



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 super-gravity. 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

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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

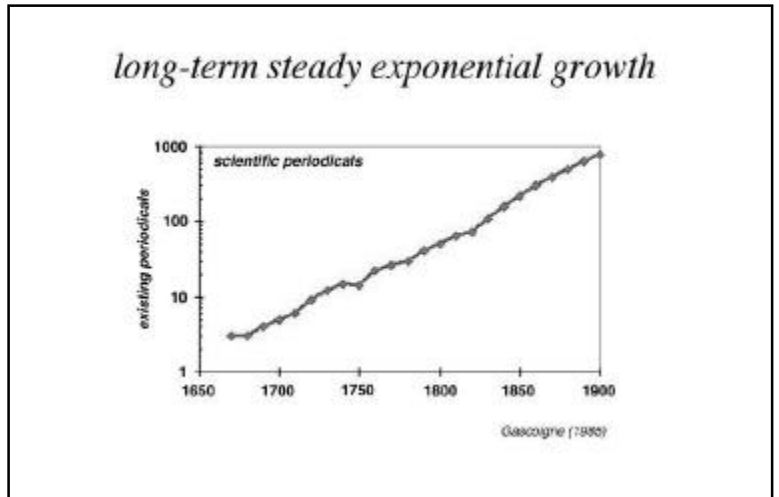


Figure 1. Exponential Growth.

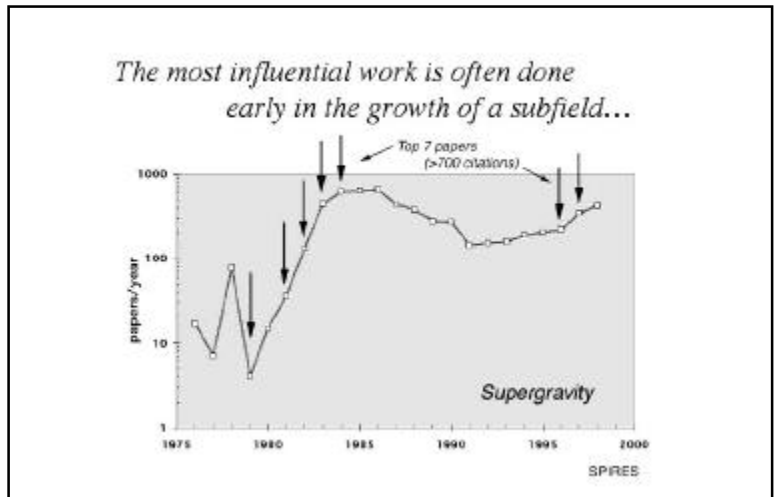


Figure 2. Influential Work.

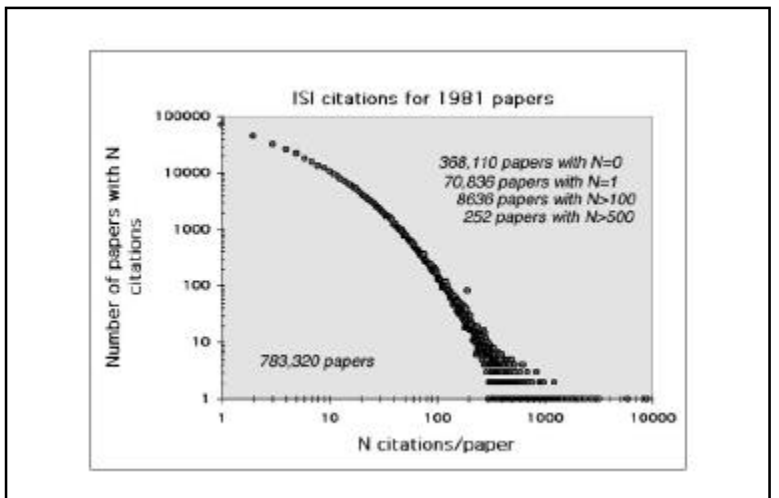


Figure 3. Paper Citations. Data from S. Redner, “How Popular Is your Paper? An Empirical Study of the Citation Distribution,” *Eur. Physics Journal B4* (1998): 131–4.



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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 Chris-

tianity 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 researcher 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



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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. ☆



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