DISCOVERING THE HARMONY OF REASON AND FAITH IN THE SYMPHONY OF ETERNAL CREATION

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Abstract: Tensions between the domain of reason and the domain of faith have been one of the most controversial issues in the history of our civilization for over three hundred years. They have contributed to many divisions, conflicts, and even wars. Contributions that have sought to reconcile the two domains have largely used the cultural approach in trying to solve this problem. The approach used in this essay views faith and reason from the perspective of cognitive operations. It shows that viewed from this perspective, faith and reason emerge as two aspects of the process of creation of new levels of organization that takes place in the human mind. The essay correlates faith and reason with such cognitive operations as equilibration and the production of disequilibrium. This approach shows that there is no fundamental ontological contradiction between faith and reason, and that cooperation between them is not only possible but actually essential for sustaining our mental work and the survival of our civilization.

Key words: Faith, reason, equilibration, production of disequilibrium, determinism, indeterminism, and the process of creation.

Introduction

Tensions between the domain of reason and the domain of faith have been one of the most controversial problems in the history of our civilization for over more than three hundred years. The rise of Modernity with its emphasis of rational thought and science challenged the domination of the Church. It led to the rivalry that is as alive today as it was three centuries ago. Battles between advocates of reason and the adepts of faith have been coming and going. They involved politicians and public figures, church dignitaries and government officials, scientists and theologians, elites and common people. These battles raged in the public arena and around dinner tables. There has been hardly another issue in the history of our civilization that has attracted as much attention at the relationship between faith and reason.

Numerous voices in the past have called for reconciliation of reason and faith. They see faith and religion as two most important domains in our cultural heritage. These voices have argued that such reconciliation will bring enormous benefits both for public and intellectual life and will help resolve many problems faced by our civilization. Mutual cooperative and complementary relations between faith and reason, they have maintained, will help heal many social and political divisions and remove obstacles to progress in science, technology, the moral fabric of our society, our aesthetic sensibilities, and in many other areas. Although the call for reconciliation is compelling, the prospects for reconciliation remain uncertain and the peace is nowhere in sight.

Those who have been and are involved in the debates largely view faith and reason as cultural phenomena, which they certainly are.[1] However, faith and reason also relate another area—the area of cognition and cognitive operations performed by human mind. Although there have been thinkers who have heeded this approach (**need sources)** their number is much smaller and is largely lost in the clamor of culture wars. This essay will use both approaches. Although certainly aware of the much louder contest in the cultural sphere, it sees important possibilities in using a cognitive approach. After a brief overview of the proposed solutions with culture in their main focus, the essay will take a cognitive path by establishing correlations between faith and reason, on one hand, and cognitive operations on the other. It is in this area that the essay will seek the resolution of the problem of reconciling faith and reason.

Reason and Faith: In Search for Reconciliation

There is no shortage of ideas on reconciling faith and reason. Patrick Quigly, for example, lists five main approaches toward reconciliation.[2] These approaches range from one extreme to another—from views that advocate subordination of faith to reason or vice versa, to views that advocate their equal but separate existence. The proposals for subordination come both from the domain of faith and the domain of reason. Examples of the former include such figures as Jerry Falwell, Robert Grant, and Pat Robertson.[3] At the other extreme of the specter we find the likes of Richard Dawkins, the enfant terrible of new atheism, Steven Weinberg, and others who ardently proclaims the superiority of scientific reason and on principle oppose any attempts even at reconciliation, to say nothing of unification.[4] A rhetorical question from Mano Singham conveys the attitude of many who subscribe to new atheism: "After all, if we concede without argument that mainstream religious beliefs are compatible with science, how can we argue that witchcraft and astrology are not?"[5]

The supporters of reconciliation include some of the most visible scientific and religious institutions, as well as prominent scientists and church leaders. Among the religious institutions supporting cooperation are the Catholic Church, the General Assembly of the Presbyterian Church, and the Central Conference of American Rabbis to name just a few. Both Pope John Paul II and Pope Benedict XVI have been very passionate advocates of harmony between religion and science.[6]

Supporters of cooperation from the domain of reason include such major organizations as National Academies of Sciences and a good number of eminent scientists, including some Nobel laureates.[7] The National Academy of Sciences (NAS), for example, has urged accommodation in one of its most authoritative statements on the subject of evolution and creationism. Alluding to radicals who consider scientific reason and faith to be totally incompatible, both on the religious and on the scientific side, the statement emphasizes: "Attempts to pit science and religion against each other create controversy where none needs to exist."[8] Some of the most prestigious scientific publications, including magazines Nature and Science, have prominently featured articles by advocates of cooperation and reconciliation. There are also numerous publications that seek specifically to bring scientific reason and faith closer together, such as *Zygon*, *Theology and Science*, *Science and Christian Belief*, *Perspectives on Science and Christian Faith*, and others.

The writings of Pope John Paul II and Pope Benedict XVI are certainly the most authoritative sources on the position of the Catholic Church. According to this position, although reason and faith relate to different aspects of reality, they both come from the same source and are intimately connected to each other. In a passage of his encyclical letter "Fides et Ratio," that is informed as much by theology as by poetic imagination, John Paul II refers to faith and reason as "two wings on which the human spirit rises to the contemplation of God."[9] He also cites the First Vatican Council in support of his views:

> Even if faith is superior to reason there can never be a true divergence between faith and reason, since the same God who reveals the mysteries and bestows the gift of faith has also placed in the human spirit the light of reason. This God could not deny himself, nor could the truth ever contradict the truth.[10]

For Benedict XVI, faith and reason are also part of the same totality. In his view, as John Allen points out, "Whatever the findings of the natural sciences, they will not contradict Christian faith, since ultimately the truth is one."[11]

While both John Paul II and Benedict XVI argue that faith and reason merely reflect different aspects of reality and in many ways complement each other, they emphasize that faith plays a unique and perhaps even primary role. Faith, they maintain, opens for reason a possibility of new knowledge and even a possibility to know what reason on its own will never be able to understand fully. In a passage discussing the mystery of Divine Revelation in his encyclical letter John Paul II writes:

> Revelation has set within history a point of reference which cannot be ignored if the mystery of human life is to be known. Yet this knowledge refers back constantly to the mystery of God which the human mind cannot exhaust but can only receive and embrace in faith. Between these two poles, reason has its own specific field in which it can enquire and understand, restricted only by its finiteness before the infinite mystery of God.[12]

Elsewhere Pope John Paul II asserts: "Faith alone makes it possible to penetrate the mystery in a way that allows us to understand it coherently . . . the world and the events of history cannot be understood in depth without professing faith in the God who is at work in them.[13]

Pope Benedict XVI has also expressed on numerous occasions his concern over what he sees as a trend in the contemporary culture to disregard the insights of religious thought and rely excessively on reason. This trend, in his opinion, severely limits the human capacity to know and is responsible for many problems that plague the contemporary civilization. In his address delivered at the University of Regensburg in 2006, Benedict XVI offers the following reflection:

