Thomas F. Torrance's Integration of Judeo-Christian Theology & Natural Science: Some Key Themes

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A major integrating aspect of Thomas F. Torrance's study of theology-natural science interrelationships is his interest in the relevance of Albert Einstein's understanding of natural science as manifest in special and general relativity. Accordingly, this paper examines Thomas F. Torrance's integration of Judeo-Christian theology and natural science with respect to seven key themes.

> From a long view of the history of mankind—even from, say, ten thousand years from now—there can be little doubt that the most significant event of the 19th century will be judged as Maxwell's discovery of the laws of electrodynamics. The American Civil War will pale into provincial insignificance in comparison with this important scientific event of the same decade.[1]
> (Richard P. Feynman, 1964)

Every time you turn on a light, watch TV, or use a microwave oven, you are experiencing the practical implications of Feynman's prophecy. But those implications, which originate in natural science—particularly physics, properly understood as a true liberal art—are far more profound. James Clerk Maxwell, a 19th-century Scottish physicist, formulated a theoretical framework which enables today's scientists and engineers to understand in a *unitary* way such complex and diverse phenomena as:

- electric motors and generators,
- communication by radio waves or microwaves,
- signals from distant stars received by radio telescopes,
- medical X-ray photographs, and
- visible light's behavior in cameras, microscopes, and telescopes.

A *unitary understanding* of physical phenomena enjoys such an inner simplicity that it can master enormous complexity by means of a few carefully chosen words or equations. This inner simplicity is the goal and content of truly creative science, including theology. $E=mc^2$ or *Jesus is Lord* (probably the first

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Christian creed) are very "simple" statements, but unpacking their intellectual and life-transforming content—with that content's ability to master awesome complexity—requires a life of dedicated work by scientist and theologian alike.

Theologian Thomas F. Torrance is a modern heir to this spiritual and intellectual tradition. Early in his long, varied, and creative career, he recognized that a sympathetic willingness to study natural science can be helpful for the redemptive betterment of humankind. He is one of the few major theologians who have edited seminal, scientific texts—in Torrance's case, James Clerk Maxwell's *A Dynamical Theory of the Electromagnetic Field*. What Torrance has written concerning Clerk Maxwell's pioneering work in natural science is reflected in his own creative, theological work. The deep appreciation that Torrance has for Clerk Maxwell springs from a sympathetic, intuitive linking of kindred spirits that goes far beyond their common Scottish roots. Torrance writes of Clerk Maxwell:

> . . . he was persistently aware of the 'vastness of nature and the narrowness of our symbolical sciences.' No human science, he felt, could ever really match up in its theoretical connections to the real modes of connection existing in nature, for valid as they may be in mathematical and symbolic systems, they were true only up to a point and could only be accepted by men of science, as well as by men of faith, in so far as they were allowed to point human scientific inquiry beyond its own limits to that hidden region where thought weds fact, and where the mental operation of the mathematician and the physical action of nature are seen in their true relation. That is to say, as Clerk Maxwell himself understood it, physical science cannot be rightly pursued without taking into account an all-important metaphysical reference to the ultimate ground of nature's origin in the Creator. Thus while Clerk Maxwell never intruded his theological, and deeply evangelical, convictions into his physical and theoretical science, he clearly allowed his Christian belief in God, the Creator and Sustainer of the universe, to exercise some regulative control in his judgment as to the appropriateness and tenability of his scientific theories; that is, as to whether they measured up as far as possible to the "riches of creation."
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> It was in that spirit that he put forward his own theories, always with reserve and always with the demand that they must be put to the test of fact, for his Christian faith would not allow him to fence off any area from critical clarification or to make any other claim for his theories than that they were of a provisional and revisable nature. . . .[2]

In the preceding quotation, if God as revealed through Jesus Christ were substituted for "nature," and if formal theological systems were substituted for "mathematical and symbolic systems," I believe these words about Clerk Maxwell could equally apply to Torrance's theological contributions.

Torrance's search for a unitary approach to theology comparable to Clerk Maxwell's unitary physics is succinctly captured in the advice he has given to young pastors. Note in what follows Torrance's connection between home and gospel as well as his unifying perspective on evangelism and ecumenism:

> If I were starting again as a young minister entering his first charge, I would do my best to engage in a Christ-centered ministry; i.e., one in which Christ has supreme place over all institutions. I would preach the gospel of unconditional grace, of reconciliation through the incarnation, passion, and resurrection of Christ, and seek to find ways of working that out in the life of the church and the community. Evangelism and ecumenism go together. . . . I would make pastoral visitation central, in which I read the Bible and prayed with people in their homes and gave them the opportunity to let me minister to them in personal ways. Only as they open their hearts to me like that can I understand the human heart in the light of the gospel, and only then can I preach to them the gospel in such a way that it strikes home to their own personal and practical needs. . . . It is only when the pulpit and the home are interconnected in this way that the gospel proves to be intimately and profoundly relevant.
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> But I would do all this while seeking to understand the astonishing changes in the modern world through the advance of our scientific knowledge, for that would be ministering in a universe which God has created and means us to understand: The universe in which his Word became incarnate and in which Christ will come again to change and renew.[3]

A major integrating aspect of Torrance's study of theology-natural science interrelationships is his interest in the relevance of Albert Einstein's understanding of natural science as manifest in relativity theory. I believe a good way to gain insight into Torrance's distinctive integration of theology and science is

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through a consideration of some key themes of Torrance's theology as related to Einstein's relativity theory. These seven key themes should enable the reader to appreciate better Torrance's pioneering efforts.

Torrance's Integration of Judeo-Christian Theology and Einstein's Relativity Theory: Seven Key Themes

1. The Unitary Character of Theological and Scientific Knowledge.
2. Relativity Theory: The Absolute Underpinning of the Relative.
3. In Creative Science, the "Invisible" Explains the "Visible."
4. The Physical Universe, a Relational Rather Than Container Model.
5. Field Theories: An Expression of the Relational Character of Reality.
6. The Universe: A Multi-Leveled Yet Integrated Whole.
7. Theology and Natural Science: Allies Rather Than Foes.

1. The Unitary Character of Theological and Scientific Knowledge

Both relativity theories, special and general, emphasize the unitary character of scientific knowledge. Empirical and theoretical factors are inseparably integrated, representing a unitary epistemological (epistemology meaning the study of the nature and the origins of knowledge) structure that should be characteristic of good physics and good theology. Torrance emphasizes two important factors regarding the unitary character of scientific knowledge.

