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An evangelical perspective on science and the Christian faith

IS MAN ONLY A COMPLEX MACHINE ?

"The fear of the Lord is the beginning of Wisdom." Psalm 111:10

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Our question is not: can we believe in our freedom on the basis of what we know of physiology, but quite the other way around: Do these facts of our experience create an embarrassment for theoretical physiology?

Donald M. MacKay
In *Brain and Conscious Experience*,
J. C. Eccles, Ed.,
Springer-Verlag (1966)

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DECEMBER 1970 PRINTED IN THE UNITED STATES OF AMERICA VOLUME 22, NUMBER 4

IS MAN ONLY A COMPLEX MACHINE?	122	
Life's Irreducible Structure	123	Michael Polanyi
Do Life Processes Transcend Physics and Chemistry?	125 128	Richard H. Bube Colin Duriez
Materialism and Modern Man	132	Russell L. Mixter
Three Perspectives on Men and Machines	135 136 136	Gary R. Collins Irving W. Knobloch Walter R. Hearn and Underwood Standard, Serial SI 1-5679794
Only a Machine, or Also a Living Soul?	137	Walter C. Johnson
Mechanism, Naturalism, and the Nature of Social Science	141	Gordon R. Lewthwaite
The Man Who is There	145	Mary Jeanne Newton
Spirit: God and Man	148	Paul E. Stanley
BOOK REVIEWS		
Mechanical Man, Dean E. Wooldridge	153	J. T. Morrison C. Daniel Geisler
INDEX, VOLUMES 20-22	157	

IS MAN ONLY A COMPLEX MACHINE?

Man *is* a complex machine. His sense detection system is the model and envy of many attempts to reproduce it in simpler machine form. Machine-like functions of man can be described in terms of the various scientific disciplines. If a man doesn't know that he is a machine, he's in trouble. If he thinks that he is an immortal and immaterial spirit who is temporarily living in and operating a finite and material body, he doesn't appreciate the Biblical teaching of the body-soul unity and the wholeness of man created in the image of God.

It's the "only" in the question, "Is man *only* a complex machine?" that causes the trouble. Every "only" is a subjective judgment of men. Science knows no "only's." That man is a complex machine is a scientific conclusion. That man is only a complex machine is a subjective philosophical speculation not derivable from science. It is simply another repetition of the old fallacy: if science shows us that man is a complex machine, and if we can know nothing except what science tells us, then man is only a complex machine.

We should expect that every event in which a human being takes part can be described on each of the levels appropriately associated with the physical sciences, the biological sciences, the psychological and social sciences, and ultimately in terms of that theology which relates the event and the man to God. It is never a question of something happening on this level but not on another; it is always a question of something happening on every level simultaneously.

We may expect, therefore, to be able to produce a physical description of every activity of a human being. Although we cannot in fact produce an exhaustive physical description at the present time, there is in principle no reason to believe that something *on the physical level* must of necessity elude us in setting forth a physical description. It is not, for example, necessary for the perspective of the Christian faith that God be invoked to supply the *physical mechanism* at some point where human understanding of the natural physical mechanisms breaks down. Even if a complete and exhaustive description on the physical level were at hand, it would be a false interpretation to conclude that no other description was valid or necessary for a complete understanding. It is at this point that the common fallacy enters; it is at this point that the true statement, "Man is a complex machine," becomes the false statement, "Man is only a complex machine."

Consider the most important event in the life of a Christian. Christian conversion is not *only* a physical event, not *only* a biological event, not *only* a psychological event, not *only* a social event, not *only* a theological event. Which of these descriptions could be left out without depleting the total understanding of what has happened in conversion? To be sure, the focus of the conversion experience is the relationship on the theological level between a man and God, but it could be no experience at all if it did not have its effects on the sub-systems of man, on his sociology and psychology, and even his biology and physical processes. It appears clear that the argument is false that the possibility of exhaustive description on a single level excludes the meaningfulness, validity, or necessity of descriptions on all other levels. Any attempt to understand the human being in terms only of sub-system descriptions will inevitably lead to an impoverishment of life and a dehumanization of man.

Man is a complex machine. But to assert that man is only a complex machine is to equate the whole with the sum of its parts, and to fail to recognize the necessity for a multi-level description in order to do full justice to what kind of creature man is. Even if it should be possible for us to describe in detail the physical mechanisms associated with every action, every thought, every impulse of a man, we would still not have a clue to what it all meant without the recognition that the man is a child of God, made by Him for love and communion.

R.H.B.

Based on a portion of a manuscript for a new book, Research and Revelation, *to be published by Word Books, Waco, Texas.*

Life's Irreducible Structure*

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Boundary Conditions

If all men were exterminated, this would not affect the laws of inanimate nature. But the production of machines would stop, and not until men arose again could machines be formed once more. Some animals can produce tools, but only men can construct machines; machines are human artifacts, made of inanimate material.

The *Oxford Dictionary* describes a machine as "an apparatus for applying mechanical power, consisting of a number of interrelated parts, each having a definite function." It might be, for example, a machine for sewing or printing. Let us asume that the power driving the machine is built in, and disregard the fact that it has to be renewed from time to time. We can say, then, that the manufacture of a machine consists in cutting suitably shaped parts and fitting them together so that their joint mechanical action should serve a possible human purpose.

The structure of machines and the working of their structure are thus shaped by man, even while their material and the forces that operate them obey the laws of inanimate nature. In constructing a machine and supplying it with power, we harness the laws of nature at work in its material and in its driving force and make them serve our purpose.

This harness is not unbreakable; the structure of the machine, and thus its working, can break down. But this will not affect the forces of inanimate nature on which the operation of the machine relied; it merely releases them from the restriction the machine imposed on them before it broke down.

So the machine as a whole works under the control of two distinct principles. The higher one is the principle of the machine's design, and this harnesses the lower one, which consists in the physical-chemical processes on which the machine relies. We commonly form such a two-leveled structure in conducting an experiment; but there is a difference between constructing a machine and rigging up an experiment. The experimenter imposes restrictions on nature in order to observe its behavior under these restrictions, while the constructor of a machine restricts nature in order to harness its workings. But we may borrow a term from physics and describe both these useful restrictions of nature as the imposing of *boundary conditions* on the laws of physics and chemistry.

Let me enlarge on this. I have exemplified two types of boundaries. In the machine our principal interest lay in the effects of the boundary conditions, while in an experimental setting we are interested in the natural processes controlled by the boundaries. There are many common examples of both types of boundaries. When a saucepan bounds a soup that we are cooking, we are interested in the soup; and likewise, when we observe a reaction in a test tube, we are studying the reaction, not the test tube. The reverse is true for a game of chess. The strategy of the player imposes boundaries on the several moves, which follow the laws of chess, but our interest lies in the boundaries—that is, in the strategy, not in the several moves as exemplifications of the laws. And similarly, when a sculptor shapes a stone or a painter composes a painting, our interest lies in the boundaries imposed on a material, and not in the material itself.

The organism is shown to be, like a machine, a system which works according to two different principles: its structure serves as a boundary condition harnessing the physical-chemical processes by which its organs perform their functions.

We can distinguish these two types of boundaries by saying that the first represents a test-tube type of boundary whereas the second is of the machine type. By shifting our attention, we may sometimes change a boundary from one type to another.

All communications form a machine type of boundary, and these boundaries form a whole hierarchy of consecutive levels of action. A vocabulary sets boundary conditions on the utterance of the spoken voice; a grammar harnesses words to form sentences, and the sentences are shaped into a text which conveys a communication. At all these stages we are interested in the boundaries imposed by a comprehensive restrictive power, rather than in the principles harnessed by them.

Living Mechanisms Are Classed with Machines

From machines we pass to living beings, by remembering that animals move about mechanically and that they have internal organs which perform functions as

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parts of a machine do—functions which sustain the life of the organism, much as the proper functioning of parts of a machine keeps the machine going. For centuries past, the workings of life have been likened to the workings of machines and physiology has been seeking to interpret the organism as a complex network of mechanisms. Organs are, accordingly, defined by their life-preserving functions.

Any coherent part of the organism is indeed puzzling to physiology—and also meaningless to pathology—until the way it benefits the organism is discovered. And I may add that any description of such a system in terms of its physical-chemical topography is meaningless, except for the fact that the description covertly may recall the system's physiological interpretation—much as the topography of a machine is meaningless until we guess how the device works, and for what purpose.

