

OPENNESS AND FORMAL LOGIC IN THE NATURAL AND THEOLOGICAL SCIENCES ACCORDING TO T. F. Torrance

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ABSTRACT: The issue of openness in the natural and theological sciences plays a significant role in the theology of T. F. Torrance. The depths of this role is made most clear when considered in light of Torrance's understanding of formal logic, a discipline long considered to be utterly closed. This essay seeks to demonstrate the openness that is necessary for all thought, not least in logic, in order to be meaningful. Additionally, it examines a concrete example of Torrance's tendency to use common terms in a distinctly differential way. Significant implications are drawn out for both natural and theological science.

Introduction

Openness of our thoughts, concepts, and systems to reality beyond them is crucial for understanding Torrance's theology. This essay will address the issues that surround openness in Torrance's major publications and ultimately relate it to the role that logic plays in his thought. However, we must understand that openness plays a role in all of Torrance's thought and not merely in how he understands logic; however, as formal, abstract logic has been treated by the mainstream of Western thought as a closed system, it provides the paradigmatic case in light of which to understand the radical function of openness in Torrance's thinking. Once the basic concepts have been elucidated, it will be possible to understand some concrete implications of the need for openness in natural and theological science and to grasp Torrance's two-fold understanding of how we come to know that which is radically new. This is a



topic of personal interest as one who has a background in pure mathematics. I find Torrance's understanding of logic to be enlightening and helpful.

Openness

From time to time, Torrance will make a distinction between working out the difficulties in knowledge we already have and the acquisition of totally new knowledge. Perhaps the most helpful discussion is regarding the shift in the asking of questions that took place by the humanists and taken up by John Calvin. The dominant form of questioning in the Middle Ages was the *quaestio*, which "is the kind of question you ask in solving a problem in knowledge you already have, in order to move from confusion to clarity. Questions of this kind arise in a complex of relations of ideas where the answer is to be found by straightening out the logical connections."¹ The form that was given dominance by people like Calvin was *interrogatio*, which is the kind of question you ask of a reality "in order to let it disclose itself to you and so reveal to you what you do not and cannot know otherwise. It is the kind of question you ask in order to learn something *new*, which you cannot know by inferring it from what you already know."²

An issue at stake in this distinction is the difference between closed and open systems. A question that deals with untangling knowledge one already has and, for such purposes, brackets out any consideration of truth or falsity, preferring to deal with validity or invalidity of reasoning, can imply that it is dealing with

1 Thomas F. Torrance, *God and Rationality* (Wipf & Stock, Eugene: 1997), 34. For a fairly extensive discussion, see Thomas F. Torrance, *Reality and Evangelical Theology* (InterVarsity Press, Downers Grove: 1999), 34–35; Thomas F. Torrance, *Theological Science* (T&T Clark, Edinburgh: 1996), 119–126, though in this passage, Torrance does not use these terms, but deals with the basic issue; Thomas F. Torrance, *Reality and Scientific Theology* (Scottish Academic Press, Edinburgh: 1985), 12–13; Thomas F. Torrance, *Transformation and Convergence in the Frame of Knowledge: Explorations in the Interrelations of Scientific and Theological Enterprise* (Eerdmans, Grand Rapids: 1984), 267–268. Also see Thomas F. Torrance, *The Ground and Grammar of Theology* (University of Virginia Press, Charlottesville: 1980) 49–50, where Torrance contrasts skeptical and dogmatic questioning.

2 Torrance, *God and Rationality*, 34.

a closed system that is not open to what is utterly new or beyond it. On the contrary, an interrogative question that seeks to uncover what is radically new, by its very nature is, or should be, open to reality outside of itself.³

Before we can say anything else, we must clarify the distinction between open and closed concepts. In Torrance's own words,

"Closed concepts" are of the kind that we can reduce to clipped propositional ideas, whereas "open concepts" are of the kind which by their very nature resist being put into a strait-jacket, for the reality conceived keeps on disclosing itself to us in such a way that it continually overflows all our statements about it. Closed concepts are rigid and easily manipulable but open concepts are elastic because they operate on the boundary between the already known and the new.⁴

The key issue that has dramatic consequences is whether our concepts and statements are open to questioning by the object of their reference or whether they are closed off and contained within themselves. The truth of open concepts and systems does not lie in themselves, for if they contained their own truth, they would be closed, but their truth lies in the reality external to themselves to which they refer.⁵ For Torrance, the radical openness of theological statements is rooted in the issues related to speaking of God, who is infinite, while using language which is finite. However, the need to use open structures of thought is not limited to speaking of God, but is similarly relevant for our statements in the natural sciences because the universe as we know it is not self-explaining but is radically contingent.

3 This caveat, that our questions should be open to reality outside of themselves is due to the fact that our questions are always laden with presuppositions, which means they can be closed without our recognition. Torrance acknowledged early on the crucial need for us to be willing to question even our questions and presuppositions. See Thomas F. Torrance, *Theology in Reconstruction* (Wipf & Stock, Eugene: 1997), 121–124.

4 *Theological Science*, 15–16. Additionally, for a discussion of the qualities and problems of closed systems of thought, see Thomas F. Torrance, *Christian Theology and Scientific Culture* (Oxford University Press, New York: 1980), 14–18.

5 See my companion essay, "Truth and Language in the Theology of T. F. Torrance," in this volume of *Participatio*.

Contingence

It is vitally important for us to consider the notion of contingency in Torrance's theology because of the implications it has for the openness of our concepts and systems. Much of Western thought has operated with a sharp dichotomy between necessity and chance, where we must think in terms of things being as they are because of some kind of logical or ontological necessity inherent in their being, or else abandon any hope of discerning order in the universe, as it must be ruled by chance. Both theology and natural science has tended to lean in the direction of necessity. The Christian understanding of the providence of God does not allow for a truly random conception of the created order; at the same time, natural science cannot operate without a deep extra-logical conviction of the ultimate order of the universe.⁶

Torrance suggests that a third option would be more in line with the core convictions of both theological and natural science and ultimately in line with the character of the universe. That the universe is contingent means that it might have been quite different than it is, or even that it might not have been at all, but that God has given the creation an order that is utterly distinct from the order that characterizes the being of God, but one that is radically dependent on that divine order. This is an order that is the result of neither necessity nor chance.⁷ Torrance also resists the tendency throughout history to pay lip service to contingency while denying it in fact by subsuming it within a larger necessity.⁸

Because a contingent creation is not a necessary creation (which would even lean in the direction of pantheism or deism), science cannot proceed through logical deduction on the basis of some kind of "first principles" akin to Euclid's five postulates. A contingent creation is, by definition, open to that upon which it is contingent. As an open system, it will not yield scientific knowledge to a method of deductive reasoning, which depends on a closed system where concepts are related *logically* as opposed to *ontologically*. Scientific knowledge can only be

6 Torrance, *Ground and Grammar*, 103–105.

7 "The contingent freedom of the universe, then, is not something bound up with randomness or chance, for it is no more arbitrary than the freedom of the God of infinite love and truth upon which it rests and by which it is maintained" (*ibid.*, 58–60).