(a) All creative science is an *integration* of practice and theory, where integration is a form of unifying, of creating a whole, which was heretofore unrecognized. Integration functions as a spontaneous organization of natural coherences embedded in nature, which we grasp only through non-analytical (informal) acts of knowledge. These acts of knowledge arise through intimate contact with—and mental reflection on—a discipline's subject matter.

(b) Theology, properly understood and practiced, is indeed a *creative science*. To understand the intent of Torrance's two-fold thrust in the context of the unitary implications of Einstein's work, one must first understand how Torrance interprets Einstein's scientific method and ultimate goal as fully compatible with those of evangelical theology.

Torrance, in agreement with Einstein's insight, suggests that all theory or doctrine comes about as a result of reflecting upon experience in the light of one's intuition and basic intellectual convictions concerning reality. From such theoretical reflection the scientist and the theologian make a jump of imaginative insight, an informed speculative and bold leap to postulate a logically-not-obvious new theoretical structure. The validity of this new theory or doctrine cannot be directly tested. Only specific theoretical propositions deduced from it can be subjected to empirical testing. Thus, one is brought back to the realm of experience. In this ongoing, cyclic methodology originating from and terminating in the realm of experience, new theories or doctrines emerge as free creations of the human mind. Upon successful empirical testing, such theory or doctrine reveals a hidden intelligibility that undergirds the realm of confusing and often seemingly contradictory human experience. The discovery of such hidden intelligibility is the principal motivation and final goal of all science—natural, social, and theological. Such *intelligibility*—shared among human observers conceptually, rather than as a matter of *sensibility* or *pictorialization*—is the cornerstone of a realistic objectivity that is grounded in and guided by today's creative science. The shared character of the awareness of any particular "reality" grounds its objectivity: for even though different observers do not experience the same sensory experience of the "reality" in question, through their diverse sensory experiences, they are able to acquire a *shared or common understanding* of it. This shared intelligibility is the linchpin upon which scientists and theologians build a consensus.

I believe that Torrance is in agreement with the distinguished particle physicist and Anglican priest, J.C. Polkinghorne, who states:

> If it is true, as I think it is, that intelligibility is the ground on which fundamental science ultimately makes its claim to be dealing with the way the world is, then it gives science a strong comradeship with theology, which is engaged in the similar, if more difficult, search for an understanding of God's ways with men.[4]

If all creative science, including theology, is really a search for a hidden, objectifiable intelligibility which progressively becomes revealed through experiential interaction with reality, then Torrance's recognition of the unitary character of scientific knowledge is one plausible consequence of such an underlying rationality. Many examples exist of such integrated wholeness with respect to the theoretical and empirical components of any science. In the methodology of natural science, observation-experiment and theory statements are inseparably interrelated. All observational-experimental facts are "theory-laden," for they have only been discovered and made intelligible in a particular theoretical framework. On the other hand, theory in science is empty without an empirical underpinning;

all theory is conditioned by the "facticity" of reality.

With respect to theology, even a cursory reading of Karl Barth's monumental *Church Dogmatics* reveals Barth's recognition that dogmatic theology and the everyday concerns of church people are always intimately related. Torrance has clearly recognized the exacting congruence between Karl Barth's unitary integration of practice and theory in all his theological work and similar unitary patterns in the scientific epistemologies of pioneering physicists. Foremost among these physicists were James Clerk Maxwell, who discovered the hidden unity of electric and magnetic phenomena manifesting themselves in the electrodynamic field, and Albert Einstein, who built upon Maxwell's work in creating special relativity theory. Special relativity displays the unity of Clerk Maxwell's electrodynamics, thereby completing his unifying insight. Building on this work, Einstein then developed general relativity in which geometry and mechanics form an integrated unity.

Torrance suggests that the invariant *character of physical laws is grounded in the faithfulness, constancy, and utter dependability of God's love manifest in all of his Creation.*

Professor Torrance's vision of a truly unitary scientific epistemology is succinctly captured in Karl Barth's discussion of the task of dogmatic theology:

> I propose that by science we understand an attempt at comprehensibility and exposition, at investigation and instruction, which is related to a definite object (the living God or physical reality), and a sphere of activity (the church or scientific community). No act of man can claim to be more than an attempt, not even science. By describing it as an attempt, we are simply stating its nature as preliminary and limited. . . . In no science is it a matter of pure theory or pure practice; on the one hand, theory comes in, but also, on the other hand, practice guided by this theory.[5]

Torrance provides a striking theological analogy which captures succinctly the unitary character of relativity—*the homoousion of physics*. The Church Fathers at the Council of Nicea found concepts borrowed from Greek philosophy, in particular the term *homoousion* (consubstantial, of one being) to be extremely helpful in formulating a creedal statement that would do full justice to the ample biblical evidence for the substantial unity of Father and Son in the Godhead; i.e., it is the one true God who is present in Jesus (and by being so providentially guided, they may have preserved the church). In Torrance's words:

> The *homoousion*, then . . . is of staggering significance. It crystallizes the conviction that while the incarnation falls within the structure of our spatio-temporal humanity in this world, it also falls within the Life and Being of God. Jesus Christ is thus not a mere symbol, some representation of God detached from God, but God in his own Being and Act come among us, expressing in our human form the Word which he is eternally in himself, so that in our relations with Jesus Christ we have to do directly with the ultimate reality of God. As the epitomized expression of that fact, the *homoousion* is the ontological and epistemological linchpin of Christian theology. With it, everything hangs together; without it, everything ultimately falls apart.[6]

It is precisely this kind of intimate interrelation of the theoretical and empirical that is contained in general relativity's integration of the space-time continuum (commonly called space-time) and energy-mass structure (matter): "Space tells matter how to move; matter tells space how to curve (thus determining matter's motion)." Torrance uses an analogy from theology, the *homoousion* interpretive framework, in order heuristically to reveal the intrinsic unity of a major physical theory, general relativity. Thus, he sheds light on the congruence existing between the unitary structures embodied in scientific and theological intelligibilities.