In this light the organism is shown to be, like a machine, a system which works according to two different principles: its structure serves as a boundary condition harnessing the physical-chemical processes by which its organs perform their functions. Thus, this system may be called a system under dual control. Morphogenesis, the process by which the structure of living beings develops, can then be likened to the shaping of a machine which will act as a boundary for the laws of inanimate nature. For just as these laws serve the machine, so they serve also the developed organism.

A boundary condition is always extraneous to the process which it delimits. In Galileo's experiments on balls rolling down a slope, the angle of the slope was not derived from the laws of mechanics, but was chosen by Galileo. And as this choice of slopes was extraneous to the laws of mechanics, so is the shape and manufacture of test tubes extraneous to the laws of chemistry.

The same thing holds for machinelike boundaries; their structure cannot be defined in terms of the laws which they harness. Nor can a vocabulary determine the content of a text, and so on. Therefore, if the structure of living things is a set of boundary conditions, this structure is extraneous to the laws of physics and chemistry which the organism is harnessing. Thus the morphology of living thing transcends the laws of physics and chemistry.

DNA Information Generates Mechanisms

But the analogy between machine components and live functioning organisms is weakened by the fact that the organs are not shaped artificially as the parts of a machine are. It is an advantage, therefore, to find that the morphogenetic process is explained in principle by the transmission of information stored in DNA, interpreted in this sense by Watson and Crick.

A DNA molecule is said to represent a code—that is, a linear sequence of items, the arrangement of which is the information conveyed by the code. In the case of DNA, each item of the series consists of one out of four alternative organic bases.[1] Such a code will convey the maximum amount of information if the four organic bases have equal probability of forming any particular item of the series. Any difference in the binding of the four alternative bases, whether at the same point of the series, or between two points of the series, will cause the information conveyed by the series to fall below the ideal maximum. The information content of DNA is in fact known to be reduced to some extent by redundancy, but I accept here the assumption of Watson and Crick that this redundancy does not prevent DNA from effectively functioning as a code. I accordingly disregard, for the sake of brevity, the redundancy in the DNA code and talk of it as if it were functioning optimally, with all of its alternative basic bindings having the same probability of occurence.

Let us be clear what would happen in the opposite case. Suppose that the actual structure of a DNA molecule were due to the fact that the bindings of its bases were much stronger than the bindings would be for any other distribution of bases, then such a DNA molecule would have no information content. Its codelike character would be effaced by an overwhelming redundancy.

We may note that such is actually the case for an ordinary chemical molecule. Since its orderly structure is due to a maximum of stability, corresponding to a minimum of potential energy, its orderliness lacks the capacity to function as a code. The pattern of atoms forming a crystal is another instance of complex order without appreciable information content.

There is a kind of stability which often opposes the stabilizing force of a potential energy. When a liquid evaporates, this can be understood as the increase of entropy accompanying the dispersion of its particles. One takes this dispersive tendency into account by adding its powers to those of potential energy, but the correction is negligible for cases of deep drops in potential energy or for low temperatures, or for both. We can disregard it, to simplify matters, and say that chemical structures established by the stabilizing powers of chemical bonding have no appreciable information content.

The morphology of living things transcends the laws of physics and chemistry.

In the light of the current theory of evolution, the codelike structure of DNA must be assumed to have come about by a sequence of chance variations established by natural selection. But this evolutionary aspect is irrelevant here; whatever may be the origin of a DNA configuration, it can function as a code only if its order is not due to the forces of potential energy. It must be as physically indeterminate as the sequence of words is on a printed page. As the arrangement of a printed page is extraneous to the chemistry of the printed page, so is the base sequence in a DNA molecule extraneous to the chemical forces at work in the DNA molecule. It is this physical indeterminacy of the sequence that produces the improbability of occurrence of any particular sequence and thereby enables it to have a meaning—a meaning that has a mathematically determinate information content equal to the numerical improbability of the arrangement.

DNA Acts as a Blueprint

But there remains a fundamental point to be considered. A printed page may be a mere jumble of words, and it has then no information content. So the improbability count gives the *possible,* rather than

the *actual,* information content of a page. And this applies also to the information content attributed to a DNA molecule; the sequence of the bases is deemed meaningful only because we assume with Watson and Crick that this arrangement generates the structure of the offspring by endowing it with its own information content.

This brings us at last to the point that I aimed at when I undertook to analyze the information content of DNA: Can the control of morphogenesis by DNA be likened to the designing and shaping of a machine by the engineer? We have seen that physiology interprets the organism as a complex network of mechanisms, and that an organism is—like a machine—a system under dual control. Its structure is that of a boundary condition harnessing the physical-chemical substances within the organism in the service of physiological functions. Thus, in generating an organism, DNA initiates and controls the growth of a mechanism that will work as a boundary condition within a system under dual control.

And I may add that DNA itself is such a system, since every system conveying information is under dual control, for every such system restricts and orders, in the service of conveying its information, extensive resources of particulars that would otherwise be left at random, and thereby acts as a boundary condition. In the case of DNA this boundary condition is a blueprint of the growing organism.[2]

We can conclude that in each embryonic cell there is present the duplicate of a DNA molecule having a linear arrangement of its bases—an arrangement which, being independent of the chemical forces within the DNA molecules, conveys a rich amount of meaningful information. And we see that when this information is shaping the growing embryo, it produces in it boundary conditions which, themselves being independent of the physical chemical forces in which they are rooted, control the mechanism of life in the developed organism.

To elucidate this transmission is a major task of biologists today, to which I shall return.

Some Accessory Problems Arise Here

We have seen boundary conditions introducing principles not capable of formulation in terms of physics or chemistry into inanimate artifacts and living things; we have seen them as necessary to an information content in a printed page or in DNA, and as introducing mechanical principles into machines as well as into the mechanisms of life.

Let me add now that boundary conditions of inanimate systems established by the history of the universe are found in the domains of geology, geography, and astronomy, but that these do not form systems of dual control. They resemble in this respect the test-tube type of boundaries of which I spoke above. Hence the existence of dual control in machines and living mechanisms represents a discontinuity between machines and living things on the one hand and inanimate nature on the other hand, so that both machines and living mechanisms are irreducible to the laws of physics and chemistry.

Irreducibility must not be identified with the mere fact that the joining of parts may produce features which are not observed in the separate parts. The sun is a sphere, and its parts are not spheres, nor does the law of gravitation speak of spheres; but mutual gravitational interaction causes the parts of the sun to form a sphere. Such cases of wholism are common in physics and chemistry. They are often said to represent a transition to living things, but this is not the case, for they are reducible to the laws of inanimate matter, while living things are not.

But there does exist a rather different continuity between life and inanimate nature. For the beginnings of life do not sharply differ from their purely physical-chemical antecedents. One can reconcile this continuity with the irreducibility of living things by recalling the analogous case of inanimate artifacts. Take the irreducibility of machines; no animal can produce a machine, but some animals can make primitive tools, and their use of these tools may be hardly distinguishable from the mere use of the animal's limbs. Or take

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DO LIFE PROCESSES TRANSCEND PHYSICS AND CHEMISTRY?

I. This is the title of one of the general symposia of the AAAS meeting on December 30, 1967, the transcript of which was published in *Zygon* 3, 442 (1968). Participants in the symposium were Gerald Holton, Chairman, Professor of Physics at Harvard University; Michael Polanyi, Professor of Physical Chemistry at Victoria University at Manchester, England, from 1933 to 1948, and then Professor of Social Sciences; Ernest Nagel, University Professor at Columbia University; John R. Platt, Research Biophysicist and Associate Director of the Mental Health Research Institute of the University of Michigan; and Barry Commoner, Chairman of the Department of Botany and Director of the Center for the Biology of Natural Systems at Washington University in St. Louis. This distinguished panel addressed itself to the question of the title. In view of the article by Dr. Polanyi published in this issue of the *Journal ASA*, we shall not repeat his perspective here, but will concentrate instead on the contributions of the other members of the panel.

Nagel argued principally that the question could not be decisively answered, maintaining that the impossibility of reducing biology to physics and chemistry was a position that could not be conclusively established. In order to answer the question posed in the title, it is necessary to know *what* theory of physics and chemistry is in mind as the basis of the explanation. Although it may not be possible to reduce biological phenomena to *presently known* theories of physics and chemistry, who is to say what the future might bring? The issue is an empirical one, not one to be solved by abstract philosophical cogitation.