8 *Ibid.*, 64–65.

gained through actual empirical investigation of the creation, through the hard work of experimentation and radical questioning of our findings until our scientific concepts become correlated to empirical reality. A contingent creation is not random; there is an order, albeit a non-necessary one, to be discovered through the sciences. Thus, only an empirical (and not merely theoretical) science can disclose a contingent order.

Breaking out of the false choice between necessity and chance, and thinking of the creation as a free act of God, enables us to recognize that the scriptures do not portray a God who does what he does because of a kind of necessitarian impulse.⁹ Rather, God's acts are consistently portrayed as free, the result of *grace* and not necessity. To speak of God as being a *necessary* God can only make theological sense so long as "necessary" is constantly kept open to the reality of God. It is, in fact, best if we do not speak of God as "necessary" at all as it will simply lead to confusion. God is necessary, not in the sense of a necessary being defined in the abstract, such as the "first cause" or "unmoved mover" of Aristotle, but as the God who *must* exist because he is the God that, in fact, *does*, exist.

If a system is contingent, it means that it is not self-explaining. To be contingent is to have the meaning of the contingent thing outside of itself; a self-explaining contingent system is a contradiction in terms. This means that the universe, as a contingent reality, is also not self-explaining. Torrance argues, "If a sufficient reason is to be found [for the universe] (and sufficient reason there must be for such an intelligible system, otherwise it would disintegrate into meaninglessness), it must come from beyond the universe altogether."¹⁰ What is interesting is that it is the discipline of physical science, where it was perhaps least expected, that has been providing such convincing evidence that the universe is not a closed, necessary, and determinist system, but one that is radically contingent, finite but unbounded (to use Einstein's expression), and

9 *Ibid.*, 57–58.

10 Torrance, *Transformation and Convergence*, 98–99. Torrance ties this observation closely with the Gödelian theorems, discussed below in the section "The Implications of Gödel's Theorems." Also, see Torrance's comments on an observation by Wittgenstein in *Christian Theology and Scientific Culture*, 120–121.

an absolutely singular event in all of history.¹¹ It is particularly interesting that while classical physics and mechanics, with and after Newton, played a major role in establishing a necessitarian framework for Western thought, it is the further development of that discipline, with relativity and quantum theory, that has done the very most in undoing such a conception, though it has taken a long time to die.

The significance of the radical contingency of creation is that the universe as a whole is an open system. It is not self-explaining and requires that we investigate every part of it scientifically. The Laplacean idea that given the condition of the universe at a single point in time, we could predict its behavior both forwards and backwards has been uprooted by post-Einsteinian science. This means that, as the universe as a whole is contingent and therefore open, it is difficult to imagine that there will be portions of the created universe that are closed and determinist. This insight has been reshaping natural science's conception of the universe but, unfortunately, has not made as deep an impact on theologians. Perhaps the most radical implication is that this means that our *logic*, as a part of this open and contingent universe is, or should be, itself open and contingent. It will be shown below how the quest for a closed, complete, and consistent logico-deductive system has failed, and indeed, has been demonstrated to be impossible.¹²

One advantage of closed systems is that the relations between ideas are clearly defined. There are accepted rules regarding how ideas are related to one another. If we could somehow get from our concepts to reality by means of logic alone, it would be easy to have the same kind of certainty in natural science as we can have within a mathematical system. This is the hope of rationalism in its different forms. However, in this contingent universe, there is not a logical bridge between empirical reality and our scientific concepts.¹³ If this is the case, some attention must be given to how we can advance in knowledge and understanding of reality external to ourselves.

11 Indeed, even Newton, in his own way, affirmed that the universe had to be open to God. See Torrance, *Ground and Grammar of Theology*, 69.

12 See below, "The Implications of Gödel's Theorems."

13 Torrance, *Reality and Scientific Theology*, 24–25.

Personal/Communal Participation¹⁴

Once our concepts and structures are seen to be open rather than closed, some serious thinking must be done to understand how we actually come to new knowledge or how we have come to know those concepts and structures. In a purely abstract, closed formal system, the primary (or only) relations are logical relations. Ideas are related together through formal logic, which is not concerned with *becoming*, but only with *is*,¹⁵ that is, timeless and spaceless relations. Within such a system, conclusions can be understood and determined through rigorous application of the human reason, especially the processes of deduction and induction. However, if it happens that a system is open and *not* closed, this is made much more ambiguous, for the rules of closed systems no longer apply.¹⁶ After all, if a system or concept is open, it means that it can no longer be seen as independent of reality outside of itself, or else it would not be open. Thus, as an open system or concept, it is intrinsically unformalizable in a complete sense, as it relies in a fundamental way on what lies beyond it.¹⁷

Torrance acknowledges that this ambiguity is only a problem if one is, overtly or covertly, committed to a frame of knowledge that equates truth with determinism. However, Torrance affirms that all knowledge is personal, that though one of the marks of rationality is that persons can distinguish between themselves and what they know, they cannot ever separate what they know from the fact that it is they who know it. People cannot jump out of their skin, as

14 For a more in-depth treatment of Torrance's understanding of Personal/Communal Participation (also known as the tacit dimension), see Elmer M. Colyer, *How to Read T. F. Torrance: Understanding his Trinitarian and Scientific Theology* (InterVarsity Press, Downers Grove: 2001), 334–344.

15 *Reality and Scientific Theology*, 90–91.

16 A striking example of this inapplicability of the rules governing closed systems to open systems is when one attempts, as is done in some apologetics, to apply the concept of entropy taken from thermodynamics as a way to undermine the theory of evolution. Such an argument would be immediately rejected, for the second law of thermodynamics applies to closed systems and not to an open system like the earth.

17 Such a complete formalization would transform the open system into a closed one, falsifying it.

it were. Even in the most formalized systems, there is an unformalizable, tacit, personal, and social coefficient of knowledge.

The personal and communal coefficient of knowledge is an extra-logical relation between the knower and what is objectively known.¹⁸ Drawing on the thought of Michael Polanyi, Torrance writes that personal knowledge¹⁹

is a way of knowing through responsible commitment to the claims of reality in which the personal and objective poles of the relation are coordinated together in the act of establishing contact with reality and grasping it in its intrinsic rationality.²⁰

This way of knowing is unable to be completely formalized and is often summarized by stating that we always know more than we can explicitly articulate at the time.²¹

What this means is that only a *person* is able to weigh the evidence for or against a theory or compare it with competing theories. Only a *person* is able to discern patterns of order in an open system. Only a *person*, who operates at multiple logical levels, is able to make sense out of the multiple levels in which reality is encountered. This means that, for Torrance, there is no shortcut by which we can bypass the *participatory* character of knowledge. Because reality is not a closed system, we cannot use logico-deductive methods to reach new knowledge, which means that we cannot use such methods to verify the discoveries of others. Only by actually coming to participate in reality in the same way as another can one verify a scientific discovery. That is to say, all appeals for verification must be directed back to the ground from which the discovery arose.