2. Relativity Theory: The Absolute Underpinning of the Relative

In his theory of relativity, Albert Einstein rejected the notion that space and time are absolute; rather, he defined them in terms of their relation to the human observer's physical frame of reference. Doing so, he did by no means abandon objectivity. Instead, he was deeply convinced that the basic laws of nature are always and everywhere the same, regardless of their respective physical frame of reference. In his relativity theory, Einstein primarily stressed the *invariant*, that is, the unchanging nature of physical law which, secondarily, results in the relativism of observational details with respect to different observational frames of reference. Torrance points out that, although Einstein abandoned the absoluteness of space and time, he did not view the simplicity and order of nature as mere constructs of the human mind, a misinterpretation of many idealist philosophers. Interpreting Einstein's insights from a Christian perspective, Torrance suggests that the *invariant* character of physical laws is grounded in the faithfulness, constancy, and utter dependability of God's love manifest in all of his Creation.

The striking character of the notion of *invariance* must be emphasized: mathematical laws that retain

their form under mathematical coordinate transformations faithfully represent the dynamic behavior of physical reality. Why is there this unusual appropriateness of mathematics in physical science? Torrance argues that natural science is made possible by the remarkable correlation existing between thought patterns intrinsic to the scientist's mind and lawful structures associated with the contingent intelligibility embodied in physical reality. Theologically this remarkable correlation is but one manifestation of God's transcendent, loving intelligibility as expressed in the utter faithfulness by which he freely created and continually sustains both human minds and the physical universe.

It is necessary to recognize the distinctive character of dissimilarity within similarity in an analogy of relatedness between physics and theology.

Finally, Torrance perceives natural science as emerging in the context of the contingent intelligibility intrinsic to physical reality. Contingency refers to the fact that a physical entity is never haphazardly formed but exists as one of many possibilities. He looks upon contingent intelligibility as a direct consequence of God's free, rational agency toward his Creation. Torrance's many writings agree with and further extend Eric Mascall's seminal insight:

> There is a very close connection *de jure* between the Christian belief in a God who is both rational and free and the empirical method of modern science. A world which is created by the Christian God will be both contingent and orderly. It will embody regularities and patterns, since its Maker is rational, but the particular regularities and patterns which it will embody cannot be predicted *a priori*, since He is free; they can only be discovered by examination. The world, as Christian theism conceives it, is thus an ideal field for the application of the scientific method, with its twin techniques of *observation and experiment*.[7]

3. In Creative Science, the Invisible Explains the Visible

A third theme drawn from Torrance's integration of theology and relativity theory is that physical theory at its best develops "invisible" conceptual "objects" that explain the behavior associated with observable, "visible" phenomena. In other words, in any truly creative scientific theory the invisible explains the visible rather than the visible explaining the invisible. The same is true in creative theology. Torrance's theme can be illustrated with two examples, one scientific, the other theological.

The space-time metric of general relativity is an excellent example of what Torrance considers to be a key invisible conceptual "object" of natural science. It is a mathematical construct that determines the "curvature" of space-time. This curvature, in turn, guides the visible motion of all observable matter in the universe. As Torrance puts it:

> In scientific thinking we do not reject the fact that we are observers who operate inescapably with appearances and images relativistic to themselves as observers. We all engage in primitive subject-object experience. Observational images, therefore, have a place in our thinking, but they are intersected, as it were, by the pattern of relations at a deeper level by which they are objectively controlled and made to refer beyond themselves. Scientific thinking and understanding moves to that deeper level, refusing to rest content with the surface patterns of observational experience. To be rather technical for a moment, what we are concerned with here are the invariant yet dynamic objective structures of the space-time metrical field, which, though inherently invisible and intangible, control all observational phenomena. Hence we do not offer explanations deduced from appearances, but we explain why things appear in such and such a way from their objective grounds. That is why scientific theories are not *argumenta ad hominem*, but are grounded upon deep object-object relations that hold good on their own, independent of appearances and observations. Thus in scientific thinking we are not concerned with appearances as such, but with objective structures in the light of which we understand appearances, and we do not consider that we can understand objective structures from appearances. . . .[8]

In theology, God's grace may be thought of as an invisible conceptual object defined as "God giving himself to humankind, so that they can know him and love him, so entering into a relationship with him which totally exceeds the relationship of creature to creature, and is therefore totally undeserved."[9] Or, Torrance perceives it as "the constant and ceaseless out-flow of the Love of God which has no other reason for its movement than the Love that God is, and is therefore entirely without respect of persons and irrespective of their reactions."[10] Accordingly, God's grace *grounds* and *guides* all of God's creating, reconciling, and redeeming interaction with humankind as revealed in the Old Testament's history of Israel, God's chosen people, and supremely in the New Testament's documentation of the words and acts of Jesus Christ.

God's grace is not "visible" in the Old and New Testament accounts of God's activity toward humankind, at least not in the sense that it is continuously acknowledged. Rather, the concept of grace brings "invisible" meaning to these accounts. Torrance has often pointed out how both fundamentalist and liberal exegetes miss the point of Jesus's parable of the laborers in the vineyard (Matthew 20:1–16). The parable makes

no sense whatever unless one has truly recognized the revolutionary, transforming nature of the unconditional grace of God.

In summary, this theme contrasts sharply with the commonly held layperson's view that natural science's progressive growth, a good indicator of its realist character, is a direct consequence of science being an activity where the "visible" guides one's interpretation of the "invisible." For the typical man or woman "on the street" natural science is made possible by its practitioners using "visible" observational patterns to guide them toward a greater understanding of the "invisible" patterns which give reality its diverse structure.

What Torrance has done, following the lead of physicist-philosopher Michael Polanyi, is to recognize that great scientists have made their discoveries through an imaginative postulation of "invisible" hidden patterns which explain the "visible" observational patterns. Such innovative leaps are grounded in and guided by the creative scientist's convictions regarding the form of nature's intrinsic creative order. In other words, Torrance recognizes that all good science must be based upon observation, but a less obvious and appreciated aspect of good science is also true: only observation grounded in and guided by theoretical insight is likely to uncover the deep regularities undergirding observational phenomena.

Thus, both natural science and theology are perceived by Torrance to be truly creative disciplines when the "invisible" guides one's interpretation of the "visible." It is worth noting that Judeo-Christian theology has always emphasized the epistemological principle that the creature is seen correctly only by the Creator's light; i.e., temporal and visible things are meaningfully understood only in the light of God's eternal and invisible truth.

4. The Physical Universe: A Relational Rather Than Container Model

The theory of relativity understands the space-time continuum on the basis of a relational, as contrasted with a container, perspective. What is meant by this distinction?