> Modern scientific reason quite simply has to accept the rational structure of matter and the correspondence between our spirit and the prevailing rational structures of nature as a given, on which its methodology has to be based. Yet the question why this has to be so is a real question, and one which has to be remanded by the natural sciences to other modes and planes of thought—to philosophy and theology. For philosophy and, albeit in a different way, for theology, listening to the great experiences and insights of the religious traditions of humanity, and those of the Christian faith in particular, is a source of knowledge, and to ignore it would be an unacceptable restriction of our listening and responding. Here I am reminded of something Socrates said to Phaedo. In their earlier conversations, many false philosophical opinions had been raised, and so Socrates says: "It would be easily understandable if someone became so annoyed at all these false notions that for the rest of his life he despised and mocked all talk about being—but in this way he would be deprived of the truth of existence and would suffer a great loss."[14]

These statements show that while recognizing that faith and reason complement each other, the Catholic position is that faith plays a unique, special, and perhaps even primary role since it allows an infinite expansion of human knowledge. The distinct feature of the Judeo-Christian tradition is its transcendent deity that possesses the power of divine creation. This tradition opens the path to knowing the unknown and grasping the mystery of creation. Scientific reason lacks these insights and has so far been refusing to deal with such issues as miracle and creation. As John Paul II put it:

> We may say, then, that Israel, with her reflection, was able to open to reason the path that leads to the mystery. With the Revelation of God Israel could plumb the depths of all that she sought in vain to reach by way of reason.[15]

There are few comparable authoritative voices that come from the domain of secular reason that would advocate the development of a worldview that fully embraces reason and faith as mutually informing each other. The position on the relationship between reason and faith of the overwhelming majority of the proponents of secular rationality advocates the so-called nonoverlapping magisteria, or NOMA. This position owes a great deal to the late Stephen Jay Gould who has articulated and popularized its main precepts. Central to Gould's view is what he sees as the fundamental difference in the role of faith and reason in knowledge production. While reason relies on rational deductions and tangible facts (experimental evidence and observations), faith and religion focus on things that are intangible (values, beliefs, and meanings) and even supernatural. In other words, reason and faith belong to different domains, or what Gould termed "magisteria" (from "magister," or teacher). Their respective magisteria do not overlap (hence NOMA, or nonoverlapping magisteria) and, therefore, there is no ground for conflict between reason and faith. In his article "Nonoverlapping Magisteria" Gould writes:

> Consideration of the method used in the various branches of knowledge makes it possible to reconcile two points of view which would seem irreconcilable . . . No such conflict should exist because each subject has a legitimate magisterium, or domain of teaching authority--and these magisteria do not overlap (the principle that I would like to designate as NOMA, or "nonoverlapping magisteria"). The net of science covers the empirical universe: what is it made of (fact) and why does it work this way (theory) The net of religion extends over questions of moral meaning and value. These two magisteria do not overlap, nor do they encompass all inquiry (consider, for, starters, the magisterium of art and the meaning of beauty).[16]

Gould suggests that a comprehensive understanding of reality should involve proficiency in both domains:

> The lack of conflict between science and religion arises from a lack of overlap between their respective domains of professional expertise--science in the empirical constitution of the universe, and religion in the search for proper ethical values and the spiritual meaning of our lives. The attainment of wisdom in a full life requires extensive attention to both domains--for a great book tells us that the truth can make us free and that we will live in optimal harmony with our fellows when we learn to do justly, love mercy, and walk humbly.[17]

In a passage charged with emotion and hope, Gould opines: "I believe, with all my heart, in a respectful, even loving concordat between our magisteria--the NOMA solution."[18]

Since Gould's formulation, NOMA has come to express "'the consensus of a great majority of professional scientists' and is quite popular among certain philosophers of science as well."[19] A statement from NAS reasserts Gould's concept of nonoverlapping magisteria:

> Science and religion are based on different aspects of human experience. In science, explanations must be based on evidence drawn from examining the natural world. Scientifically based observations or experiments that conflict with an explanation eventually must lead to modification or even abandonment of that explanation. Religious faith, in contrast, does not depend only on empirical evidence, is not necessarily modified in the face of conflicting evidence, and typically involves supernatural forces or entities. Because they are not a part of nature, supernatural entities cannot

> be investigated by science. In this sense, science and religion are separate and address aspects of human understanding in different ways. Attempts to pit science and religion against each other create controversy where none needs to exist.[20]

And just like Gould, NAS affirms that "Science is not the only way of knowing and understanding" but merely a way of knowing based on "empirical evidence and testable explanations."[21] It even suggests the equality of faith and reason as "different ways of understanding" and chastises the opponents of this concordat for reducing "the potential of both to contribute to a better future."[22] This statement issued in 2008 goes quite a bit further that the earlier one in 1999 that merely claimed that faith and reason "occupy two separate realms of human experience" and warned that a demand "that they be combined detracts from the glory of each."[23]

Many prominent individual scientists and secular philosophers have spoken and continue to speak in support of NOMA. This support is particularly strong among those scientists who profess their commitment to Christian faith. They include such recognized authorities in the field of sciences as biologist Francisco Ayala, recipient of 2001 National Medal Of Science and 2010 Templeton Prize, physicist John Polkinghorne, a recipient of the Templeton Prize Francis Collins, director of the Human Genome Project and the National Human Genome Research Institute at the National Institute of Health, Father George Coyne, Catholic priest and a former director of the Vatican Observatory, and many others.

There certainly has certainly been a sizable opposition that has challenged NOMA. The opponents of cooperation between reason and faith constitute a very diverse group. It includes many prominent scientists, such as Steven Weinberg and Richard Dawkins, as well as prominent religious leaders and groups, chief among them are New Earth, Intelligent Design, and Creationists. Representatives of this group argue that perspectives on reality provided by science and religion do not have equal validity; rather one is superior to the other. As has already been mentioned above, critics of cooperation from the domain of reason such as Steven Weinberg, Richard Dawkins, and others have attacked NOMA and other approaches focused on cooperation and accused them of a sell-out.[24]

The NOMA approach has not proven to be a lasting one. Under intense questioning the main premise of nonoverlapping magisteria—the existence of two separate and largely incommensurate domains of faith and reason—has turned out for many to be untenable from both theoretical and practical point of view. As a result, many who at one time supported the principle of equal but separate as a solution for the relationship between faith and reason shifted their focus away from NOMA in search of a new model. Proposals that are currently in circulation range from the need for an interactive dialogue to various degrees of integration of faith and reason and the development of a worldview that would be fully scientific and theologically sound—one in which faith and reason would mutually inform each other.[25] However, despite their efforts, the attainment of the resolution of this problem—i.e., creating fully cooperative and equal relations between faith and reason—remains elusive.