18 See *Transformation and Convergence*, 88–89. See also Thomas F. Torrance, “The Framework of Belief,” in *Belief in Science and Christian Life: The Relevance of Michael Polanyi’s Thought for Christian Faith and Life*, ed. Thomas F. Torrance (Hansel Press, Edinburgh: 1980), 10.

19 This personal knowledge is knowledge that includes a personal and communal coefficient. For Torrance as well as Polanyi, *all* knowledge is personal knowledge. See *Theological Science*, 303; *Reality and Scientific Theology*, 26–27; Thomas F. Torrance, *The Christian Frame of Mind: Reason, Order, and Openness in Theology and Natural Science* (Helmets & Howard, Colorado Springs: 1989), 115–117; and “The Framework of Belief,” 9–10.

20 *Christian Theology and Scientific Culture*, 67.

21 For one such statement, see Torrance, *Christian Theology and Scientific Culture*, 13.

It is also crucially important to note that there is a strong communal element to all knowledge. Each of us comes to self-awareness within a particular community, and, as science is coming to understand more and more, that community plays a considerable role as to how we understand the world around us. This is significant because every way of looking at things simultaneously excludes another way of looking at them.²² We see the communal facet of knowledge in the natural sciences in “the worldwide community of science,” with whom the individual scientist shares “accepted standards of truth and falsity consistent with the body of universally established knowledge.”²³ This is, or ought to be, true for theological science as well, where theologians participate in the worshipping life of the church alongside other faithful Christians.²⁴ Both theological and natural science operate within a community of verifiers,²⁵ if for no other reason than because we do not encounter reality alone but along with others.²⁶

This emphasis on personal and communal participation in reality is an assertion that it is not possible to encounter, or gain new knowledge about, reality without such participation. Reference was made above to the lack of a “logical bridge” connecting our concepts to reality.²⁷ Our contact with reality is decidedly *extra*-logical. The problem of relating our words and concepts to reality was described as an “extra-logical problem,” which can only be resolved intuitively.²⁸ In practice, this takes place through a process of “indwelling,” where

22 “The Framework of Belief,” 14.

23 Torrance, *The Christian Frame of Mind*, 115.

24 Torrance, *Reality and Scientific Theology*, 121–122.

25 Torrance, *Reality and Scientific Theology*, 122–123. Closely related to this is the role of tradition in knowledge. See Thomas F. Torrance, *Divine Meaning: Studies in Patristic Hermeneutics* (T&T Clark, Edinburgh: 1995), 389–390. Though Torrance only speaks of the need for tradition in making theological statements, it holds equally true for natural science.

26 Torrance speaks of the relevance of this for theology by pointing out that, in theology, we are not simply concerned with God/Human relations, but God/world/Human relations. See *The Ground and Grammar of Theology*, 45 and *Reality and Evangelical Theology*, 25–30.

27 See footnote 12 and its related discussion in the main body of the essay.

28 Torrance, *Transformation and Convergence*, 115.

we acquire our first intuitive clues through which we apprehend reality.²⁹ These clues, called “foreknowledge” by Polanyi and “prolepsis” by the Greeks, consist of “a tenuous and subtle outreach of the understanding with a forward thrust in cognition of something quite new.”³⁰

It is an authentically heuristic act in which the understanding leaps across a *logical gap* in the attainment of a new conception, and then guided by an intuitive surmise evoked by that conception probes through deepening coherences to lay bare the structure of the reality being investigated.³¹

How this proleptic grasp of reality functions in Torrance’s understanding of discovery will be discussed below.³²

This calls for much hard work in every field of inquiry, but none more than in theology where we have to do, not with an inanimate or impersonal reality, or even another human subject, but with the God who is an absolute Subject who nevertheless gives himself to be known by us objectively. Real discovery, that is, the uncovering of new knowledge that we could not have told ourselves, requires that we allow ourselves to be open to the inexhaustible revelatory capacity of reality, especially the reality of God. However, once we have gained an insight into this utterly new knowledge, it is important that we unpack its significance for the rest of our knowledge, and for this, we need to use the tools made available to us through the study of logic.

Logic

When Torrance writes explicitly on the nature and problems of logic, a significant and often rather confusing aspect of his theology comes to sharp focus. Torrance has a habit of taking words that are in common parlance, significantly redefining them and then using them in their transformed sense without further comment. This is completely consistent with Torrance’s understanding of the development of theological language in the era leading up to and following upon the council

29 Ibid., 93.

30 Ibid., 114.

31 Ibid., 14.

32 See below, “Two-fold Process of Scientific Discovery.”

of Nicaea in 325 A.D. One such example is that, while it is true that the early church took over words, such as *ousia* or *hypostasis*, from the Greek philosophy of their time, these terms were transformed in this appropriation so that they took on a decidedly *personal* character, being defined in light of the being of God. It is precisely when these terms were used in their pre-Christian hellenic sense that confusion arose in the church.³³

Torrance, in his chapter on logic in his monumental work, *Theological Science*,³⁴ engages in precisely this kind of radical reinterpretation. Whereas logic has almost universally been understood as what Torrance will call “The Logic of Systematic Form,” Torrance insists on beginning by defining logic in terms of the inner rationality or intelligibility of the being of God. Only after he defines logic in light of the divine being does he apply it in a lesser sense to the inner rationality or intelligibility of created beings. Although he finally does take up the traditional notion of logic, Torrance’s significantly redefined notion tends to marginalize it. It is not my purpose to critique this practice, as it seems demanded by Torrance’s theological method in general; however, it is important that this be explained so that misunderstanding can be avoided.

Torrance himself never takes up the issue of logic in a comprehensive way in his later works, and tends to favor terms like “inner intelligibility” and “inherent rationality,” to speak of what he earlier referred to as “the logic of God” or the “inner logic” of God or created beings.³⁵ Because of this, whereas Torrance’s treatment of “The Logic of Empirical Form” and “The Logic of God” predominantly used the term *logic* in this radically differential way, that practice will be avoided in this paper for the sake of clarity, though those titles will remain.

33 For Torrance, a case in point is when some of the Cappadocian fathers forgot the understanding of *ousia* as *being* in its interrelations. See Thomas F. Torrance, *The Trinitarian Faith: The Evangelical Theology of the Ancient Catholic Church* (T&T Clark, Edinburgh: 1988), 241–242. For the decidedly “un-Greek” appropriation of Greek terms, see 68–75, especially 74. Additionally, this same issue came into play when Boethius logically derived *person* from the idea of universal substance, rather than from the triune being of God. See *Reality and Scientific Theology*, 174–175.