In the container model of the space-time framework, the physical universe is conceptualized as a huge bucket which serves as a receptacle in which all the energy-mass structures that constitute being (material objects and events) are poured. On the other hand, in the relational universe's model of the space-time framework, the physical universe represents a stage forming the expanding outer boundary of interactional relations between the objects and events that constitute its being.[11] Torrance argues that Einstein's relational understanding of the space-time framework is congruent with the ideas of some ancient Church Fathers (Athanasius, Hilary) who were responsible for the development of Christological truth contained in the Nicene Creed. The biblical affirmation that the Creator of the space-time universe entered into his own creation—i.e., in the Incarnation of Jesus Christ—is made more comprehensible by using a relational, rather than a container, understanding of the space-time continuum. In his early major book relating theology and science, *Space, Time, and Incarnation*, Torrance exactly addressed these questions. The relational character of uncreated reality (the Godhead as a unitary, triune community of divine love) and created reality has been an ongoing theme of his attempt to integrate theology and natural science.

5. Field Theories: An Expression of the Relational Character of Reality

The theory of general relativity is a "field theory." Torrance argues that field theories, constituting a relational understanding of physical reality, have a number of structural elements that are analogous to concepts in Judeo-Christian theology. One analogy is that of personhood, understood in a relational context (compared with an elementary particle), considered as a relational (field) entity.

The material of which the entire cosmos is constituted (heaven and earth) is an orderly and interrelated continuum, a structural unity.

If this difficult affirmation of Torrance is to make sense so that its radical implications for our culture can be creatively recognized and explored, some clarifying discussion is in order. It must be made clear that Torrance almost exclusively uses the concept of analogy in a *disclosure* rather than a *pictorial* manner. Theologically speaking, analogy is a *God-created correspondence* existing between two knowledge structures representing distinct objects or relationships of reality. Analogy is defined as similarity within dissimilarity, a commonality arising from certain aspects of the entities being compared. An analogy thus represents a partial likeness or reflection which is true but not exhaustive.

Torrance's analogies are always *across* logical levels of reality; they are *heuristic* (exploratory, discovery-oriented, stimulating further investigation) in character. Each of them establishes a *disclosure* relationship between entities at different logical reality levels. This contrasts with the kind of analogy that establishes a purely *formal* correspondence between entities at the *same* logical reality level.

Torrance argues, rather, that in the integration of natural science and theology, how *and* why *questions occur in both disciplines and cannot be separated.*

In Torrance's work, an analogy, with its capacity for *disclosure*, represents a heuristic *pointing from one level to another* occurring *between* similar aspects of two objects or relationships that either represent or constitute elements of different reality levels. Finally, it is necessary to recognize the distinctive character of dissimilarity within similarity in an analogy of relatedness between physics and theology. Torrance always emphasizes that theological concepts concerning relatedness have a life-transforming and life-directing quality of much deeper personal dimensionality than the analogous concepts associated with physical relatedness. Thus, when *disclosure analogies* are used, both the similarities and the dissimilarities are heuristically instructive. As does Torrance, I believe it cannot be emphasized enough that all truly creative thinking has an analogical component.

Building on this understanding of Torrance's use of analogy, one can fruitfully explore his use of the physicist's field theories to illuminate theological structures. Field theory in physics came into being through the efforts of the two great 19th-century physicists: Michael Faraday and James Clerk Maxwell, both devout Christians whose lives exhibited a remarkable unity of service to others, integrated with spiritual and intellectual insight. Faraday's experimental studies of the complexity of electric and magnetic phenomena led him to reject the conventional wisdom derived from Newton that charged particles or magnets attracted or repulsed one another acting instantaneously across an intervening empty space. Faraday rather envisioned charged particles or magnets as interrelated to one another by *invisible lines of force-fields which fill all space.*

Clerk Maxwell developed a mathematical theory that consistently represented the two fields—electric and magnetic—which fill all space when charges or magnets are present. All electrical and magnetic phenomena and their interrelations can be understood by these two interacting fields. From Clerk Maxwell's theory a revelation came: changing magnetic fields generate electric fields and changing electric fields can generate magnetic fields. Furthermore, a disturbance in one field affects the other in such a way that a self-perpetuating cycle of electric and magnetic fields is created. *A disturbance in the fields thus can take on a life of its own.* Once the process gets started, it does not need help from the outside (from charged particles) to keep it going. Electric and magnetic fields can thus have their own reality apart from the matter that created them. This dynamic disturbance represents an integration of electric and magnetic fields called the electromagnetic field. Clerk Maxwell identified this dynamic field disturbance as light (either visible or invisible, as in, say, radio waves or X-rays), and his famous four equations brought electricity, magnetism, and optics together in a unitary theoretical framework.

How does Torrance understand Clerk Maxwell's seminal field theory, and what wider theological implications does he recognize? Torrance sees Clerk Maxwell as searching for a deeper way of interpreting nature that was not linked to the classical, Newtonian notions of mechanical necessity as manifested in isolated particles interacting externally and causally with one another. This search led Clerk Maxwell, as a mature scientist, to develop his theory of the electromagnetic field, an idea which brought about a paradigm shift in scientific understanding. In this theory the field concept was first formally articulated as a *relational* way of describing particles as inseparable from their interactions. The relationship between particles—as represented by the continuous, space-filling electromagnetic field—were an *intrinsic part of what particles really are.* Thus, this relational notion of fields of radiation and their structure become an independent reality in their own right.

> The relations he [Clerk Maxwell] referred to were not just imaginary or putative but *real* relations, relations that belong to reality as much as things (particles) do, for the interrelations of things, are, in part at least, constitutive of what they are. Being-constituting relations of this kind we may well speak of as 'onto-relations.'[12]

This field concept of physical reality introduced by Clerk Maxwell is heuristically analogous to the biblical concept of the *person* as developed by the early Church Fathers in order to understand the biblical evidence pointing to the triune nature of God. Central to this theological understanding of the person is *the reality of*

human relationships as an integral part of what persons really are. You as a person are not a cut-off, isolated individual, like the Newtonian particle, separated from other autonomous particles. Rather, you as a person are interrelated with others, your parents, your friends, even people with whom you disagree. These *interrelationships constitute the very stuff of personal being.* Torrance suggests that it was this Christian theological understanding that played a motivating role in Clerk Maxwell's development of the relational notion of the electromagnetic field to describe particles as never separable from their interactions.