Take, for example, Robert Pollack, a biologist and a believer, who tries to provide an answer to the question he uses as the title for his essay "Can Faith Broaden Reason?"[26] Although he tries to strike a balance between faith and reason, he still recognizes the impossibility of reasoning about creation, thus admitting that reason cannot achieve its principal goal of rendering reality intelligible in the case of creation.[27] While one may agree with Pollack that faith is irrational, one cannot accept his suggestion that reason cannot render intelligible the irrational aspects of faith. After all, Zigmund Freud has successfully used reason to analyze irrational drives and impulses.

In the end, the solution that Pollack envisions is that reason and faith should mutually inform each other, although Pollack provides no rational understanding of how they should inform each other or what would be the end result of such process.

He writes:

> In specifically Jewish terms, then, it is the God-given, inexplicable reality of free will that allows us to act well — or not. That choice – available not just to Jews but to all people as their birthright – makes us all the active determiners of our fate. Pain, suffering, unreasonable maldistribution of good and bad fate: these are the very stuff of the natural world, the visible expression of the random genetic variation which provides natural selection with the eerie capacity to produce some living thing that will survive any contingency. It is my faith that informs me of my obligation as a scientist to use my own free will to work against these deepest mechanisms of the natural world, and thereby to work against the meaningless of these mechanisms.[28]

Reconciling Faith and Reason

Operational Equivalents of Faith and Reason in Mental Processes

Faith and reason are both related to human thinking. They represent, however, different types of mental operations that the human mind can perform. Since they are both parts of what the human mind does, they must be related to each other. Therefore, understanding this relationship is essential for bringing them together as two specific cases of how the mind works.

This essay is not the first attempt to understand biological and cognitive underpinnings of faith and reason. This approach to the subject is still in the process of development. Contributions of this nature range from serious and systematic to banal and even anecdotal, which are merely used to ridicule the opposing side.[29] An article by Wanting Zhong, et al, is a good example of trying to explore possible connections between faith and brain functions.[30]

There are two ways in which we understand reason. We often regard reason as the human mind and the sum total of its operations. Such understanding represents the use of the word "reason" in a very general sense. We also use the word "reason" in a functional sense, as specific operations that our mind can perform. In this latter sense, we understand reason and reasoning as our capacity to make inferences that are logically valid—that is, inferences made in accordance with the rules and norms of human rational thinking. In this sense, reasoning is the kind of mental operations that connect mental constructs with each other. In this sense reason and reasoning represent a form of equilibration that balances various mental constructs with each other. As such, reason is also about continuity.

As a cognitive tool, faith is very different from reason. It is decidedly not about logical connections between our mental constructs. As mental constructs, objects of faith cannot be inferred from other mental constructs. For this reason, we consider the source of faith and its objects to be illogical, intuitive, and irrational. In contrast to reason that is about continuity, faith has little to do with continuity of logical sequences; it is about disruption and radical discontinuity. Also, if reason relates to establishing logical equilibrium, or equilibration, faith relates to disequilibrium, or the capacity of our mind to produce disequilibrium. Thus, in the operational sense, one is perfectly justified to represent the problem of the relationship between faith and reason as the problem of the relationship between equilibrium and disequilibrium, or the relationship between equilibration and the production of disequilibrium.

Determinism and Indeterminism in the Contemporary Conceptions of Reality

Most contemporary thinkers see equilibrium and disequilibrium as two diametrical opposites. They associate equilibrium with entropy, chaos, and disorder. By contrast, they describe disequilibrium as an ordered state of a system that evolves in a certain direction. In other words, they see the relationship between equilibrium and disequilibrium as the relationship between order and chaos or between determinism and indeterminism.

There are two ways in which thinkers view reality today. The dominant view is that ontologically reality is ultimately indeterminate, chaotic, and does not obey causal laws. This view serves as the foundation for quantum theory, thermodynamics, theory of biological evolution, and many others. For example, according to quantum mechanics, the processes that occur at the most fundamental level of reality—that is, at the level of elementary particles and atoms—are random and do not obey the laws of causality.[31] The universe described by quantum mechanics appears to make absolutely no sense when viewed outside its formalism. For example, how can one make sense of non-locality that involves speeds faster than the speed of light that is considered to be the absolute speed attainable in nature? What should one make of superposition that describes a quantum system that can be in two different states at the same time? The contradictions with our familiar sense of how physical reality is are so great that even those who are intimately familiar with quantum theory find its puzzles hard to comprehend. Richard Feynman, who received a Nobel Prize for his achievements in quantum mechanics, cautioned:

> Do not keep saying to yourself, if you can possible avoid it, "But how can it be like that?" because you will get 'down the drain,' into a blind alley from which nobody has yet escaped. Nobody knows how it can be like that.[32]

Unsurprisingly, the view of quantum reality as random and uncertain sets limits to what we can know about it. In a characteristic remark Stephen Hawking, one of the most authoritative voices in modern physics, summarizes the view to which many contemporary physicists would subscribe:

> I do not demand that a theory correspond to reality because I don't know what it is. Reality is not a quality you can test with litmus paper. All I am concerned with is that the theory should predict the results of measurements. Quantum theory does this successfully.[33]

The view of reality as random is not limited the processes that occur at the level of elementary particles, or the micro level. Some physicists identify macro processes that display quantum phenomena. For example, a group of Russian physicists led by S. Korotaev has described phenomena of non-locality that occur in geomagnetic correlations.[34] Many biologists who subscribe to neo-Darwinism believe that the mechanism of the biological evolution involves random genetic mutations. The late Stephen J. Gould regarded contingency to be the basic creative force of life. In his view, contingency played a decisive role in the evolution. He writes: ". . . run the tape again, and the first step from prokaryotic to eukaryotic cell may take 12 billion years instead of two . . . ."[35]

There have also been challenges to the exclusive emphasis on randomness that is central to standard quantum mechanics. Einstein's famous adage that "the Old One does not play dice" most succinctly summarizes this position. David Bohm, a famous American physicist, is one of the most influential thinkers and scientists who advocate the view of reality as deterministic.[36] Bohm first formulated his theory back in the early 1950. Initially, the theory was quite successful and was able to gain some support in the physics community. However, as time passed, its influence waned and has only recently experienced some revival.[37]

Bohm certainly accepts the most important contribution of the currently dominant theory of quantum mechanics—its mathematical formalism. By contrast with the dominant theory, however, in Bohmian mechanics this formalism is more than just a convenient way of calculating and predicting outcomes of quantum experiments. The phenomena that quantum equations formalize are, for Bohm, the actual properties of reality. Bohmian mechanics explains even the weirdest quantum phenomena—such as non-locality, superposition, and backward causality—in terms of causes and effects. In Bohm's theoretical perspective, for example, non-locality—a quantum phenomenon that involves speeds faster than the speed of light—is not merely a mathematical representation of some results of quantum experiments. It is, for Bohm, a fundamental property of reality. The famous wave function is not just a convenient formula for calculating outcomes of quantum experiments; in the Bohmian world it actually guides particles and determines their state. One can also see such causal deterministic approach, for example, in John Cramer's transaction interpretation of quantum mechanics[38] and in the work of Russian physicist Pavel Kurakin and his colleagues who proposed a "conversational," or "dialogue model of quantum transitions."[39] According to John Cramer, the originator of the transaction interpretation of QT, the greatest

