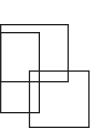


Photographer: Hikaru Iwasaka (1923-)

Terry B. Ball





HE REVEREND JOHN POLKINGHORNE, A CAMBRIDGE professor of physics and a truly world-class scientist, once expressed a dilemma experienced by many scientists who are also persons of faith with the following observation:

There is a popular caricature which sees the scientist as ever open to the correcting power of new discovery and, in consequence, achieving the reward of real knowledge, whilst the religious believer condemns himself to intellectual imprisonment within the limits of an opinion held on a priori grounds, to which he will cling whatever facts there might be to the contrary. The one is the man of reason; the other blocks the road of honest inquiry with a barrier labelled "incontestable revelation." If that were really so, those of us who are both scientists and religious believers . . . would be living schizophrenically, believing the impossible on Sundays and only opening our minds again on Monday mornings.¹

In recent times, religious scientists not only have had to defend their faith in God and revelation, but also frequently

Terry B. Ball is dean of Religious Education at Brigham Young University.

find their commitment to scientific principles unjustly questioned. A Georgia judge, arguing against the teaching of evolution in school, offered an overzealous polemic that illustrates the point well. Making absurd accusations about the effect of Darwin's theories on society, the judge claimed that the "monkey mythology of Darwin is the cause of permissiveness, promiscuity, pills, prophylactics, perversions, pregnancies, abortions, pornotherapy, pollution, poisoning and proliferation of crimes of all types." Such pejorative and irrational rhetoric only serves to fan the flames of hostility between science and religion while deepening the dilemma for men and women devoted to both disciplines.

Rather than adding to the tension that some individuals and institutions create between science and religion, a Brigham Young University education should help students increase their understanding and appreciation for both. As President George Albert Smith taught, "The university has a dual function, a dual aim and purpose—secular learning, the lesser value, and spiritual development, the greater. These two values must be always together, neither would be perfect without the other."3 President Smith's counsel indicates that we should not only avoid alienating secular learning from spiritual development but also endeavor to avoid compartmentalizing and departmentalizing the two. Spiritual development can and should occur in all classes taught on the BYU campus, and secular learning may indeed find application in Religious Education classes. It is the responsibility of both faculty and students to see that President Smith's counsel is followed

Students at BYU are fortunate to have many examples of members of the Church, past and present, who illustrate that one can indeed harmonize secular scientific learning and spiritual development. Some, for example, though trained as scientists, have provided great ecclesiastical leadership to the Church, like the Apostles John A. Widtsoe, a chemist and agronomist; James E. Talmage, a geologist; Joseph F. Merrill, a

chemical engineer; Russell M. Nelson, a physician; and Richard G. Scott, a nuclear engineer.⁴

Others, while maintaining faith in the restored gospel, have made significant contributions to their scientific fields, like the physicist Philo T. Farnsworth, whose research led to the development of the television;⁵ the chemist Henry Eyring, who developed the absolute rate of chemical reactions theory; and the physicist Harvey Fletcher, who pioneered the development of stereophonic sound reproduction.⁶

Today, in every department at BYU, there are individuals carrying on the legacy of these men by maintaining faith in God while serving in the Church, contributing to their disciplines, and teaching in the classrooms. Likewise, in those classrooms are many students who in the future will do the same, students who will render tremendous service in the restored gospel and who will also become renowned for their scientific contributions.

How tragic it would be if a BYU student who had the potential to become a James E. Talmage or a Henry Eyring never reached that potential because some teacher, purposefully or unwittingly, convinced that student that one must abandon faith in God in order to be a credible scientist, or conversely, that one with a testimony of the restored gospel cannot accept the tenets of science. It is imperative that as a community of learners at BYU we work to avoid such a tragedy. Every student here needs to understand, as Elder Widtsoe taught, that "the Church supports and welcomes the growth of science. . . . The religion of the Latter-day Saints is not hostile to any truth, nor to scientific search for truth."

One area of persistent tension between science and religion is the relationship between faith and the scientific method. Among practicing scientists, there is a wide variety of opinions on the nature of that relationship. A review of the basic philosophies of the two most opposing schools of thought on the issue is helpful in understanding the controversy. For the sake of convenience I will refer to one extreme as scientific atheism, and the other as scientific theism.