A final word about fields. Building upon Clerk Maxwell's synthesis of electricity, magnetism, and optics as differing aspects of one electromagnetic field, Einstein was able, in the first place, to develop relational field structures which brought about a more unitary understanding of electrodynamics (the study of electric and magnetic fields in interrelationship with one another, particularly how they vary with time) and mechanics (the study of systems of particles and their resulting motions as a consequence of force interactions between them) resulting in the equivalence of mass and energy (special relativity). Secondly, he created a perception of the physical universe as an integrated whole of matter and space-time in dynamic interrelation with one another (general relativity).

Today, physicists continue to pursue the vision of unification that began with Clerk Maxwell's synthesis by creating quantum field theories. Such theories replace the Newtonian vision of a universe filled with discrete particles, each existing independently, by a universe permeated with a few interpenetrating fields, lines of force filling space. And when such fields are excited, concentrations of energy are produced, field "quanta" if you like, that represent discrete particles. Quantum field theory is not a finished story without problems, but its partial success does motivate physicists in attempting to discover the ultimate unification: a single field from which all fields, electromagnetic, nuclear, and gravitational originate—in other words, a *grand unified field theory.*

Professor Torrance recognizes the physicist's goal of ultimate *unification* as consistent with and, rightly understood, motivated by the first article of the Nicene Creed where Christians affirm their faith in "one God—the Father Almighty, Maker of Heaven and Earth, and all things, visible and invisible." This confession emphasizes a profoundly biblical theme—God's guarantee of the trustworthiness and wholeness of Creation. The material of which the entire cosmos is constituted (heaven and earth) is an orderly and interrelated continuum, a structural unity. Its very reality, its wholeness and trustworthiness, is a revelation of the unique, unitary character of God in what he has brought into being. Perceived through the "ears and eyes of faith," *the Creation is not God but has imprinted in it the trace of his nature.* It is worth noting that in biblical theology, hearing has primacy over seeing—Torrance emphasizes the primacy of auditory cognition in both theology and natural science.[13]

6. The Universe: A Multi-Leveled Yet Integrated Whole

Another theme in Professor Torrance's development of theology-science integration is that the universe is comprised of interrelated levels of being, each of which is far from closed in upon itself, but is open to and explainable in terms of its immediately higher level and, indeed, of the whole multi-leveled character of the universe. In Torrance's words:

> The universe that is steadily being disclosed to our various sciences is found to be characterized throughout time and space by an ascending gradient of meaning in richer and higher forms of order. Instead of levels of existence and reality being explained reductionally from below in materialistic and mechanistic terms, the lower levels are found to be explained in terms of higher, invisible, intangible levels of reality. In this perspective the divisive splits become healed, constructive syntheses emerge, being and doing become conjoined, an integration of form takes place in the sciences and the arts, the material and the spiritual dimensions overlap, while knowledge of God and of his creation go hand in hand and bear constructively on one another.[14]

Torrance's heuristic vision of the universe has a number of principal sources: the theology of the early Church that reached creative expression in the Nicene Creed, Michael Polanyi's heuristic understanding of science, and Ilya Prigogine's irreversible thermodynamics seen in light of relativity theory. The latter two sources may not be as well known as they should.

Michael Polanyi was a distinguished physical chemist who became a philosopher of science. He developed an understanding of science as a human enterprise carried out not through continual, critical doubting, but rather an exploratory attempt by the scientific community to work out, through theoretical and experimental questioning of nature, a fuller understanding of their basic, intellectual convictions concerning the universe's intrinsic order. According to Polanyi, natural science is, like theology, a human endeavor where "faith is in search of greater understanding." Polanyi further saw natural science as revealing the universe to be multi-leveled with successive levels of reality interrelated by *a principle of marginal control.* In this principle, the higher level's laws and structures are dependent upon the laws and structures of the lower level for their

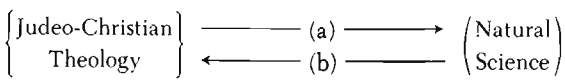
being. But the laws of the higher level are not reducible to those of the lower level (cannot be accounted for on a lower level), and these higher level laws control the behavior of the lower level.[15]

Ilya Prigogine's work on the thermodynamics of open systems—systems where energy, matter, and information can flow across system boundaries—has provided a credible theoretical description of how a multi-level reality structure can come into being. His theory suggests how such highly ordered, complex systems as living organisms can emerge in a universe in which irreversible (one way, dissipative-frictional) processes usually lead to an increase of entropy (a quantitative measure of a system's disorder) signifying more disorder.[16]

Torrance perceives that an underlying unity exists between relativity theory and irreversible thermodynamics, in that both theories suggest the universe is dynamic in character; i.e., both point to the historicity of the cosmos. General relativity predicts that the universe is expanding*, and such an expansion in the context of irreversible thermodynamics may result in the emergence of ever more complex matter-energy structures resulting in a hierarchical, multi-leveled physical reality (pointing to and open to a transcendent reality beyond it that provides meaning).

7. Theology and Natural Science: Allies Rather Than Foes

Much of the spirit of Torrance's integrative work with respect to Judeo-Christian theology and natural science can be understood as a transformational extrapolation of Einstein's famous remark, "Science without religion is lame; religion without science is blind." The extrapolated form of the remark is that Judeo-Christian theology motivates and gives meaning to natural science, which in turn sharpens and clarifies theology. This insight may be schematically represented as follows:



(a) = Motivates, gives meaning to
(b) = Sharpens, clarifies

In this schema, the different parentheses, { } and ( ), symbolically represent the distinctiveness of the two disciplines, while the arrows going both ways, represent the mutual reciprocity of interrelation between the two disciplines, made possible by honest and open dialogue between theologians and scientists. Such dialogue is properly grounded in the recognition that both disciplines are concerned with the discovery of a *shared intelligibility* (see theme 1) resulting from, on the one hand, the divine order primarily revealed in God's redemptive historical interaction with humankind and, on the other hand, the contingent order revealed through humankind's exploration of the expanding (historical, time-embedded) physical universe. Thus, both disciplines represent distinct shared intelligibilities which interpenetrate each other in significant ways. After all, theologians and scientists are both integral components of the space-time universe that natural science investigates. Dialogue between theologians and scientists, respecting one another as allies rather than foes, enables the interpenetration to be better understood. Such clarified interrelationship integrates theology and natural science into a greater whole, whose unitary intelligibility is grounded in the relation between divine and contingent order.

