apart, you can't blame God either.*

***Eden:*** *It is a testimony to the skills that God has given us that everything we construct is still from creation. We haven't yet concocted something that we haven't taken from the created world. We've taken all our tools from creation, whether it's an atom that we split or materials we mine out of the ground. Even when making synthetic materials with molecules that aren't normally found in nature, one still must use atoms that are found in nature to put together the new material. I'm still working with the tools God provided and using a brain that he provided.*

***Audience:*** *That reminds me of a joke I heard. Some scientists went to God and said, "We want to have a contest because we think we can create stuff on our own. We can make humans." God said, "Fine. Let's have a contest. Do just as I did back in Genesis." And they said, "Great!" They started gathering up dirt and God said, "No, wait a minute. You go get your own dirt."*

***Audience:*** *I understand that God is in my robot because a created being built the robot and because it uses matter or electricity to work the way it does, according to God's laws.*

***Audience:*** *In my studies, I make very small magnetic particles that go through all sorts of processing. One way I see God in my applications or in my engineering is that, while this particle is such an intricate little human-made thing, I know God knows all about it and has allowed me to discover it or understand it. In the same way, I could be the little thing he also intricately desires to know.*

***Audience:*** *Sometimes trying to build something simple takes all the effort I have and so many hours of hard, intense work. Then, when I meditate on God's creation, I'm even more in awe of the design, the robustness of everything that God is able to accomplish. It knocks me down and humbles me. Our capabilities are great, yet very weak compared to what God can do. So sometimes it's not our technical strengths but our weaknesses that help us to see.*

***Eden:*** *That's really true. The longer I work in the field, the more I realize the almost superhuman effort it takes to make the simplest thing work. For example, one of my students has made a glass fiber laser, using a synthetic fluoride glass. But I know that God knew that was possible, so I feel the same way that Newton must have felt. God understood that the fiber laser was a possibility. I think he is pleased when we find those things.*

***Audience:*** *Just being in this group makes me aware of the lack of community that I normally have to discuss things like applying technology. I wondered if all of you had any aspirations of either building a greater community like this or if you already have found it. For example, I make little microsystems. I don't know if these things might be useful on the mission field somewhere. Have you found places to discuss these kinds of things?*

***Audience:*** *I have a community group. We have a weekly prayer meeting with about six faculty members from the College of Engineering. We're all professors. It's great to get together and talk about the struggles of believers in response to certain things that come up. It's great to be able to pray over things that are very specific instead of the kind of general things that you would feel more comfortable mentioning in a regular prayer group where people don't really understand what you're doing and you don't want to burden them with those details. It's been wonderful and I would encourage you to meet and pray together. Start by just praying about your work realizing that things you're working on come from God.*

***Audience:*** *One thing we're talking about is social impact. I am alone, off by myself. To do the things that are envisioned requires Christian people in various disciplines – political science, economics, sociology, and a lot of different fields – to gather and work on the problem. Much of our research doesn't necessarily have direction for the social good. I was wondering if a group of applied scientists can predict the outcome of a given research focus. If we can get together and build an atomic bomb, can we build something that's really for tremendous social good? Will I be able to maintain a vision that's different from my department for the kinds of things I want to do instead of getting swallowed up or let my contribution be so small that it's never going to matter? It is more than just knowing people in other places but to really collaborate with other people. I have vision. I have a longing for a true Christian community of researchers that work together toward something.*

***Eden:*** *It's exciting to hear what you're describing. Perhaps one possible manifestation of what you're describing could be a society of Christian engineers, a group that tries to bring together individuals to effect action of different kinds. I'm sure you're all aware that in several disciplines Christians have formed academic societies. There's a strong one in philosophy and they hold meetings along with the annual meetings of the American Philosophical Association.*

***Audience:*** *Another group I have been a member of since I had my first job is the American Scientific Affiliation. It has given me a sense of bonding with other evangelical scientists and engineers.* ☆

Session V

# What Are the Research Needs in Science?

*I believe the real issue today is: "Is it worth your time?"*

## Brad Keister:

The discipline of science, I think, is consistent with God's creation of the world and of humanity created in his image. Furthermore, the roots of modern science and the scientific method owe a considerable debt to Christian thought, notably the Reformers. For example, seven out of ten of the founders of the Royal Society were Puritans. The burden of proof, I believe, is for the non-Christian to demonstrate philosophically a consistent world view which allows for a system of inquiry based on rational thought and experimentation that leads to new knowledge. I think that the secular community has co-opted the scientific method as its own and treated it as a victory in the progress of science over religious-based world views. This idea is important to say and is also important in determining choices of research topics and areas of need.

The nature of "call" reflects on the purpose of research and on gauging potential impact. A related issue, particularly in universities, is the education of students, which is a role you will play if you remain in the university. Let's apply the five conference bases to areas of research need.

**Basis 1:** *We are stewards answerable to God for his creation of minds and other resources.*

**Basis 2:** *Do all that we do to the glory of God.*

Combining these two bases, I see two issues. One is the nature of "call," and for that I would recommend the book, *The Call* by Os Guinness. Guinness stresses that we are called to *be* rather than to *do*. I think that diffuses the issue of what you should do or what topic you should choose. I see two main purposes of basic research. First, basic research provides the potential for ultimate, practical applications. That may not drive what we do, but we can be confident that some of the things we do will have practical applications. Second, basic research can change the way we think about the world. For example, the taxi driver may be interested in knowing how super novae work. Thus, everyone can participate in some of the outcomes of basic research even if it does not have immediate practical application. Basic research is consistent with our charge to understand the world and be stewards of it.

The other issue is the potential impact of your chosen work. Need is one element, but I don't think it is the main issue. I believe the real issue today is: "Is it worth your time?" You're going to spend eight, ten, or twelve hours a day on a basic research area. Never mind whether anybody gives you any money for it or whether it's trendy. Is it worth, before God, spending that much time for two or three years? That's really the first question.

**Basis 3:** *Be disciples of Jesus as you go about doing good.*

This involves exhibiting the fruits of the Spirit. How would Jesus as professor, compared to Jesus as carpenter, apply his trade? One issue involves being a source of grace for those around us in the university community. Being a source of grace is actually a rarity if you spend any time in a university, particularly with people like support staff, undergraduates, and other people who are sort of at the bottom of the food chain.

The choice of research topics should involve its educational value and long-term

**Brad Keister**, *Ph.D. Physics, Stanford University, was professor at Carnegie Mellon University before joining the National Science Foundation as program director for Nuclear Physics in 1997. He is a fellow of the American Physical Society. His research interests include multiple scattering theory, relativistic quantum mechanical models, computational physics and numerical analysis.*

benefit to the student. The time and energy spent by a professor with students goes to the heart of the university's value system. The university's value system is not in the speeches of the president or in alumni magazine articles, but in how tenure decisions are made and where money is spent. Money is often at the heart of what drives the university. A young faculty member has to make very, very difficult choices because he or she won't be able to do it all, but the university expects it! I think this is more significant as a choice than "Do I work on super novae or neutron stars?" I think God cares deeply that you do one of them, but I'm not sure that it matters to God which one you choose.

**Basis 4:** *Resist the strong temptation to choose as research questions only those areas that are most easily funded or trendy.*

I think there are two ways of looking at what governs trendiness. One way is to see if the research area is mission related, which means that an agency sees societal benefits that affect their charge. The other way is to determine its potential for intellectual impact.

Some attractive trendy subjects, such as string theory, need only a few people. However, other areas open up because they are entirely new and provide many opportunities for exploration. In those situations, Christians can have a real impact on shaping the field, not just through seminal papers, but by saying, "Here's where we think it should go," by the kind of research that they do.

Beware of the trap of searching for a distinctly Christian research topic. That gets back to why I made the original statement as to the scientific method having Christian roots. If you then turn around and say, "Oh no, I want to do something that's distinctly Christian; I don't want to do something that's like my colleague down the hall," you may undercut the whole basis for why you're doing it. The most likely overarching goal of most universities is money intake in contrast to things like truth, education, and other issues. Decisions about hiring and tenure really pinpoint where the university's value system lies and that is the toughest thing you may have to face as a faculty member.

**Basis 5:** *The rising concern about technical developments in our day and the lack of ethical directions for them.*

Let me recommend three books. One is *The Call* by Os Guinness, to which I've already referred. Another is George Marsden's, *The Soul of the American University*, which traces the movement of many institutions in America from Christian roots to a secular basis, which he calls "the scientific method." I would add that the final step is the focus of many research universities on money. The third book is *Pasteur's Quadrant* by Donald Stokes. It's about the impression most people have that there is a one-dimensional scale between basic research and applied research. So, if you're in basic research you are at one end of the scale. If you're in applied research, you're at the other end of the scale. You have to pick between the two and move around. Stokes argues that it is a two-dimensional plot: (1) the contribution to basic knowledge; and (2) the contribution to ultimate end use. You can be in some sense positive on both of them like Pasteur, or you can be strong in the basic end of things like Bohr, or you can be strong on the end use like Edison. It's not an either/or situation. I think that's important because it eliminates the fallacy that if you're doing basic research then you're not doing full-time Christian service because there's no end use to it. Basic research is a legitimate thing to pursue if it's within the will of God and if he provides an open door for you.

One of the things that struck me at a *Following Christ; Shaping our World Conference* in Chicago, was the last lecture by N. T. Wright. Wright called on Christians, as perhaps their biggest task, to work alongside their colleagues by struggling where they struggle and thereby understanding the pains and the dilemmas of their field. Part of your credibility in some sense is earned by engaging that community and by working alongside them rather than pulling yourself out and arguing with them.

## Martin Price:

The group with which I work, Educational Concerns for Hunger Organizations (ECHO), is a Christian nonprofit organization in the warm part of southwest Florida, where we can grow tropical plants. Our goal is to give technical backup to missionaries in the national church and, in fact, anyone. We're especially pleased when missionaries are working through the church with people in poor rural communities who almost always struggle to make a living under difficult conditions.

While I was working on my doctorate in biochemistry from Indiana University, I had an opportunity to visit a missionary and some people with whom he worked. I was quite taken by the level of need. It was hard to get that out of my mind. I returned to my work at the laboratory, where I was trying to look for the mechanism of an organic reaction involving the addition of an ion to a complex molecule. Now there's nothing at all wrong with that kind of research, but I came to the point where it wasn't where I "was at" anymore. I wanted to find a more direct way to meet human need. Gradually that evolved into the question of "How can I as a scientist help the poor?" Foreign missions became a special concern of mine. So you might say that my mid-life crisis began at the age of twenty-four! That's a good time to start because now at





*How can I as a scientist help the poor?*

fifty-seven, I'm utterly happy and fulfilled. However, I had twelve pretty rough years, making some wild lurches in career direction. I remember praying once, "I don't mind being a fool for Christ but what if *he* thinks I'm a fool." I wasn't always certain which kind of "fool" I was.

What would science look like in helping the poor? We're so blessed by science, not just because we study it, but because it affects our lives. It is generally true that we receive benefits of science because we pay for them or a government pays for them or some third party pays for them on our behalf. To help the poorest of the poor, the benefits need to be something that will cost them nothing. So what kind of thing can you come up with in science where the poor can get benefits from it that will cost them nothing? At first it might sound hard, but it's really pretty easy to think of examples.

One example is to develop a nonhybrid seed that is resistant to certain diseases or yields extra heavily in the tropics. This has been done many times. If the new seed introduced to a small farm community is productive and liked by the people, then a positive situation exists. The farmers only need to multiply the seed and continue to use it. If the seed is really good, a missionary couldn't keep it from spreading around if he wanted to. That's one way for science to help the poor. I'm a little frustrated that many agricultural scientists at universities are looking, not to develop nonhybrid breeds, but to develop either something on contract that will be patented (because it's hard to get money to do research) or a hybrid seed that will be sold to someone.

There's still lots of opportunity in plant breeding and the development of plant varieties. That's one of the principle things that ECHO is doing—not developing plants—but acquiring them, putting them in our seed bank, and then distributing trial packets for the workers around the world to evaluate. In that sense, we're helping missionaries to be experimenters. We can't just start with something totally new to an area and safely introduce it. We have to evaluate it first to see what it will do.

Let me give you a really good example of scientific research that has helped the poor. A graduate student from Tanzania, working at Michigan State University, was looking at the problem of a certain weevil that got into beans. It is very frustrating to go through all the hassle of growing food, protecting it, and storing it, and then when you take it out of storage, to find empty bean shells! That was commonly happening. So this student decided to investigate how the little weevil got in through the hard shell. She found that the weevil rubs with a part of its mouth against a certain spot. But it can't do that on just one bean. It has to prop itself up against another bean or against the side of the container and then work with its little mouth parts for about 19 to 24 hours to get through the bean shell.

Then she hit on a very simple idea to control the beans: Roll the bean bag. So two or three times a day for a few weeks they rolled the bean storage bags so that the weevil, who has enough energy to work for about 28 hours, was whirled in chaos! The beans flipped everywhere and the weevil had to start on a new bean. It can only do this for 28 hours and it takes 19–24 hours to get through. They found that the bean loss plummeted by that simple technique. That is research that can benefit the poor.

Since part of me is still a biochemist and a research scientist, I like to collect ideas. I think one of the hottest ideas concerns the use of a coconut as an incubator or fermentation chamber for bacteria cultures. Gardeners know about an organic method of insect control that uses "Dipel," a bacterium that is very widely sprayed on crops. One bite of it is enough to give a fatal intestinal disease to a caterpillar. Another strain of the same bacteria will kill mosquito larva. A Peruvian scientist discovered that he could use a coconut as an incubation chamber for this bacterium. Inject the bacterium in the coconut, leave it for a certain

**Martin Price**, *Ph.D., Indiana University, was formerly assistant professor of chemistry and biochemistry at Geneva College, Beaver Falls, PA. He did his postdoctoral work in biochemistry at Purdue University, and he worked at Bettel Memorial Institute in Columbus, OH, in research management. Since 1981, he has been the executive director of ECHO, Educational Concerns for Hunger Organization. He is a member of the Board of Directors of the African Institute for Scientific Research and Development, Kenya, and of the Association of Evangelical Relief and Development Organizations, and the Society for Economic Botany. A theme of his career is using science to help the poor.*

number of days, and then open the coconut and pour the coconut milk in mosquito infested water to kill the mosquitoes.