Nagel also emphasized two other points of relevance. (1) The observation that terms exist in laws at a higher level that do not exist in laws at a lower

a set of sounds conveying information; the set of sounds can be so obscured by noise that its presence is no longer clearly identifiable. We can say, then, that the control exercised by the boundary conditions of a system can be reduced gradually to a vanishing point. The fact that the effect of a higher principle over a system under dual control can have any value down to zero may allow us also to conceive of the continuous emergence of irreducible principles within the origin of life.

We Can Now Recognize Additional Irreducible Principles

The irreducibility of machines and printed communications teaches us, also, that the control of a system by irreducible boundary conditions does not *interfere* with the laws of physics and chemistry. A system under dual control relies, in fact, for the operations of its higher principle, on the working of principles of a lower level, such as the laws of physics and chemistry. Irreducible higher principles are *additional* to the laws of physics and chemistry. The principles of mechanical engineering and of communication of information, and the equivalent biological principles, are all additional to the laws of physics and chemistry.

But to assign the rise of such additional controlling principles to a selective process of evolution leaves serious difficulties. The production of boundary conditions in the growing fetus by transmitting to it the information contained in DNA presents a problem. Growth of a blueprint into the complex machinery that it describes seems to require a system of causes not specifiable in terms of physics and chemistry, such causes being additional both to the boundary conditions of DNA and to the morphological structure brought about by DNA.

This missing principle which builds a bodily structure on the lines of an instruction given by DNA may be exemplified by the far-reaching regenerative powers of the embryonic sea urchin, discovered by Driesch, and by Paul Weiss's discovery that completely dispersed embryonic cells will grow, when lumped together, into a fragment of the organ from which they were isolated.[3] We see an integrative power at work here, characterized by Spemann and by Paul Weiss as a "field"[4], which guides the growth of embryonic fragments to form the morphological features to which they embryologically belong. These guides of morphogenesis are given a formal expression in Waddington's "epigenetic landscapes"[5]. They say graphically that the growth of the embryo is controlled by the gradient of potential shapes, much as the motion of a heavy body is controlled by the gradient of potential energy.

Consciousness is a principle that fundamentally transcends not only physics and chemistry but also the mechanistic principles of living things.

Remember how Driesch and his supporters fought for recognition that life transcends physics and chemistry, by arguing that the powers of regeneration in the sea urchin embryo were not explicable by a machinelike structure, and how the controversy has continued, along similar lines, between those who insisted that regulative ("equipotential" or "organismic") integration was irreducible to any machinelike mechanism and was therefore irreducible also to the laws of inanimate nature. Now if, as I claim, machines and mechanical processes in living beings are themselves irreducible to physics and chemistry, the situation is changed. If mechanistic and organismic explanations are both equally irreducible to physics and chemistry, the recognition of organismic processes no longer bears the burden of standing alone as evidence for the irreducibility of living things. Once the "field"-like powers guiding regeneration and morphogenesis can be recognized without involving this major issue, I think the evidence for them will be found to be convincing.

There is evidence of irreducible principles, additional to those of morphological mechanisms, in the sentience that we ourselves experience and that we observe indirectly in higher animals. Most biologists set aside these matters as unprofitable considerations. But again, once it is recognized, on other grounds,

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level cannot be used as conclusive evidence that the laws at a higher level cannot be explained by laws at a lower one. (2) Two questions must be kept separate: whether it is possible to give a physicochemical explanation of biological laws as they relate to biological organisms *at the present,* and whether it is possible to give a physicochemical explanation of the laws involved in the historical or evolutionary *development* of biological organisms. Nagel feels that it is quite possible that the answer is yes to the first of these questions, and no to the second.

Platt answered an emphatic, "Yes," to the question of the title. His reasons fall into three categories. (1) *Ordinary analysis from the "objective" point of view.* Emergent properties—"systems properties"—characterize biological systems with increasing size and complexity, and systems properties are not easily predictable from the properties of the subsystems. Can one predict the properties of gravity from atomic and nuclear physics? the properties of a traffic jam from those of individual cars? the significance of the sign, "Joe's Bar and Grill", from a knowledge of gas-discharges? the properties of 10^{14} synapses in the human brain from the properties of the approximately 10^3 properties of physics, the 10^7 questions treated by chemistry, or the 10^9 bits of information in the DNA chain in biology? (2) *Experimental and logical unpredictability.* There is one kind of practical indeterminacy that derives simply from the fantastic complexity of the human brain. There is a second kind of indeterminacy: the logical invalidity of self-prediction, i.e., scientific predictability in the realm of interpersonal human actions affects the nature of the action, as discussed by D. M. MacKay. (3) *The role of subjectivity.* The world is divided into two parts; yet these two parts are inseparable. There is the world of physics, the external half-world in which spoons are picked up and dropped again. There is also the world of cybernetics, the internal half-world in which the *choice* is made to pick up a spoon and to drop it. "The result is that the world of physics and chemistry is only half a world. It's the world 'out there.' It is

that life transcends physics and chemistry, there is no reason for suspending recognition of the obvious fact that consciousness is a principle that fundamentally transcends not only physics and chemistry but also the mechanistic principles of living beings.

Biological Hierarchies Consist of a Series of Boundary Conditions

The theory of boundary conditions recognizes the higher levels of life as forming a hierarchy, each level of which relies for its workings on the principles of the levels below it, even while it itself is irreducible to these lower principles. I shall illustrate the structure of such a hierarchy by showing the way five levels make up a spoken literary composition.

The lowest level is the production of a voice; the second, the utterance of words; the third, the joining of words to make sentences; the fourth, the working of sentences into a style; the fifth and highest, the composition of the text.

The principles of each level operate under the control of the next-higher level. The voice you produce is shaped into words by a vocabulary; a given vocabulary is shaped into sentences in accordance with a grammar; and the sentences are fitted into a style, which in turn is made to convey the ideas of the composition. Thus each level is subject to dual control: (i) control in accordance with the laws that apply to its elements in themselves, and (ii) control in accordance with the laws of the powers that control the comprehensive entity formed by these elements.

Such multiple control is made possible by the fact that the principles governing the isolated particulars of a lower level leave indeterminate conditions to be controlled by a higher principle. Voice production leaves largely open the combination of sounds into words, which is controlled by a vocabulary. Next, a vocabulary leaves largely open the combination of words to form sentences, which is controlled by grammar, and so on. Consequently, the operations of a higher level cannot be accounted for by the laws governing its particulars on the next-lower level. You cannot derive a vocabulary from phonetics; you cannot derive grammar from a vocabulary; a correct use of grammar does not account for good style; and a good style does not supply the content of a piece of prose.

Living beings comprise a whole sequence of levels forming such a hierarchy. Processes at the lower levels are caused by the forces of inanimate nature, and the higher levels control, throughout, the boundary conditions left open by the laws of inanimate nature. The lowest functions of life are those called vegetative. These vegetative functions, sustaining life at its lowest level, leave open—both in plants and in animals—the higher functions of growth and in animals also leave open the operations of muscular actions. Next, in turn, the principles governing muscular actions in animals leave open the integration of such actions to innate patterns of behavior; and, again, such patterns are open in their turn to be shaped by intelligence, while intelligence itself can be made to serve in man the still higher principles of a responsible choice.

Each level relies for its operations on all the levels below it. Each reduces the scope of the one immediately below it by imposing on it a boundary that harnesses it to the service of the next-higher level, and this control is transmitted stage by stage, down to the basic inanimate level.

The principles additional to the domain of inanimate nature are the product of an evolution the most primitive stages of which show only vegetative functions. This evolutionary progression is usually described as an increasing complexity and increasing capacity for keeping the state of the body independent of its surroundings. But if we accept, as I do, the view that living beings form a hierarchy in which each higher level represents a distinctive principle that harnesses the level below it (while being itself irreducible to its lower principles), then the evolutionary sequence gains a new and deeper significance. We can recognize then a strictly defined progression, rising from the inanimate level to ever higher additional principles of life.

This is not to say that the higher levels of life are altogether absent in earlier stages of evolution. They may be present in traces long before they become prominent. Evolution may be seen, then, as a progressive intensification of the higher principles of

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the world without values, without love, without death, without vomiting."