SCIENTIFIC ATHEISM

Although the term *scientific atheism* is usually associated with the Marxist-Leninist world outlook,⁸ the term can appropriately be used to describe the extreme position of those scientists who insist that there can be no relationship between faith and the scientific method. Three basic philosophies seem to lead them to this conclusion. First, they tend to believe that the scientific method is a supremely efficient and reliable tool for discovering truth. As one author describes it, they wish to view the scientific method as a "methodological threshing machine in which the flail of experiment separates the grain of truth from the chaff of error."

This confidence in the efficiency and reliability of the scientific method naturally leads them to a second philosophy, which is that the scientific method by itself can answer all kinds of questions. As the nuclear chemist Jan Rydberg professed, "Science has no limits. There are no questions it should not approach." ¹⁰

With the assurance that the scientific method can efficiently answer all kinds of questions, scientific atheists arrive at a third philosophy, which is that there is no need for faith or religion by one skilled at using the scientific method in the pursuit of truth. This philosophy was well illustrated by Pierre Simon Laplace when, as tradition has it, he responded to Napoleon's observation that he had failed to mention God in his book on the origin of the universe by saying, "Sire, I have no need for that hypothesis."

Not only do scientific atheists claim no need for faith, but they also declare that any conclusions based on faith are categorically unscientific. As Brezhnev proclaimed to the Soviet Central Committee, "True science takes nothing on faith." This philosophy leads its adherents to reject any superhuman source of enlightenment and to disallow any data that cannot be perceived and described by the physical senses. The final conclusion drawn by those who accept these philosophies was well illustrated by the German physicist Wilhelm Westphal when he lamented, "If there is a God, then I am very sorry to

say that he has never revealed himself to me. He could have done this, in fact he should have. But he didn't. Therefore I became an atheist." Rydberg confessed he had arrived at this same conclusion when he declared, "I do not need a God" and "I have no use for religion." 14

SCIENTIFIC THEISM

In contrast to the faithless philosophies of scientific atheists, those who support the tenets of the school of thought I call scientific theism feel that a practitioner of the scientific method need not abandon faith. Although scientific theists are willing to agree that the scientific method is an efficient and reliable research tool, they do not believe that it is supremely or unquestionably so. Recognizing that the scientific method does not always yield unchallengeable truth, the chemist John Friedrich offered this disclaimer: "Scientists are guite often misquoted in the area of certainty. I don't believe anything is absolutely certain. Things are more or less certain depending upon the data which we have to support a given conclusion. If there is a sufficient amount of data supporting some conclusion, and no contradictory data, then we say with a certain degree of certainty that it is a true reliable conclusion."15

Dr. Bernard Waldman carried the thought further when he suggested that there are some scientists who, not realizing the limits of the scientific method, are "brash and very sure of what they are doing and how they have solved all the problems," but, in his discipline of physics, "the people who make the major contributions and the major breakthroughs are remarkably humble." In recognizing the limits of the scientific method, scientific theists are also willing to admit that there are some questions that it simply cannot address. Willis Worcester, while serving as the dean of the College of Engineering at Virginia Polytechnic Institute, asserted that these questions often deal with issues of faith when he explained: "There are people who feel that everything can be explained on a purely scientific basis, but all of them eventually run into

unanswerable questions, questions of their own origin, of the earth's origin, of their ultimate fate, which simply cannot be answered on the basis of any currently known scientific method."¹⁷

Some proponents of scientific theism are willing to suggest that not only can one utilize the scientific method without abandoning faith, but in reality, a kind of faith can play an important role in the scientific method itself. A former dean of the School of Science at MIT, Robert Alberty, expressed the principle this way:

Faith is not too different from a part of the regular life of the scientist. If he didn't have faith that experiments can be reproduced and that the human mind is competent to learn more and that somehow things can be rationalized, he wouldn't go into the lab. All these acts of faith are necessary to the scientist. Maybe he doesn't look at it as faith, but it really is. This doesn't necessarily make him accept things easily, but it's wrong to think that he operates by some kind of cold calculating logic. Good scientists are highly intuitive and don't follow rigid logic. They have a great feel for things, as opposed to a detailed mastery. We present it to our students as if it were all coldly factual, but that's not the way the frontier of science is.¹⁸

What Alberty would call intuition, others have called inspiration. The Norwegian physicist Ole Gjotterud said, "I feel that science is the process of asking questions and trying to answer them critically, but also with inspiration." This inspiration is a source of enlightenment that would be discounted by many scientific atheists because it cannot be quantified nor described in terms of the physical senses.