> weakness of QT . . . is not that it asserts an intrinsic randomness but that it supplies no insight into the nature or origin of this randomness. If "God plays dice," as Einstein has declined to believe, one would at least like a glimpse of the gaming apparatus that is in use.[40]

In the most recent one, the physicists Sheldon Goldstein, Detlef Dürr, and Nino Zhangi offer an interpretation of quantum mechanics that is, in Goldstein's words, "precise, objective—and deterministic."[41] In their view, the observed randomness is merely apparent. In another challenge, the data obtained in the study of neutron resonances have led a group of physicists at Oak Ridge Electron Linear Accelerator, headed by Dr. Paul Koehler, to question the applicability of random matrix theory to movements of neutrons and protons in the nucleus. The data indicate that the particles in the nucleus are moving in a coordinated fashion, rather than randomly as suggested by random matrix theory.[42] At the same time other physicists report observing quantum phenomena in macro events. A group of Russian physicists, led by S. M. Korotaev, has observed the phenomenon of non-locality, usually associated with the quantum domain, in dissipative geomagnetic macro processes.[43]

As the above shows, although physicists apply deterministic perspectives mostly to the so-called macro domain, there are quite a few physicists and philosophers of physics who interpret quantum phenomena in terms of deterministic laws.[44] Determinists also challenge the contingency perspective on biological evolution. The famous biochemist Christian de Duve advocates a deterministic interpretation of the origin of life on Earth,[45] as does Herbert Morowitz in his well-known book Beginnings of Cellular Life.[46]

However, does either of these views represent an objective representation of reality? There are two main conditions that satisfy the requirement for objectivity. In order to be considered objective, a view must be able to withstand the test of rational justification. In other words, one should be able to show that the selection of such view does not depend on one's subjective and arbitrary will but it on rationality and laws of reason, or logic, that humans share. Empirical verification is another important condition of objectivity--that is, there should be facts of reality that confirm this view.

On close examination, both views of reality—one that sees reality as ontologically indeterminate and uncertain and the other that sees it as ontologically determinate or ordered--do not withstand both tests of objectivity.

In his article Ulvi Yurtsever makes a strong argument that quantum mechanical probabilities may very well be truly genuine, that is, that they are algorithmically random, or incompressible. However, he also emphasizes that "no algorithmically incompressible binary string can ever be constructed via a finitely-prescribed procedure (since, otherwise, such a procedure would present an obvious algorithm to compress the string thus obtained)."[47] This observation recognizes that although truly algorithmically random strings may indeed exist, their existence cannot be logically demonstrated.

Jean Bricmont's analysis yields a result that simply dismisses the entire issue of the intrinsic nature of indeterminism vs. determinism as ultimately irrelevant. Bricmont raises a question whether there is a function--in a Platonic sense (that is, independent of our ignorance)--that determines a finite sequence of sets of numbers that never repeats itself in a unique way. His answer is that the existence of such function is simply impossible to disprove because one can always find a function or even many functions that map "each set into the next one."[48] Bricmont's conclusion dismisses the whole issue of indeterminism and determinism as utterly irrelevant to science. In his view, "there is no notion of determinism that would make the question [of determinism] scientifically relevant . . . ontically it [determinism] is true but uninteresting [that is, impossible to disprove]."[49] "I don't know," he adds, "how to formulate the issue of determinism so that the question becomes interesting."[50]

For Hans Primas, indeterminism and determinism refer strictly to ontic descriptions. Like Bricmont, he makes a very convincing argument against conflating, as is often done, determinism with predictability. According to his argument, even quantum interactions that are notoriously unpredictable are "governed by strict statistical laws."[51] Primas follows the principle of scientific determinism as formulated by the French mathematician Jacque Hadamard. According to this principle, ". . . in a well posed forward-deterministic dynamical system every initial state determines all future states uniquely."[52] However, in contrast to others that subscribe to similar definitions of determinism (for example, Laplace), Primas follows Hadamard in regarding the principle of determination as regulative, and not in some absolute sense; in other words, if in some cases this principle is not satisfied, "it can be enforced by choosing a larger state space."[53] According to Primas, such enforcement is perfectly compatible with mathematical probability theory because:

> Every mathematically formulated dynamics of statistically reproducible events can be extended to a description in terms of a one-parameter group of automorphisms on an enlarged mathematical structure which describes a fictitious hidden determinism. Consequently, randomness in the sense of

> mathematical probability theory is only a weak generalization of determinism.[54]

In his best selling book A New Kind of Science Steven Wolfram also shows that randomness can evolve into order and vice versa.[55] Adducing to the fractal geometrical patterns in nature, Paul Carr observes that many natural phenomena reveal "the complex interplay between randomness (symbolized by dice) and global determinism (which loads the dice). The Neo-Darwinist approach to evolution, as Carr points out, also emphasizes interplay between random genetic mutations and the globally deterministic natural selection.[56] Summarizing the evidence related to such diverse phenomena as turbulent flows and neurons, Tamas Viscek in his article that appeared in Nature stresses that:

> . . . in both these systems [turbulent flows and neurons] (and in many others), randomness and determinism are both relevant to the system's overall behavior. Such systems exist on the edge of chaos, they may exhibit almost regular behavior, but also can change dramatically and stochastically in time and/or space as a result of small changes in conditions.[57]

In another piece, also published in Nature, Kees Wapenaar and Roel Snieder make a similar point, drawing on evidence from physics:

> Our view of the universe may have shifted from the deterministic to the random, but since the turn of the last century physics itself has provided a less simplistic view. Fields generated by random sources can be used for imaging and for monitoring of systems such as Earth's subsurface, or mechanical structures such as bridges. Randomness is no longer at odds with determinism, it has instead become a new window on the deterministic response of the physical world.[58]

As the physicist Joseph Ford succinctly put it, "God plays dice with the universe. But they are loaded dice."[59]

It is not difficult to see similarities in the way that Bricmont, Primas, and others resolve the problem of indeterminism vs. determinism. They see that by enlarging the state space one can always find a deterministic function for a sample or a set. This solution resonates with the famous proof of consistency and completeness by the Austrian logician and mathematician Kurt Gödel. As Gödel has shown, any deductive system can have true sentences whose truth is indemonstrable. In order to demonstrate their truth, one should resort to meta-mathematical procedures and construct a new and broader axiomatic structure that would be powerful enough to make such proof possible. However, according to Gödel's proof, even the new and enlarged structure will not be able to escape the same paradox as it will also allow other true but improvable sentences.[60] In other words, any axiomatic system is indeterminate and determinate at the same time depending on whether it includes or excludes statements that are not consistent with the foundational axiom.