Commoner argued that the work of Kornberg, Lederberg and Crick establishes clearly on empirical grounds that life transcends chemistry. He restricted himself to a particular aspect of biology, namely the property of life that involves inheritance, self-duplication, replication. In the "central dogma", as set forth by Crick, it is proposed that DNA determines RNA, RNA determines protein, protein determines inheritance, *and the reverse processes are forbidden.* Commoner interprets recent experiments that show that when DNA is synthesized by a protein (DNA polymerase), the biochemical specificity of the polymerase influences the nucleotide sequence of the DNA, as contradicting the "central dogma" because it shows that the source of genetic specificity (protein) is derived partially from DNA, and that the specificity of DNA is partially derived from protein. Thus he argues that "it is now clear that the origin of genetic specificity in self-duplication is not monomolecular. It does not come from DNA; it comes from the interaction of an array of molecules." He argues further that the work of Nierenberg has shown that the code which translates the DNA nucleotide sequence into the amino acid sequence in proteins is not universal (empirically, seven out of twenty cases were not universal). Finally he argues that not even chemistry has been reduced to physics since it is not possible to use quantum mechanics to predict otherwise unknown molecular structures.

A final quote from Commoner may be appropriate to conclude this summary:

> *I think the trouble with molecular biology is that it's a brilliant attempt to reduce biology to old-fashioned and outmoded physics. Atomism works beautifully in a certain realm of physics—in atomic physics. . . . . It may well turn out that atomic physics is a special case in which atomism works and that in the rest of the universe we are confronted with a totally new problem.*

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life. This is what we witness in the development of the embryo and of the growing child—processes akin to evolution.

But this hierarchy of principles raises once more a serious difficulty. It seems impossible to imagine that the sequence of higher principles, transcending further at each stage the laws of inanimate nature, is incipiently present in DNA and ready to be transmitted by it to the offspring. The conception of a blueprint fails to account for the transmission of faculties, like consciousness, which no mechanical device can possess. It is as if the faculty of vision were to be made intelligible to a person born blind by a chapter on sense physiology. It appears, then, that DNA *evokes* the ontogenesis of higher levels, rather than *determining* these levels. And it would follow that the emergence of the kind of hierarchy I have defined here can be only evoked, and not determined, by atomic or molecular accidents. However, this question cannot be argued here.

Understanding a Hierarchy Needs "from-at" Conceptions

I said above that the transcendence of atomism by mechanism is reflected in the fact that the presence of a mechanism is not revealed by its physical-chemical topography. We can say the same thing of all higher levels: their description in terms of any lower level does not tell us of their presence. We can generally descend to the components of a lower level by analyzing a higher level, but the opposite process involves an integration of the principles of the lower level, and this integration may be beyond our powers.

In practice this difficulty may be avoided. To take a common example, suppose that we have repeated a particular word, closely attending to the sound we are making, until these sounds have lost their meaning for us; we can recover this meaning promptly by evoking the context in which the word is commonly used. Consecutive acts of analyzing and integrating are in fact generally used for deepening our understanding of complex entities comprising two or more levels.

Yet the strictly logical difference between two consecutive levels remains. You can look at a text in a language you do not understand and see the letters that form it without being aware of their meaning, but you cannot read a text without seeing the letters that convey its meaning. This shows us two different and mutually exclusive ways of being aware of the text. When we look at words without understanding them we are focusing our attention on them, whereas, when we read the words, our attention is directed to their meaning as part of a language. We are aware then of the words only subsidiarily, as we attend to their meaning. So in the first case we are looking at the words, while in the second we are looking *from* them *at their meaning*: the reader of a text has a *from-at* knowledge of the words' meaning, while he has only a *from* awareness of the words he is reading. Should he be able to shift his attention fully toward the words, these would lose their linguistic meaning for him.

Thus a boundary condition which harnesses the principles of a lower level in the service of a new, higher level establishes a semantic relation between the two levels. The higher comprehends the workings of the lower and thus forms the meaning of the lower.

II. William Paley, the eighteenth-century Christian apologist, pictured God as making the universe like a watch which He wound up, left to tick, and occasionally repaired. For those modern Christians who are ashamed of Paley, it will come as a shock that a kind of teleological argument from mechanical design is seriously being reintroduced by the distinguished non-Christian scientist and pilosopher, Dr. Michael Polanyi. This is all the more interesting because, instead of God being the designer, the design is attributed to an evolutionary process which is not personified, and which cannot be described in the scientific language of physics and chemistry.

Considering the universe for a moment as a machine, let us look at Polanyi's argument. Almost all scientists today believe, of course, that, in the words of Polanyi, "so far as life can be represented as a mechanism, it is explained by the laws of inanimate nature". Dr. Polanyi's position is antithetical, and this is his revolution: "I differ . . . most from biologists, by holding that no mechanism—be it a machine or a machine-like feature of an organism—can be represented in terms of physics and chemistry." Even more strongly than this, he expresses incredulity that

> for 300 years writers who contested the possibility of explaining life by physics and chemistry argued by affirming that living things are *not*, or not wholly, machinelike, instead of pointing out that the mere existence of machinelike functions in living beings proves that life cannot be explained in terms of physics and chemistry.

The reasons he gives for his hypothesis fall into three major points.

1. His first reason is that *machines are not reducible to a description in terms of physico-chemical laws*. This is because they are defined by the distinctive functions which the mind of man has imposed upon them; machines are shaped and designed for a special purpose. A 'washing-machine' is defined by its function of 'washing clothes', and the clothes-washing function is what moulds it to its typical recognizable shape.

An illustration reminiscent of Paley that Polanyi gives in several essay-articles is the watch: a physical and chemical molecular topography of his watch would not give enough information to tell you 'what' it is. In contrast, a child's description—the thingamajig you have on your wrist to tell the time with—gives this information. There is a related problem when more obvious means of conveying information are considered. A physical chemical topography of the page you are reading at this moment would say nothing of its word content, or the total meaning of those words.

2. It will prove easier to understand his second point if it is realized that *all machines as a whole make up a boundary condition* (a term borrowed from physics). What Dr. Polanyi calls a 'boundary condition' may be taken to mean any form which is distinct in quality from all other forms, and which can have a diversity of possible contents. The sonnet-form in poetry would be such a 'boundary condition'; so would the medieval Christian and early modern scientific concept of the universe, and so would be such a thing

And as we ascend a hierarchy of boundaries, we reach to ever higher levels of meaning. Our understanding of the whole hierarchic edifice keeps deepening as we move upward from stage to stage.

The Sequence of Boundaries Bears on Our Scientific Outlook

The recognition of a whole sequence of irreducible principles transforms the logical steps for understanding the universe of living beings. The idea, which comes to us from Galileo and Gassendi, that all manner of things must ultimately be understood in terms of matter in motion is refuted. The spectacle of physical matter forming the basic tangible ground of the universe is found to be almost empty of meaning. The universal topography of atomic particles (with their velocities and forces) which, according to Laplace, offers us a universal knowledge of all things, is seen to contain hardly any knowledge that is of interest. The claims made, following the discovery of DNA, to the effect that all study of life could be reduced eventually to molecular biology, have shown once more that the Laplacean idea of universal knowledge is still the theoretical ideal of the natural sciences; current opposition to these declarations has often seemed to confirm this ideal, by defending the study of the whole organism as being only a temporary approach. But now the analysis of the hierarchy of living things shows that to reduce this hierarchy to ultimate particulars is to wipe out our very sight of it. Such analysis proves this ideal to be both false and destructive.

Though rooted in the body, the mind is free in its actions—exactly as our common sense knows it to be free.

Each separate level of existence is of course interesting in itself and can be studied in itself. Phenomenology has taught this, by showing how to save higher, less tangible levels of experience by not trying to interpret them in terms of the more tangible things in which their existence is rooted. This method was intended to prevent the reduction of man's mental existence to mechanical structures. The results of the method were abundant and are still flowing, but phenomenology left the ideal of exact science untouched and thus failed to secure the exclusion of its claims. Thus, phenomenological studies remained suspended over an abyss of reductionism. Moreover, the relation of the higher principles to the workings of the lowest levels in which they are rooted was lost from sight altogether.