In this new unity of theological and scientific insights, which the schema represents, many old dualisms will be transformed and healed. In particular, the schema *does not* represent the old dualist separation of natural science and theology into *how*-questioning and *why*-questioning disciplines. In such a dualist's perspective, as Torrance suggests, natural science is primarily concerned with questions of *how* the physical universe works in terms of causal mechanical processes, while theology is primarily concerned with questions of *why* the universe exists understood in terms of humankind's beginning and final end. Torrance argues, rather, that in the integration of natural science and theology, *how* and *why* questions occur in both disciplines and cannot be separated. Furthermore, *how* and *why* questions in each discipline are transformed, acquiring new meanings when they are linked together. In other words, both theology and natural science are properly concerned with *how* and *why* questions concerning all reality and the form, function, and meaning of such questions for each discipline will be transformed when both disciplines are understood as integrated together pointing toward a larger unitary intelligibility.

As one example of such transformational unity, Torrance cites the fundamental role that time plays in current physical theory. In today's physics, time is seen to be a central constitutive element of the physical universe, forcing physicists to ask basic questions concerning the universe's beginning and final end. Today the physical universe and many of its constitutive components are perceived as having a history in the same sense that humanity has a history. Hence, the *why* questions of theology, forged primarily in response to biblical revelation concerning human origins and human destiny, help the physicist in formulating simi-

*Strictly speaking, general relativity—without a cosmological constant—only tells us that the universe is not static. It could be contracting, as far as Einstein's field equations are concerned. Astronomical observation has confirmed the validity of expanding solutions of the field equations.

lar questions concerning the physical Universe's beginning and end.

Finally, Torrance argues that the integrated intelligibility of theology and natural science in interrelation is grounded in the *relation* between Divine and contingent order. Torrance perceives that *relation* to be the loving intelligibility of the living God which is supremely revealed in the entering of the Creator into his own space-time Creation. The incarnation of Jesus Christ, his life, death, resurrection, and ascension, particularly his sharing in and redeeming human creaturehood on the Cross, is a central component of all Torrance's efforts to integrate into a larger whole scientific and theological intelligibilities. The following extended quote deserves careful reading, for it summarizes the theological unity of the Old and New Testaments which undergirds all of Professor Torrance's integrative efforts with respect to theology and natural science:

> The doctrine of the creation of the world out of nothing, of course, had its roots in the Old Testament and the Jewish understanding of the one God, who is the source of all that is outside himself, and who remains transcendent Lord over all that he has made, so that if he were to withdraw his creative and upholding presence from the creation it would lapse back into chaos and sheer nothingness. This teaching carried with it a conception of the free (non-necessary) relation of God to the world, by which its contingent nature is constituted, and a unitary outlook upon the world creatively regulated by God's Word, which calls into question all forms of religious, cosmological, and epistemological dualism. The creative act which brought the universe into being and form was not regarded as limited to its impulse, but as remaining unceasingly operative, preserving, unifying, and regulating all creative existence which conversely was contingent in every respect of its nature and in no sense divine. Thus Judaism contributed to a profound understanding not only of the absolute beginning, but of the continuity, stability, and uniformity of the natural world as grounded beyond itself in the constancy, faithfulness, and reliability of God its Creator and Preserver.
>
> However, it was Christian theology which radicalized and deepened the notion of contingence and gave reality to the notion of contingent intelligibility, through thinking out, in critical and constructive discussion with Greek science, the relation of the creation to the incarnation of God's Word in Jesus Christ within the spatio-temporal realities and intelligibilities of contingent existence in this world. The incarnation made it clear that the physical world, far from being alien or foreign to God, was affirmed by God as real even for himself. The submission of the incarnate Son of God to its creaturely limits, conditions, and objectivities carried with it an obligation to respect the empirical world in an hitherto undreamed-of measure.[17]

Hence, nature is indeed real! Accordingly, the seemingly small details of nature are important—worthy of detailed study. It is not a waste of culture's finite resources for some people to worry about such things as how small versus big stones fall.

> On the one hand, clear differentiation between the incarnation as the personal embodiment of God's Logos being embodied in it, shattered the Greek idea that the intelligible order of the world is to be understood as a general embodiment of the divine Logos immanently within it; i.e., as its necessary, inner cosmological principle. That was to have very far-reaching effects in liberating the world from its inward bondage to divine changelessness in virtue of which it was held to be impregnated with final causes, and thus in liberating nature from the iron grip of sheer necessity that resulted from them. On the other hand, the interrelation of the Logos and the creation of all things, visible and invisible out of nothing by that same Logos, called for a profound rethinking of the relation between God and the world . . . in which it is recognized the incarnation has the constant effect of affirming the contingent intelligibility of the Creation, reinforcing the requirement to accept it as the specific kind of rationality proper to the physical world, and as the only kind capable of providing evidential grounds for knowledge of the universe in its own natural processes.[17]

Conclusion

In this paper, I have tried to help the reader acquire a Christian theological instinct for key themes in Thomas F. Torrance's distinctive integration of theology and natural science. I hope that an understanding of these themes will help the reader to better appreciate the range, comprehensiveness, and creative truthfulness of Torrance's thought with respect to this aspect of the encounter between Christ's Church and contemporary culture.

One might wonder, why would a theologian be willing to commit valuable time and effort to acquire substantial understanding of another discipline; i.e., natural science? All of Torrance's efforts to integrate theology and natural science are grounded in and guided by the recognition that the early Christian church not only communicated the Gospel to the Graeco-Roman world but also transformed the prevailing cultural framework, thereby allowing the Gospel to take deep root and grow from within. As then, so for every age, the gospel's creating, reconciling, and redeeming power can have a renewing-transforming impact upon the whole frame of human culture, science, and philosophy.

Today, Torrance suggests, such transforming healing will again take place when theologians and scientists, reconciling in friendship, recognize that there are indeed basic interconnections existing between the structures of theological and scientific knowledge. In particular, Torrance perceives that Karl Barth's creative reformulating of the Trinitarian faith of the early church, and James Clerk Maxwell's, Albert Einstein's, and Michael Polanyi's contributions to basic science, both in content and method, *share* interconnected concepts and *bear* structural, epistemological congruences with one another. A wider recognition of such interconnections and knowledge congruences by theo-

logians and scientists engaged in cordial, serious dialogue will result in a transformation and convergence of thought that can do much to heal the fragmentation which denies the unity God intends for our scientific-technological civilization.