The willingness of scientific theists to recognize that faith and inspiration can play a role in the pursuit of truth facilitates their belief in the divine. Many confess that the further they progress in their scientific investigations, the greater their faith in, and conviction of, a supreme being becomes. Alberty said that it is this very phenomenon that "keeps God alive for scientists." Atomic physicist Dr. Jules Duchesne agrees as he concludes that "the scientist's universe has become so large, so wonderful, so unexpected, he almost needs a God." Perhaps the best response to the arguments of the scientific atheist was offered by the Nobel Prize–winning physicist Max Born when he simply declared, "Those who say that the study of science makes a man an atheist must be rather silly people." 22

The experiences of students who are taught the scientific method at BYU should be similar to that of the scientific theists. They should find that their scientific education and investigations increase rather than diminish their faith. In my experience as both a teacher of religion and a researcher in a scientific field, there are three principles that have been especially beneficial in helping me recognize a harmonious relationship between faith and the scientific method.

Principle 1: Faith enhances the truths learned through the scientific method. Henry Eyring introduced this principle well when he wrote, "The scientific method which has served so brilliantly in unravelling the mysteries of this world must be supplemented by something else if we are to enjoy to the fullest the blessings that have come of the knowledge gained. It is the great mission and opportunity of religion to teach men 'the way, the truth, the life,' that they might utilize the discoveries of the laboratory to their blessing and not to their destruction." Eyring's teachings suggest that when the discoveries of the scientific method become working partners with faith, each enhances the other to the blessing of humankind.

Principle 2: Faith has an application in the scientific method as well as in religion. While teaching the Zoramites, the Book of Mormon prophet Alma declared, "Faith is not to have a perfect knowledge of things; therefore if ye have faith ye hope for things which are not seen, which are true" (Alma 32:21). In other words, Alma taught that one cannot have real faith in something that is directly visible or in something that is not true. This observation leads to the question, how then does one know if something not seen is true? An answer can

be found in Paul's definition of faith: "Now faith is the substance of things hoped for, the evidence of things not seen" (Hebrews 11:1). Paul's definition suggests that one can have hope for and faith in something not seen by examining the evidence of its existence. For example, though one has not seen God, the witness of the Holy Ghost can provide sufficient spiritual evidence necessary to develop faith in his existence. Moreover, many have testified that temporal evidence for the existence of God can be found in the complexity and wonders of his creations.

This principle of faith—that through observing evidence one can have confidence in the existence of something not directly seen—has found similar application in science. For example, no scientist has ever seen electrons, yet the evidence of their travel through a bubble chamber testifies of their existence.²⁴ In similar fashion, long before the planet Neptune was ever viewed in a telescope, Adams and Leverrier were able to predict its existence by the evidence of its gravitational influence on the planet Uranus.²⁵ By Paul's definition, both Adams and Leverrier exercised a principle of faith in their scientific investigations. "Now faith is the substance of things hoped for, the *evidence of things not seen*" (Hebrews 11:1; emphasis added).

After so hypothesizing or arousing ones faculties, Alma indicates that the next step, just as in the scientific method, is to perform an experiment upon the word. He explains how to conduct the experiment and evaluate the data: "Now, we will compare the word unto a seed. Now, if ye give place, that a seed may be planted in your heart" (Alma 32:28). Thus Alma instructs that the experiment should be conducted by metaphorically planting the seed of the word in one's heart. This can be interpreted as meaning that seekers of truth are to apply the teachings of Alma in their personal lives.

The third step of the scientific method, the analysis of data, is paralleled in Alma's teachings: "Behold, if it be a true seed, or a good seed, if ye do not cast it out by your unbelief, that ye will resist the Spirit of the Lord, behold, it will begin to

swell within your breasts" (Alma 32:28). Thus as one evaluates the data, one recognizes that some kind of growth—a good kind of growth—has taken place.