I have mentioned how a hierarchy controlled by a series of boundary principles should be studied. When examining any higher level, we must remain subsidiarily aware of its grounds in lower levels and, turning our attention to the latter, we must continue to see them as bearing on the levels above them. Such alternation of detailing and integrating admittedly leaves open many dangers. Detailing may lead to pedantic excesses, while too-broad integrations may present us with a meandering impressionism. But the principle of stratified relations does offer at least a rational framework for an inquiry into living things

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as speech. (The latter is one of Polanyi's own examples.) But the 'boundary condition' also necessarily includes the function defining a machine which we discussed in the first point. Thus we may say—even though the more important constituent of the two is not made explicit—that it is the structure or form of the machine, with its function, which makes up its boundary condition.

In all machines, the boundary conditions exert a *control* or organization over the materials which compose them, even though the material nevertheless works autonomously according to physico-chemical laws. Polanyi concludes therefore that any mechanism is clearly under a hierarchical *dual* control. The 'upper level' is under the control of a particular boundary condition—constituted by the distinctive machine-structure plus its related function—which harnesses the baser 'lower level' controlled according to physical and chemical laws. If, for example, a car is smashed into a cube in a junk-yard, the 'lower level' laws of physics and chemistry continue to work just as inexorably in the cube as they did in the car when it was speeding down the freeway.

By this principle of boundary condition, Polanyi says that it follows that *machine-like* structures of living beings appear likewise to be irreducible to terms of physics and chemistry. A biological organism has the two aspects of a boundary condition: its organs are defined by their vital functions (for example, the *digestive* function of the stomach), and its total shape or 'morphology', with the shapes of its parts, enable it to be recognized; both aspects together tell 'what' it is. The former aspect partially parallels the function of a machine. The more important formal or morphological aspect of the biological organism parallels the structure of the machine. Without these irreducible plant and animal morphologies or forms, of course, biological science would not exist. It categorizes the observed in plants and animals. On the impossibility of biology ever being a molecular science, Polanyi says,

> Even supposing we did produce a mathematical expression for the shape of one living specimen, including all its anatomy at one particular moment, the formula would not cover its changes due to growth and decline and it would of course fail even more widely to cover the variety of specimens belonging to one species.

Not only is a comprehensive species a boundary condition, but also the unity of identity of a growing plant or animal from seed to adult.

3. The third step in Polanyi's argument is this: *the code or 'template'*—as Prof. J. D. Bernal calls it—*on the helix or coil of the DNA molecule is similarly not describable in terms of physics and chemistry.* James Watson and Sir Francis Crick, and the majority of biologists, believe that DNA templates determine the growth and morphologies (forms) of all the animate world, making life "one biochemically interconnected unity every element of which, down to the smallest virus, operates its synthesis by this . . . molecular mechanism" of DNA (Bernal, *Science in History,* p. 198). This seems to prove the contrary to Polanyi's view; it seems to make 'life' determinable by the inanimate laws of physics and chemistry.

and the products of human thought.

I have said that the analytic descent from higher levels to their subsidiaries is usually feasible to some degree, while the integration of items of a lower level so as to predict their possible meaning in a higher context may be beyond the range of our integrative powers. I may add now that the same things may be seen to have a joint meaning when viewed from one point, but to lack this connection when seen from another point. From an airplane we can see the traces of prehistoric sites which, over the centuries, have been unnoticed by people walking over them; indeed, once he has landed, the pilot himself may no longer see these traces.

The relation of mind to body has a similar structure. The mind-body problem arises from the disparity between the experience of a person observing an external object—for example, a cat—and a neurophysiologist observing the bodily mechanism by means of which the person sees the cat. The difference arises from the fact that the person observing the cat has a *from*-knowledge of the bodily responses evoked by the light in his sensory organs, and this *from*-knowledge integrates the joint meaning of these responses to form the sight of the cat, whereas the neurophysiologist, looking at these responses from outside, has only an *at*-knowledge of them, which, as such, is not integrated to form the sight of the cat. This is the same duality that exists between the airman and the pedestrian in interpreting the same traces, and the same that exists between a person who, when reading a written sentence, sees its meaning and another person who, being ignorant of the language, sees only the writing.

Mechanisms, whether man-made or morphological, are boundary conditions harnessing the laws of inanimate nature, being themselves irreducible to those laws.

Awareness of mind and body confront us, therefore, with two different things. The mind harnesses neurophysiological mechanisms and is not determined by them. Owing to the existence of two kinds of awareness—the focal and the subsidiary—we can now distinguish sharply between the mind as a "from-at" experience and the subsidiaries of this experience, seen focally as a bodily mechanism. We can see then that, though rooted in the body, the mind is free in its actions—exactly as our common sense knows it to be free.

The mind itself includes an ascending sequence of principles. Its appetitive and intellectual workings

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But, argues Polanyi, DNA is in itself a boundary condition, and as such cannot be reduced to physico-chemical laws. In the first place, the DNA is defined by its *genetic* function, the biological equivalent to a machine's reason for being constructed. In the second place, and more important, it bears a quantity of information that "determines the genetic development of an organism". This is because, by self-duplication, the information-content of the DNA mechanism induces in posterity "an equivalent amount of organic differentation". In short, it in reality *determines the plan or animal morphology,* or structure.

This 'shaping' aspect of DNA has two implications: (i) as an information-conveyor, the DNA code, like a page of print, defies reduction to physics and chemistry; (ii) as DNA bears a pattern or blue-print 'informed' with the *shape* of the potential new organism, the pattern must be regarded as just as much a morphological (or structural) feature of that organism as that shape is. As a morphological feature of an organism, the DNA pattern cannot therefore be reduced to physico-chemical laws. This means simply that DNA in its vital function of shaping life fulfills the requisites of a boundary condition, and as such controls or organizes from a 'higher level' the various chemicals which materially make up the DNA coil; constituents which, as the 'lower level', also work autonomously according to the laws of physics and chemistry. This 'upper level' boundary condition says Poanyi "brings the vital shaping of offspring by DNA into consonance with the shaping of a machine by the engineer".

Cosmic Implications

Moving from the micro level to the cosmic, Polanyi does not regard the universe to be under a boundary condition in its totality. He believes it to be essentially disorganized; that is, in a probable state according to the Second Law of Thermodynamics. This does not relieve him of the designer-difficulty, however. His belief that the *animate* portion of nature and man-made machines are controlled by boundary conditions, leaves open the question of morphogenesis (the emergence of form from chaos) and the beginnings of consciousness just as urgently as if the universe is regarded as a mechanism. More naively, the question could be formulated, 'Who or what is the designer of the mechanisms of animate nature?'

It is significant that Dr. Polanyi feels the current theories of evolution to be quite inadequate to these problems. This is because, in describing biological organisms, the biologist *assumes* their shapes (morphologies; boundary conditions) to be valid scientific data. Yet the biologist then attributes morphogenesis and the arrival of consciousness to natural selection. Polanyi, in terms too technical to repeat here, argues clearly that such a probable or *predictable* selection as natural selection in such an arrangement as the four mobile chemical substituents on the DNA coil would allow no information-content, content which obviously must be there if DNA carries the blueprints for all living organisms. Information requires an improbable or unpredictable organization by an imposed boundary condition. A partial but good analogy is the way word-symbols have been arranged in this article by my mind. The words are not in an alphabetical sequence, or in any other orderly predictable sequences based on such factors as the numbers of letters or syllables (*e.g.*, ones before twos, twos before threes, *etc.*). Rather they serve me in my communication-attempt, and are selected and organized from my vocabulary with this function in view, although of course some modifications of style and grammar have taken place.

At this exciting point in his theory, Dr. Polanyi

are transcended by principles of responsibility. Thus the growth of man to his highest levels is seen to take place along a sequence of rising principles. And we see this evolutionary hierarchy built as a sequence of boundaries, each opening the way to higher achievements by harnessing the strata below them, to which they themselves are not reducible. These boundaries control a rising series of relations which we can understand only by being aware of their constituent parts subsidiarily, as bearing on the upper level which they serve.

The recognition of certain basic impossibilities has laid the foundations of some major principles of physics and chemistry; similarly, recognition of the impossibility of understanding living things in terms of physics and chemistry, far from setting limits to our understanding of life, will guide it in the right direction. And even if the demonstration of this impossibility should prove of no great advantage in the pursuit of discovery, such a demonstration would help to draw a truer image of life and man than that given us by the present basic concepts of biology.