The obvious question, which to my knowledge no one has ever researched, is: "Can you do this with the other strains of bio-insecticides?" This is something that anybody should be able to work on who has a reasonably equipped laboratory at a Christian college. It would be a lot of work. There are many unanswered questions dealing with length of storage, exactly how to do the procedure, and so forth. But if it works, we could simply send one little bacteria packet to a community somewhere and have somebody trained to be the local insecticide maker – maybe in a micro-enterprise. Then they are off and running.

*What can I do that's significant in terms of research in the setting of a small college?*

I'd be glad to talk to any of you who might be considering a move to a Christian college where the issue might be, "What can I do that's significant in terms of research in the setting of a small college?" I'm emphasizing Christian colleges because I don't think universities are going to pick up on this. Doing research in a small Christian college requires that you be more nimble! Small colleges typically have low research budgets. However, significant research projects can be done on a low budget. At Geneva College where I taught for four years, we required our graduates in chemistry to do a senior research project. When I inquired what my budget was, the answer was, "Oh, $200 or $300." But we had a lot of instruments and a well-equipped stock room. You really can do significant research even at that level.

Problem-solving research in big universities tends to be interdisciplinary. If a researcher receives a grant for do something and then discovered that help was needed from another department, it wouldn't make the department chair real happy to learn that the research was going to give half of the grant money to somebody else. Whereas, if you are on low budget research to begin with, nobody cares. You could even collaborate with other Christian colleges.

I will share a final example. Dr. Rolf Myhrman, at Judson College, creatively picked up on an interesting research idea. I was recently at an invitation conference for the Rockefeller Foundation in Honduras. Dr. Myhrman was there. The conference subject was the exact theme that he was working on with some other scientists. He had developed a method to analyze for the presence of a particularly harmful substance in an otherwise wonderful bean. Several Third World scientists also presented papers there. Probably three-fourths of them had their research backed up by Myhrman doing their analyses in his lab. Was it elegant? No, it needn't be elegant. Did it require him to show his brilliance? No, but he has a mission statement to use his laboratory and his students to help the poor. He does most of the work in the summers and he has a "post bachelors research associate" position that brings in young graduates full of energy and enthusiasm who will work for less money and get a lot done.

## Mark Foster:

When I was first thinking about research needs in science, I came also to the question of "call." I recommend reading the book *Courage and Calling* by Gordon Smith that was published in 1999, by InterVarsity Press. Smith makes some of the same points that are in Os Guinness's book.

Let's focus on more discipline specific thoughts. I think the most important issue is not whether a given research project is fundamental or whether it's applied, but whether it glorifies God and serves others out of the love for Christ. When I was trying to think of different topics in the material science area that would be good areas for Christian researchers to work in, I used five different "sieves" in my thinking process.

### 1. Our Fundamental Research Interests

I'd like to make the argument that it's not wrong to study hot topics if we're studying them for the right reasons. I think there's a lot to be done in the area of materials that are in systems of very small dimensions, that is, atomic or near molecular dimensions. This happens to be an area that interests me because I study surfaces and interfaces. (Certainly the topics that I'm suggesting here represent a strong influence of my own bias and my own expertise.)

A second general area is complex materials and phenomena. My research approach, which has been very successful, is to take difficult problems and break them down into simple problems with model systems. But there are some problems that simply can't be tackled that way. They have to be tackled with their complexity right up front. As a person who's not too familiar with biological sciences, it strikes me that many biomaterials problems and biophysics problems have a complexity that simply can't be avoided. With recent advances in computational capabilities and with characterization techniques, it's now possible to go at some difficult phenomena and systems that we haven't dealt with before.

The third area, again an area of particular interest to me, is how molecular architecture affects the behavior of large molecules, macromolecules. With advances that have been made in synthesis in the last ten to twenty years, we can now control the architecture of molecules in ways that

**Session V**

we couldn't before. This offers very interesting possibilities for controlling their behavior. I think that's still an area where there are opportunities to get in at the ground level.

## 2. Technology-Driven Research Areas

For the second "sieve," I ask myself what areas might be of interest for technology-driven research. I would submit that quite a bit of materials research is actually driven by other technologies. To make advances in technology, people come to materials scientists and ask for thus and such a material. Two important areas of such technology-driven research have been technologies for transportation and technologies for information.

*I think the most important issue is not whether a given research project is fundamental or whether it's applied, but whether it glorifies God and serves others out of the love for Christ.*

In transportation technologies, I see the opportunity for the stewardship of scarce fuel resources. If I'm going to do a good job of stewarding fuel resources, I would work on high temperature engines. That means making high temperature ceramic components for engines because, if I can increase the engine temperature, I can improve the thermodynamic efficiency. If I'm going to increase the temperature of the engine, I need high temperature plastics and elastomers for so-called "under-the-hood" applications. I could also work on lightweight batteries, not only for transportation that is electrically driven, but also for transportation with internal combustion engines. Lightweight batteries improve fuel economy. And then, finally, I go to an area touching on my own expertise and interests: creating plastic parts for automobiles and for many other things requires the use of a lot of fuel. By tinkering with the architecture of the molecules in that plastic, it may be possible to reduce the amount of fuel required to do the processing. That's another way to save fuel resources.

In information technologies, I see the opportunity for the stewardship of finite time. Information technology calls for ever denser storage media and the ability to read and write things faster and faster. This would be particularly helpful in combinatorial science, where we generate tremendous amounts of data in short times that have to be stored and recalled in a reasonable way. This will require some advances. But I think that it is important as a Christian to remember that data, even large amounts of data, are not the same things as knowledge and wisdom. We want to keep those ideas distinct as we think through the real implications of what our work in information technology might be.

## 3. Research that Serves Others

Moving to the third "sieve," what are some obvious areas where I as a materials scientist can contribute to the well-being of others? One area is making materials for improved safety. My family and I recently survived a house fire and we learned that the flammability of vinyl house siding is a big problem. There's important work to be done there. The issue of low flammability garments is another area where work could be done, as is reduced flammability for aircraft interiors. If there's a fire on an aircraft, people have three minutes to get out, that is, if they survive the toxic combustion products. In the medical area, we need a more puncture resistant material for gloves, materials for prosthetics, and materials to contact the body or bodily fluids.

I echo remarks that I've heard earlier in the conference. It's not enough for Christians to avoid or to say no to certain kinds of technologies, like stem cell technology. Rather Christians need to proactively come up with alternative and better approaches.

## 4. The Study of Natural Materials

My fourth "sieve" is that God said that everything he made was good. So every material I could study would be a legitimate research object for a Christian. I think there are not only important technological lessons to learn, but there are lessons for me in looking at every material that God has

**Mark Foster**, *Ph.D. Chemical Engineering, University of Minnesota, is professor in the Department of Polymer Science at The University of Akron and has done postdoctoral research at both the Max-Planck-Institut for Polymer Research and the University of Minnesota. His honors include the Whitaker Foundation Biomedical Engineering grant. His research interests include the study of the microstructure of polymer thin films and surfaces and protein adsorption at interfaces.*

made. One lesson is that God makes things which are beautiful, and it is wonderful to look at the beauty of God's nature in what he has made and the materials he has made. A second lesson is that God loves complexity. One example is collagen which has a wonderful structure that gives it particular properties dependent upon its complex hierarchical structure.

### 5. Peculiarly Christian Topics

My fifth "sieve" is intentionally provocative: "Are there materials science topics that I might take on as a Christian that are somehow peculiarly Christian?" When I was looking at the biblical records to see if materials science was a legitimate area of research, I looked at the materials used in worship. Should we still be using the same materials we have always used to worship? If I'm to give God the best of what he has given me, should I as a materials scientist perhaps think of new materials that might address needs in worship or that I might simply make to give God glory? What does it mean to have a need for a new material? Certainly worshiping God is a legitimate reason to create a material. In the Old Testament, God gave certain materials that were to be used specifically in worship.

In a more problematic sense, are there Christian ministries I could assist in materials science? Those that come immediately to mind are frontier missions, disaster relief, and medical missions. Certainly frontier missions have benefitted from a number of technologies that have been developed due to driving forces which were not Christian. But isn't world evangelization an important enough reason to develop specific materials that support frontier missions?

Much of materials research requires tremendous capital investment. Are there investors who would be willing to put money into work for specific kinds of materials for missions? It strikes me that maybe many missions require materials that aren't so complex or technologies that aren't so prestigious. Unfortunately, that might be one reason why I'm not so interested in what my medical missions colleagues have in mind. I can think of two possibilities which would be good topics. One would be puncture resistant gloves and membrane materials for water treatment or remediation.

By rushing through this long list, I was trying to generate a laundry list of ideas in materials science, some of which overlap a little bit with some other areas. I think God does give us, in the freedom of his grace, an opportunity to study many different topics. There are some good questions we can ask when we consider the details. I think in particular it would be nice to think about what opportunities there are for materials research in areas that are specifically Christian.

## Brent Seales:

I've also thought about worship from the information technology or computer science point of view. I see two emerging trends in information technology and computer science. Let me give key words to these trends and some examples so that you can apply them to other areas.

## Two Emerging Trends in Information Technology and Computer Science

### 1. Scale

The first trend I see is one of scale. Scale in information technology wasn't an issue in the early days because just getting anything to work was the basic idea. So, for example, people didn't think a lot farther than the emergence of the arpanet, a network that worked originally at getting two machines to talk to each other. Now, when you think about networks, we're worried about having global access to the Internet, which is a completely different ball game from the original intent of how the network had emerged. Therefore, some redesign is important to handle the emergence of this idea of scale. It applies to other areas of information technology as well, such as data management. Your data archives are huge, and even if you're not in information technology per se, you generate huge amounts of data that you need to save and then mine in a very rapid way. The number of users, the number of machines, everything is just rapidly increasing in scale. Let me give you two examples of large scale problems that I think are moving the field forward and are really interesting for us to consider.

One large scale problem is the global Internet, and a second is the extension of the Internet to space. I heard a talk by an information science leader this week at the opening of our new building. He is recognized as one of the early developers of IP, which is the protocol underneath most of the network technology now. He's working on a protocol for deep space communication anticipating that interplanetary probes will communicate and when they do, they'll need a long haul type protocol to make that communication possible. So in the area of large scale problems, we need to think beyond where we are and push technology in that direction.

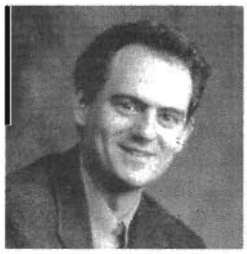
Another large scale idea is massively parallel computation e.g., Napster. It's an idea that emerged from college kids wanting to play music without buying more CD's. It's an example of harnessing parallel computation effectively and efficiently. This is an area of ongoing research. I heard someone at the University of Wisconsin say a while back that parking garages may well become the super computers of the future because, when people drive their car to work, they could plug it in, and the computers

**Session V**

inside the cars could be harnessed all across the nation as a super computer. That's an example of another emerging trend toward large scale systems and the problems in the systems that are important to examine.

### 2. Convergence

A second trend is convergence. I call it vertical integration, which is bringing to bear separate solutions and technologies into a complete system to solve a very big problem. I have a couple of examples, one of which is the human genome project. Lots of different technologies combined and lots of different solutions for this technology were working together to try to build this data base, solve problems and then provide some meaningful results from those problems.



*We need to position ourselves to be ready to make [ethical] policy statements, to develop those concerns, and then articulate and enforce them, if necessary, as part of the community at large.*

The second example I'm interested in is the digital library. Emergence of a digital library is something that has been funded by the National Science Federation only over the past several years. A lot of movement in that direction has been done and there are various parts of the digital library problem where convergence is necessary to get a viable solution. For example, when you enter data into a digital library, you have to consider how that happens, the quantity of data that you generate, and how to manage it. Then there are steps in the middle that need to converge in terms of bringing new technology to bear. The final piece is actually looking at the data. Do you really want it to come into your small computer screen and try to look at a piece of data that's been digitized in incredibly good resolution? It's like going to a museum and being given a tiny peephole to observe everything that's in the museum. It's not very satisfying. So new technologies have to be brought to bear there and I call that convergence. Those two general trends encompass a lot.

## Three Ethical Concerns

Along with those two trends I'd like to identify some ethical concerns and policies and impacts that will have to be assessed and developed. This is especially critical, and a Christian perspective is really important. We need to position ourselves to be ready to make those policy statements, to develop those concerns, and then articulate and enforce them, if necessary, as part of the community at large. There are three issues here to which I want to point.

### 1. Privacy

The first issue is privacy. There is going to be a huge impact on all of our privacy in the next ten to fifteen years, especially related to the world wide web and the development of the Internet. Homes will have a large number of individual Internet addresses. For example, your furnace will probably have an Internet stack so that the power company can observe the proper function of your furnace and so that you, from a remote site, can control your thermostat. All of those things are well and good. Your refrigerator may have networks so that it can communicate to the grocery store that you're getting low on milk. There is a prototype refrigerator already that has an email screen connected to the Internet. You may be wearing monitors for health concerns that transmit data across the Internet to your doctor. But imagine how bad that could be if your health monitor Internet stack told your refrigerator not to open the door because you're on a diet! That's a humorous example of a bigger problem about losing privacy and in the process maybe marginalizing people and reducing all of us to objects for the bean counters. You can imagine all kinds of other reasons why people would use data that they would collect from those kinds of things, so we'll need strong policies about how to move forward.

### 2. Data Provenance

The second issue is data provenance [data origin]. Repositories of data will become the library, the foundation of our research, and the primary document. How that data changes, who changes it, who's allowed to change it, and how it migrates over time become extremely important. Policy about how to allow changes to data and how to

**Brent Seales**, *Ph.D. Computer Science, University of Wisconsin, Madison, is an associate professor at the University of Kentucky. He was a postdoctoral scholar at INRIA, Sophia-Antipolis, France, and a visiting associate research professor at the University of North Carolina-Chapel Hill.*

track and record changes to that data will become very important.

### 3. Virtualization

The third issue is virtualization. Large displays, which liberate you from the computer monitor, open up a simulation world that appeals to the senses and becomes much more compelling than the kind of medium we have right now with the computer. Virtualization will make a huge social impact, not only for us as researchers, but more so for the naive user and the user who is the focus of a commercial endeavor. I think virtualization—its future impact and policy development—is going to be really, really important.