The final step of the scientific method, that of making a conclusion, finds a cognate in Alma's paradigm for developing faith. Alma teaches that after analyzing the data of the experiment upon the word, one will come to the realization that "it must needs be that this is a good seed, or that the word is good, for it beginneth to enlarge my soul; yea, it beginneth to enlighten my understanding, yea, it beginneth to be delicious to me" (Alma 32:28). This enlarging and enlightening can be considered the spiritual data produced by the experiment.

It should be noted that this kind of spiritual evidence is very different from the physical data acceptable to the scientific method. Unlike physical data, spiritual information cannot be quantified or easily described in terms of our physical senses; rather, its observation requires the development of spiritual faculties. As a result, it may never be observed by one who has not learned how to use the spiritual senses or who limits his or her tools for pursuing truth to the scientific method. Moreover, spiritual information may manifest itself in different ways to different individuals. Thus, for those following Alma's procedure for developing faith, the spiritual data generated may not be felt or recognized by each experimenter in exactly the same way. This admission does not, however, diminish the reality or reliability of the data for those who have observed it. This may be the greatest source of frustration for scientific atheists. Because they cannot accept or recognize data in the form of spiritual witnesses and evidences, they are handicapped in their ability to learn religious truth and often deny its existence. As Paul explained to the Corinthians, "The natural man receiveth not the things of the Spirit of God: for they are foolishness unto him: neither can he know them, because they are spiritually discerned" (1 Corinthians 2:14). Biologist Hanjochem Autrum expressed a similar concept when he suggested that "science cannot find God, but the scientist can."26

In the remainder of his discussion on faith, Alma takes the scientific method one step further and in so doing illustrates what every good scientist should do with a newly discovered truth. He instructs that it should be nourished and cared for so that the experimenter may "reap the rewards of your faith, and your diligence" (Alma 32:43); or, using the words of Henry Eyring, "that they might utilize the discoveries of the laboratory to their blessing."²⁷

The scientific method demands that the data gathered and the conclusions drawn from an experiment be reproducible by anyone who follows the procedures of the original experimenter. As Latter-day Saints, we believe that the experiment by which one can gain faith as outlined by Alma does indeed meet this criteria. And this in part helps explain the success of the great missionary program of the Church. In a sense, our missionaries challenge investigators to be "scientific" by conducting this experiment upon the word, with the promise that if they follow the procedures and carefully analyze the results, they too will come to the conclusion that God lives and that the restored gospel of Jesus Christ is true.

With the understanding of the above principles—that faith can enhance and supplement the scientific method, that the principles of faith can have application in the scientific method as well as in religion, and that the process for developing faith can be similar to the scientific method—students and educators alike can have the confidence that one need not abandon faith to be a scientist and, conversely, that a testimony of the gospel does not mandate the forsaking of science.

These principles have served me well as both a research scientist and religious educator at Brigham Young University. Over and over, my faith has informed my science, and my science has informed my faith. As an example, I would like to share a study of a passage from Isaiah 28:

Give ye ear, and hear my voice; hearken, and hear my speech.

Doth the plowman plow all day to sow? doth he open and break the clods of his ground?

When he hath made plain the face thereof, doth he not cast abroad the fitches, and scatter the cummin, and cast in the principal wheat and the appointed barley and the rie in their place?

For his God doth instruct him to discretion, and doth teach him.

For the fitches are not threshed with a threshing instrument, neither is a cart wheel turned about upon the cummin; but the fitches are beaten out with a staff, and the cummin with a rod.

Bread corn is bruised; because he will not ever be threshing it, nor break it with the wheel of his cart, nor bruise it with his horsemen.

This also cometh forth from the Lord of hosts, which is wonderful in counsel, and excellent in working. (Isaiah 28:23–29)

This metaphor begins with a series of rhetorical questions. They make the point that a wise farmer does not spend all his time plowing his field over and over again, but rather, when the job has been adequately accomplished and the ground has been broken open and harrowed, he then proceeds to level it and sow the seeds. Five different cultivars are sown in the field of this wise farmer, each according to the manner that best suits its growth requirements and relative value.