Summary

Mechanisms, whether man-made or morphological, are boundary conditions harnessing the laws of inanimate nature, being themselves irreducible to those laws. The pattern of organic bases in DNA which functions as a genetic code is a boundary condition irreducible to physics and chemistry. Further controlling principles of life may be represented as a hierarchy of boundary conditions extending, in the case of man, to consciousness and responsibility.

REFERENCES AND NOTES

[1]More precisely, each item consists of one out of four alternatives consisting in two positions of two different compound organic bases.

[2]The blueprint carried by the DNA molecule of a particular zygote also prescribes individual features of this organism, which contribute to the sources of selective evolution, but I shall set these features aside here.

[3]See P. Weiss, *Proc. Nat. Acad. Sci. U.S.* 42, 819 (1956).

[4]The "field" concept was first used by Spemann (1921) in describing the organizer; Paul Weiss (1923) introduced it for the study of regeneration and extended it (1926) to include ontogeny. See P. Weiss, *Principles of Development* (Holt, New York, 1939), p. 290.

[5]See, for example, C. H. Waddington, *The Strategy of the Genes* (Allen & Unwin, London, 1957), particularly the graphic explanation of "genetic assimilation" on page 167.

[6]See, for example, M. Polanyi, *Amer. Psychologist* 23 (Jan. 1968) or ——, *The Tacit Dimension* (Doubleday, New York, 1967).

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makes a profound optimistic jump in his reasoning. Mechanical control in animate nature, he points out, is not determinable from the 'lower level' of physico-chemical laws. Furthermore, there is a hierarchy of mechanisms with man at the top. Man alone has sufficient consciousness to impose boundary conditions without a prewritten blueprint such as DNA; man alone can make blueprints. If biological structures are irreducible to physico-chemical laws, and likewise such things as man-made machines and communication symbol-systems, then why cannot man's consciousness be accepted as irreducible? Such an irreducibility frees a man from the shackles of believing himself to be a machine whose blueprint is completely prewritten, a belief strongly adhered to by Sir Francis Crick or Gilbert Ryle, for example.

Dr. Polanyi's optimism concerning the reality of consciousness is a logical jump because he at present has no basis for it:

> We need a theory of knowledge which shows up the fallacy of a positivistic scepticism and authorises our knowledge of entities governed by higher principles (boundary conditions). Any higher principle can be known only by dwelling in the particulars governed by it. Any attempt to observe a higher level of existence by a scrutiny of its several particulars must fail.

To 'authorise' the higher levels we observe in animate nature, and sense in our own consciousness, a designer is necessary, a designer who has some man-like qualities (*e.g.*, the ability to create blueprints for mechanisms). This designer must also be big enough, at least, to control and organize the vastness of the apparent hierarchy of animate nature. Against bigness such as this, the nations are as a drop in a bucket.

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Colin Duriez

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Faith in the so-called immortality of the soul is no faith at all. It is rather a highly questionable assumption, which can be made even by a complete heathen and worldling. One can make it without caring two pins for God. One can still make it, even if one considers the resurrection of the Lord a highly superfluous spectacle of pious fantasy. . . . There is no such thing as immortality; God gives immortality.

Helmut Thielicke
How the World Began, Fortress Press, Philadelphia, Pa. (1961), pp. 248, 249

Materialism and Modern Man

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Is man just interacting chemicals? If a scientist says he is, he says it because of his belief that only what science can see, feel, hear, and analyze is real. Douglas Spanner said that a scientist cannot know that he has the single source of a knowledge of reality: if he believes this, his source of belief is not from his scientific methods, and so contradicts itself.[1] Science cannot know that science knows everything.

David Dye

In commenting on the nature of physical reality, David L. Dye in his book, *Faith and the Physical World*[2], writes, "atheism, or any religious view, is not scientific, nor necessarily antiscientific, but rather *ascientific*". He emphasizes that "the strongest claim that science may make is that its descriptions account for all known data consistently."[3] It cannot comment on whether a soul exists because a soul is not observable by scientific apparatus. "If we deny real existence of nonobservables, that is, if we assume naturalism or atheism, we can have no implicit assurance that logic is applicable to reality."[4] Logic is based on the assumption that there is uniformity and consistency in human minds and the world they observe. So he insists that any particular view of reality is based on one's preference in interpreting data. "What happens in practice is that we select the data or interpretation of data that best fits the meaning we want reality to have. Then some of us have the temerity to assert that one or another world view is 'scientific' or 'proved'. It is clearly seen that such an argument is circular. One's view may be modified, developed, or rationalized, but insofar as it is not physical but metaphysical it is based on unprovable (although possibly consistent) presuppositions."[5]

Everyone realizes how well science has explained the observable world. From distant stars to some of the intricacies of mental activity, experimental methods have revealed the processes involved in many phenomena. We can explain where the impulse starts which can be detected traveling over particular pathways to definite muscle fibers. The chemistry of contraction of muscle fibers is fairly well known. Feelings can be initiated by drugs. John Brobeck, Professor of Physiology at the University of Pensylvania, stated, "These range all the way from what might be called super-reactivity, through more conventional states regarded as normal, and on through sedation to deep stupor, with elation, well-being, indifference, dependence, and depression or independence, defiance or aggression to be had almost for the asking."[6] Undoubtedly the many expressions of the mind are materially based. Yet it is difficult to imagine that unselfish love, worship, and delight in beauty result from unguided combinations of complicated chemicals.

There is another urge that is characteristic of mankind, man's need for extra-scientific meaning, as phrased by Dye.[7] He notes that Augustine mentioned this need in his often quoted classic "we are restless until we find our rest in God." And recently Paul Tillich has "described the tendency of the scientific age to substitute means for ends, to reduce man's status from subject to object." Science has explained the observable world but has not given us guiding moral principles by which we can use the means it gives us for controlling nature for the benefit of mankind. These principles must be derived from the conscience of modern man as it is influenced by the Biblical imperative of love used in wisdom and justice.

It has seemed to me unreasonable that man, with his imagination and ability to state abstract ideas about his past and future, should spend his mental energy in trying to show that he is just a mass of interacting chemicals.

Michael Polanyi

"Life transcends physics and chemistry" is the thesis of Michael Polanyi who has distinguished himself in both physical and social sciences. Two of his recent writings[8] give the basis of his belief which is summarized in the following paragraphs.

Instead of using the argument that there are some aspects of living organisms that are not machine-like and therefore are unexplainable by scientific laws, Polanyi argues that the more machine-like a living being is found to be, the more it needs to be explained by the controls that were exerted upon it during its formation. "The essence of a machine is to serve a purpose acknowledged by its designer." Much as a dean influences a department chairman who passes on suggestions to his faculty, so living things work on the principles of hierarchies. For example, responsible choice controls intelligence which produces patterns of behavior influencing patterns carried out by muscular actions, whose function depends on the vegetative activities of respiration and circulation. "The material of the machine is subject

to the laws of physics and chemistry, while the shape and consequent working of the machine are controlled by its structural and operational principles." Machines are made by men, but chemicals could exist even if men were eliminated. This would also be true of DNA which has a molecular pattern of four bases (A,T,G,C, the initials of complex chemicals) arranged in pairs in a long series. This series varies throughout its length and the variations determine what protein will be produced to influence development in an embryo or the heredity of a succeeding generation. The nature of DNA is not determined by the necessary activity of physical and chemical processes but DNA passes on information as a machine designed by engineering principles. Life controls DNA, not DNA controls life. "DNA *evokes* the ontogenesis of higher levels; rather than determining those levels." Just as a machine was designed, so DNA had to be produced by controlling principles.

A description of a watch in physical and chemical terms, says Polanyi, would not tell you what a watch is. The term "watch" has to be understood in terms of its structure of having hands whose purpose is to "tell" time. Of course, you and I tell time, not the watch, but by knowing what a watch is for, we can let its physical parts be interpreted into a sensible thought of the hour and minute of the day. "A physical-chemical topography of my watch might make it possible, at least in principle, to indentify this particular watch as an object. But it would fail to identify it as a watch, for it is incapable of defining a *class* of watches, as needed for assigning the watch to that class."

