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]

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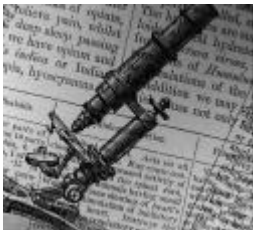

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The other example is Michael Faraday, probably the greatest experimental physical scientist of all time, a founder of electromagnetism and pioneer in other branches of chemical and electrical studies, working all his scientific life at London's Royal 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-

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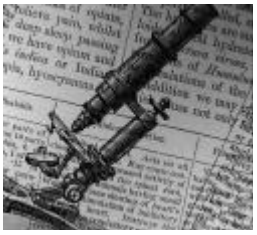

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The most important decision we probably have to make is our choice of director.

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.

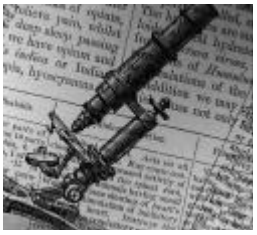
For all of our diligence in selecting the "right" research topic, we can never be sure of the outcome, how useful or innovative or even harmful it may be. Michael Faraday is supposed to have countered a question as to the utility of his electromagnetic research with the question, "What use is a baby?" 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



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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.* ✰