## Cal DeWitt:

I guess if I were a graduate student right now, I'd be a little overwhelmed. And if I really were the graduate student I once was, I would now go down into my basement and I'd look at my parakeets. I'd look at my little aquarium and tropical fish, get my tweezers out and drop a few worms to the fish, watch them eat, and reflect on how beautiful a world it is in this little aquarium. I might reflect on what really is happening over there on the Amazon River where these fish come from. Anyway, I like to think my own experience as a graduate student, and as a pre-graduate student as well, was fundamental to doing research: to have a love for what you're doing.

This started with me at age three with my first turtle in a growing backyard zoo. My field notes, probably from my early years of high school, show I was a scientist then as well. My field notes were typed and all the scientific names were spelled properly. Keep your mind and eyes open to wonder! And record what you see.

### Start with Wonder

The first thing I'd like to say to you is: Put on the mind of a student of God's creation and don't get captured by what is popular. That is your very first step. Be captured by your work as a student in God's creation. Start with wonder. I say to my students, "I like your individual research projects very much. They're absolutely the most critical thing you could be doing." The reason I say that is that you have to start where you are and you have to start with a love for what you're doing. If you love what you're doing, you will want to do it very well. If you want to do it very well, you're going to work hard to make sure you do it very well, which means you're going to consult with people. Perhaps you are one who is afraid normally to meet with another professor but you love what you're doing so much that you will make the appointment, go over, and discuss your project with him or her because research is in your heart.

### Sense your Research as Being a Psalm You're Singing to the Lord

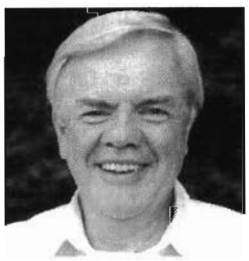
What drives you as a Christian is that your research is really a psalm that you're singing to the Lord! If you don't sense your research as being a psalm you're singing to the Lord, you have to stop a bit and ask if you are on the right page or the right verse. If you don't have the love for your research, then you have to do something to make sure that it is something that is lovable and that inspires you. If you do what you love to do, and you try then to do it very well and you do it very well, what Dad told me is true. Someone will eventually pay you for it!

However, don't first seek the money; seek the dream. If you're a geologist, go out and look at rocks. Do as I did as a boy, go out to Postma's gravel pit and pick up as many fossils as you can and put them on your dresser and wonder about them. Or do as I did when I sat for hours looking at the desert iguana and wondered how this organism really functions. How does it manage to survive in an area where surface temperatures often reach 170° F. in the summer? You have to keep shifting your feet around so as not to burn them. It's so hot you can't even pick up a screwdriver to reconnect your thermocouples to your recorder, but the lizard is living there and never sees free water. Wonder at that. I think research comes from wonder and from that wonder you want to know. If you're a Christian, you will want to do it as a psalm.

### Research with Side Branches in Place or Available so that You Can Move

Another thing I would suggest: pick a problem or nurture a problem so that it will have connections to other problems so that you do not get stuck in the place you began. Many of my colleagues have produced students who are just like themselves. They continue to be just like themselves for the whole career and they produce others just like themselves. Scientists sometimes dig trenches, get in them, and then assure themselves that they are looking at the world as they look at each other. As the trenches get deeper and deeper, they fail to see the whole landscape. Do your research with side branches in place or available so that you can move. You cannot see the future. You cannot know what you're going to discover and once in a while you discover things that are marvelous simply as a result of pursuing another question. When my graduate students say, "Look what new thing I found!" I have responded, "Oh, you're going to have to redefine your question, for which this is the answer." Be ready to make those shifts.

Session V



*As you're doing your research, you should do it as a companion to consulting the Word and as a companion to prayer, because your research itself not only is a psalm but it is also a prayer.*

## Do your Research as a Companion to Consulting the Word and as a Companion to Prayer

*"The earth is the Lord's and the fullness thereof, the world and all that dwell therein"* Ps. 24:1. First, this brings to mind that as you're doing your research, you should do it as a companion to consulting the Word and as a companion to prayer, because your research itself not only is a psalm but it is also a prayer. It's a prayer of praise to God. Sometimes it's a prayer for persistence. Sometimes it's a prayer to make me look in the right direction so that I will be able to see what's there. If you read some of Einstein's biography you will see that he did that a lot. Second, pay real attention to some of the things you're reading in the Scriptures in the light of what you're doing. For example, you could use one of the interlinear Bibles that has Hebrew and Greek in it and find that passage in the Hebrew. It would be translated as "'*eres*' is the Lord and the fullness thereof." Then as a researcher just taking a little break, you could put your computer cursor on '*eres*' and see where all of the other verses are with that word.

Also, you can pick up your Septuagint, the Old Testament in Greek. It may give you insights to these words that are not otherwise available to you. Maybe even theologians haven't thought about it but you have because you're an investigator, a scientist. The way the Septuagint translated these words into the Greek is "the *ge* is the Lord's (i.e., geology) and the *oikoumene* and all that dwell therein." This is the model for the World Council of Churches' ecumenism. It happens to be in the Septuagint and it predates the World Council, so don't push your Septuagints off the shelf because you think they are too liberal. It's in the Bible. *Oikoumene* is translated "world and everything that dwells in it." It's the biosphere. The geological earth is the Lord's and the biosphere is the Lord's. That's the context within which we're doing our research.

## Evaluate your Small Starting Projects in Light of Where You're Heading

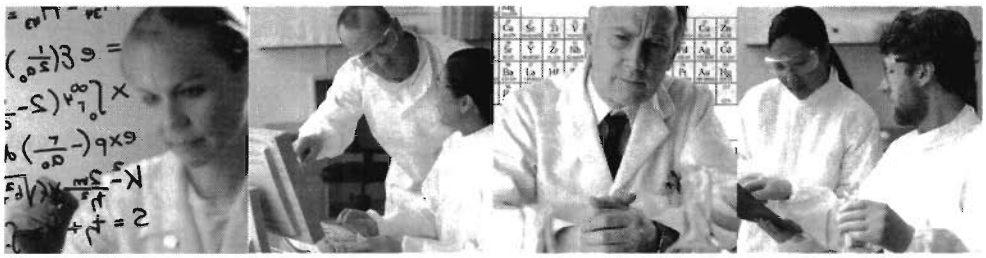
The top research priority is biospheric physiology with integrity. Now think about that. By physiology, I mean the processes of *oikoumene*. One of the things we know is that this structure is something to which we are very strongly chained. We have become a major geological force on earth as a human species and the question we have to be asking is this: "What do we do to the earth that is the Lord's?" And if the earth is the Lord's, we have to do our research accordingly. So evaluate your small starting projects in light of where you're heading. The research and the earth is not ours. The *oekomene* is the Lord's. This answers a great number of questions we've been asking. For example, do we change our own genome so that in another 200 years we can look back at what human beings were like, now that we can see them from the perspective of post-humans, from the perspective of a genome now chosen by the market rather than by God's casting the lot? Does God make choices through Wall Street or does God make choices through the flipping of the coin or other ways? All of our research, I think, can be measured against whether this research that we're doing ultimately leads to making our psalm part of this greater Psalm.

If you're frustrated by this, get an aquarium, buy a packet of white worms, and feed fish!

## Moderator:

As the panel members were sharing, it dawned on me, what an array of human variation, intellectual variation, and style variation we have seen from our speakers! That thought fills me with a great deal of hope. If the Lord has supplied folks like these to ask and answer the questions we're all concerned about and he supplied you and lots of others like you around the world, I think there's a lot of hope for the Christian community and for science. I feel more positive now than I have for a long time. ☆

**Calvin DeWitt**, *Ph.D. Zoology, University of Michigan is professor of environmental studies in the University of Wisconsin's Institute for Environmental Studies and director of the Au Sable Institute of Environmental Studies. He is a member of the University of Wisconsin-Madison graduate faculty of land resources, conservation biology and sustainable development, water resources management and oceanography limnology; a Fellow of the University of Wisconsin Teaching Academy; and a recipient of the Chancellor's Award for Distinguished Teaching.*



# Discussion Session

***Audience:*** *How do you maintain a sense of wonder when working on your research? What about the saying that familiarity breeds contempt?*

***DeWitt:*** *Albert Szent Györgyi, who is a Nobel Prize winner and physiologist, wrote an essay in* Perspectives in Biology and Medicine *when he was 65 or 70. He described how he was in love with rabbits and wanted to really understand them. He began to study rabbit muscle and tried to find a straight muscle with parallel fibers. He further examined the biophyics of the rabbit psoas muscle by investigating its structural components, actin and myosin. Then late in his career, he discovered that he'd lost something, his love for rabbits! In his essay, he described trying to ascend the ladder back to discover where he lost what he lost. He also said that there were some scientific areas of great interest that he intentionally did not study so that he could maintain his sense of awe and wonder.*

*I think you can maintain your sense of awe and wonder about things you really know, but Szent Györgyi discovered just what you're saying. Things became routine even though they were initially wonderful. So he kept some things unstudied so that his wonder would continue. He was like a child right on through to his death. I think that a researcher needs to be a person with childlike wonder that bubbles over when sharing information with others.*

***Audience:*** *I'd like to hear from other members of the panel about how they maintain their sense of wonder.*

***Keister:*** *Sometimes that you have to push through a routine and finish something. There is a sense of wonder but it doesn't always carry the day. Robert Bly wrote a book that deals with various personal characteristics that one can cultivate and strengthen. One of them is what Bly calls "the warrior." He particularly gives examples of what a warrior trait is and it's not simply going into battle with a machine gun. It's things like finishing your Ph.D. dissertation. He mentions that explicitly. I think there's a place where one has to say, "Yeah, this is wonderful and all that but I have to finish it." At some level the loss of wonder is simply a consequence of "the fall." I don't know anybody in any profession who maintains wonder 24 hours a day. We all stumble, and the thorns of life come up and beat us down.*

***Price:*** *In my work at ECHO, it is easy because we are dealing with some of the incredible living resources that God has created and put on the earth. These resources can be a benefit to the poor. I strongly suspect that there's no need for anybody to be poor if we just adequately studied the universe and learn how to make use of it. I don't believe God has put more people in the world than we are capable of feeding. In many ways, it's a worship experience when I walk around the farm.*

*The moringa tree from India is one example of God's resources. The moringa tree is pretty widely spread around the world. It grows very fast, the first year to about 18 feet, stops at around maybe 30 feet, and the leaves are very nutritious. In fact, a number of people now are making leaf powder and using it in hospitals and clinics in the Third World for malnourished babies, mothers who are pregnant that have had a bad history with giving birth, and mothers who cannot give enough milk to feed their babies. If you go to a hospital, you expect to get a shot or medicine. But if you are told to eat a leaf of a tree, that might not make you too excited. The Church World Service in Senegal got amazing results prescribing moringa tree extracts. They give patients a little baggie with green powder from the moringa tree leaves and prescribed adding a quantity to baby food.*

*The seeds of the moringa tree can also be used to purify water. People along the Nile River discovered a formula for use years ago: mash the seed up, add mash from one seed per quart of water, receive clarified water by the next day*

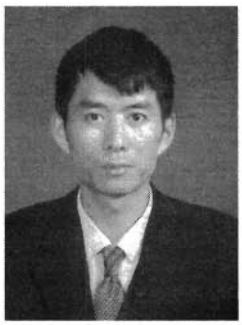
Peter Venable is a graduate student studying computer science at Carnegie Mellon University.

Megan Anderson is a graduate student in pharmaceutical chemistry at the University of Kansas.





Anthony Gerig is a graduate student at the University of Wisconsin studying medical physics.



Henian Cao is a graduate student in cardiovascular genetics at the University of Western Ontario.

*because the solids have settled down and 95% of the microorganisms have settled out with them. I still wouldn't want to drink that if I had other options, but it's a lot better than drinking contaminated water. The roots can be used as a horseradish substitute and are even sold that way in some cases. The blossoms taste about like a radish. The pods are a very popular vegetable in India. That's just one plant in God's creation!*

***Foster:*** *For me, the Christian life is life in tension. I wish that every morning I could get up with joy and wonder, but I don't. A lot of days I soldier through, and I think that's the way life is. On the days when it starts to bother me, I ask, "Am I in the wrong thing?" I'm a person who constantly asks questions and I don't like to take things for granted. If you are constantly asking questions about life, you're going to be asking questions about the things you really enjoy. Even when there is a sense of wonder and there is a sense of joy, the thoughtful life is a life of questions and a life of tension.*

*Another possible point of tension is the question of family – relationships with a spouse and children. I have five children and I really enjoy coming home and seeing my 19-month-old come to the door. He's very excited to see me. I have to balance that with the enjoyment of seeing data at 2:00 a.m. from the neutron beam. I love being in the lab, but I love being with my kids. So I have to balance those loves. Maybe that's something like communication within the Trinity that we heard about earlier. God loved his Son and yet he gave him for us. I have a love for the work that I do, but I also have a love for my children. The Christian life balances various wonders, joys, and loves.*

***Seales:*** *Every time I turn on my Windows 2000 machine and it runs, I'm full of wonder! I started out working in computer vision and I worked really hard to try to build systems that could do intelligent things. The best vision system I ever built was my daughter. She sees better than anything I ever built in the lab and it happened a lot easier. I echo the comments about family. Whenever I lose the wonder with what I'm doing, I bring my kids into the lab and I show them the stuff we're doing. Seeing their reaction makes it worthwhile again because they love it. It brings the wonder back to me because I see it through their eyes.*

***Keister:*** *C. S. Lewis writes about the joy that surprises you. He also writes that if you seek it on its own, you'll never have it.*

***Audience:*** *Last spring, I read some of the writings of Richard Feynmen, a Nobel Prize physicist, who writes about joy and wonder! Books about science will tell you about the scientific method, hypotheses, testing, etc. Einstein took issue with that. He said science moved ahead by wonder and joy.*

***Audience:*** *Aspects of my job are wonderful! There are other things that I have to do that aren't as wonderful. Often when I get caught up in those non-wonderful things, I start to question the bits that are really wonderful.*

***Seales:*** *The faculty group that I pray with every week really helps me. Requests can be shared with them that are a lot more specific than what you usually do at a prayer meeting in your church. You know you can pray for the Dean and the decision that he's going to make over you and other people in the department. Working through those things helps me to realize again that God is sovereign, and that takes some of the difficulty out of it for me. That is very empowering*