Some neurophysiologists would explain the ability of the mind to memorize as the result of events being recorded in the RNA molecule. This may be true: the RNA is a chemical akin to DNA and it is affected by conditions outside itself. It is like the tape in a tape recorder which depends on the "pattern of the impacts in which the message was embodied." Polanyi calls the determiners of processes and structures the "boundary controls" and these transcend physics and chemistry by being *profoundly informative interventions*. The structure "serves as a boundary condition harnessing the physical-chemical processes by which its organs perform their functions."

In dealing with the relation of mind to body his conclusion is "the mind harnesses neurophysiological mechanisms and is not determined by them." He sees a parallel with the hierarchies of the body in that the mind also has principles of responsibility transcending its appetitive and intellectual workings and as one recognizes this he can live on the highest level.

Frank T. Rhodes

A thorough analysis of the relationship of materialism to spiritual realities is found in the symposium edited by D. M. MacKay titled *Christianity in a Mechanistic Universe*.[9] The summary of his work that follows will enable you to evaluate the nature of man effectively.

Frank H. T. Rhodes discusses the subject as follows. Some observers felt that the mechanistic interpretation of nature either weakened the traditional basis of Christian belief or made the Christian faith either untenable or superfluous. By scientific methods, using observation and experiment, the new age dispensed with tradition and authority. "With the growth of the scientific method there developed, however, the inevitable and necessary attempt to interpret nature as a single, integrated and therefore, within these limits, self-explanatory and self-sufficient system."

Science arose in Western Europe in its Christian civilization which insisted on the rationality of God, as A. N. Whitehead has commented. Science therefore depends on Christian theology as seen in the presuppositions of modern science, which are "belief in an orderly, regular, rational universe, a belief that this orderliness is intelligable to the modern sicentist, a belief in the reliability of human reason, and a belief in a broad principle of causality." These assumptions were made by the pioneers in science because of their belief in a "personal, rational, and dependable God."

To be sure science also had its effect upon Christianity. As illustrations, Rhodes mentions the belief in "the value of social, medical and material progress, and its concepts of the nature and apprehension of truth."

Actually the reason the popular mind associated modern science with atheism or agnosticism was that science was popularized and 'explained' by non-theistic writers such as Fontenelle and his descendants. The scientists themselves in many cases were devout Protestants and Catholics. The mechanistic view is popular because most of the questions we ask are the ones that "are asked in and demand answers in mechanistic and often quantitative terms."

A scientist has made progress by "conscious elimination from scientific argument of questions of final cause and purpose." He selects the aspects of reality he wishes to investigate but he "is never in the position to claim that those which he consciously selects are the only ones which exist or that they are ultimately more relevant or important or real than the rest. He repeats Douglas Spanner's idea by writing, "Science by its conscious abstraction, can never claim to be the only method of apprehending reality." Science only exists because there are people. We should not limit the fields science investigates for it can predict other observations and events besides those already observed. Even though mechanism is found everywhere, "it is everywhere the servant of purpose. The two conceptions are not alternative but complementary" as Prof. John Baillie has written. God is not to be used to fill the gaps in our knowledge. Rather nature in all its variety testifies to the activity and nature of its Creator.

Rhodes continues by treating the limitations of science. One is that it is inadequate to treat the whole range of phenomena. To describe light, science has to use the complementary views that light sometimes acts like corpuscles and at other times like waves. "Both are necessary to do justice to our present experience of light." So matter and mind debates would bring out the need to look at reality as both matter and mind which become complementary principles. I like especially his illustration, "If, for me, the love between man and woman or parent and child is adequately and fully described only in terms of physiological and psychological mechanisms, then, as any lover or parent knows, I have never experienced that love, only observed it. I have never participated in it, only recorded it."

The conclusion of this first essay is that just as we cannot know our next door neighbor by mere observation and analysis but must "participate in the encounter as a person" so to know God one must "participate as a person in whatever encounters there may be with Him."

Donald M. MacKay

The second essay is by Donald M. MacKay, the editor, on *Man as a Mechanism*. He mentions that "there is a continual two-way connection between what we can say about people's subjective experience (of sights, sounds, itches, pains) and what we can say about electro-chemical activity in their brains." So man is a mental-bodily unity. It is misleading and dangerous to discuss the relation between mental activity and the corresponding brain activity as one of cause and effect. "It is a relation of necessity, but not a relation of scientific causality." "We have in human nature a 'unity' which demands, to do justice to it, at least two levels of discussion: the level of the mechanical, appropriate for the outside observer, and the level of the personal, appropriate from the inside standpoint of the agent himself." He sees the biblical view as a spiritual life 'embodied' in man's psychological mechanism.

David J. E. Ingram

Plan and Purpose in the Universe is treated by David J. E. Ingram. They are not contradictory but part of a greater whole. At present we cannot show the link between gravitation and electro-magnetic energy and matter, but scientists are active in trying to find this relationship which they feel must exist. So a relationship will eventually be found between plan and purpose, even though a scientist cannot prove that "a pattern necessarily involves a purpose." The author stresses that the best way God could reveal his plan is for "Mind to become man" as He has done through His entering man's society in the person of His Son. He writes, "To my mind, the complete and over-all plan and purpose which Christianity gives us is far more intellectually satisfying, far more all-embracing and coherent than any alternative view." "But if we ourselves are to have any part in that pattern, ... we require not only the example of His life but the power that comes from His death and resurrection to enter into it ourselves."

Robert L. F. Boyd

The final discussion is on *Reason, Revelation and Faith*. Robert L. F. Boyd says that any guiding light for behavior must come either from our own reasoning or be given to us by revelation. Since man alone among the animals "can take an active, intelligent and purposive part in moulding his own future" he should do it. If men reject revelation, it is because "either their God is too small (to quote J. B. Phillips) or their cosmos is too small." To my mind, Boyd shows how big God is, and relates Him to the mechanistic world very effectively when he says, "He is the eternal, unconditional cause of all, of all its being and of all its history, of all the complex pattern of its causal relationship and of all its events. Its existence is always and momentarily contingent on His willing and that same will is continually fulfilled by its operations." Miracles then become, not a violation of nature, but "still God's activity and in no sense irregular from the divine point of view."

I conclude this review of these concepts by four men of science, a geologist, a professor of communication and two physicists by this quotation from Professor Boyd which clearly states an attitude needed by all scientists. "In this age of science we require in our search for truth an empirical openness to all the data that may be relevant. In approaching matters of faith, therefore, we must not reject the evidence of historical events."

The Christian admits that his belief in a mind, or soul, or spirit, is based on his belief in the reliability of the revelation in Scripture. Here is the crucial issue: is the Bible true? Once that faith has been established the reader can confidently search the Scriptures for answers that science cannot give because scientific research is confined to the material aspects of the universe.

Obviously there is the problem of how mind, a non-physical entity, can exert its control on matter. What originates the thought that causes one to want to raise his arm? Each of us is conscious of a self, a being, a person within but beyond his brain and his muscles that somehow initiates brain functions which cause muscles to work. This personal hunch is corroborated by the many Scripture references to a distinction between body and soul.

God is not to be used to fill the gaps in our knowledge. Rather nature in all its variety testifies to the activity and nature of its Creator.

Robert E. D. Clark

In his provocative book, *The Christian Stake in Science*[10], Robert E. D. Clark speculates on the seat of the soul. Perhaps the view of Eccles "according to which the mind lives in the dominant hemisphere —that is, in the cortex of the left side for a right-handed person" is a likely view. He also thinks that possibly the ether of space is the meeting point between God, the Spirit, and the matter with which we are acquainted. Somehow pure spirit has to influence obvious matter. Although Eccles is merely making a hypothesis here, we can be assured that the non-material does have its way of influencing the material. Dr. William Wallace in his lecture to the philosophy of science conference at American University in the summer of 1966 said, "The scientific climate now permits scientists to allow for the immaterial, even the spiritual. No responsible author maintains there is now a conflict between science and religion, although there are tensions."

On the positive side recall that much of life is explained on a spiritual basis. Every man has a sense of what is right. If not for himself, at least for what is not right for the other fellow to do to him. Our communication with a higher spiritual power, with God Himself, is the result of our own spirit recognizing Him and having feelings about Him. How could mere material substance imagine anything which is non-material?