34 Torrance, *Theological Science*, 203–280.

35 It is entirely possible that this shift in terminology may have come about because Torrance felt he was being misunderstood by his hearers and readers.

The logic of systematic form³⁶

The logic of systematic form is concerned primarily with the internal consistency of our thinking.³⁷ Strictly speaking, the logic of systematic form is not concerned with truth or falsity but with valid or invalid argumentation.³⁸ In this way, it can be said that the logic of systematic form is most closely related to the discipline of pure mathematics, such as Euclidean geometry.³⁹ Such forms of mathematics operate with carefully worded definitions and basic principles and work with a rigorous application of logic to draw conclusions from these premises.

It must be remembered that, as classically understood, logic in this form is considered to be independent of time and space.⁴⁰ Logic is not concerned with *becoming*, but only with *is*.⁴¹ The entirety of Euclidean geometry is already implied in the five postulates that form its basis. Because systematic form is concerned only with a finite number of fixed axioms and the implications of their interrelation, logico-mathematical systems have been treated as utterly closed systems, completely detached from the empirical world.

36 For this section, see *Theological Science*, 246–263. When Torrance writes on these issues, he does so under the headings, “The Logic of Existence-Statements,” and “The Logic of Coherence-Statements,” drawing on concepts he developed in chapter 4 of *Theological Science*, “The Nature of Truth.” Though the logic of existence-statements and the logic of coherence-statements are roughly equivalent to the logic of empirical form and the logic of systematic form, respectively, they are not truly identical. It seems that Torrance wanted to emphasize the continuity between his understanding of truth and language and his understanding of logic. However, as our purpose here is to emphasize the open character of these various levels of logic, I have chosen to use these alternative terms used by Torrance. It should also be noted that the distinction between these two kinds of “logic” are significantly parallel to the distinction between a correspondence and coherence theory of truth, respectively.

37 *Theological Science*, 249.

38 *Ibid.*, 247, 249–250.

39 The distinctive features of Euclidean geometry will be discussed below in the section titled “Euclidean Geometry.”

40 *Theological Science*, 254.

41 *Reality and Scientific Theology*, 90–91.

Because of their closed and abstract nature, logico-mathematical systems have often been praised as being the most rigorous and thus most pure form of logic. According to Torrance's understanding of logic, as alluded to above and more fully fleshed out below, the exact opposite might be said to be true.⁴² The radically closed nature of the logic of systematic form makes it the least deserving of the title, "logic." If logic is the inherent rationality of existents, the logic of systematic form is the least logical of the three levels we have considered here.

Even though this is the case, it must be emphasized that Torrance does not wish to do away with formal, abstract logic. Indeed, when used as a tool to ensure non-contradiction within a complex of statements, and as a means by which we can work out the implications of what we know, the logic of systematic form is absolutely indispensable.

The casting of scientific results into a mathematical notation may not only give them consistency, making them precise and clear, but, as it were, do some difficult thinking for us by unfolding the implications of our scientific work beyond what we could determine with our empirical statements alone.⁴³

Without rigorous understanding and application of the logic of systematic form, there is much that we would not know. Whatever else Torrance's critical realism may imply, it certainly does not imply a rejection of formal logic.

In spite of this affirmation, however, Torrance refuses to give the logic of systematic form the primacy and authority that others have given it. In itself in the form of a closed system, the logic of systematic form tells us nothing about reality. It only tells us how we can decide if a statement is true given another statement of the same kind.⁴⁴ In order for the power of logico-deductive systems to be harnessed to helpful or meaningful ends, it must be open to empirical reality at key points. This does not mean that every formal-logical statement must have an empirical correlate, or that we can decide ahead of time which

42 See above, under the section heading, "Logic." Again, it must be remembered that at this point, Torrance is departing rather radically from the traditional meaning of "logic." Torrance once referred to this kind of logic as "paper-logic." See *Theological Science*, 219.

43 *Theological Science*, 25; *Reality and Evangelical Theology*, 62.

44 See the quotation of John Wisdom in *Theological Science*, 267.

statements must have such empirical correlates,⁴⁵ but there must be a real connection if such logic is to be meaningful in our world of space and time.

This is crucially important for it means that, for Torrance, even logic, which has been affirmed for its power as a closed system, must be kept open at crucial points or else it is utterly meaningless. Just as the contingency of the universe as a whole points to the openness of systems within the universe, the openness of the logic of systematic form, the most closed of all concepts, indicates that nothing can be truly closed off from empirical reality outside of itself without resulting in the falsification of our conclusions or the rendering of them useless.

Euclidean Geometry

If there were ever a discipline that has been seen as utterly closed, it is formal logic, especially in its most rigorously developed form in pure mathematics. Perhaps the paradigmatic example that will best help us understand the nature of closed, formal-logical systems is that of Euclidean geometry. Euclid put forward five postulates that he considered self-evident and so made no attempt to prove. From these five basic ideas, he proceeded to develop the whole of geometry as it was known for hundreds of years. Regardless of how complicated geometry became, it was always possible (at least in theory) to trace a given theorem back to its ground in the five basic postulates. This was a logico-deductive system that was built from the ground up. It was utterly closed to outside influences and stood for centuries as the premier example of what the human mind was capable of. Because it is closed, Euclidean geometry is capable of providing an absolutely explicit account of its conclusions and the reasons for them.

Because of the incredible success that various thinkers had in describing the behavior of natural phenomena in terms of Euclidean geometry, the reasoning

45 Empirical correlates are points at which a scientific (whether natural or theological) theory bears on reality. Empirical correlates are the points at which a theory can be verified or falsified. Without such correlates, a theory would have no real bearing on reality and is thus scientifically useless. See *Reality and Evangelical Theology*, 34–39, and *Theological Science*, 237, 294–295. Also, see the section “The Stratified Nature of Reality” in my companion essay in this volume of *Participatio*, “Truth and Language in the Theology of T. F. Torrance.”

employed in it became the standard by which, in practice, logic was defined and this was applied to every field of inquiry. Indeed, in the Middle Ages, to think more rationally was to think *more geometrico*.⁴⁶ According to this kind of practice, logico-deductive systems akin to Euclidean geometry were seen to be the purest form of logic, and if something did not measure to that standard, it was seen as deficient or illogical.

The Insights of Clerk Maxwell and Einstein

In the years following thinkers such as Newton and Kant, there was a striking emphasis on phenomena as the only appropriate basis on which to build scientific knowledge.⁴⁷ However, Scottish physicist and committed Christian, James Clerk Maxwell, insisted that mathematics could not be isolated from empirical science, and that we must operate with “embodied mathematics.”⁴⁸ This means that our understanding of mathematics must arise from nature itself, rather than applied as an external parameter. Additionally, after trying and failing to describe the behavior of an electro-magnetic field in terms of Newtonian mechanics,⁴⁹ Clerk Maxwell developed a relational understanding of nature, that there are relations that are constitutive of realities. Torrance refers to such relations as “onto-relations.”⁵⁰

Einstein took this insight very seriously, calling Clerk Maxwell’s work in field theory the most important advance in physics since Newton.⁵¹ his work brought geometry into the heart of physics, making it a “natural science.” This further development of field theory revealed the inadequacy of Euclidean geometry to

46 Torrance, *Transformation and Convergence*, 320–321; *Reality and Scientific Theology*, 41–42.

47 This stems largely from Newton’s claim (since then shown to be erroneous) that he framed no hypotheses and Kant’s radical distinction between phenomena and noumena.