One can also glean the connection of this problem to epistemology—that is, the way we approach reality, rather than what this reality actually is--from another angle. There is a great deal of empirical evidence suggesting that nature does not give preference to either randomness or determinism. In fact, many natural phenomena point to a close relationship and complex interaction between random and deterministic processes. Many processes in nature can be often classified as non-deterministic and deterministic at the same time.[61] The Nobel laureate Ilya Prigogine noted a close relationship between random and deterministic processes in his book with a characteristic title Order out of Chaos.[62]
There is much empirical evidence that shows that nature does not favor either indeterminism equilibrium (associated with equilibrium) or determinism (associated with disequilibrium). For example, in his interpretation of the current state of the universe, the astrophysicist Manasse Mbonye conjectures that "the universe is always in search of a dynamical equilibrium," which suggests a n interplay between the states of equilibrium and disequilibrium.[63] Although the currently dominant cosmological theory asserts that our universe originated in the state of original disequilibrium, or Big Bang, numerous critics of this theory point to its speculative nature and argue that since it is an extrapolation from the current conditions into the past, this theory is not justified and still lacks unambiguous empirical support.[64]

The above discussion leads to the conclusion: one cannot regard either determinism (disequilibrium) or indeterminism (equilibrium) as objective in the ontological sense. In other words, neither determinism nor indeterminism reflects the ontological state of reality. They appear only as particular aspects of this reality on the phenomenological level—that is, on the level of phenomena. Assumptions that they are real in some ontological sense are subjective and arbitrary. As such, they cannot serve as a foundation for any theorizing about reality that claims to be objectivity.

Equilibration and Production of Disequilibrium in Human Thought

If determinism and non-determinism are but particular aspects of the underlying ontological reality and are merely its phenomenal manifestations, so must be their cognates, including equilibrium and disequilibrium. Since equilibrium and disequilibrium are products of processes--equilibration and the production of disequilibrium—these processes also belong to the phenomenological, not ontological level of reality. As such, they both have common underlying ontological source, or ontological reality. Equilibration and the production of disequilibrium are integral aspects of this source and are both included in its frame. Therefore, they must be related to each other as parts of this common frame.

As has been pointed out, reason and reasoning involves making logical inferences--that is, inferences made in accordance with the rules and norms of logic. In other words, reasoning is the kind of operation that establishes connections between our mental constructs. In this sense reason and reasoning represent a form of equilibration that balances various mental constructs with each other. Since this operation establishes connection between mental constructs, it is about continuity. Therefore, reason and reasoning as representations of this operation are also about continuity.

Faith, as has also been pointed out, is not about logical connections. It is not about establishing logical connections based on inferences between objects of faith and other mental objects. Faith is not about continuity. It is precisely about grasping objects that are not connected or derived from other mental constructs by using logical operations. Objects of faith represent radical disruptions, discontinuity; they produce disequilibrium. Faith, thus, relates to the capacity of our mind to produce disequilibrium.

Just as we are fully justified to reformulate the problem of the relationship between faith as reason as a problem of the relationship between equilibration and the production of disequilibrium, we are also perfectly justified to invert the problem of equilibration and the production of disequilibrium into the problem of the relationship between faith and reason.

We know that our mind can execute logical operations and is, therefore, capable of performing equilibration. We also know that our mind can create radical novelty. Therefore, our mind is also capable of producing disequilibrium. Since our mind can perform equilibration and also produce disequilibrium, the two must be related to each other in the broad frame of what our mind can do. Since both faith and reason, or equilibration and the production of disequilibrium, represent operations that are performed by the human mind, therefore they must be in some way related to each other.

We are all familiar with logical operations. These operations perform one function that appears to be vital to our thinking. They establish connections between our mental constructs. But why does our mind need to establish these connections?

Our mental constructs are products of operations that produce them. Like other operations and their products that we can observe in nature, mental operations have to be conserved. Conservation is ubiquitous in our universe. It is fundamental to its very existence.

Our universe is all there is. Nothing can come into our universe from outside, because there is no outside to our universe. Nothing can disappear from our universe because there is nothing outside our universe into which something can disappear. Everything, therefore, must be conserved. Thus conservation is fundamental to and, therefore, ubiquitous in our universe and everything that exists in it, including the human mind. Thus conservation is fundamental to the activity of human mind.

All systems, including the human mind, have functional operations--that is, they do something. The capacity to do what they do defines systems and is their most important property. Systems are what they do—that is, the kind of operations that they do. Therefore, conservation is about conserving the functional operations of a system.

Functional operations are forms of action; and the only way to conserve action is by acting it out. Therefore, the more functional operations are used, the better they, and the system they constitute, are conserved. Evolution favors systems that exercise their functions as much as possible since such systems conserve themselves better; they are selected for fitness and, therefore, survive.

In order to do what they do, systems require resources. Resources are critical for conservation. Since resources are always finite, systems must be frugal and use their resources efficiently. The more efficiently a system uses resources available to it, the more it stays active and the better it is conserved. Evolution favors those systems that use their resources very efficiently.

However, no matter how frugal a system is, no matter how efficiently it uses its resources, these resources are still limited. While efficiency and frugality help and are rewarded by nature, they do not solve the fundamental problem of the finitude of resources. The only way to solve this problem is by accessing new resources. Since it is the only way to solve this problem, evolution must favor systems that are capable of gaining access to new resources.

In order to gain access to new resources, a system must expand its range of possibilities—new ways and capacities to act—which requires new properties—new ways of acting--that are different from those that the system possesses. In other words, expanding the range of possibilities requires the inclusion of something that the system is not, or differences. The inclusion of differences enriches the system and makes it more powerful. Thus conservation requires changes that make a system more powerful. In order to conserve itself, a system must evolve. Conservation is the engine of evolution. A system that does not evolve cannot conserve itself and begins to disintegrate.[65]

All systems have a mechanism that regulates their functional operations. Since this mechanism regulates all functional operations, it represents a global operation. As such, it has more power—that is, its range of possibilities is wider—than each individual local operation or their sum total. Its power represents a multiplication, not a sum total, of all possibilities of all functional operations of the system. In other words, its range of possibilities exceeds all possibilities of all functional operations in the system, which means that the regulatory mechanism is capable of recognizing what the system is not. It has the power of recognizing and embracing its negation. Its level of organization is more powerful than that of any other level of organization in the system and, in this sense, it transcends the system. Due to its power, the mechanism of regulation plays a critical role in systems. It regulates functional operations and their interactions. It also controls all interactions between the system and its environment.

As has been indicated, regulation is a global function. Its primary role is to conserve the entire system, which includes the mechanism of regulation. In other words, regulation also needs to be conserved. If regulation is not conserved, the entire system will start disintegrating. The principle in conserving regulation is the same as conserving any other operation: it has to be active. The more regulation is activated, the better it is conserved. The most proximate source of activation is local functional operations of the system. Thus, conservation of the regulatory mechanism requires multiple connections between this mechanism and local functional operations. Such integration involves both assimilation and adaptation.