Nutmeg flower and cumin. The first two types of seeds sown are fitches and cumin. Fitches have been variously identified as dill, vetches, carraway, and poppies, but are now usually understood to be a plant commonly called nutmeg flower or black cumin.²⁸ It is an annual herb of about thirty centimeters tall and has finely incised leaves. Its branches end in a showy white to blue flower possessing a five-maris corolla. The mature fruit is a pubescent capsule which contains a plethora of very small black seeds.²⁹ These aromatic seeds are as pungent as pepper and are thought to predate pepper

in their use as a spice. In the Holy Land and Egypt, they are sprinkled over breads and pastries or added to curries and other dishes.³⁰ Cumin also produces small pungent seeds used as a flavoring for breads and dishes. The seeds have a taste similar to carraway seeds and have been used in folk medicine as an antispasmodic. They are also the source of an oil used in perfumes. Cumin is an annual herb of the carrot family with highly dissected leaves. It grows from one to two feet tall and produces white to pink flowers in terminal umbels.³¹ Because both nutmeg flower and cumin have plentiful and relatively small seeds which do not require special spacing in their planting, the wise farmer sows them by merely throwing and scattering them over the earth.

Wheat and barley. Three different kinds of cereal grains, two wheats and one barley, were next planted in the wise farmer's fields. The first mentioned, *chittah*, was most likely the bread wheat *Triticum aestivum*, as it was the most common wheat grown at the time.³² This remarkable wheat produces seed heads that do not spontaneously shatter, and yet with only a minimal amount of threshing they yield an abundance of naked kernels. A superior bread flour is made from its high-gluten grains. Accordingly, the wise farmer sows these valuable seeds much more cautiously. Rather than haphazardly broadcasting them about, he carefully places the valuable seeds in furrows, thus ensuring adequate germination, spacing, and watering.³³

The next grain mentioned, barley, was also to be sown in this prudent manner, in its appointed place. Three types of barley are known to have been cultivated in biblical times: common barley, two-rowed barley, and six-rowed barley.³⁴ Although barley was generally considered inferior to wheat for human consumption, it was still grown for animal use at locations where the soil, moisture, and temperature would not support the less-tolerant wheats.³⁵

The last cereal grain sown in this metaphor, translated as "rie," was probably a type of spelt wheat (that is, one in which the seed is firmly encased in the inflorescence bracts or "chaff" and thus not easily threshed).³⁶ Being an inferior wheat mostly used for animal fodder, the wise farmer planted the rie "in its place," which is better translated as "in the field's edges or borders."

Just as the wise farmer planted each cultivar in the field in the most efficacious manner, he also threshed them in the way that would yield optimal results. The delicate herbs, cumin and nutmeg flower, were not threshed with threshing sledges or cart wheels, but rather carefully beaten out with a stick. In contrast, the more robust cereal grains were threshed with a cart, but not to the extent that the kernels were crushed.³⁷

Thus in his preparation, sowing, and harvesting, the wise farmer treated each cultivar in the best manner. The metaphor suggests that Jehovah acts in the same way. He has prepared for each people a place that is best for their growth and development, and placed them there in the fashion that best suits their needs and his plans for them. When it comes time for threshing (that is, chastising, separating out, or gathering in) the people, he will not do it so vigorously as to destroy them, but rather in a fashion that will maximize his harvest of saved souls.

This passage from Isaiah has become significantly more coherent and meaningful to me thanks to my scientific experience. I have enjoyed countless similar experiences of understanding in my gospel study, and my faith has played an important role in directing my scientific study. I feel to exclaim, as Isaiah, "This also cometh forth from the Lord of hosts, which is wonderful in counsel, and excellent in working" (Isaiah 28:29).

NOTES

This text combines two previously published works: Terry B. Ball, "Faith and the Scientific Method," in *Approaching a School in Zion: Proceedings of the Third Annual Laying the Foundations Symposium* (Provo, UT: Brigham Young University, 1994), 127–33, and portions of Terry B. Ball, "Isaiah's Imagery of Plants and Planting," in *Thy People Shall be My People: The 22nd Annual Sperry Symposium* (Salt Lake City: Deseret Book, 1994), 17–34.