***DeWitt:*** *Don't mistake committee work for research. When I came to Wisconsin, I was so pleased and so amazed at our committee meetings. Some of them were very important committee meetings. I got the agenda, usually from a secretary, not from the scientist who was heading up the committee. We went through the entire work of the committee and finished in 1¼ hours, and we'd have the final report. I didn't think that was possible but that's the way most of my committees are at the University of Wisconsin. Sometimes we meet twice.*

*I'm chairman of the Undergraduate Research Awards Committee. We dispense about two-thirds of a million dollars and we have two 1¼-hour meetings per year to do that. We love to do research, so we hire other people to do a lot of the other stuff. One of my committees hired a person to write up meeting results because we all wanted to get back to our research. It was kind of fun doing it quickly. It's a scientist thing to figure out if you can do something really important fast and well.*

***Keister:*** *It has not been my experience that acrimonious debates occur in the universities*

*because the stakes are so low. Things like revising the curriculum generate enormous amounts of acrimony, including committees of very busy people.*

***Foster:*** *I read a story about Paul Brandt's life,* Ten Fingers for God, *describing how Brandt worked several years as a carpenter. Brandt used that experience later. I wonder, "What skill does God want me to learn so that I use it later?"*

***Audience:*** *What is technology going to look like in the future? Do we consider the perils of technology or the promise of technology? To what extent do Christians have a responsibility to exert influence in situations where there is potential peril in technology?*

***Seales:*** *We have teamed up with an educator and a psychologist, who can do human studies for us in some of our projects. As we build technology, we do so with humans in mind. We try to analyze these preliminary studies and release the developed technologies together with our findings about how the technology impacts humans.*

***DeWitt:*** *Two people came out on the wetland behind my house where I do much of my research. It was a great day. There were a lot of things there and as we came back, the man said, "One thing that I'm wondering about is where are all the animals?" I looked at him with amazement but he was serious! I looked at his wife and she was agreeing. It was a great day for animals. We saw lots of animals. These were very educated people. So I quizzed them and discovered that this was the first time they were really out on a wetland. But prior to that they had watched nature films on public television. If my marsh had been put into their control for a major land use decision, they would have allowed the marsh to be filled because they did not know that wetlands are peaceful places with not much happening. There aren't predators swooping out of the air all the time picking up muskrats. It's just basically a very peaceful world.*

*I worry about virtual reality and about education that comes to us largely through videotapes and other visual means. Most of the world is very different than how it is being portrayed in videos. We run the risk of losing creation, while carefully preserving all the good videos!*

***Audience:*** *How does a Christian deal with intellectual property? How do you maintain control of intellectual property so that it can be used in an appropriate way rather than sold to the highest bidder?*

***Price:*** *The botanical garden in St. Louis has a man, who at personal risk, made a collection of all the moringa species in the world. Since his graduate work would soon be done, he wanted to find a place that would love the moringas. So he sent us the cuttings of a couple of them. He later sent me an email and said, "I will be in trouble the rest of my career if these are given to anybody. I signed a collection permit that restricted the passage of this stock to others unless I could guarantee that no commercial use would ever be made of them without an authorized agreement."*

*How could I ever possibly guarantee if a missionary in Nigeria wanted this plant that nothing would happen to it? I understand developing countries are upset that rich companies come in and make a lot of money from their plants, but it may also work the other way. In our case, we want to disburse things that God has made around the world. This plant doesn't belong to a particular developing country. It is part of God's creation. Such a restriction would complicate our ability to operate a free seed bank that shares God's creation. We are going to destroy these donated moringa species since we do not want to cultivate any plant that we're not allowed to give away.*

***Seales:*** *I've seen two approaches to intellectual property. One is to release things to the public domain. A second is to start a company and then dispense with it as you will.*

***Audience:*** *Another problem is that many universities maintain ownership of intellectual property, and so they decide how to market the intellectual property.*

***Foster:*** *It's a complex topic. I know the university's increasing interest in making money off my ideas has made it harder to get funding from industrial sources.*

***Audience:*** *We have something new in our department. Previously we just developed crop varieties and then freely dispensed them. If there was any money, it would come back to the department in a general sort of way and go into developing new varieties. Now we have a very specific system that directs 20% of the profits back to the researchers. A researcher with a lucrative product can make a lot of money! It's not good to research something risky or that has little impact.*

*I have questions about priorities in research. How can we as Christian researchers prioritize the development of high tech stuff that makes life easier with technology and that cares for people who make $2/day? How do we wrestle with this issue?*

***Price:*** *It's hard to know your own heart. If you believe God is calling you to do a particular thing, that answers the question. Otherwise, I think God gives us a lot of freedom. We need to be doing science. We need basic research, applied research, and a wide range of things.*

***DeWitt:*** *The verse in Matthew 6:33, "Seek ye first the kingdom of God..." is good to keep in mind when you're making choices.*

***Price:*** *I wonder about the verse in Ephesians 2:10 (NLT) "For we are God's masterpiece. He has created us anew in Christ Jesus, so that we can do the good things he planned for us long ago." If the correct interpretation of that passage is that God has prepared good works, then a particular good work might be developing non-hybrid crops for the poor part of southern Illinois. Maybe God has a whole range of good works, and we should pick some of them while not worrying about the ones we can't do.*

*Keister: While the American graduate education system is considered the best in the world, it does not convince the products, the students, that they are actually better prepared to do a lot of things other than their thesis research project. There's a need in the world for generalists and Christians are well suited for that. Your graduate school experience gives you the ability to dig deeply into something. Particularly as a Christian that ability and experience may prepare you to do something different in the future. Keep in mind again as a Christian to say, "I'm not going to be the clone of my advisor. I'm going to proceed in this project and if God calls me to do something very different five years from now, I'll have the tools to do it."*

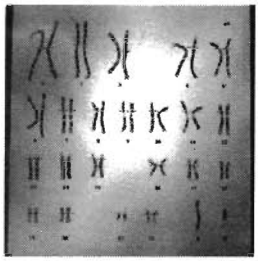
*Price: When I was near the end of my doctoral studies, a professor told me something very liberating when he said, "Now you've shown you can master a field, go master whatever God calls you to master."*

*Foster: I was just in China where they were harvesting rice by hand. My question was, "What is my response to be to the poverty that I see?" I didn't have an answer to that question. I've asked myself, "Should I be doing my research or should I be doing something more spiritual such as feeding the poor?" God can use things that don't seem to be so spiritual. I need to be faithful in what I'm doing right now.*

*I was in Ukraine speaking on the subject, "Are religion and science compatible?" A student came up to me after the main session and said, "You know, I used to be an engineer and then I became a Christian. I was convinced that the only way I could serve God was to go to seminary. Now you've come and talked about your work as a believer and as a scientist. You can present a witness to a community which I can never reach as a seminarian. Why did I give up being an engineer? I never knew this possibility existed."*

*There are strategic opportunities in all kinds of fields. We have to be careful we don't use that as an excuse to do anything that our whims lead us to, but there is something to be said for strategy.*

*Audience: The important thing, that strikes me as being so obvious and yet is so rare in my experience, is having a Christian community that can pray through rough decisions with you. Often it's very difficult to get a church community to grasp your dilemma. It is good to pray with a peer group of believing scientists or academicians.* ☆



**Session VI**

# Where Do We Go From Here?

## Paul Anderson:

When I saw the title for the conference, "Asking the Right Questions," I actually thought about this in reverse. Not how do I as a Christian ask the right question in my work as a scientist, but rather how does science inform or relate to my faith? That's mostly been my walk in the past thirty years. So I approached this conference not really able to clearly formulate the essence of the question. It is a question that I have only implicitly addressed. I'd like to share what I have perceived as five central themes for the conference.

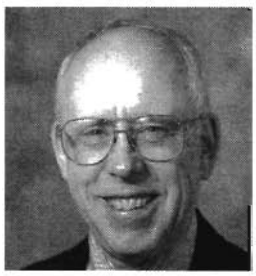
### Five Central Themes

1. *Ask questions* within the context of God's Word and faith. *The Galileo Connection* by Charles Hummel talks about some of the early giants of science who believed nature *and* revelation are both true. A related theme is one of calling or vocation. I once stopped in Colorado Springs to visit a fellow who was a plumber—just a good solid Christian guy. I was educated and he was wise. I said to him, "You know I think I am going to chuck all of this and go to seminary." He hauled out his Bible and traced through some of the things about the Apostle Paul. He said, "Now the Apostle Paul went around and started all these churches. How do you think they kept going?" Answering his own question, he said, "It was people like the local biochemist working at the university who helped keep the church going." Then he added, "You have a ministry in your profession."

2. *Take action.* Work with non-Christians. Within this idea of a calling I have observed a couple of issues especially for Christian students. First, students are reluctant sometimes to get started in a vocation but rather wait around for something special to happen. My sense is this: pray about it, live in God's Word, and take action! The second issue is that we must be out in the world and be a responsible part of the world. I don't think we can be effective ambassadors of Christ nor have an impact on important decisions in the world or government unless we work side by side with non-Christian colleagues.

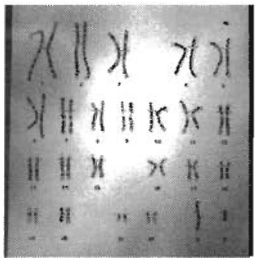
3. *Use your minds.* I had the opportunity to edit the book, *Professors Who Believe.* In the preface, Condoleeza Rice, then Provost at Stanford University, made a wonderful statement when she said:

> I believe that God gave us a brain and intends for us to use it. I believe it is part of His plan that we know more about the universe today than the disciples who walked with Jesus knew about their universe. That, I believe, is part of the growth of humanity (Anderson 1998, 12).



*How does science inform or relate to my faith?*

**Paul Anderson**, *Ph.D. University of Minnesota, is professor of biochemistry and molecular biology in the School of Medicine at the University of Minnesota, Duluth, serving as head of the department from 1971-1986. He is a fellow of the American Association for the Advancement of Science, serves on the Editorial Board of the* Journal of Biological Chemistry, *and has been visiting professor/scholar at the Universities of Washington, Guelph, and Limoges, and National University of Singapore. Current research activities include urea cycle and nitrogen metabolism in fish, cyanate metabolism in bacteria, and mechanism of action of amidotransferases and cyanase.*



**Session VI**

*To avoid a given area, because it doesn't fit with your conscience, may not be the best course of action in which one can have a positive impact.*

4. *Pursue excellence* in what we do. It takes hard work. I don't think we can be effective witnesses unless we do so. I think our main role should be as witnesses to let people know about God through Jesus Christ.

5. *Act with humility.* I've picked that up from many personal conversations. We experience, with awe and wonder, God's grace that provided the opportunity for us to be here in this conference.

Two scriptural passages have impressed me.

> *He has showed you, O man, what is good. And what does the Lord require of you? To act justly and to love mercy and to walk humbly with your God* (Micah 6:8, NIV).

> *My purpose is that they may be encouraged in heart and united in love, so that they may have the full riches of complete understanding, in order that they may know the mystery of God, namely, Christ, in whom are hidden all the treasures of wisdom and knowledge* (Colossians 2:2–3).

## Choices

I think the starting decision point for young people is simply whether to pursue a career in science. It's an important decision because it's going to set the tone for later choices. Some situations present fewer choices. For example, in a military research environment, the goals are set forth and you are asked to work on them. Let's suppose that you have a choice between two different research areas. Maybe one doesn't fit with your faith very well, so you decide not to work on it. However, that area probably will get done anyway because some other team will do it. It might be better to be part of that team. Then you may have an opportunity to influence specific directions in the problem area. So to avoid a given area, because it doesn't fit with your conscience, may not be the best course of action in which one can have a positive impact.

If you are in a university setting, you presumably have freedom to pursue topics of your own interest, but there are a lot of influences on that. First of all—at least in our department—when we hire someone, we have an area in mind that we need to cover. Your choice to accept the position can be influenced by your interest, aptitude, your prior experience, available funding, and the expectations of the department or school. All of that usually determines if you are hired.

As a faculty person, when you help a student select a thesis project funded by a granting agency, you may have conflicting responsibilities. You have a responsibility to guide your student in a project that is fulfilling and adds to his or her education. But you also have a responsibility to the granting agency to complete a specific project. You have to choose a balance between these responsibilities.

Science can demand enormous amounts of time. I do not take that as a negative, because within the enormous amount of time that you spend on science research, ample opportunity exists to witness about your faith. Additionally, as Christians it is very important to glorify our Creator by performing at the maximum of our ability. Your witness to colleagues and to students is affected by your perceived commitment to your work. Choose to give your best efforts in your work to do good science.

Be a good citizen. We're not just free spirits in the university. Should the expectations of others influence one's choice of research? For example, as a professor of biochemistry at a medical school, do I serve the school well if I choose to work on photosynthesis? I just got turned down for an NIH grant because it was leading in the direction of plant biochemistry. I understood that, so I asked myself a question, "Is this research project really good for a medical school, as opposed to other areas that are more related to medical sciences?" For example, if the school establishes a research center with an emphasis on neuroscience to attract funding, should I participate even if it means that I have to change directions in my research? These are thoughtful choices. I think we bring our Christian world view to bear on them.

Finally, we should talk about ethics. In my field anyway, there are some tremendous future ethical decisions that clearly are going to provide us with opportunities for choices.

## Loren Haarsma:

Studying God's creation scientifically is fine Christian scholarship, but we may have trouble explaining that to people outside this group of Christian scientists. There is usually little framework to help you explain this point. So I want to offer you ideas from the Vision Statement of Calvin College: In addition to "conserving" Christian scholarship which promotes an understanding of Christian traditions, there is also "transforming" Christian scholarship which tries to transform society, and "enriching" Christian scholarship, which can "... enhance appreciation for God's creation and human experience, expand the fund of human knowledge and wisdom, help Christians engage in proper self-criticism or self-understanding, and enrich the testimony of the Christian message." You can use that framework, especially the last two categories, to explain to others why your scientific research really is Christian scholarship.