48 Torrance, *Transformation and Convergence*, 226–229.

49 It must be noted that even this failure was not without its fruit as it led to Clerk Maxwell’s development of partial differential equations that have proved so important.

50 Torrance, *Transformation and Convergence*, 230.

51 *Ibid.*, 233.

describe nature and, together with non-Euclidean geometries, helped scientists to see these limitations and foster a way of thinking that derived geometrical conceptions from reality instead of clamping them *upon* reality.⁵²

The Implications of Gödel's Theorems⁵³

Though Torrance does not base his conclusions on the work of mathematician Kurt Gödel, he often cites his work as a dialogue partner and as one who has reached conclusions in the philosophy of mathematics that are remarkably parallel and congenial to his own conclusions in theology and philosophy of science.⁵⁴ A brief sketch of the context that gave rise to Gödel's groundbreaking work and its implications for logico-deductive systems will be given here.

In the late 19th and early 20th centuries, there was a tremendous effort made to establish powerful logical systems that would be both consistent, that is, no proposition could be both proved and disproved within it, and also complete, that is, that every proposition that is expressible in terms of the system can be either proved or disproved within it. This goal inspired the development of meta-mathematics and other incredible efforts of human intelligence. Perhaps the greatest achievement toward this end was the writing of *Principia Mathematica* by Alfred North Whitehead and Bertrand Russell. This massive undertaking was designed to develop a considerably useful system that was both consistent and complete, as well as closed; that is, it did not rely on anything beyond itself for its completion or consistency.

The reason why this is desirable is that it would enable us to make entirely explicit everything that we implicitly rely on in order to prove something. There would no longer be any need to assume the consistency of a wider set of axioms

52 For a comment on the congeniality between the advances in logic and those in physics, see *Theological Science*, 248. See also *Ground and Grammar of Theology*, 91–91 for Torrance's discussion, using Euclidean geometry as an example, that closing off a system in independence from reality distorts and falsifies it.

53 For this section, see primarily *Transformation and Convergence*, 135–148.

54 Torrance, *Transformation and Convergence*, 322–323; *Ground and Grammar of Theology*, 70; *Reality and Evangelical Theology*, 73–74; *Reality and Scientific Theology*, 123–126.

in order for a system to function. The problem here is expressed several times by Torrance in Pascal's observation that, even in something as simple as the definition of a word, we must use other words that, for the purposes of the definition, must remain undefined.⁵⁵ It is the desire to eliminate such imprecision in mathematics that fueled much of this endeavor.

As it turns out, however, such a goal is inherently impossible. This was shown by the epoch-making work of Kurt Gödel and his famous "incompleteness theorems," published in 1931 in the essay, "On Formally Undecidable Propositions of *Principia Mathematica* and Related Systems." The main thrust of Gödel's point, and why it is significant for our purposes, is that it demonstrated that no formal system, provided it be of sufficient richness,⁵⁶ can be both complete and consistent within itself. This has radical implications because it means that, in any formal-logical system, there are propositions that can be expressed in terms of the system that are true, but also not provable.

This does not mean that any given system is hopelessly incomplete, but that it is incomplete *in itself*.⁵⁷ If the system were to be open to a richer, more comprehensive system, propositions that would otherwise have been undecidable within the original system can be decided with reference to the higher and wider meta-system. It must be noted, however, that this only solves the problem of completeness and consistency for the original system. This higher and wider system is also a formal-logical system, which means that Gödel's theorems

55 See Torrance, *Christian Theology and Scientific Culture*, 114.

56 This level of richness is a caveat because one could construct a closed, consistent, and complete system that is so simple that it is of no value. Such an example might be as follows: If a proposition has an odd number of words, it is true; if it has an even number of words, it is false. This is closed, consistent, and complete, but utterly pointless.

57 As Gödel's theorems demonstrate that a closed formal-logical system cannot be *both* complete and consistent, it stands to reason that, just as a system can be consistent but not complete, one could conceivably be complete but not consistent. The emphasis in Torrance, to speak of no others, is on a consistent system that is completed beyond itself. This seems to be because a system that is complete but not consistent has severely limited usefulness (indeed, it may even be shown to be useless), whereas a consistent but incomplete system has considerable usefulness, especially if it *can* be completed beyond itself.

apply to it as well, thus showing that even this second system cannot be both complete and consistent.

In theory, this process could go on forever, always making an appeal to a higher and wider system, but in practice, as Torrance points, out, we tend to work with only three levels of thought. The significance of Gödel's theorems is that, just as the empirical sciences have been increasingly demonstrating that we must understand reality as stratified and operate with a multi-leveled natural science, even mathematics which has so often been treated as something operating on only a single level, must operate on multiple logical levels and is marked by a fundamentally open character.⁵⁸

The Logic of Empirical Form⁵⁹

Though we have already discussed Torrance's understanding of the logic of systematic form, we must understand that Torrance, in his most significant chapter on logic, does not do so in this order, but subordinates the whole concept of formal logic to more dynamic forms of logic rooted in reality. To understand what he does here, it is instructive to look at his understanding of how Calvin altered the practice of asking questions as compared to the common practice at the time. Aristotle spoke of four questions that were reduced to three by Cicero: *quid sit* (what is it), *an sit* (whether it exists), and *quale sit* (what sort of thing is it).⁶⁰ Rather than begin with questions dealing with abstract ideas and possibilities, Calvin reversed the question, asking along the lines, "What sort of God is this revealed to us in Jesus Christ?" This way of thinking prioritized actuality over possibility, concrete over abstract, material thinking over formal thinking.

This is precisely what Torrance does in his understanding of logic. Rather than prioritizing a way of thinking that does not depend on actuality but only on

58 See Torrance, *Theological Science*, 259–263; *Transformation and Convergence*, 304–305; *Ground and Grammar of Theology*, 17.

59 For this section, see *Theological Science*, 222–246.

60 Aristotle's fourth question was *propter quid*, which was combined into *quale sit* by Cicero. See Thomas F. Torrance, *The Hermeneutics of John Calvin* (Edinburgh: Scottish Academic Press, 1988), 121. Also see *God and Rationality*, 33–34.

abstract possibility, he turns instead to what actually exists. More specifically, he turns to deal with logic first and foremost as manifested in God as the only one who is existent in his very being, everything else having existence only by virtue of relation to God. For Torrance, God is so far from being illogical that he is the only place where we really encounter logic in the fullest sense of the word, for God is the only one in whom *logos* is *enousios*.⁶¹

Torrance has a tendency to use the word *logic* differentially. In this section and the following one, instead of continually speaking of the *logic* of God or the *logic* of empirical reality, we shall prefer to use phrases such as *intrinsic intelligibility* and *inner rationality* as synonymous expressions that will, we hope, bring increased clarity to Torrance's treatment of logic.