Since the global level of organization at which regulation operates is the most powerful level in the entire system, regulation can assimilate local functional operations and include them into its operational schemes. This process leads to the differentiation of regulation. Once local functional operations are included, they have to adapt to the powerful global mechanism. Such adaptation requires making global operations accessible to local ones, which means that the less powerful operations must "understand" more powerful ones. The translation of operations of greater power into the terms of operations of lesser power involves the emergence of a new frame that has sufficient power to include both the local and the global level as its particular cases. The emergence of this new frame marks the beginning of a new cycle in the evolution of the system. The adaptation of local operations to the global level enriches and changes them. As a result of change, they require re-equilibration with each other. This re-equilibration produces a new mechanism of regulation and the evolution of the system as a whole.

Using its own functional operations is not the only way systems can conserve themselves. Environment, including other systems, offers a large array of differences that can be used to enrich and conserve a system. Since the regulatory mechanism is more powerful than all the local functional operations that constitute a system, it has the capacity to transcend the boundaries of the system. It can sense excitations in the environment of the system, including excitations created by other systems, not just those that originate within the system. The regulatory mechanism can also use these external excitations for its conservation.

Thus, regulation allows establishing connections between the system and its environment, including other systems. The result of such structural coupling—the term used by neurobiologists Humberto Maturana and Francisco Varela[66]—of regulatory mechanisms of different systems is coordination of regulatory operations of different systems and the eventual emergence of a common regulatory mechanism and a new structural whole in which each constituent part becomes a subsystem. Such new integrated functional totality offers more possibilities and, consequently, offers access to a greater array of resources. The common regulatory mechanism activates subsystems more often, which also helps to conserve them.

No matter which path the system takes—internal, external, or a combination of the two—the outcome is the same: the emergence of new and more powerful levels of organization with a more extensive array of possibilities. The wider array of possibilities allows access to new resources and greater stability. As a result, the system is better conserved; and whatever is conserved better is "selected for fitness." Thus, conservation requires creation of new and increasingly more powerful levels of organization. The emergence of new and increasingly more powerful levels of organization constitutes evolution.

Here is a schematic representation of how creation of new and more powerful levels of organization works:

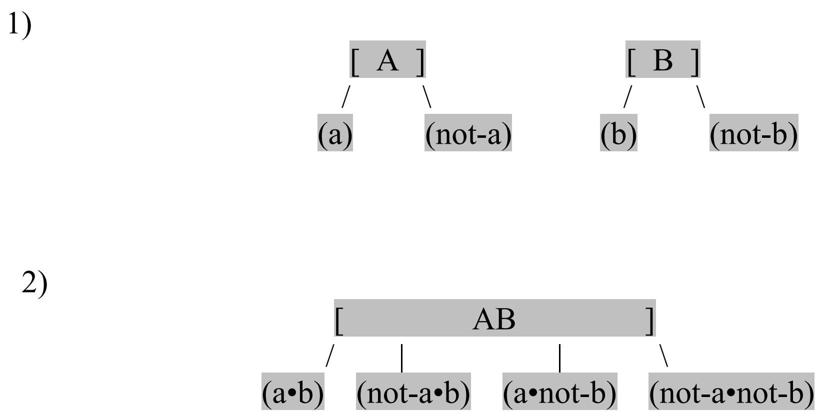

Figure 1: Schematic representation of the process of creation

One can clearly see in Figure One that each operation on its own can perform only two kinds of action—it either acts or it does not. Each operation has only two such possibilities; and the total for both of them is four. When combined with each other, each operation acquires four possibilities, for a total of eight for both. Each possibility represents a distinct way of acting. Each possibility expands the range of what a system can do and therefore increases its power. Greater power is a new property that did not exist prior to its emergence. This is the essence of creation. Thus conservation leads to combination and combination creates new properties. Conservation leads to creation. There is no conservation without creation and evolution. If a system does not evolve, it will start disintegrating because it will not be able to conserve its regulatory mechanism that holds the system together and sustains it.

An example from early child development described by famous psychologist and cognitive scientist Jean Piaget in his book *The Origin of Intelligence in Children* is a good illustration of how systems evolve.[67] For Piaget, the starting point in this development is reflexes that are triggered by nerve signals. Neural functions regulate physiological functions (for example, muscle contraction). Signals from neurons activate physiological functions and thus conserve them. The more frequently this triggering occurs, the more active and, consequently, more stable these physiological functions are going to be. Thus neural networks regulate physiological functions and conserve them. Combined together, neural and physiological functions constitute sensory-motor operations.

Sensory-motor operations, or schemata in Piaget's terminology, are also subject to the law of conservation. They conserve themselves in two ways. First, they become increasingly oriented toward external reality in search of stimulation. This process evolves from casual encounters with stimuli to random groping in search of stimulation, and then to a more directed search for stimuli. The directed search leads to the gradual construction of the object on the level of sensory–motor operations (although not yet on the representational level). In other words, the child begins to simulate the presence of an object that the child has assimilated into sensory-motor operations in previous encounters (for example, simulating hand movements necessary for grasping an object). As more objects are incorporated into sensory–motor schemata, the infant becomes increasingly more orientated toward the external environment.

Sensory–motor operations (for example, tactile, audio, visual, gustatory, and other functions) also conserve themselves through mutual assimilation; that is, by including each other into their assimilative schemata. One example of such mutual assimilation is the activation of the audio function by the visual one, and vice versa. Piaget discusses several such instances. For example, he notes that at a certain age when the infant hears mother's voice, the child begins to turn the head, searching for the familiar image. Mutual assimilation of sensory-motor operations results in the emergence of stable connections between them and common regulation. As a result of the emergence of common regulation, each sensory-motor operation receives more stimulation and consequently is better preserved. The common regulatory mechanism offers more possibilities for stimulation and, therefore, is more powerful than the level of each sensory-motor operation or their sum total; these operations become particular cases in this more powerful arrangement. The adaptation of sensory-motor operations to this new totality completes the process. This new and more powerful level of organization gives rise to permanent mental representations that are equivalents of sensory-motor operations on the level of neural organization. The process is completed at the beginning of the second year of life when infants begin to look for objects that are hidden from their direct view. The search for a hidden object indicates that the object is present in the child's mind even when it is not in front of him or her; it indicates that the infant has already constructed a permanent mental image of the object.

The emergence of neural networks that give rise to mental images marks the beginning of a new cycle in child development. While these networks regulate and conserve sensory-motor operations, they also require conservation. Such conservation involves mutual assimilation of networks, creation of a common regulatory level of organization with subsequent assimilation into and adaptation to this new totality. Regulation stabilizes these connections and open the path for the development of symbolic operations, or what we commonly call thinking.