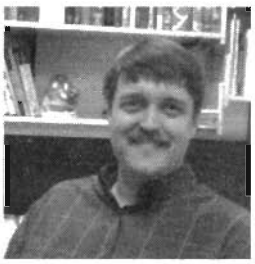
You can also use what C. Stephen Evans wrote in his lecture, "Christian Scholarship and the Biblical Drama," which he gave at Yale University in 1999. He described *explicit* Christian scholarship where Christianity obviously effects your choice of topic, *implicit* scholarship where Christian faith shapes your choice of issues and the hypotheses you test, and *vocational* Christian scholarship, which involves Christians doing excellent work in their disciplines, contributing to the development of new knowledge, furthering the general good and also demonstrating that it is indeed possible for a thoughtful and educated person to live as a Christian in today's world.

We're doing Christian scholarship. How do we make that true day by day in our own work? Several people, Cal DeWitt especially, did some wonderful things at this conference in bringing wonder and appreciation for God's creation. Terry Morrison talked about bringing the presence of God with you into your work. Plenty of opportunities occur each day when you can step back, take a breath, and reflect by bringing the presence of God into the moment. Additionally, share your sense of wonder in your work with other Christians, with other Christian faculty that you know, or with Christians in your church. Maybe they can't all appreciate it, but some of them can. Share something about the sense of wonder in your work so that other Christians, especially children in the church, can help you appreciate God's creation.

How do we pick a research group? One piece of advice I have is to make use of the built-in wisdom and experience of the scientific community. We've been warned about how the scientific community can negatively influence our choice. People use pride, self-interest, and ego to pick their research. Contemporary research trends, agendas of the military, or interests of corporate sponsors can be negative influences that affect our research choice. But there's also a lot of good wisdom and experience built into the scientific community, people who have been in the field longer than you have.

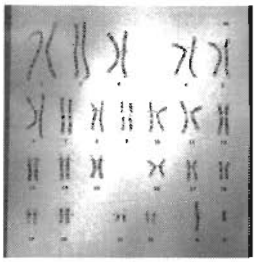
Some scientists working in certain discipline fields, such as artificial intelligence, the environment, brain research, genetics, evolutionary biology, evolutionary psychology, and some developments in technology, are prone to put an atheistic interpretation on their research area. You may know of other areas where people are putting an atheistic interpretation on the research. If you are in one of these areas—maybe you feel called into one of those fields—then you can use the sense of calling to think strategically about what research topic you want to explore. Or maybe you entered that field of study from a sense of wonder and you suddenly say, "Oh, look what's going on here?" I'm in neuroscience so I feel a special calling to be aware of what neuroscientists are saying about human nature. Some neuroscientists want to put an atheistic, materialistic interpretation on what neuroscience is saying. I believe I have to be especially aware and respond to that.

Also, as we are thinking about what research topic to choose, there are areas of scientific and technological research where you can impact the poor more directly and



*Studying God's creation scientifically is fine Christian scholarship.*

**Loren Haarsma**, *Ph.D. Physics, Harvard University, has done postdoctoral research in neuroscience at Tufts University and at the University of Pennsylvania. He is currently an assistant professor in physics and astronomy at Calvin College. His research focus is the functional organization of the retina.*



**Session VI**



*Think especially about people with whom you could collaborate, who are not at rich American and European universities. "Can I make a good advance while collaborating with someone who doesn't have optimal resources?"*

more immediately. If you feel called by God to do scientific research that more directly affects the poor, then you should think strategically about going into an area such as the environment, certain kinds of engineering and technology development, most forms of medical research, science education, and research into behaviors like drug addiction, etc.

Once you have entered into your research topic, the methods you use are very important. Sometimes when you are doing your research, you have to go to the "big stars" in the field. Honestly, you have to go to them to learn how to do your research project. But there is also the temptation to try and hitch your wagon to their "stars" to advance your own agenda. You could choose to collaborate with somebody who also does very good work, and who may even need your help to advance their career. You can serve the poor and needy in the sciences. Think especially about people with whom you could collaborate, who are not at rich American and European universities. "Can I make a good advance while collaborating with someone who doesn't have optimal resources?" You could help them even as they help you. That's worth considering as you think about how to direct your research topic.

I want to advise persons who are thinking about switching their career or who are at a stage in their career where they are thinking, "I can take a new direction now. What can I do?" An obvious response to that question is to read newspapers, professional journals, and attend professional conferences. Maybe a less obvious response is to think about your own particular talents. We're not all going to be top scientists in the field. But I believe that you possess a few talents that are better than anyone else in your research group. Likewise, you have a few areas where you may not be as good or may be the worst in your research group. A successful research group needs a collaboration of talents. If you use your particular talents to serve your group you are being a servant. Also that helps you think strategically. If you know what your particular talents are, you can find and fill the right niche. Know your talents and know your motives. Step back and remind yourself about the themes of this conference. Motives are important. You want to serve God. You want to serve society. Egotism is not your motive. Thinking about those motives can sometimes help direct you.

What specific things can we do coming out of this conference? Maybe InterVarsity Christian Fellowship with the American Scientific Affiliation can put together a web page with profiles of Christians who are doing research in science that includes a little biography and an explanation of the research they are doing. Then young people could go there and see whom they want as a mentor. Or, maybe biologists, who want to think about ethics, might connect with the Christian Medical and Dental Society, which has an ongoing program of ethics. Pass on what you have learned here. There are many Christians in science, who didn't come to this conference, who have a feeling they should be thinking about these issues, but they haven't explicitly thought about them. They don't even quite know how to put it into words. You can talk to them. You can take what you've learned in this conference to help them think about their choice of a research topic.

Let's go back to that first question. "Why does God care about research topic choice?" There were some really good answers given this weekend. One answer is that your own personal spiritual relationship with God needs to grow and your vocation is part of that relationship. Part of your spiritual life is in both the big decisions and the little decisions you make every day in your research. God can use your vocational choices and your research topic to help other people. God can put you in place so you can witness to other people. Since God wants you to delight in his creation, you should pick a research topic that allows you to delight in it.

God also wants us to learn wisdom, both individually and corporately. God devotes whole books in the Bible to wisdom. How you do your research every day is going to affect how you learn wisdom in your life. Contributions you make to knowledge, both for the world in general and for the church, are ways you can help us corporately grow in knowledge and wisdom. God wants us to learn wisdom. That's why God cares.

## William Dembski:

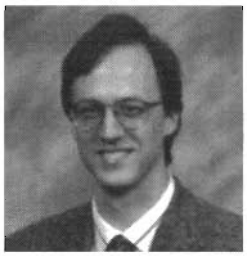
As a philosopher of science, my interest is to maintain the integrity of science. There's a Russian story, *The Fixer* by Bernard Malamud, of a young man, Yakov Bok, raised in a small town who wanted to go to the big city. He packed up his few belongings, left his family and his security, and went on his way. The trip took probably a day but it was raining and cold. He began to reflect on whether he should go back or go on to the city. The question that motivated him to go to the big city was this: "Does a man really have a choice if he does not know what his choices are?"

I think we should consider that in our own context. Do we know what our choices are as scientists? Do we really have choices? Do we have freedom in science if we don't know what our choices are? And in terms of asking the right questions, can we ask the right questions? The questions we can ask are in some ways artificially constrained for we may not have the academic freedom to ask the questions we want to ask. I am facing this very issue at Baylor University, where in 1999, I started a center called the Michael Polanyi Center named after one of my heroes. Polanyi, a physical chemist, turned to philosophy because he was upset with what he saw happening in the scientific world when philosophical presuppositions were constraining scientific inquiry and really preventing science from being the fruitful sort of enterprise that it could be. I have a broad set of interests in the central questions of science, science/religion questions, and also Intelligent Design questions.

Intelligent Design asks, "Do mathematical and empirically based methods exist that detect the effects of intelligence, and if so, how can those methods be applied to the natural sciences?" That approach raises a lot of hackles, because intelligence, especially if you are wedded to a Darwinian and naturalistic world view, is not something that's really fundamental or intrinsic. It's not that God by wisdom created the world, rather intelligence is something conferred by natural selection. It's an adaptation. It's something that helps us survive and reproduce. And I have actually seen that fine line of thinking in the people who have challenged me. That should cause us some pause because it is by means of our intelligence that we have inferred or come to a Darwinian view.

The Intelligent Design question—the question that I just posed—has caused controversy at Baylor. We put together a conference in April of 2000 entitled "The Nature of Nature: The Role of Naturalism in Science" and attracted two Nobel Laureates, Christian De Duve and Stephen Weinberg, and several members of the National Academy of Sciences. It was a resounding success! In fact, Christian De Duve toasted the conference afterwards at dinner and raised the question, "Perhaps there was an intelligent design behind this conference?" It was really quite heartwarming. That was on a Saturday evening, but a few days later the Baylor Faculty Senate voted 26 to 2 to shut down the Polanyi Center. The Baylor faculty largely boycotted the conference. So this has been disconcerting for me.

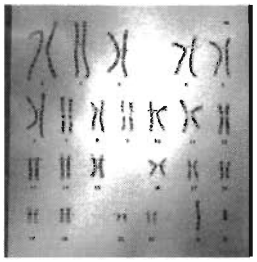
I am trying to get a microbiologist to work with my group at the Michael Polanyi Center, who is working on applications of some of the methods I've developed to individual enzymes and showing that these things are really pretty finely tuned. He has published in *The Journal of Microbiology*, the *Proceedings of the National Academy of Sciences*, etc. I was asked to show this paper to some of the biologists at Baylor. One of these biologists appeared on the front page of the *Houston Chronicle* criticizing the Polanyi Center. When he first got the paper he said, "Oh, this is an excellent paper! It's an excellent paper, but I don't see what it has to do with design." And then when it was pointed out to him what the connection was, he said, "Oh, this is just political. This isn't scientific." So this is the sort of thing I have been dealing with. I'm not trying to



*Does a man really have a choice if he doesn't know what his choices are?*

---

**William Dembski**, *Ph.D. Philosophy, University of Illinois, Chicago; Ph.D. Mathematics, University of Chicago; and M.Div. from Princeton Theological Seminary, is a mathematician and philosopher, associate research professor in the conceptual foundations of science at Baylor University and a senior fellow of Discovery Institute's Center for the Renewal of Science and Culture. He has taught at Northwestern University, Notre Dame, and the University of Dallas. He has done postdoctoral work in mathematics at MIT, in physics at the University of Chicago, and in computer science at Princeton University.*







*There exist world view conflicts that create violence at the local level and, in my view, create violence to research and inquiry.*

convert you or make a plea for Intelligent Design. Where you come out on this is your thing, but I would like to have a place at the table of discussion. I would like to be able to ask certain questions, but what I find is that because of certain philosophical presuppositions, I'm not being permitted to ask certain questions. Now I think it's important to keep in mind that there's an asymmetry in the role of philosophical presuppositions in terms of, on the one hand, motivating research and on the other hand blocking the raising of certain questions and certain research.

In the past there have been all sorts of philosophical presuppositions that have motivated research, some of which you may regard as kind of flaky. Maybe the initial research, which they motivated, was kind of flaky, but it has still produced some good things. Take alchemy, for instance. It was a precursor of modern chemistry. What was the philosophy driving alchemy? It was the Platonic views about The Great Chain of Being. Given the view that everything is part of this hierarchical structure, going from base to precious metals, let's say, would be something that should be possible. Lead, let's say, would be lower on the chain of being so all you needed was the proper "filip" to drive lead to gold. This Platonic view was driving a certain research project. We discount that project, we discount the philosophy, and yet it has led to some fruitful things. I say that philosophical or theological motivations in driving research are just fine. Stanley Jaki, a great historian of science, argues that it was a Christian world view that gave rise to modern science. Many different civilizations have gotten to the point where the development of science would have been possible, but in fact, it took a belief in the creator God who had made a world that was open to inquiry which was not divine, but could be experimented with, to birth modern science.

I think philosophical and theological presuppositions can motivate research. And I think naturalistic presuppositions can also motivate research. Take the SETI program, Search for Extraterrestrial Intelligence, for instance. I think what drives that is some sort of super Copernican principle, or Principle of Mediocrity, that somehow we're not special, so of course, there will be life elsewhere. So people are looking. Now there's been no good evidence for life being elsewhere, but this research could conceivably lead to something interesting. Now if I were an NSF program officer, I would fund SETI research. In fact they are being largely privately supported these days. My philosophical presuppositions would influence me in terms of what I would support. I would let "a thousand flowers bloom" in that regard. When philosophical presuppositions block research and the questions that we can ask, a real problem becomes evident. That's where I would caution you. Watch this closely. Watch the philosophical presuppositions especially when they prevent you from asking certain questions.

**Susan Drake Emmerich**, *Ph.D. candidate in Environmental Science, University of Wisconsin, Madison is a Harvey Fellow and consultant to the Tangier Watermen's Stewardship for the Chesapeake. She was formerly director of the Au Sable Institute of Environmental studies, East Coast and consultative faculty member at Salisbury State University's Center for Conflict Resolution, in addition to working at the U.S. State Department as the U.S. representative for Environmental Affairs at the United Nations and U.S. negotiator for the U.N. resolution establishing the earth summit biological diversity convention and global climate convention. She was also director of the International Secretariat for the International Coral Reef Initiative and senior conservation officer working on bilateral affairs in China, Japan and Brazil.*

## Susan Drake Emmerich:

Let's step back for a moment and instead of introspectively focusing on research questions—though very important—think through the importance of knowing the times in which we live. The conflicts that we, as researchers who are Christian, encounter are very real. There exist world view conflicts that create violence at the local level and, in my view, create violence to research and inquiry. I suggest that there are at least two types of conflicts that we need to be aware of as we think through the more introspective questions.

## Conflict: Religious Freedom in the University

First, conflict exists in the universities over the freedom of religion and religious expression. For example, InterVarsity Christian Fellowship has been struggling at Tufts University to maintain its freedom as an organized campus group which holds to a particular biblical world view regarding requirements for its leadership.

Second, conflict exists over the freedom of expression. There is a silencing in university classrooms and among faculty of particular viewpoints that tend to be teleological in nature. One example is of a Christian law student at a state university who was brought before the institution's board to explain why he favored the views of a particular conservative Supreme Court judge that, according to one of his classmates, is racist because he was against affirmative action. The state university was concerned about graduating someone with this student's particular views.

Third, conflict exists over freedom of scientific inquiry. It takes many forms. One of them is the type of inquiry or, more specifically, research questions permitted by departments of social science, humanities, and natural science. I have been very fortunate at the state university I attend to have had complete freedom to choose a faith-related topic for my dissertation. But that was due to the fact that my committee chair is a person of faith and helped me choose other committee members who would either not be averse to the topic or would be somewhat sympathetic. However, many graduate students are not so fortunate.