It must be repeated that the three levels of logic (logic of systematic form, logic of empirical form, logic of God) cannot be sharply divided. Inasmuch as the logic of God is understood to be the logic of a particular existent who is existent in the fullest sense whereas all other existents are so only in a derived sense, there is significant overlap in our understanding and articulating the logic of God and the logic of other empirical realities, though the uniqueness and priority of the logic of God must be maintained in spite of this overlap. Additionally, one significant aspect of knowledge is that it is never separated from a particular form. Form and being are deeply integrated, and the idea that we can have access to knowledge independent of form is meaningless, as we cannot understand anything, much less communicate it, unless it is in some kind of form.

Form arises, however, in two different ways, as we reflect upon external relations in the world, and as we seek to correlate what we apprehend in reducing the internal relations of our thought into orderly patterns. It may even be right to speak of two different kinds of form, *empirical form* deriving from objective relations in states of affairs, and *systematic form* deriving from the combination of our thoughts in consistent sequences, but if so they are found only in a polar relation to each other.⁶²

61 It is at precisely this point that confusion may arise as this turns the traditional understanding of logic on its head.

62 Torrance, *Theological Science*, 222–223.

It is because of this formal aspect of knowledge that we must deal with the logic inherent in such form. In this way, much of the above discussion on the logic of systematic form will overlap with this discussion and the one on the logic of God.

The logic of empirical form is concerned with the inherent connections and rationality in a given existent. The difference between the logic of empirical form and the logic of God is that the former is far more general, dealing with existents in general, both divine and created. It is important to note that, though the logic of empirical form precedes the logic of God in this essay, this is not how Torrance understands the relationship between these two forms of logic. Torrance is taking the insights gained from understanding the logic of God and generalizing them to deal with created realities and not taking insights gained from understanding the logic of empirical form and then applying them to understanding God. God always has priority, even in our understanding of logic.

The primary issue in the logic of empirical form is that it is a logic of discovery.⁶³ It deals with the inherent rationality of existents that are external to ourselves and our logico-linguistic systems.⁶⁴ As such, what we learn through encounter with empirical reality is content that we could not have taught ourselves in isolation from that reality. The logic of empirical form is a logic of reference, where the statements we use to speak of the internal logic of various existents do not contain the truth in themselves but refer to states independent of themselves through a semantic relation.⁶⁵

It could be said, for the sake of clarity, that, as the logic of systematic form is mostly closely related to mathematics, the logic of empirical form is most closely related to the discipline of empirical science, in that it is concerned with knowledge that is truly *new*. As such it is characterized by open concepts and structures, which derive their content from the realities to which they refer and are revisable in light of them. The logic of empirical form is not simply concerned

63 Torrance, *Theological Science*, 230–231, 239–240.

64 Reality proves itself to us with its own self-evidential force that we cannot rationally resist. See *Ground and Grammar of Theology*, 97–99, and *Reality and Evangelical Theology*, 103.

65 See my companion essay in this volume of *Participatio*, "Truth and Language in the Theology of T. F. Torrance."

with validity and consistency but with *truth*, the truth of existents in being what they are and not something else. Learning the truth in this sense requires that the questions we ask be interrogative in nature.⁶⁶

The Logic of God⁶⁷

In spite of the fact that we have, for the sake of clarity, begun our discussion of logic with the logic of systematic form, it is important to stress yet again that, to really comprehend Torrance's understanding of logic, we must grasp that he operates with a very different starting point. For Torrance, understanding logic in general must start with understanding the logic of God. When he speaks of "The Logic of God,"⁶⁸ Torrance is not uncritically applying his theological tradition with normative force, as if we could identify our human logic with the logic of God. Rather, the logic of God is the rationality that is inherent within the being of God and as such stands in judgment over all human logic.

There is tremendous overlap between the three types of logic discussed here. This is because, though our understanding of the logic of God must insist on its priority over the logic of other existents, both the logic of God and material logic more generally deal with the problem of what Torrance calls "ontologic," or the intrinsic intelligibility of existents, regardless of whether they are mundane or divine.⁶⁹ Additionally, regardless of whether we are speaking of God, other existents, or the relations between ideas, we have no choice but to use language, so Torrance's understanding of language overlaps with his understanding of logic.

Torrance understands the rationality of God, which deals not only with the problem of "ontologic," but also with "theologic,"⁷⁰ as deeply Christocentric.

66 See the discussion above in the section "Openness" on the comparison of *quaestio* and *interrogatio*.

67 For this section, see *Theological Science*, 203–222.

68 It should be remembered that we shall use the phrase "rationality of God," and others like it, as clarifying synonyms for "the logic of God."

69 Torrance, *Theological Science*, 205

70 For a discussion of the interior logic of theological knowledge, see *Ibid.*, 212–214. Also see *Reality and Scientific Theology*, 91, and *Theological Science*, 205.

By “the Logic of God” we can only mean Jesus Christ, for he and no other is the eternal *Logos* of God become flesh. he is the incarnate *Logic* of God, the Logic of God’s grace and truth toward us, and therefore we are bound to think in terms of this incarnate Logic in Christ. The Logic is in Christ before it is in us; it is in the given reality before it is in our knowledge of him. What we have to do is to lay bare the organic meaning or structural coherence of theological knowledge as it takes form and order in accordance with the living unity and order of the truth in Jesus Christ.⁷¹

When we set ourselves to understand the logic of God, we must not import a way of thinking derived outside of our field of inquiry, but derive it from within. This means that we must seek to understand God in accordance with how God comes to meet with us, which is in and through Jesus Christ.

There are two main facets of Torrance’s understanding of the logic of God that must be addressed. first, the logic of God is the logic of *grace*.⁷² Within this facet there are two issues that must be noted. For Torrance, the being and thus the logic of God always has priority over our being or our understanding. Because of this, we are not able to impose our own understanding on the being and logic of God without falsifying it. This demands a level of objectivity that is as rigorous as the hard sciences, if not more so. After all, we are dealing in theology with the God of all who will not be mastered by our creaturely concepts.

The second aspect of the logic of grace, and perhaps most important for our discussion, is that God is under no compulsion to be the truth of our theological statements. There is a sense that, when we engage in the natural sciences, the objects of our knowledge are under our control in the sense that, when we know them, they *must* be known, that they *must* submit to our probing and questioning.⁷³ God, however, is under no such obligation. God does not need to reveal himself to us, nor to make himself the object of our investigation. The fact

71 Torrance, *Theological Science*, 205–206.

72 Ibid., 214–216

73 Though it is true that, in this limited sense, the objects of natural science are under our control, inasmuch as genuine insights are never done away with, we must not make too much of this control as nature continually reveals itself to be unpredictable and reveals our need to carefully develop experiments and tools to know it.

that God has indeed done this requires us to always remember that we are not the masters of God but that God is *our* master.