- John Polkinghorne, Reason and Reality: The Relationship Between Science and Theology (Philadelphia: Trinity Press International, 1991), 49.
- 2. Quoted in E. Geissler and H. Hörz, "Darwin Today—Introductory Lecture," in *Darwin Today: The Eighth Kuhlungsborn Colloquium on Philosophy and Ethical Problems of Bioscience*, ed. E. Geissler and W. Scheler (Berlin: Akademie-Verlag, 1983), 19.
- 3. George Albert Smith, in *Messages of the First Presidency of the Church of Jesus Christ of Latter-day Saints, 1833–1964*, comp. James R. Clark (Salt Lake City: Bookcraft, 1965), 6:234.
- 4. Robert L. Miller, "Science and Scientists," in *Encyclopedia of Mormonism*, ed. Daniel H. Ludlow (New York: Macmillan, 1992), 3:1272–74.
- Ronald W. Walker and Richard W. Sadler, "History of the Church: c. 1898–1945, Transitions: Early Twentieth-Century Period," in *Encyclopedia of Mormonism*, 2:634.
- 6. Miller, "Science and Scientists," 1274.
- 7. John A. Widtsoe, *Evidences and Reconciliations* (Salt Lake City: Bookcraft, 1943), 1:129.
- 8. Vladimir Zots, "Atheism and the Spiritual Culture of Socialism," in *Religion in the USSR: The Truth and Falsehood* (Moscow: Social Sciences Today Editorial Board, 1986), 31.
- 9. Polkinghorne, Reason and Reality, 49.
- 10. Frederick E. Trinklein, *The God of Science* (Grand Rapids, MI: Eerdmans, 1971), 21.
- 11. Quoted in Henry Eyring, *The Faith of a Scientist* (Salt Lake City: Bookcraft, 1967), 57.
- 12. Stephen Fortescue, *The Communist Party and Soviet Science* (London: Macmillan, 1986), 22.
- 13. Trinklein, God of Science, 68.
- 14. Trinklein, God of Science, 68.
- 15. Trinklein, God of Science, 4.
- 16. Trinklein, God of Science, 15.
- 17. Trinklein, God of Science, 30.
- 18. Trinklein, God of Science, 19–20.
- 19. Trinklein, God of Science, 2.
- 20. Trinklein, God of Science, 61.
- 21. Trinklein, God of Science, 64.
- 22. Trinklein, God of Science, 64.

- 23. Eyring, Faith of a Scientist, 37.
- 24. Cyril Henderson, *Cloud and Bubble Chambers* (London: Methuen, 1970), 1–5.
- 25. Morton Grosser, *The Discovery of Neptune* (Cambridge, MA: Harvard University Press, 1962), 99–101.
- 26. Trinklein, God of Science, 67.
- 27. Eyring, Faith of a Scientist, 37.
- 28. Harold N. Moldenke and Alma L. Moldenke, *Plants of the Bible*, vol. 1 of *Chronica Botanica* (Waltham, MA: Chronica Botanica, 1952), 152.
- 29. Michael Zohary, *Plants of the Bible* (Tel-Aviv: Sadan Publishing House, 1982), 91.
- 30. Moldenke and Moldenke, Plants of the Bible, 152-53.
- 31. Moldenke and Moldenke, *Plants of the Bible*, 89; Zohary, *Plants of the Bible*, 88.
- 32. F. Nigel Hepper, *Baker Encyclopedia of Biblical Plants* (London: Three's Company, 1992), 85.
- 33. The word translated as "principle" (sorah) in KJV, Isaiah 28:25 is enigmatic. The Modern Language Bible translates it as "rows or furrows," as does Delitzsch, probably reading shurah rather than sorah. (Franz Delitzsch, Biblical Commentary on the Prophecies of Isaiah (Grand Rapids, MI: Eerdmans, 1965), 2:15. Brown suggests it is either dittographical for barley, seorah, or refers to some unknown kind of cereal grain. Francis Brown, The New Brown-Driver-Briggs-Gesenius Hebrew and English Lexicon (n.p.: Christian Copyrights, 1983), 965. In any case, the use of the verb sam, meaning "to put or place," suggests a careful sowing of the seeds.
- 34. Moldenke and Moldenke, *Plants of the Bible*, 112.
- 35. Hepper, Encyclopedia of Biblical Plants, 86.
- 36. The wheat referred to here, *cusemeth*, is not our modern spelt *Triticum spelta* (see Hepper, *Encyclopedia of Biblical Plants*, 86), but probably some other wheat that does not easily yield naked grains upon threshing, all of which are generically called "spelts," such as einkorn (*T. monococcum*) or emmer (*T. dicoccon*).
- 37. Victor L. Ludlow, *Isaiah: Prophet, Seer, and Poet* (Salt Lake City: Deseret Book, 1982), 266.