## Science under Attack within the Evangelical Community

Those of us who are Christians in the environmental sciences are faced with a modern-day backlash against science, particularly environmental science that has its roots in the reaction against liberalism that infiltrated the church and the university in the 1930s.

While in a Deerfield, IL, coffee shop, I found a newspaper with the following headlines: "Science Debunked on DDT—Fine for Use on Crops" and "Science Debunked on Global Warming." Each article took the view that the science promoted in the public on such issues as DDT and global warming is suspect if not downright false and known as "junk science." As Christians in the sciences, it is our responsibility to teach fellow Christians the difference between "sound science" and "junk science." The latter is science that does not conform to the rigors of scientific inquiry and peer review. University of Maryland's Center on Ethics and Public Policy has disproved the claim that most environmental science is "junk science."

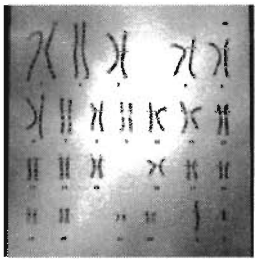
## Ministry of Reconciliation

My dissertation research is an extension of the biblical call for all believers to be ministers of reconciliation. I would like to share with you the way in which I was able to express this ministry in my research.

I received a phone call from a colleague of mine who served with me on the board of the Au Sable Institute and was the Vice-President of the Chesapeake Bay Foundation (CBF). He told me that CBF's shed on Smith Island had been burned down by watermen who were angry over a regulatory proposal that CBF had made to help slow down the decline in the blue crab fishery. Smith and Tangier Islands are located in the middle of the Chesapeake Bay and eighty-four percent of their population consider themselves conservative Christians. My colleague asked if I would be interested in focusing my dissertation on resolving this conflict. I immediately took this request to God in prayer. It is important to intimately know God in order to understand the research to which God has called us. It took almost three months of prayer before I understood that God, rather than my own interests, was leading me to conduct this research.

I would encourage every one of you to develop an intimate prayer life with the Lord because it will sustain you and enable you to persevere throughout your research. Every morning I awake and before I do anything, I sit quietly and read and study the Word of God. Next, I take time to ask the Lord for wisdom to understand the best

*I would encourage every one of you to develop an intimate prayer life with the Lord because it will sustain you and enable you to persevere throughout your research.*



**Session VI**



*Don't hold back your faith. Be bold. There's no reason to not subordinate your research to your faith unless you are unwilling to pay any costs at all. Often, there is no cost to pay.*

way to write the next section of my dissertation such that the content will glorify God and I will be blessed with peace and calmness while writing.

My dissertation research addresses the influences that create social and personal change. My own belief is that to have sustained social change, it must be accompanied by personal transformation. The research paradigm that most closely aligns with this view is called a "participatory paradigm." Its purpose is to create movement for personal and social transformation in order to redress injustices, support peace, and promote democracy and ecological harmony. As opposed to other paradigms (positivist or interpretative), it allows for the researcher to "participate" with people of a community in generating new knowledge. This process is called collaborative action inquiry and involves an action-reflection process.

My research design is a mixed methodology of ethnography and action research. While conducting an "ethnography" of the culture, I became a part of the community by teaching Sunday school and living with a widow and her two children. This helped me form relationships with the islanders as a sister in Christ rather than simply as a researcher. These bonds of friendship were invaluable in eventually reconciling the broken relationship between the islanders and the CBF environmentalists.

The ethnography provided an assessment of the factors contributing to the conflict. They were: (1) the watermen's fear of losing their way of life and economic livelihood; (2) the watermen's inaccurate perceptions and suspicion of the motivations of outsiders, especially environmentalists; (3) the lack of understanding and respect by each party for the other's knowledge and world view; and (4) external factors such as a changing technology, a global economy, and different stakeholder agendas. The ethnographic results were provided to the islanders to assist them in understanding the problems they faced in the fishery and the ideas their own people had to change in the future.

I was asked to return to the island to assist them in developing a biblical environmental stewardship effort for the island. Through this faith-based effort, the islanders developed a "20/20 Vision Plan," a ten-page plan of action to address fishery, economic, and pollution concerns from a biblical perspective. In addition, the people made a pledge to be better stewards of God's creation and to obey all the civil and fishery laws under a "Watermen's Stewardship Covenant." The watermen knew that if they fully complied with all of the laws, it likely meant financial sacrifice. Regardless, the watermen made the pledge to God.

The environmentalists had been working to instill an environmental ethic on Tangier for fifteen years and were amazed at the radical transformation that seemingly took place overnight. Seventy- and eighty-year-old watermen were seen placing trash bags on their boats for the first time in their lives because they realized they needed to obey God in all areas of their life. The personal transformation that took place fostered a community-wide social transformation among islanders. Many of the Tangier people came to understand what it meant to walk in right relationship with God, with their neighbor, and with creation. There was reconciliation between the Tangier people and the environmentalists after each asked for forgiveness for their respective actions toward the other.

New organizations were formed as a result of the faith-based stewardship effort. Several Tangier women formed an educational and advocacy group called "FAIITH" (Families Actively Involved in Improving Tangier's Heritage) which, among other things, sought to collaborate with government and advocacy groups to find solutions to maintain the watermen's heritage. By gaining a voice in the legislative process, they won several legislative battles that affected their livelihoods. In addition, the island is much cleaner than it had been in twenty years and the Bay surrounding the island is also cleaner. Constant prayer among the leadership and members of the effort was a vital component throughout the initiative.

This research has elicited a very positive response from nearly every person who has seen the recent PBS film about the effort called "Between Heaven and Earth: The Plight of the Chesapeake Bay Watermen"

or have been involved in the effort. Whether they are environmentalists, scientists, government officials, or academics, all have found the research methodology and results to be illuminating and thought provoking.

The moral of this story of research is: Don't hold back your faith. Be bold. There's no reason to not subordinate your research to your faith unless you are unwilling to pay any costs at all. Often, there is no cost to pay. ☆

## Discussion Session

***Audience:*** *I will direct this question to Loren. Is coming from a self-identified Christian institution, either a handicap or opportunity within a broader scientific community?*

***Haarsma:*** *It's a real opportunity to open conversations. In my experience, when people find out a little bit about Calvin College, their curiosity often drives a subsequent conversation. Obviously some people will think negatively about me simply because I am a Christian or come from a Christian college. I haven't encountered that personally, unless some people were really good about hiding it. Instead what I find is that some people don't want to talk any further about Christianity if they know I am a Christian. But other people do want to talk more. They want to find out what's going on. So I find it opens the door.*

***Audience:*** *Are you excluded from certain scientific circles because of being a Christian?*

***Haarsma:*** *Since I am young in this field, I don't know what to say about that. You could ask older people at Christian colleges that question. It's hard to disentangle what effect that might have from my heavy teaching load that makes it difficult to produce a lot of new research on my own. The general impression I get from the rest of the faculty at Calvin College is that they have colleagues who know them and who respect their work, both the work they did in graduate school and as post docs and the work they have done subsequently. Again scientists are pragmatists. They respect competence and if you have shown that, then that's good enough.*

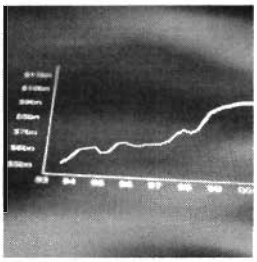
***Russell:*** *I'd like to carry on with something the last two speakers said. My heart warmed when Susan used the word "radical" because that is exactly what we have to be as Christians, for Jesus Christ was the most radical person who ever lived. I think we have to remember that. But she touched also on a theme as many others have the last two or three days and that is the fact that our churches don't love us. This is not anything I have ever met in the UK but it clearly is a problem over here. And one has to deal with it.*

*Secondly, one reason for the general disenchantment with science in the UK is that we have failed to make a distinction between science, which we have to defend, and scientism, which we have to attack with all the forces we have. Scientism is an exaltation of science that owes much to Thomas Henry Huxley. It says, "Science is a method of finding out facts. Science is the great end. Science is the thing which we should always be proud to belong to. And science is always something to be worshiped."*

*Many of us don't make the distinction clearly between science and scientism. We must defend science but we can't defend scientism because scientism is actually anti-Christian. We also need to distinguish between real Christianity and what I would call "Christianity plus," which is adding to basic Christianity suppositions such as those in Young Earth Creationism. Christianity is not tied up to a particular interpretation of the book of Genesis, for example. And we have to be desperately careful that we can make that distinction, so that when non-Christian scientists attack us, it's on the right grounds. Let it be because we believe in one God, we acknowledge the Lordship of Jesus Christ, and we acknowledge the trustworthiness of Scripture, etc. Let's be attacked because of these things but not because we import all sorts of add-ons. We have to be so careful about that. And that's where we have to be radical.* ☆

John F. Bratton works at the U.S. Geological Survey Woods Hole Center as a postdoctoral researcher in geology.

Christoph Mertz is a postdoctoral researcher in robotics at Carnegie Mellon University.



Conference Summary

# What are the Major Themes of this Conference?

*"Did we provide a set of steps by which we can determine the right research question infallibly?" "No!"*

We asked ourselves the question, "How should our Christian faith influence our choice of research problems?" Every presentation and each discussion revolved around that concern. Here, in outline form for ease of interaction, are distillations of the weekend's conclusions and development of further questions. Please refer to the various talks to further develop these perspectives.

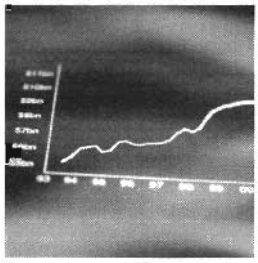
I. What guidance can we find to direct us to answer our question?

A. General

1. The essential being of God—the Father, Son, and Holy Spirit united in love, action, and knowledge—is caring for and involved in the creation. Since God is our Savior and lives in us, of course, he cares what we, his children, do and what is done with his cosmos. To most effectively experience this care of God for us and his creation, we must work to develop fully Christian minds (cf. Suppe, p. 221).
2. Of first importance is to grapple with the call of God, for our lives and our research. There is the general call to love God with our all and to seek his kingdom before all else. But all were agreed that we can know that he called us into science and to our particular place in it, even including our current work site (cf. Harper, p. 225).
3. Arthur Holmes said, "If all truth is ultimately God's truth, then we have no reason to denigrate some areas of learning by regarding them as either worldly or beyond help, or as having little or no importance. On the contrary such learning needs to be restored to the wholeness of God's truth from which it is torn."

B. Specific guidance

1. Colin Russell gave us seven "determinants of choice" derived from his survey of the history of this question and from his own experience.
   a. Fascination for the topic.
   b. To the greater glory of God.
   c. Social benefit.
   d. The intentions of the research supervisor or director.
   e. Personal ambition.
   f. Financial gain.
   g. Is it ethically objectionable?
2. Many addressed the issue of permitting the possible availability of funding to solely or largely determine what we study, indicating that this was not the appropriate motivation for Christians (cf. Eden, p. 263) but funding agencies do have two mandates that direct our action and we find them appropriate: Does the research promise societal benefit and/or does it have high potential intellectual impact?
3. We must always ask of any proposed research effort, "Is this a





good stewardship, before God and his values, of my days and years and of the talents and experiences he gave me? (cf. Keister, p. 270 and Eden, p. 263).

4. Many pointed out the need for collaboration in research and for life as a Christian researcher:
   a. With experienced, more senior members of our research discipline, fellow believers and/or nonbelievers.
   b. With researchers in more difficult circumstances, where we may serve by our joint efforts, e.g., Christians in developing country universities or in non-research oriented Christian colleges here in the U.S.
   c. In prayer and searching the Scriptures with small groups of believing fellow researchers at our own institution or in our own disciplinary national groupings.
4. We can ask very specific questions of potential research areas such as those given by Mark Foster which he called his "five sieves":
   a. What fundamental areas of research do I think would be of interest?
   b. What kind of technology driven research do I think would be of interest?
   c. What sorts of research might I do that would have obvious components of service to others, not necessarily from a Christian point of view?
   d. He looked at the question of naturally occurring materials and asking what areas of interest are there for me there?
   e. Are there materials science research topics that are peculiarly Christian?

II. What are some of the barriers we may face as we seek right directions?
   A. There is often an anti-science prejudice to be found in evangelical/fundamentalist churches. For biologists in particular, this is a tricky issue. How do we find support and encouragement for our vocational discipleship from those at our own church families?
   B. So many at the conference complained of isolation from other Christians in science. How can we get informed discussion of these issues on a more regular basis with fellow believers?
   C. There is often opposition, covert or overt, from the non-Christian culture around us. It may take the form of an unhistorical dismissal of Christian faith as "disproved by science" or it may be an unwillingness to consider certain issues because they could lead to affirmations of God's being. Some believers in the university have experienced discrimination in hiring and promotion etc. because of the open character of their faith.
   D. One of the great weights upon us is the fear that our discoveries may be used for ends we find to be unethical and counter to God's values. We fear that we cannot control the application of what we believe God led us to.

III. In light of all this, what recommendations can we make?
   A. Try to discern the future, yours and that of your discipline and the larger culture around you.
      1. Will there be opportunities opening up which you could take to use your research to benefit others? For instance, the poor?
      2. Think deeply about potential developments in your own field, as was modeled for us by Brent Seales as he looked at issues in computer science.

         Issue 1—Privacy
         Issue 2—Data providence
         Issue 3—Virtualization

         Each of these are major areas for research and development in computer science but also each will have significant impact on our culture and probably on believers.

*"Did we provide helpful insights, suggestions, and models to help in this process?" "Yes!"*

B. Be sure to do your work in the right spirit, as Cal DeWitt counsels. Be sure you are doing what you love and loving what you do—or get out! He also urged us to do our work as a "psalm we are singing to God." Someone else referred to it as "doxological work."

C. Use the ideas of C. Stephen Evans as quoted by Loren Haarsma to look at your own work. Evans talks about "*explicit* Christian scholarship where Christianity obviously affects your choice of topic, *implicit* scholarship where Christian faith shapes your choice of issues and the hypotheses you test and *vocational* Christian scholarship, which he described as Christians doing excellent work in their disciplines, contributing to the development of new knowledge, furthering the general good and also demonstrating that it is indeed possible for a thoughtful and educated person to live as a Christian in today's world." This may help you see the why of your research more clearly.