Furthermore, this means that all our theological concepts must be radically open to God's gracious revelation. We can never round off our ideas and close them in so they have the same kind of timeless and spaceless certainty as an arithmetical expression. This means that there is an element of *decision* in our theological activity.⁷⁴ This is not to be understood as if our decision *makes* our conclusions true, but rather must be understood as a response to *election*. God has chosen to be truth for us so we must respond with decision that God and nothing else might be truth for us. Although this is particularly relevant in theological science, it is true, *mutatis mutandis*, in natural science as well.

The second key facet to understanding the logic of God is that it is the logic of *Christ*.⁷⁵ It is because of the absolute Christocentricity of the logic of God that we must conclude that the logic of God is radically *personal* and *dynamic*.

When we do that we are directed to Jesus Christ, to the Incarnation, to the hypostatic union, the unique togetherness of God and man in Christ which is normative for every other relationship between man and God.⁷⁶

However, there are dangers with this facet as well. We must not think of the hypostatic union as a static concept but rather a dynamic one whose significance runs throughout the whole of Christ's life, death, resurrection, and ascension. Additionally, Torrance warns us that we must not "turn the doctrine of the hypostatic union into ideological truth, and use it as the masterful idea of a system of thought."⁷⁷ That is to say, we must not make our doctrines (including such central ones as the hypostatic union) into *closed* concepts that are no longer open to modification or interpretation from the reality they signify.

Out of the three subdivisions of "logic" dealt with here, the logic of God is the most firmly *logic* as it is rooted in the Logos inherent in the very being of God, which is the only thing that, for Torrance, deserves to be called logic in the

74 Torrance, *Theological Science*, 214–216.

75 *Ibid.*, 216–222.

76 *Ibid.*, 216.

77 *Ibid.*, 216.

fullest sense.⁷⁸ It is also the most fully personal and dynamic of all logic. Most significantly for our purposes, it is also the most radically open. Though we must use language to speak of the logic of God, which binds Torrance's discussion of this topic to the logics of empirical and systematic form, which were discussed above, this logic in itself is not bound to our words but utterly transcends them. It is a logic of divine being and so cannot be reduced to closed human concepts. Our understanding of the logic of God must be radically open to the being of God, for the logic of God is the inherent rationality and coherence within the being of God.

Significance of Openness for Natural and Theological Science

It is important that we take a moment and explore some of the key implications this understanding of openness has for our natural and theological sciences. The first of these implications is that it shows that the age of determinism is indeed over. Rigid determinism, which is a prerequisite of prediction, is only possible within closed systems, whose connections are logical⁷⁹ ones and in which time is not an internal parameter of the system (though it might be applied in an external way). With the increased understanding that we live in an open universe and that God truly does greatly exceed all our thoughts about him, determinism has been radically critiqued, though it is taking a long time for the popular mind to shift out of determinist categories.⁸⁰ Because of this, prediction is becoming less important as a criterion of theoretical proof.

78 At the risk of being repetitious, it should be emphasized again that Torrance uses the word "logic" differentially. It is to be clearly understood that Torrance is indeed calling, by his practice, for a radical redefinition of logic, akin to the redefinition of Greek philosophical terms by the early church.

79 This is in contradistinction to ontological interrelations, which Torrance believes to be constitutive of open systems.

80 The legacy of determinism in science has made many theologians hesitant to relate theology to science. However, theologians seem to be slow to understand the significance of the critique of determinism in natural science. See *The Ground and Grammar of Theology*, 18–20.

Since the realities we investigate, whether empirical reality or the being of God, cannot be captured in words, our statements and concepts must be continually kept open to reality, or else they will become false by transferring their truth from reality to themselves, thereby reducing ontological truth and relations to linguistic truth and relations. This means that the rationality of our concepts or statements is dependent on the rationality that is inherent in the reality to which they refer (their inner logic). It may seem as though this will lead to a tremendous decrease in precision, for we cannot reduce our concepts to clear-cut statements that we can manipulate at will. However, the opposite is the case. By closing our mental and linguistic structures off from the reality to which they refer, we make them most *imprecise* (or else we make them extremely precise but of no empirical value). The openness of our concepts drastically increases their precision because they renounce any truth in themselves but insist on directing our attention to the truth of reality.

Because we are dealing with open mental and linguistic structures, which implies that we are not able to reduce reality to statements *about* reality, we must expect that, though we have a grasp on key issues in understanding reality, this openness will lead us periodically to have our whole way of thinking and understanding radically changed and rebuilt in such a way that the key insights from before the shift are not lost, but that our structures of thought and speech bear a stronger relation with the structures of reality.⁸¹ It is precisely because this *does* happen (such as with the development of Nicene theology and relativity theory) that we are convinced that our theological and natural science is not self-generated, but is built on what is "heard" from beyond it. In the case of natural science, this takes the form of understanding that we gain through empirico-theoretical investigation of the universe; in theology, it takes the form of what we learn through the self-revelation of God. Because both are rooted in a source outside of ourselves, they continually break through our concepts and forge new ones.

Because of this need to be open to reality so that our terms can take on a fuller precision, our terms are always revisable in light of reality, so that terms may

81 Torrance, *Theological Science*, 345. Torrance occasionally uses Thomas S. Kuhn's term "paradigm shifts" to describe such radical changes in understanding. See *Theological Science*, 296.

need to be coined, reinterpreted, or discarded, depending on further disclosure from reality. In the natural sciences, this took place with the development of non-Euclidean geometries, where terms that were previously defined in a common sense way (such as "point" and "line") were radically reinterpreted as technical terms. Theologically speaking, this means that even key doctrines like the *homoousion* or the hypostatic union are not sacrosanct or beyond reformulation, but that they have their content in the reality of God's self-revelation in Christ, and if it should happen that it becomes clear that the terms need to be modified to better reflect reality, this can happen. If it happens that terms are not redefined, it is not because they contain the truth in themselves or because they are, as statements, adequate to the truth, but because they have proved remarkably fruitful at enabling us to understand and articulate the inner rationality or logic of the realities to which they refer.

Two-fold Process of Scientific Discovery

In light of the preceding discussion, it is clear that one could easily fall into two errors. The first of these is to make the kind of logic we see in closed formal-logical systems the ideal for all knowledge. To make this mistake in natural science would be to radically close our concepts and to affirm that knowledge is effectively isomorphic to Euclidean geometry. In this case, what we call "discovery" is really nothing of the sort, but the making of logical connections within the mind and a reverting to a quasi-Platonic understanding where all our knowledge is already innate in the mind but has to be uncovered by logical processes.