Professor Torrance, by prayerfully motivated and guided thought, and by his willingness to befriend, listen, and converse with the scientific community, has contributed significantly to advancing such healing transformation. He has been particularly helpful through his emphasis that careful, precise thought is essential in order that basic interconnections and congruences of thought between theology and natural science not be pushed further than they naturally go. As an integrative thinker, he clearly recognizes that theology and natural science truly are integrated redemptively only when the distinctiveness of each God-motivated discipline is preserved as the deep unity of interrelationship between disciplines is recognized, understood, and explicated.

This creative interrelationship between the two disciplines can be illustrated by using a concept borrowed from Torrance's theology. Early Christian theologians used the Greek word *perichoresis* to discern the way in which "the Divine and human natures in the one Person of Christ interpenetrate each other without the integrity of either being damaged by the other" (Torrance, *The Ground and Grammar of Theology*). The word indicates a sort of dynamic, mutual containing, or mutual involution, of realities which is often spoken of as a *coinherence* (the root *chora* is also present in choreography, which describes the orchestration of dancers, indicating the word's dynamic aspects).

Such a dynamic coinherence between theology and science would preserve the integrity of both disciplines while healing the breach that has opened up between them. Our age is saturated with scientific-technological achievements, but strongly lacks a coherent sense of overall meaning and the necessary moral leadership to use such achievements wisely. Only a very confused culture can uncritically accept the legitimacy of both astrology and the findings of satellite-based astronomy. A clarified understanding of the *perichoresis* between theology and natural science could have a substantial healing impact upon our scientific-technological society, for such a refined understanding would restore the sense of purpose and moral guidance our civilization lacks.

Professor Torrance's integrative framework provides many creative insights into the *perichoretic* interpenetration of theology and natural science; this framework serves as a base for both scientists and theologians as they build bridges between their disciplines. Furthermore, it is a base which may be modified as such exploratory activity clarifies and enriches both theological and scientific knowledge. Such healing understanding can come about if both scientific and theological communities are willing, as Professor Torrance has graciously done, to sacrificially commit the time and effort required for serious dialogue. Such demanding dialogue will succeed only as each community trusts and respects the other's basic convictions, while at the same time honestly and openly articulates those areas where real divergences of understanding exist. Christian love manifesting itself in mutual tolerance and total honesty is one "leaven" that can guarantee the fruitfulness of such dialogue.

Christian love is particularly manifest in one component of Thomas Torrance's work with the scientific community that is "invisibly" present and grounds the "visible" accomplishments of his integration of theology and natural science. That "invisible" component is the sincere friendship which he has cultivated with many members of the scientific community, including this writer. His willingness to give unsparingly of his time as a sympathetic yet always critical listener, his shared enthusiasm for basic science, his ability to offer wise counsel, and his perceptive humor in tense moments are all aspects of true friendship, a quality essential for any civilization's creativity and well-being. Torrance's life[18] and thought is a unity grounded in the realization that "all meaningful knowledge is for the sake of action, and all meaningful action is for the sake of friendship" (John MacMurray—Scottish theologian-philosopher).

Friendship is an attribute that Thomas Torrance perceives as essential in helping the human family, all God's children, become "Priests of Creation"—loving stewards of God's good creation. It is a consequence of humankind being made in the image of God, thereby reflecting something of the Triune God's interrelational character, a unitary community of love.

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NOTES

[1]Richard P. Feynman (Nobel Prize-winning American Physicist), *Lectures On Physics*, Volume II. (Reading, MA: Addison-Wesley Publishing Co., Inc., 1964), p. 11.

[2]James Clerk Maxwell, *A Dynamical Theory of the Electromagnetic Field*, edited by T.F. Torrance. (Edinburgh, Scotland: Scottish Academic Press, 1982), p. x.

[3]Thomas F. Torrance, "If I were starting again," *The Presbyterian Outlook*.

[4]John C. Polkinghorne, *The Way the World Is*. (Grand Rapids, MI: Eerdmans Publishing Co., 1983), p. 11.

[5]Karl Barth, *Dogmatics in Outline*. (New York: Harper & Row, 1959), p. 9.

[6]Thomas F. Torrance, *The Ground and Grammar of Theology*. (Charlottesville, VA: University Press of Virginia, 1980), pp. 160–161.

[7]E.L. Mascall, *Christian Theology and Natural Science*. (New York: The Ronald Press Company, 1956), p. 94. Torrance has acknowledged Mascall's pioneering contribution as one of the first theologians of this century to grasp the grounding of natural science in God's free, rational agency. See, in particular, Mascall's discussion of Christian Theism and contingency contained in Chapter three, pp. 91–98.

[8]Thomas F. Torrance, *The Ground and Grammar of Theology*, pp. 120–121.

[9]Alan Richardson and John Bowden (eds.), *The Westminster Dictionary of Christian Theology*. (Philadelphia, PA: The Westminster Press, 1983), p. 245.

[10]Thomas F. Torrance, *Christian Theology and Scientific Culture*. (New York: Oxford University Press, 1981), p. 84.

[11]Newtonian physics forms a good example of a "container" model of the universe. Basically, Newton *separated space from what happened in it* and suggested the idea of an infinite receptacle formed by space *and* time, which he held to be the container of all physical being. Space and matter were understood dualistically, space and time had an absolute status independent of material existence, but causally conditioning its character and qualities as an inertial system. Einstein's general theory of relativity is an apt example of a relational model of the universe. In general relativity, space-time is a continuum existing in inseparable relation to mass-energy structures; i.e., mass-energy objects determine the curvature of space-time. That curvature, in turn, controls the motion of the masses. Thus, mass-energy structure and space-time geometry are dynamically, integrally related. For Professor Torrance's perspective see Thomas F. Torrance, *Space-Time Incarnation*. (New York: Oxford University Press, 1969).

[12]Thomas F. Torrance, "Christian Faith and Physical Science in the Thought of James Clerk Maxwell," in *Transformation and Convergence in the Frame of Knowledge*, edited by Thomas F. Torrance. (Grand Rapids, MI: William B. Eerdmans Publishing Co., 1984), p. 230.

[13]Thomas F. Torrance and Walter Thorson argue that human knowing takes place primarily through three cognitive modes—auditory, visual, and manipulative—with the auditory mode "awakening" and guiding the other two cognitive modes.