D. A number of speakers pointed out how necessary it is to know ourselves well; our calling, giftedness, talents, experiences and hopes. Write out an inventory and consult with others.

E. Susan Drake Emmerich urged us to be radical in the sense of living by values that go right down to the root of reality and to live by a bold faith sustained by lots of prayer.

So, did we provide a set of steps by which we can determine the right research question infallibly? No! Did we provide helpful insights, suggestions, and models to help in this process? Yes! There are lots of next steps for many of you in this collection of papers. We had a great time together in this conference. We would love to do it again, and we all know there is a lot more to be done. Join us in growing in these areas. Feel free to comment either to Roman Miller, editor of *Perspectives on Science and Christian Faith* (millerrj@rica.net), or to me (tmorrison@ivcf.org). ☆

Terry Morrison, Ph.D.
*Conference Organizer*
*Director of Faculty Ministries*
*InterVarsity Christian Fellowship*

United States Postal Service
**Statement of Ownership, Management, and Circulation**

| 1. Publication Title | 2. Publication Number | 3. Filing Date |
|---|---|---|
| Perspectives on Science and Christian Faith | 0 9 9 2 - 2 6 7 5 | September 25, 2001 |
| 4. Issue Frequency: Quarterly | 5. Number of Issues Published Annually: 4 | 6. Annual Subscription Price: $30.00 |

7. Complete Mailing Address of Known Office of Publication (Not printer) (Street, city, county, state, and ZIP+4): 55 Market St, Ipswich, Essex County, MA 01938-0668 — Contact Person: Laurie Grover; Telephone: 978-356-5656

8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer): American Scientific Affiliation, PO Box 668, Ipswich, MA 01938-0668

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do not leave blank)
Publisher (Name and complete mailing address): American Scientific Affiliation, PO Box 668, Ipswich, MA 01938-0668
Editor (Name and complete mailing address): Dr. Roman J. Miller, American Scientific Affiliation, PO Box 668, Ipswich, MA 01938-0668
Managing Editor (Name and complete mailing address): Lyn Berg, American Scientific Affiliation, PO Box 668, Ipswich, MA 01938-0668

10. Owner (Do not leave blank. If the publication is owned by a corporation, give the name and address of the corporation immediately followed by the names and addresses of all stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, give the names and addresses of the individual owners. If owned by a partnership or other unincorporated firm, give its name and address as well as those of each individual owner. If the publication is published by a nonprofit organization, give its name and address.)

| Full Name | Complete Mailing Address |
|---|---|
| American Scientific Affiliation | PO BOX 668, Ipswich, MA 01938-0668 |

11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check box → ☒ None

| Full Name | Complete Mailing Address |
|---|---|
| -none- | |

12. Tax Status (For completion by nonprofit organizations authorized to mail at nonprofit rates) (Check one)
The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes:
☒ Has Not Changed During Preceding 12 Months
☐ Has Changed During Preceding 12 Months (Publisher must submit explanation of change with this statement)

PS Form 3526, October 1999 (See Instructions on Reverse)

| 13. Publication Title: Perspectives on Science and Christian Faith | 14. Issue Date for Circulation Data Below: September 2001 | Volume53:Number 3 |
|---|---|---|
| 15. Extent and Nature of Circulation | Average No. Copies Each Issue During Preceding 12 Months | No. Copies of Single Issue Published Nearest to Filing Date |
| a. Total Number of Copies (Net press run) | 2480 | 2537 |
| b. Paid and/or Requested Circulation (1) Paid/Requested Outside-County Mail Subscriptions Stated on Form 3541. (Include advertiser's proof and exchange copies) | 2124 | 2050 |
| (2) Paid In-County Subscriptions Stated on Form 3541 (Include advertiser's proof and exchange copies) | 0 | 0 |
| (3) Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Non-USPS Paid Distribution | 0 | 0 |
| (4) Other Classes Mailed Through the USPS | 0 | 0 |
| c. Total Paid and/or Requested Circulation (Sum of 15b. (1), (2),(3),and (4)) | 2124 | 2050 |
| d. Free Distribution by Mail (Samples, complimentary, and other free) (1) Outside-County as Stated on Form 3541 | 157 | 169 |
| (2) In-County as Stated on Form 3541 | 0 | 0 |
| (3) Other Classes Mailed Through the USPS | 24 | 2 |
| e. Free Distribution Outside the Mail (Carriers or other means) | 0 | 0 |
| f. Total Free Distribution (Sum of 15d. and 15e.) | 181 | 171 |
| g. Total Distribution (Sum of 15c. and 15f) | 2305 | 2221 |
| Copies not Distributed | 175 | 316 |
| Total (Sum of 15g. and h.) | 2480 | 2537 |
| i. Percent Paid and/or Requested Circulation (15c. divided by 15g. times 100) | 92.2% | 92.3% |

16. Publication of Statement of Ownership
☒ Publication required. Will be printed in the December 2001 issue of this publication. ☐ Publication not required.

17. Signature and Title of Editor, Publisher, Business Manager, or Owner: Laurie P. Grover, Financial/Circulation Manager — Date: September 25, 2001

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

**Instructions to Publishers**

1. Complete and file one copy of this form with your postmaster annually on or before October 1. Keep a copy of the completed form for your records.
2. In cases where the stockholder or security holder is a trustee, include in items 10 and 11 the name of the person or corporation for whom the trustee is acting. Also include the names and addresses of individuals who are stockholders who own or hold 1 percent or more of the total amount of bonds, mortgages, or other securities of the publishing corporation. In item 11, if none, check the box. Use blank sheets if more space is required.
3. Be sure to furnish all circulation information called for in item 15. Free circulation must be shown in items 15d, e, and f.
4. Item 15h., Copies not Distributed, must include (1) newsstand copies originally stated on Form 3541, and returned to the publisher, (2) estimated returns from news agents, and (3), copies for office use, leftovers, spoiled, and all other copies not distributed.
5. If the publication had Periodicals authorization as a general or requester publication, this Statement of Ownership, Management, and Circulation must be published; it must be printed in any issue in October or, if the publication is not published during October, the first issue printed after October.
6. In item 16, indicate the date of the issue in which this Statement of Ownership will be published.
7. Item 17 must be signed.

*Failure to file or publish a statement of ownership may lead to suspension of Periodicals authorization.*

PS Form 3526, October 1999 (Reverse)

# Bibliography


Anderson, Paul, ed. *Professors Who Believe.* Downers Grove, IL: InterVarsity Press, 1998.

Bacon, Francis. Bacon's work is available online at: http://www.uoregon.edu/~rbear/adv1.htm

Berman, M. *Social Change and Scientific Organisation, the Royal Institution, 1799–1844.* London: Heinemann, 1978.

Bernal, J. D. *The Social Function of Science.* 1939. Reprint; Cambridge, MA: MIT Press, 1967.

Berry, R. J., ed. *Real Science, Real Faith.* Crowborough: Monarch, 1995.

Brand, Paul with Philip Yancey. *Fearfully and Wonderfully Made.* Grand Rapids, MI: Zondervan Publishing House, 1997.

Brown, Hanbury. *The Wisdom of Science.* Cambridge: Cambridge University Press, 1978.

Calvin, John. Preface to *Commentary on Romans.* Quoted in E. Harris Harbison. *The Christian Scholar in the Age of the Reformation.* New York: Charles Scribner's Sons, 1956.

Cantor, G. *Michael Faraday, Sandemanian and Scientist.* Basingstoke: Macmillan, 1991.

Collins, Francis. "The Human Genome Project." In J. Kilner, R. D. Pentz, and F. E. Young, eds. *Genetics Ethics: Do the Ends Justify the Genes?* Grand Rapids, MI: William B. Eerdmans, 1997.

Darwin, Charles. Darwin's work is available online at: http://www.literature.org/authors/darwin-charles/the-origin-of-species-6th-edition/index.html

DeWitt, Calvin. *Earth-Wise: A Biblical Response to Environmental Issues.* Grand Rapids, MI: CRC Publications, 1994.

Guiness, Os. *The Call.* Nashville, TN: Thomas Nelson Publisher, 1998.

Holmes, Arthur. *All Truth is God's Truth.* Grand Rapids, MI: Eerdmans, 1977.

Hummel, Charles E. *The Galileo Connection: Resolving Conflicts Between Science and the Bible.* Downers Grove, IL: InterVarsity, 1986.

Johnstone, Patrick J. *Operation World.* Grand Rapids, MI: Zondervan Publishing House, 1993.

Malamud, Bernard. *The Fixer.* Bergenfield, NJ: Penguin Twentieth-Century Classics, 1994.

Malik, Charles. *The Two Tasks.* Westchester, IL: Cornerstone Books, 1980.

Malik, Charles. *A Christian Critique of the University.* Downers Grove, IL: InterVarsity Press, 1982.

McKeon, R. *Rutherford.* London: A. & C. Black, 1964.

Morley, *The Sensitive Scientist.* London: SCM Press, 1978.

Noll, Mark. *The Scandal of the Evangelical Mind.* Grand Rapids, MI: Eerdmans, 1995.

Pascal, Blaise. *Penseés.* In *Pascal. Great Books of the Western World,* vol. 33, edited by R. M. Hutchins. Chicago: Encyclopedia Britannica, 1952.

Rose, Hilary & Steven Rose. *Science and Society.* Harmondsworth: Penguin, 1970.

Russell, C. A. *Edward Frankland: Chemistry, Controversy and Conspiracy in Victorian England.* Cambridge: Cambridge University Press, 1996.

Wheeler, L. P. *Josiah Willard Gibbs.* New Haven: Yale University Press, 1962.

Wilson, Dorothy Clark and Philip Yancey. *Ten Fingers for God: The Life and Work of Dr. Paul Brand.* 1996.

Wolterstorff, Nicholas. *Reason within the Bounds of Religion.* 2d ed. Grand Rapids, MI: Eerdmans, 1984. ☆

# Conference Participants

MEGAN ANDERSON, *Graduate Student in Pharmaceutical Chemistry, Kansas University*

PAUL ANDERSON, *Professor of Biochemistry and Molecular Biology, School of Medicine, University of Minnesota, Duluth*

BRIAN (HOWIE) AUKEMA, *Graduate Student in Entomology, University of Wisconsin*

MICHAEL BOWLING, *Graduate Student in Computer Science, Carnegie Mellon University*

JOHN F. BRATTON, *Postdoctoral Researcher in Geology, U.S. Geological Survey Woods Hole Center*

HENIAN CAO, *Graduate Student in Cardiovascular Genetics, University of Western Ontario*

CHRISTINA CHAN, *Graduate Student in Geophysics, The Ohio State University*

LEE DEHAAN, *Graduate Student in Plant Genetics, University of Minnesota*

WILLIAM DEMBSKI, *Associate Research Professor in the Conceptual Foundations of Science, Baylor University*

CALVIN DEWITT, *Professor of Environmental Studies, University of Wisconsin-Madison*

JOY DOAN, *Postdoctoral Researcher in Medical Microbiology, National Jewish Medical and Research Center, Denver, CO*

GARY EDEN, *Professor of Electrical and Computer Engineering, University of Illinois*

MARTYNA ELAS, *Postdoctoral Researcher in Radiation-Oncology, University of Chicago*

SUSAN DRAKE EMMERICH, *Doctoral Candidate in Environmental Science, University of Wisconsin-Madison*

MARK FOSTER, *Professor of Polymer Science, University of Akron*

KELLY GARDNER, *Graduate Student in Biomolecular Chemistry, University of Wisconsin*

ANTHONY GERIG, *Graduate Student in Medical Physics, University of Wisconsin*

DEREK J. GINGERICH, *Graduate Student in Plant Genetics, Cornell University*

LOREN HAARSMA, *Assistant Professor in Physics and Astronomy, Calvin College*

JENNIFER HAMPTON, *Graduate Student in Physics, Cornell University*

JEFF HARDIN, *Associate Professor of Zoology, University of Wisconsin-Madison*

CHARLES HARPER JR, *Executive Director and Senior Vice President, John Templeton Foundation, Radnor, PA*

ERIK FORBES Y. HOM, *Graduate Student in Biophysics, University of California at San Francisco*

AMY C. HSIAO, *Graduate Student in Materials Science, Carnegie Mellon University*

B. SCOTT JACKSON, *Graduate Student in Neuroscience, Syracuse University*

BRAD KEISTER, *Program Director for Nuclear Physics, National Science Foundation*

RANDALL KERSTETTER, *Postdoctoral Researcher in Biology, University of Pennsylvania*

HENRY A. (CHIP) KOBULNICKY, *Postdoctoral Researcher in Astronomy, University of Wisconsin*

DAVID F. LEMMERHIRT, *Graduate Student in Electrical Engineering, University of Michigan*

BRYAN MARK, *Graduate Student in Geology, Syracuse University*

BUD MAYFIELD, *Graduate Student in Forest Biology, State University of New York*

CHRISTOPH MERTZ, *Postdoctoral Researcher in Robotics, Carnegie Mellon University*

ROMAN MILLER, *Professor of Biology, Eastern Mennonite University and Editor of* Perspectives on Science and Christian Faith, *American Scientific Affiliation*

TERRY MORRISON, *Director of Graduate & Faculty Ministries, InterVarsity Christian Fellowship*

CHINEDU NJOKU, *Postdoctoral Researcher in Veterinary Preventive Medicine, Ohio State University*

TODD PEDLAR, *Postdoctoral Researcher in Nuclear Physics, Cornell University*

MARTIN PRICE, *Executive Director of Education Concerns for Hunger Organization, Florida*

BRENT N. REXER, *Graduate Student in Medicinal Chemistry, Vanderbilt University*

CINDY ROY, *Postdoctoral Researcher in Cell Biology, University of Oregon*

COLIN RUSSELL, *Professor in the History of Science and Technology, The Open University, UK*

BRENT SEALES, *Associate Professor of Computer Science, University of Kentucky*

JOHN SUPPE, *Professor of Geosciences at Princeton University*

DAVID E. THOMPSON, *Postdoctoral Researcher in Analytical Chemistry, Stanford University*

PETER VENABLE, *Graduate Student in Computer Sciences, Carnegie Mellon University*

JENNIFER WISEMAN, *Postdoctoral Researcher in Astronomy, Johns Hopkins University*

JONATHAN WRUBEL, *Graduate Student in Condensed Matter, Cornell University*

## How Do I Join The ASA?

Anyone interested in the objectives of the Affiliation may have a part in the ASA.