The above discussion makes clear that equilibration and the production of disequilibrium are two vital operations performed by the human mind. As equilibrium grows, so does disequilibrium. Thus equilibration produces disequilibrium, and the presence of disequilibrium results in re-equilibration. Equilibration and the production of disequilibrium complement each other and are closely interrelated. Their close and complementary relationship plays a vital role in conserving the mental states and constructs by creating new and increasingly more powerful levels of mental organization. Without such constant creation we cannot conserve our mental states and cannot survive.

The understanding of how equilibration and production of disequilibrium are related and complement each other in the creation of new and increasingly more powerful levels of mental organization renders the process of creation intelligible. Once this process becomes intelligible, we can understand and control it. Control is a regulatory function. In other words, we can regulate this process in a way that will make it run in the most efficient manner.

Using the Process of Creation for Sustaining Human Civilization

In order achieve such efficiency, we must make sure that our control over this process rests on the objective and non-arbitrary foundation, rather than subjective and arbitrary. In other words, we have to make sure that it can withstand the test of rational justification and empirical verification.

First, one has to emphasize that the process of creation is not an arbitrary concept created by our subjective mind. It can withstand the test of rational justification and empirical verification.

Humans observe reality. This observation is not direct; it is mediated by our mental constructs. Our senses transmit electrical signals into our brain that interprets these signals using its mental constructs. Mental constructs play a critical role in observing reality. Without them, we would not be able to observe anything.

However, mental constructs are not innate. As Piaget has shown, we create them—that is, we use the process of creation to create our mental constructs. Without creating them, we would not be able to observe anything in our environment. The world as it exists for us would be impossible without us creating mental constructs and observing reality. Therefore, without the process of creation the world would not exist for us. The world that is so familiar to us simply would be logically impossible; it would simply not exist. This is the rational justification for the existence of the process of creation: without the process of creation reality as it exists for us would simply not exist.

The universe in which we live is full of objects that are results/products of the process of creation. The products of creation are all around us: minute sub-atomic particle and atoms, molecules, nebulas, stars, planets, galaxies, life, organisms, and much else. Humans are also products of this process that drives the evolution. As products of the process of creation, we inherit its properties. We can create. Objects we make, houses we build, plants we grow, books, poetry, art, science, technology, our social organization, and our civilization as a whole—all of these are our creations. They constitute empirical evidence for the existence of our capacity to create. They provide empirical verification for the existence of the process of creation.

However, the recognition that the process exists and is real does not yet guarantee that what we say about this process is objective. The objective representation requires that we view the process of creation from the objective position that does not depend on our subjective choice. If this condition is not observed, we can still end up with a subjective view of an objective process.

Objective and universal knowledge should incorporate the activity of knowing, that is, the process by which knowledge has been created. It should include the observer/knower into the field of observation. Observing the process of creation requires identifying an objective position from which this process can be observed. But how can one identify such objective position? The very act of identification is a human act and a result of human choices; these choices inevitably involve subjectivity. Is it possible to make such identification without getting into an infinite reflective regression, as Luhmann has argued?[68] On also can put the question this way: can one reflect on the process of creation from within the process of creation without placing one's point of view outside this process?

Our current dominant epistemological approach offers no satisfactory and conclusive answers to these questions. It is aware of the problem of self-referentiality of knowledge and of the fact that observation is a function of the observer.[69] However, it provides no definitive solution to this problem. Luhmann, arguably the most insightful and nuanced theorist who has addressed this issue, fully understands, for example, that the circularity and self-reflectivity of observing is unavoidable and proposes to introduce what he calls "conditioning" to interrupt this circularity. Such conditioning, according to Luhmann, is a proper function of reason, or rather reasons, as he puts it. He is perfectly aware that rationality is not a panacea. In his words, rational conditioning merely transforms "the vicious circle into an infinite regress" since "one must ask for the reasons behind the reasons."[70] However, for Luhmann this infinite regress "is fitted with hopes of approximating ever more closely to reality, which are finally anchored in functioning complexity."[71] In Luhmann's view, awareness of circularity of reason is the key to a normative practice for observing reality:

> If one in turn justifies the reasons and keeps every step of this process open to critique and ready for revision, it becomes more improbably that such an edifice could have been constructed without reference to reality. The circularity is not eliminated. It is used, unfolded, de-tautologized. Without this fundamental self-reference all knowledge would collapse.[72]

Luhmann's answer to the paradox of observing is not, as Loet Leydesdorff complains,[73] in the absolutism of a super-observer. Rather, it is a cautious reminder that "questions of final justification can only be answered within the self-referential theories of self-referential systems" and in "the logic of universalistic theories that forces them [theories] to test on themselves everything they determine about their object."[74] The direction for resolving the paradox of observing pointed by Luhmann reveals modern sensitivity toward reflexivity, self-referentiality, recursivity and complexity. Yet it ultimately, too, is not a solution since Luhmann does not define the position from which one may be able to observe the object and the process of observing, and yet be simultaneously embedded, as it is, in this process.

The solution lies in understanding the process of creation. It is logically correct to view the process of creation as a system. Since it is a system, this process also relies on regulation in order to sustain itself. Regulation is essentially a reflective operation. The view of the process of creation as infinite may suggest, as it does to Luhmann, that there is really no way to reflect on this process since for every reflective position there will always be a possibility of constructing another one. Every point of reflection can and will be succeeded by another one, no less embedded in the process of observing than its predecessor. Should one conclude, then, that the problem of the embedded observer cannot be resolved and all that is left is to rely on palliatives, such as Luhmann's conditioning?

Just like any other system, the process of construction requires stabilization and, therefore, regulation that offers a possibility of reflection. If the process of construction requires regulation, there must exist a position from which one should be able to reflect on the entire process while at the same time remaining deeply embedded in this process. As has been repeatedly pointed out, conservation and regulation are at the heart of the process of creation. Conservation of functional operations requires regulation. In the initial stages of their development the regulatory mechanism is unstable. In order to acquire stability, it needs a regulatory mechanism of its own. As the new mechanism stabilizes itself, the process enters a new cycle. Thus the process of creation involves constant oscillation between equilibrium and disequilibrium, between equilibrating the current level and constructing a new (regulatory) level of organization, thus producing disequilibrium. Both equilibrium and disequilibrium are dynamically related in the evolution of the process of creation. As equilibrium grows in the course of equilibration, so does disequilibrium that equilibration produces. The repetition of the cycle of equilibration and production of disequilibrium eventually leads to the improvement of the function of regulation and the process becomes increasingly more stable, despite constant changes. One can probably best describe this dynamic stability as homeorhesis, rather than homeostasis. Biologist Conrad Waddington has introduced this term to convey the capacity of maintaining the path of the evolution rather than a static condition. Homeorhesis implies the existence of a stable balance between equilibrium and disequilibrium. This dynamic balance has a function of regulation and, as a regulatory operation, offers a possibility of reflecting on the functioning of the process of construction/creation as a whole. It allows one to reflect on the process from the position of this dynamic balance that is inherent to the process; that is, in full awareness of both equilibration and the disequilibrium that it generates. Any mental construct (theory, idea, etc.) can and should be viewed with full awareness of the fact that it ultimately is a stage in the transition to new and more powerful levels of organization and that our task is to facilitate this transition and make it efficient.