Auditory Cognition—Hearing and Listening

Hearing and listening places primary emphasis on "the other" rather than the activity of the knower. "The objective other" consists of those objects and/or persons that exist external to the knower (external reality). Hearing and listening is primarily a Hebrew notion, both Old and New Testaments emphasize hearing and listening to the Word of God; the believer listens when "thus says the Lord" is pronounced by a prophet or finally by Jesus, himself. This mode is primarily a passive process. It is significant that Jesus Christ, The Eternal Creative Word and True Man, is reported to have said that to truly know him you must become as a little child. This was a favorite quote of the great agnostic, Thomas Huxley. He argued by analogy that a scientist must intitially stand as a little child before nature listening to its behavior in a fully trusting, expectant, responsive and open fashion in order to gain insight into the intrinsic order that undergirds physical reality. It is by hearing and listening that we become "tuned in" to a "speech" embedded in reality beyond ourselves. In this manner we become aware of those ultimate commitments which motivate and guide all specific acts of understanding in any given discipline, theology, natural science, history, and so forth. It is by hearing and listening to all human experience (including religious) that natural scientists have developed the strong conviction that behind the rich, complex regular yet sometimes chaotic behavior of physical reality there are intrinsic patterns of contingent order that can be discovered; i.e., revealed by patient theoretical and experimental analysis with "beautiful" mathematical structure often "faithfully" representing physical reality. Every natural scientist is motivated to formulate specific working commitments or theories by the hope that this ultimate commitment provides. Note also that hearing and listening may allow us to recognize intuitively a specific intrinsic pattern of order, thereby making a specific discovery concerning external reality.

The auditive mode of cognition, listening and hearing, functions only as we are *responsive* and *obedient* to what is beyond ourselves. It may be characterized by two distinctive features: (a.) This passive process awakens an awe and an attitude of humility toward external reality. No deliberate attempt is made to impose our preconceived notions upon the reality being observed. In this passive mode of cognition we allow external reality to reveal its intrinsic structure not distorted by our attempts to manipulate or alter such structure as would happen if we were to engage in active questioning. (b.) The auditory mode allows an intuitive comprehension of reality to develop, intuition being defined by Calvin as "direct knowledge of an acutally present object, naturally caused by that object and not by another [or our own preconceived ideas]." In other words, by first listening we allow the object being observed to control our understanding. Note that Thomas F. Torrance, following Michael Polanyi, defines intuition as "not the supreme immediate knowledge called 'intuition' by Leibniz, Spinoza or Husserl but the inexplicable apprehension or insight into hidden occurences or intelligible order . . . the spontaneous process of sensing and integrating clues in reponse to some aspect of reality seeking realization in our minds."

Visual and Manipulative Cognition—Seeing and Grasping

Seeing, a Greek mode of knowing, is basically an active recognition of form and pattern motivated and guided by one's ultimate commitments to the existence of order and the possibility of finding "faithful" modes of representation of that order whether numerical, geometrical or more qualitative in character. Such wholistic pattern recognition is central to theory formulation. It must always be tested against external reality as it can easily become self-centered and passive. This testing pattern may be looked upon as a grasping process.

Grasping, a Roman mode of knowing, is controlling and manipulative, being guided by one's working commitments and theories concerning external reality. It is indeed active but can easily become just a form of self expression. Taken together, seeing and grasping allow a knower to discover partial but potentially objective knowledge about reality, such knowledge can then be "feedback" to enhance and alter the seeing and grasping process.

Specific references to Professor Torrance's insights into auditory cognition are: Thomas F. Torrance, "Theological and Scientific Inquiry," *Journal of the American Scientific Affiliation*, Vol. 38, No. 1, pp. 2–10 (1986); Walter Thorson, "Scientific Objectivity and the Word of God," *Journal of the American Scientific Affiliation*, Vol. 36, No. 2, pp. 88–97 (1984).

[14]Thomas F. Torrance, *Reality and Scientific Theology*. (Edinbugh, Scotland: Scottish Academic Press, 1985), p. ix.

[15]The following references discuss Polanyi's *Principle of Marginal Control* and its wider implications: Michael Polanyi and Harry Prosch, *Meaning* (particularly the chapter entitled "Order"), (Chicago: The University of Chicago Press, 1975); Michael Polanyi, "The Structure of Consciousness" and "Life's Irreducible Structure," in *Knowing and Being: Essays by Michael Polanyi*, edited by Marjorie Grene, (Chicago: The University of Chicago Press, 1969); Drusilla Scott, *Everyman Revived: The Common Sense of Michael Polanyi*, (Lowes, Sussex, U.K.: The Book Guild Limited, 1985); Howard H. Pattee (ed.), *Hierarchy Theory*, (New York: George Braziller, 1973); Thomas F. Torrance, "The Place of Michael Polanyi in the Modern Philosophy of Science" and "The Open Universe and the Free Society," in *Transformation and Convergence in the Frames of Knowledge*, (Grand Rapids, MI: William B. Eerdmans, 1984), pp. 107–189.

[16]Prigogine has shown how order can arise in open systems far from equilibrium. In the systems studied by Prigogine, that order controls only a few degrees of freedom such as found in convection currents or wave patterns of chemotactic activity; i.e., the Belousov-Zhabotinski Reaction. His nonlinear themodynamics doesn't begin (at the present time) to account for the information content (millions of degrees of freedom) found in living systems. It does, however, serve as a heuristic model to enlarge our understanding of living systems. See: A. Babloyantz, *Molecules, Dynamics and Life: An Introduction to Self-Organization of Matter*, (New York: John Wiley & Sons, 1986); Ilya Prigogine and Isabelle Stengers, *Order Out of Chaos*, (Toronto: Bantam Books, 1984); Ilya Prigogine, *From Being to Becoming*, (San Francisco: W.H. Freeman & Co., 1980); Paul Davies, *The Cosmic Blueprint*, (New York: Simon & Schuster, 1988).

[17]Thomas F. Torrance, *Divine and Contingent Order*. (New York: Oxford University Press, 1981), pp. 32–34.

[18]A helpful biographical interview that gives an overview of Professor Torrance's personal life and ministry is found in *The Reformed Review*. I. John Hesselink, "A Pilgrimage in the School of Christ—An Interview with T.F. Torrance," *The Reformed Review*, Vol. 38, No. 1, pp. 49–64 (1984).