**Full membership** is open to all persons with at least a bachelor's degree in science who can give assent to our statement of faith. Science is interpreted broadly to include anthropology, archeology, economics, engineering, history, mathematics, medicine, political science, psychology, and sociology as well as the generally recognized science disciplines. Philosophers and theologians who are interested in science are very welcome. Full members have voting privileges and can hold office. Full member dues are $55/year.

**Associate membership** is available to interested nonscientists who can give assent to our statement of faith. Associates receive all member benefits and publications and take part in all the affairs of the ASA except voting and holding office. Associate member dues are $55/year.

Full-time students may join as **Student Members** (science majors) with voting privileges or as **Student Associates** (nonscience majors) with no voting privileges. Student member and student associate member dues are $20/year.

**Spouses** may qualify for a reduced rate of $10/year. **Full-time overseas missionaries** are entitled to a complimentary membership.

An individual wishing to participate in the ASA without joining as a member or giving assent to our statement of faith may become a **Friend** of the ASA. Friends receive all member benefits and publications and take part in all the affairs of the ASA except voting and holding office. Friend dues are $55/year.

**Subscriptions** to *Perspectives on Science & Christian Faith (PSCF),* are available at $30/year (individuals), $45/year (institutions) and $20/year (students).

## What Do I Receive as a Member in the ASA?

**Publications**. As a member, you receive the ASA's quarterly journal, *Perspectives on Science & Christian Faith*, and bimonthly newsletter, *Newsletter of the ASA and CSCA* (Canadian Scientific & Christian Affiliation). *Perspectives on Science & Christian Faith* has become an outstanding forum for discussion of key issues at the interface of science and Christian thought. It also contains news of current trends in science and reviews of important books on science/faith issues. The newsletter brings you news of the scientific work and Christian witness of ASA members, reports of ASA activities, and other items of current interest. It also carries notices of ASA members seeking employment and of positions open to Christians trained in science.

**Books**. The *ASA/CSCA Membership Directory* is sent to all new members when available. As long as our supply lasts, new student members also receive *Being a Christian in Science* by Walter R. Hearn. Full members receive *God Did It, But How?* by Robert B. Fischer. Additional copies of these books and *Teaching Science in a Climate of Controversy* are available for purchase through the home office.

**Fellowship**. The spiritual and intellectual stimulation of ASA meetings is a distinctive feature of ASA membership highly valued by those who participate. An Annual Meeting, which usually includes three days of symposia, papers, field trips, and worship together, has been held each year since 1946 in late July or early August. For the convenience of members, the location moves across the country on a regular cycle. Local and regional meetings are held throughout the country each year. Members keep in contact with each other through the newsletter, the Internet, and at ASA gatherings at national scientific meetings.

**Opportunities for Service.** The ASA sponsors and encourages individual and group efforts to serve both the Christian community and the scientific community. Major efforts are made to clear up misunderstandings of one group by the other. We seek opportunities to witness as a body of people with a grasp of biblical truth wherever that witness is needed.

The ASA is a member of The Evangelical Council for Financial Accountability.

### ASA Application/Subscription Form

(Subscribers complete only items 1, 2 & 8)

**American Scientific Affiliation, P.O. Box 668, Ipswich, MA 01938-0668**

1. Name (please print): _____ Date: _____

2. Home Address: _____

_____ Zip: _____

Office Address: _____

_____ Zip: _____

Home phone: _____ Office phone: _____

FAX: _____ E-mail: _____

I prefer my ASA mailings sent to: ❑ home ❑ office

I give permission to publish my home phone number in the membership directory: ❑ yes ❑ no

3. Sex: ❑ male ❑ female

4. If married, spouse's name: _____

5. Academic Preparation:

| Institution | Degree | Major | Year |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Field of Study (broad): _____

Concentration within the Field (2-word limit): _____

Briefly describe your present or expected vocation: _____

_____

_____

_____

_____

(Please complete back of this form ☞)

6. How did you learn about the ASA? _____

I am interested in the goals of the American Scientific Affiliation. Upon the basis of the data herewith submitted and my signature affixed to the ASA Statement below, please process my application for membership.

**Statement of Faith**

I hereby subscribe to the Doctrinal Statement as required by the Constitution:

1. We accept the divine inspiration, trustworthiness and authority of the Bible in matters of faith and conduct.
2. We confess the Triune God affirmed in the Nicene and Apostles' creeds which we accept as brief, faithful statements of Christian doctrine based upon Scripture.
3. We believe that in creating and preserving the universe God has endowed it with contingent order and intelligibility, the basis of scientific investigation.
4. We recognize our responsibility, as stewards of God's creation, to use science and technology for the good of humanity and the whole world.

Signature: _____ Date: _____
(required for Full Member, Associate Member, Student Member, Student Associate status)

7. If you are an active overseas missionary, please give the name and address of your mission board or organization to qualify for complimentary membership.

Mission Board: _____

Street: _____

City: _____ State: _____ Zip: _____

8. I have enclosed in U.S. funds (Please check one):

_____$55, Full Member _____ $55, Associate Member _____$55, Friend of the ASA

_____$20, Student Member _____ $20, Student Associate _____$10, Spouse

_____$30, Subscriber

MasterCard or VISA: ☐☐☐☐-☐☐☐☐-☐☐☐☐-☐☐☐☐

Expiration Date:_____ Signature: _____

Name as it appears on your credit card: _____
(Please print)

**Please mail to: American Scientific Affiliation, P.O. Box 668, Ipswich, MA 01938-0668**

## How Do I Become More Active in the ASA?

Each member will be asked to choose a primary and secondary affiliation or commission from the list below. Affiliations are autonomous but usually meet in conjunction with the ASA Annual Meeting. Commissions are led by a four- to six-member board with a chairperson. Each commission is asked to relate its discipline toward science. They also usually meet in conjunction with the ASA Annual Meeting.

### Affiliations

- Affiliation of Christian Biologists (ACB)
- Affiliation of Christian Geologists (ACG)
- African Institute for Scientific Research and Development (AISRED)
- Christian Engineers and Scientists in Technology (CEST)

### Commissions

- Bioethics
- Communications
- Creation
- Global Resources and Environment
- History and Philosophy of Science
- Physical Sciences
- Science Education
- Social Sciences

Local Sections of the ASA are organized to hold meetings and provide an interchange of ideas at the regional level. Additional information can be obtained from the national office. Listed below are some of the more active local sections.

### Local Sections

- Chicago–Wheaton
- DC–Baltimore
- Eastern PA
- Rocky Mountain
- San Francisco Bay
- Southwest (AZ)

## What Is the American Scientific Affiliation?

The American Scientific Affiliation (ASA) is a fellowship of men and women in science and related disciplines, who share a common fidelity to the Word of God and a commitment to integrity in the practice of science. Founded in 1941, the ASA has grown significantly since then. The ASA's stated purposes are: "to investigate any area relating Christian faith and science" and "to make known the results of such investigations for comment and criticism by the Christian community and by the scientific community."

Science has brought about enormous changes in our world. Christians have often reacted as though science threatened the very foundations of Christian faith. ASA's unique mission is to integrate and communicate properly researched science and biblical theology in service to the Church and the scientific community. ASA members have confidence that such integration is not only possible but necessary to an adequate understanding of God and his creation. Our total allegiance is to our Creator. We acknowledge our debt to him for the whole natural order and for the development of science as a way of knowing that order in detail. We also acknowledge our debt to him for the Scriptures, which give us "the wisdom that leads to salvation through faith in Jesus Christ." We believe that honest and open study of God's dual revelation, in nature and in the Bible, must eventually lead to understanding of its inherent harmony.

The ASA is also committed to the equally important task of providing advice and direction to the Church and society in how best to use the results of science and technology while preserving the integrity of God's creation. An evangelical organization, the ASA provides a forum where scientists, social scientists, philosophers, and theologians can interact together and help shape Christian views of science. The vision of the ASA is to have science and theology positively interacting and affecting one another.

American Scientific Affiliation
55 Market Street, Suite 202
P.O. Box 668
Ipswich, MA 01938-0668

Phone: (978) 356-5656
FAX: (978) 356-4375
E-mail: asa@asa3.org
Web site: www.asa3.org

# American Scientific Affiliation

Founded in 1941 out of a concern for the relationship between science and Christian faith, the American Scientific Affiliation is an association of men and women who have made a personal commitment of themselves and their lives to Jesus Christ as Lord and Savior, and who have made a personal commitment of themselves and their lives to a scientific description of the world. The purpose of the Affiliation is to explore any and every area relating Christian faith and science. *Perspectives on Science and Christian Faith* is one of the means by which the results of such exploration are made known for the benefit and criticism of the Christian community and of the scientific community.

**EXECUTIVE DIRECTOR, ASA:**
Donald W. Munro, P.O. Box 668, Ipswich, MA 01938-0668

**EDITOR, ASA/CSCA NEWSLETTER:**
Dennis Feucht, 14554 Maplewood Rd., Townville, PA 16360-9801

**EXECUTIVE COUNCIL, ASA:**
Jay L. Hollman, 4412 Lake Lawford Ct., Baton Rouge, LA 70816-4417 —President
Dorothy F. Chappell, Wheaton College, Wheaton, IL 60187 —Vice President
Kenell J. Touryan, P.O. Box 713, Indian Hills, CO 80454-0713 —Secretary-Treasurer
Fred S. Hickernell, 5012 E. Weldon, Phoenix, AZ 85018
Martin L. Price, ECHO, 17391 Durrance Rd., N. Ft. Myers, FL 33917

# Canadian Scientific & Christian Affiliation

A closely affiliated organization, the Canadian Scientific and Christian Affiliation, was formed in 1973 with a distinctively Canadian orientation. The CSCA and the ASA share publications (*Perspectives on Science and Christian Faith* and the *ASA/CSCA Newsletter*). The CSCA subscribes to the same statement of faith as the ASA, and has the same general structure; however, it has its own governing body with a separate annual meeting in Canada.

**EXECUTIVE DIRECTOR, CSCA:**
David A. Humphreys, 3 Highland Park Drive, Dundas, ON L9H 3L7

**EXECUTIVE COUNCIL, CSCA:**
Robert Mann, University of Waterloo, Waterloo, ON —President
Esther Martin, University of Guelph, Guelph, ON —Secretary
Esther Abraham, 4269 Crescent Ave., Beamsville, ON
Denis Lamoureux, St. Joseph's College, University of Alberta, Edmonton, AB
Norman MacLeod, 4001 Bayview Ave. Apt. 907, North York, ON
Don McNally, NetAccess Systems and St. Michael's College, The University of Toronto, Hamilton, ON
Dan Osmond, University of Toronto, Toronto, ON
Gary Partlow, University of Guelph, Guelph, ON
Thaddeus Trenn, P.O. Box 639, Colborne, ON
Robert E. VanderVennen, Institute for Christian Studies, Toronto, ON

# Local Sections

Local sections of the ASA and the CSCA have been organized to hold meetings and provide an interchange of ideas at the regional level. Membership application forms, publications, and other information may be obtained by writing to: American Scientific Affiliation, P.O. Box 668, Ipswich, MA 01938-0668 or by contacting the ASA web site at: http://www.asa3.org or Canadian Scientific & Christian Affiliation, P.O. Box 40086, 75 King St. S., Waterloo, ON, Canada N2J 4V1 or by contacting the CSCA web site at: http://www.csca.ca

| | | | |
|---|---|---|---|
| Chicago–Wheaton | DC–Baltimore | Eastern PA | Guelph, ON |
| Rocky Mountain | San Francisco Bay | Southwest (AZ) | Toronto, ON |

**INDICES** to back issues of *Perspectives on Science and Christian Faith* are published as follows:

| | | | | | |
|---|---|---|---|---|---|
| Vol. 1–15 | (1949–1963) | *Journal ASA* | 15 | 126–132 | (1963) |
| Vol. 16–19 | (1964–1967) | *Journal ASA* | 19 | 126–128 | (1967) |
| Vol. 20–22 | (1968–1970) | *Journal ASA* | 22 | 157–160 | (1970) |
| Vol. 23–25 | (1971–1973) | *Journal ASA* | 25 | 173–176 | (1973) |
| Vol. 26–28 | (1974–1976) | *Journal ASA* | 28 | 189–192 | (1976) |
| Vol. 29–32 | (1977–1980) | *Journal ASA* | 32 | 250–255 | (1980) |
| Vol. 33–35 | (1981–1983) | *Journal ASA* | 35 | 252–255 | (1983) |
| Vol. 36–38 | (1984–1986) | *Journal ASA* | 38 | 284–288 | (1986) |
| Vol. 39–41 | (1987–1989) | *PSCF* | 42 | 65–72 | (1990) |
| Vol. 42–44 | (1990–1992) | *PSCF* | 44 | 282–288 | (1992) |
| Vol. 45–47 | (1993–1995) | *PSCF* | 47 | 290–296 | (1995) |
| Vol. 48–50 | (1996–1998) | *PSCF* | 50 | 305–312 | (1998) |

A keyword-based on-line **subject index** is available on the ASA web site at: http://www.asa3.org

Articles appearing in *Perspectives on Science and Christian Faith* are abstracted and indexed in the CHRISTIAN PERIODICAL INDEX; RELIGION INDEX ONE: PERIODICALS; RELIGIOUS & THEOLOGICAL ABSTRACTS, and GUIDE TO SOCIAL SCIENCE AND RELIGION IN PERIODICAL LITERATURE. Book Reviews are indexed in INDEX TO BOOK REVIEWS IN RELIGION. Present and past issues of *Perspectives* are available in microfilm form at a nominal cost. For information write: University Microfilm Inc., 300 North Zeeb Rd., Ann Arbor, MI 48106.

Proceedings from the conference,

**ASKING THE RIGHT QUESTIONS: Christian Faith and the Choice of Research Topic in the Natural and Applied Sciences**

October 13–15, 2000

Sponsored by InterVarsity Graduate and Faculty Christian Fellowship and Funded by The JOHN TEMPLETON FOUNDATION

Mundelein, IL