The other mistake one could make is to avoid formal logic altogether because of its limited use in describing the universe and its inability to truly *discover* utterly new truths, being able only to work out logical implications from known premises. However, to do this is to neglect the fact that logic is a tool that can be tremendously helpful, so long as it is not pressed beyond its inherent limitations. As Torrance has said in the statement quoted above, logic can "do some difficult thinking for us by unfolding the implications of our scientific work beyond what we could determine with our empirical statements alone."⁸²

82 See footnote 42.

The fact that Torrance affirms both the indispensability of formal logic and its inability to teach us something new makes it not surprising to see that he describes the gaining of knowledge as a two-fold process that includes both a leap forward in knowledge through a proleptic insight and a working out of the logical implications of that insight.⁸³ This enables Torrance to value formal logic but to resist the temptation to set it up as a standard that is independent of reality.

It is important to emphasize the fact that the insight that we must have to move forward in our knowledge is not something that we could have taught ourselves on the basis of what we already knew. That is to say, this new knowledge is not logically deducible from our previous knowledge. Because of this, truly new knowledge will not fit nicely into the logical form that we had before we had the insight, which can make it seem a-logical, or perhaps even *illogical* at first glance.⁸⁴

However, once the insight is gained, we can begin to unpack its significance. The implications of a new insight are sometimes so profound that it might take a long time to exhaust its significance. For example, after Einstein wrote his original ground-breaking papers on relativity theory, it took decades for scientists to fully appreciate what was accomplished. Once the implications have been understood, we take another leap forward with another insight, and the process begins all over again. It stands to reason, however, that our insights may very well come more quickly than we can understand their full significance. There is no requirement that we exhaust our understanding of an insight before we have another one.

It would be most appropriate to give a few examples from Torrance's own writings to help illustrate how he understands this as having taken place. Perhaps the strongest example is that of the apostles coming to understand the significance of Christ.⁸⁵ While they followed Jesus, they heard what he said

83 This bears some resemblance to Kuhn's notion of Scientific Revolutions and leaps forward in knowledge. *Transformation and Convergence*, 243; *Ground and Grammar of Theology*, 47–48. Also, see *Reality and Scientific Theology*, 83–85, and *Reality and Evangelical Theology*, 102.

84 Torrance, *God and Rationality*, 203.

85 See Thomas F. Torrance, *The Christian Doctrine of God: One Being Three Persons* (T&T Clark, Edinburgh: 1996), 44–45.

and watched what he did, but at the end when he was arrested and crucified, they scattered, returned to their previous lines of work, and locked themselves in rooms so they might not share Christ's fate. And yet, after they received the Holy Spirit on Pentecost, and understood the significance of Christ in a way that they could not have taught themselves (after all, nothing short of the very being of God taking up residence inside of them could generate this insight in them; not even the resurrection accomplished this), they became radically different people. All of a sudden, the whole of Christ's ministry took on new depth. They remembered all the times when he accepted identification as the Son of God and son of man, and they emphasized it in their passing on the story of the life of Jesus. The implications of this key insight were so profound that those who once fled from Christ's fate eventually willingly and boldly joined him in it.

Another, if somewhat less dramatic, example is the impact of humanist studies on John Calvin.⁸⁶ He had studied at Montaigu, learning especially, as Torrance affirms quite strongly, from Scottish philosopher John Major. However, there was much from his early learning that, because of the insights of the humanist movement, was seen to be a hindrance. Though he was careful not to abandon what he learned at school in its entirety, "everything had now to be looked at from a new angle, the relation of language to culture and of good letters to the realities signified."

Before a discussion on the significance of openness and logic and how they both play a role in this two-fold process of scientific discovery can be closed, some brief comments are called for in order to give a more full account of how Torrance envisions this process taking place.

It is important to note in this regard that Torrance's resistance to the usefulness of axiomatic systems is that they are made up of *fixed* axioms that are determined in an *a priori* manner and are not modifiable in light of experience. Torrance advocates the use of what he calls *fluid* axioms.⁸⁷ These are like fixed axioms in that they arise in the mind without logical proof, but are unlike fixed axioms in that they *can* be modified in light of experience. In a sense, fluid

86 See Torrance, *Hermeneutics of John Calvin*, 100.

87 Torrance, *Reality and Scientific Theology*, 77–79, 92–93; *God and Rationality*, 99–100. For three examples of how fluid axiomatic structures have been used throughout church history, see *Reality and Scientific Theology*, 86–91.

axioms are “free inventions” of the mind,⁸⁸ but they must not be understood as if they bore no relation to reality because they arise under the impact of reality upon the scientist and by his or her personal participation in that reality. These fluid axioms form the basis of the various theories through which one discerns reality.⁸⁹ However, as reality tends to outrun and outstrip all our most careful formulations, these axioms must be modified in light of what we learn and made to better reflect reality as it has been disclosed to us.

This is deeply related to what Torrance calls *disclosure models*.⁹⁰ Unlike what he calls *picturing models*, Torrance thinks that we need to maintain a real distinction between our models and what they are meant to refer to. Because of this, we must never allow our models to get in the way of our perceiving reality but be the medium *through* which we perceive it.⁹¹ In Torrance’s understanding, scientific theories are precisely this kind of model. They function as compound questions put to nature and have to be revised progressively in the light of the answers that come back from nature so that they may become more and more transparent media through which nature discloses its mysteries to us and imprints its truth on our understanding with its own self-explicative and evidential power.⁹²

The purpose of our theories is to understand reality more fully. They are media through which we come to know reality but reality always retains ontic priority over our theories.⁹³

88 Torrance, *Transformation and Convergence*, 79. “Free invention” is language Torrance borrows from Einstein. See also Albert Einstein, *The World As I See It* (John Lane, London: 1935), 134.

89 Torrance, *Reality and Evangelical Theology*, 50–51, 64–65.

90 For a discussion on disclosure models, their construction and use, see *ibid.*, 85 –86.

91 Torrance, *Transformation and Convergence*, 255, 274–275; *Ground and Grammar of Theology*, 124 –127.

92 Thomas F. Torrance, “Theological Realism,” in *The Philosophical Frontiers of Christian Theology: Essays Presented to D. M. MacKinnon*, eds. B. Hebblethwaite and S. Sutherland (Cambridge: Cambridge University Press, 1982), 183–184.

93 A common theme in Torrance’s writing is that for our questions to be purified, they must be questioned down to their roots. See *God and Rationality*, 53–54.

By this process, we come to progressively deeper and more complete understanding of the natural world (in the natural sciences) and the God who created the universe (in theological science), while never forgetting the utter primacy the object of our knowledge has over our knowing of it. Torrance insists on appropriating the tremendous power of formal-logical processes but, through using the logic of God as his paradigmatic example by which he understands what logic truly is, insists rightly that logic must always be open to the reality it serves and must never be allowed to clamp an artificial framework down upon reality. Torrance's understanding of openness and logic is fully integrated and consistent with his critical realist epistemology.