Conclusion

This essay has set out to prove a possibility of reconciling faith and reason. In contrast to most contributions that approach faith and reason cultural phenomena, this essay uses the approach that focuses on reason and faith as cognitive operations performed by the human brain. In pursuing this approach, the essay has first transformed the problem of the relationship between faith and reason into the problem of the relationship between equilibration and the production of disequilibrium—two important operations that are performed by the human brain. The establishment of equivalence between reason and faith, on one hand, and equilibration and production of disequilibrium, on the other, permits further transformation of the original problem into the problem of determinism and non-determinism.

In addressing the relationship between determinism and non-determinism, this essay has reviewed the current perspectives on reality as either deterministic or non-deterministic. The analysis of these perspectives has led to the conclusion that both determinism and non-determinism are not relevant to ontological reality. One cannot consider either determinism or non-determinism as ontologically primary. Both belong to the phenomenal sphere—that is, they appear as phenomenal manifestations of the underlying ontological reality. They are both products of the process of creation that constitutes this reality. Since they are manifestations of the common ontological reality, they are not ontologically opposed to each other, rather they are intimately related and complementary phenomena generated by the common and ontologically primary process of creation.

The demonstration that the two phenomenological binaries--determinism and non-determinism—are interrelated and complementary to each other allows to extend this demonstration to other binaries cognate with determinism and non-determinism—namely, equilibration and the production of disequilibrium, as well as faith and reason as cognitive operations associated with equilibration and production of disequilibrium.

Thus, this essay has demonstrated that faith and reason are part of the phenomenal sphere. Neither of them can claim ontological primacy over the other. Also, they do not represent two separate and largely independent magisteria, as Stephen Gould among many others has argued. They are two phenomena closely related and complementary to each other in the frame of the process of creation that gives rise to both of them. As two intimately related and complementary phenomena, faith and reason are integral parts of our common human heritage. The recognition of their commonality will allow us to use and combine the important achievements made in the domain of faith and in the domain of reason.

The emphasis on creation as the fundamental property of reality will certainly enrich the domain of reason and add to its power. The domain of reason will also undoubtedly benefit from the intuition articulated in the domain of faith about the fundamental unity of all that exists and the intimate relationship between truth/knowledge, justice/morality, and beauty/pleasure. At the same time, the domain of faith will certainly benefit from the recognition of the infinite power of human reason to render all of reality, including the process of creation, intelligible and accessible to rational analysis.

Such mutual enrichment will benefit humanity as a whole. The mutual cooperative and complementary relationship between the two domains will undoubtedly help our civilization to solve many problems it faces today—problems that are associated with deep divisions produced by the opposition between reason and faith. This process of rapprochement between faith and reason has already started. We see it in the appearance of new theoretical approaches, such as systems theory that sees complex interactions between both the local and the global level of organization and that uses a holistic as well as atomistic approach; theory of emergence that essentially focuses on the rise of discontinuity, or what religion identifies as miracles; and theory of complexity that tries to understand the process of evolution of complex system, or the process of creation of new and increasingly more powerful levels of organization. We also see this rapprochement in the emphasis on reason and analysis, and the acceptance of science as integral to our understanding of reality in the works and pronouncements of church dignitaries, including Pope John Paul II and Pope Benedict XVI.

The growing cooperation between the domain of faith and the domain of religion will allow us to understand and control the process of creation. As a result, we will be able to utilize the process of creation more effectively and efficiently. By controlling the process of creation, by using it more efficiently in creating new and increasingly more powerful levels of organization, we will be able to conserve, rather than destroy, our civilization and thus sustain it into an indefinite future.

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[32] Online source at http://www.spaceandmotion.com/Physics-Richard-Feynman-QED.htm#Quotes.Richard.Feynman (accessed on October 20, 2008).

[33] Stephen Hawking and Roger Penrose, "The Nature of Space and Time," *Scientific American*, vol. 275, no. 1 (July 1996): 60-65, p. 65.

[34] S. M. Korotaev, et al., "Experimental Study of Macroscopic Non-locality in Large-Scale Natural Dissipative Processes," *NeuroQuantology*, issue 4 (2005), pp. 275-94.

[35] See S. J. Gould, Wonderful Life (London: Penguin Books, 1989), as quoted in Pier Luisi, "Contingency and Determinism" (Philosophical Transactions of the Royal Society of London A, vol. 361 [2003], p. 1142). Luisi echoes the same contingency view in his article: "At the present stage, one should accept the view that these few proteins of life are with us as the products of the bizarre laws of contingency, followed by chemical evolution processes" (ibid., p. 1144). See also Francois Monod, Chance and Necessity: Essay on the Natural Philosophy of Modern Biology (New York: Alfred A. Knopf, 1971) and Francois Jacob, The Possible and the Actual (Seattle: University of Washington Press, 1982).

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[37] David Bohm, "A Suggested Interpretation of the Quantum Theory in Terms of 'Hidden' Variables. I." *Physical Review*, vol. 85, no. 2 (January 15, 1952): 166–79; David Z. Albert, "Bohm's Alternative to Quantum Mechanics," *Scientific American*, 1994, pp. 53-64.

[38] Gennady Shkliarevsky, "Of Cats and Quanta," p. 14; Cramer, "Transactional Interpretation," p. 658. John Cramer provides a detailed description of these interpretations in the addendum to his article "The Transactional Interpretation of Quantum Mechanics," *Review of Modern Physics*, vol. 58, no. 3 (July 1986), pp. 647-87.

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[40] Cramer, "Transactional Interpretation," p. 658.

[41] Mark Buchanan, "Quantum Determinism: Is There Such a Thing as Pure Chance?" *New Scientist* 197, no. 2648 (March 22, 2008): 28–31. https://doi.org/10.1016/S0262-4079(08)60732-0.

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[48] Bricmont, "Determinism," p. 4.

[49] Bricmont, "Determinism," p. 4

[50] Bricmont, "Determinism," p. 1.

[51] Primas, *Hidden Determinism*, p. 1 (emphasis in the original).

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[53] Primas, *Hidden Determinism*, p. 10.

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[61] Joseph Berkovitz, Joseph, Roman Frigg, and Fred Kronz. “The Ergodic Hierarchy, Randomness and Hamiltonian Chaos.” *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics* 37, no. 4 (December 2006): 661–91, p. 661, https://doi.org/10.1016/j.shpsb.2006.02.003.

[62] I. Prigogine and I. Stengers, *Order out of Chaos* (New York: Bantam Books, 1984), particularly pp. 292-95.

[63] Manasse Mbonye, “Constraints on Cosmic Dynamics,” arXiv:gr-qe/0309135v1 30 Sep 2003, pp. 1-2 (accessed November 21, 2008).

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