J. Bronowski

It has seemed to me unreasonable that man, with his imagination and ability to state abstract ideas about his past and future, should spend his mental energy in trying to show that he is just a mass of interacting chemicals. Therefore I find it refreshing to read the review *On The Uniqueness of Man* in *Science*[11] where J. Bronowski of Salk Institute stresses some of our unique features. This review is of the work of the noted paleontologist, George Gaylord Simpson, who is not noted for his appreciation of teleology. But the review quotes this significant statement of Simpson's. "Looking at man as a biological species, some biologists, professional and amateur, have become so preoccupied with the fact that man is an animal that they have neglected the fact that he is an absolutely unique animal." I think his uniqueness is the result of God-given attributes.

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THREE PERSPECTIVES ON MEN AND MACHINES

I. In their attempts to understand issues and find solutions to complex problems, scientists often form pictures or models of what they perceive to be reality. According to Bube, the formation of models

> . . . is the theoretical side of the scientific process. In order to form these models of reality, the . . . (scientist) attempts to simplify the actual problem, singling out the really important elements of the problem and neglecting minor effects. He almost immediately deserts physical reality for a model of his own making that he can profitably use in thinking about the problem. Without the use of simplifying assumptions to reduce the number of variables that enter the problem, the scientist would be generally unable to solve it. . . . Success in dealing with nature consists only in the ability to construct a satisfactory model (1968, pp. 23, 38-9).

The scientific study of man, like the study of physics and chemistry, has postulated a number of different models. Freudians and the researchers in animal psychology have used biological models. Gestalt psychology was built on a model from physics. Estes and other contemporary learning theorists have utilized mathematical models. Some have conceptualized human behavior in terms of neurophysiology, communication systems, and economic models.

More recently, behavioral scientists have been using a computer model. According to this conception, man is viewed as a complex electronic machine which receives "input" data; codes, categorizes, stores, manipulates, and retrieves information; and responds with behavioral "output" (see Miller, et. al., 1960). Unlike earlier models, this newer approach to behavior permits us to test our theories by programming them into a computer. If the computer "behaves" like a person, then we can assume that our model is an accurate picture of reality. If the computer's "behavior" does not approximate human responses, we assume that our theoretical model needs correcting. (Mehrabian, 1968).

The use of models as pictures of reality and guides to scientific inquiry, has contributed significantly to man's ability for understanding, predicting, and controlling behavior. There is always the danger, however, that a model will be taken too seriously and that we will begin to think that people really are the same as the models. In many respects, man is *like* a machine, and in some computer simulations machines are very much like men. From this it does not follow, however, that man *is* a machine. To say, as does the question in this symposium, that "man is only a complex machine" is to make the error of confusing the model with reality.

In a recent paper entitled "The machine that is man," Harvard psychologist B. F. Skinner quotes from a paper by D. M. MacKay.

> If I say that an electric advertising sign is . . . (only) a certain array of lamps and wires, I may mean one of two things: 1) I may mean that an electrician could make a complete catalogue of all that is there, and have nothing left over, without mentioning 'the advertisement.' This is true. 2) Or I may mean that since there is nothing left over from the electrician's account, there isn't really an advertisement there at all. This is the error of reductionism. It consists in confusing *exhaustiveness* with *exclusiveness.* The electrician's account is *exhaustive*, at least in the sense that a perfect replica could be constructed from it. But the electrician's account and the advertiser's account of 'all that is there' are not mutually *exclusive.* The advertisement is not something to be fitted into a gap in the electrician's account. It is something that we find when we start all over again to describe what is there in another complementary language (1969, p. 62).

The complete description of the sign does not reveal "all that is there." According to Skinner, "an 'advertisement' is not a physical property of a sign, and no physical analysis will permit us to predict its effect upon those who see it. Yet it is this effect that

makes it an advertisement' (1969, p. 62).

Even if all of man's behavior could be simulated by a machine (and this is very unlikely), this would not be an exclusive account of "all that is there." There would still be something missing. Human feelings, aesthetic appreciations, moral standards, awareness, beliefs, attitudes, satisfactions, aspirations, meanings, and faith, to name a few, could never be built into a machine. A model, be it a machine or something else, can only be an incomplete picture of the complex man that was created by God, after His own image.

Several months ago, an entire issue of *Psychology Today* was devoted to the topic "Man and Machine." The authors of the various articles did not seem to be much interested in the question of man's nature and whether or not he is "only a machine." Instead, they were concerned lest the machines which men have created, which have served us so effectively, and which have been used as models of behavior, become too complex and so powerful that they take over. "All we will require is a computer, however simple, to form another more complex than itself, however slightly. That will be the chain reaction that will produce the computer explosion" (Asimov, 1969, p. 39) in which the creator (man) is in danger of being destroyed by the creation (machines.) Such a possibility is too real to be relegated to the status of science fiction.

According to the Bible, man was created not as a machine, but as a creature "in the likeness of God" (Genesis 5:1). Man was given pre-eminence over other creatures. He was instructed to subdue the earth and to have dominion over divine creation (Genesis 1:28; Psalm 8:6). We must now make practical efforts to insure that the creation does not get dominion over us.

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II. Serenity seems to be becoming an increasingly rare commodity these days. Where are the solid, placid folks so common in the "good old days"? Is it just an illusion that most people seem harried, impatient, frustrated and, at times, bitter? Where will it all end, in Bertrand Russell's pit of despair?

So fearful are many that they seek solace and answers in Indian mystics, in astrologers and, not a few, in various religious movements.

We are writing here, for reasons of space, on only one aspect of twentieth-century uncertainty. We refer to the conflict between mechanism and vitalism. Well might you ask why this dispute is worrisome when we might better write about the evilness of war or the decay of law, order and justice? Mechanism implies that the universe operates strictly by natural laws, that it came into existence by the operation of these same laws and that there is no such thing as a vital force or God operating today. Vitalism is an idea implying the opposite view. There is a Creator, there is a provider and there is a glorious purpose to life. Someone answers your prayers and someone cares.

The objections to mechanism are (1) that it supposes that laws operated in the pre-historical past and that they always will operate (clearly an assumption), (2) that mechanistically-inclined scientists are discovering *the* truth and *reality* (and this is highly dubious) and (3) that a "machine" like the universe, infinitely more complex than any known machine, was brought into being without the aid of a Designer (a very improbable situation).

The objections to vitalism are, in part (1) it is a hindrance to research if supernatural causes must be reckoned with when scientific work is undertaken, and (2) no case is on record in which it can be proven that divine providence interfered with the operation of the universe.

Each person must decide for himself which side he will be on. No ready answer is available. Some of us prefer to believe in aspects of both theories. We believe in a Creator or Designer whom we will all meet when the Second Law of Thermodynamics has reached its terminus. On the other hand we think that man, with free will and an advanced cerebral cortex, is complete Master of his fate while here. God's logical function now is only in the realm of the *spiritual*. Man's only legitimate hold upon God today is in the foregiveness of sins to the end that His ultimate purpose may be realized.

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III. People I enjoy most are those least like machines; machines I enjoy most are those least like people. Yet I realize how much I have in common with machines. My heart is a mechanical pump. My brain is full of wires and transistors. And if as a Christian I think of myself as God's creature, that puts me in the same huge class as other "made" things. Considering my humanity a gift, I try not to be a snob: I mourn for elms and behave cordially toward ants or raindrops attending picnics uninvited. I keep my pocketknife free from rust and enjoy its companionship. I feel a moral obligation to bring out the best in my fellow creatures, both people and things, but I also feel I should keep the distinction clear.

A machine is in the sub-class of things to be appreciated, taken care of, and used wisely. A person is more, a special kind of creature to be appreciated and taken care of, but not to be used. Instead, he is to be known and loved. In a sense you can know and love a machine. That is, you can know enough about it to admire its perfection. You do this by a logical process. Man can be known by the same process; a hydraulic engineer already knows a lot about the human heart.

The basic difference between man and machine

is that you can know a man in a unique way. Here the logical process will not work, because it gives power over the known to the knower. For personal knowledge a fiducial process is necessary. That is, you trust yourself to the other person. The trust must be mutual, a reciprocal giving that is impossible between man and machine.

It isn't clear to me at present whether there is more to this difference than complexity. As machines get more complex we recognize many man-like characteristics. Recently I had an amusing interview with a computer programmed to give psychiatric help. Conversely, it is certainly possible for men to act like machines—precisely the goal of military training. Sometimes we want human behavior to be as predictable as clock-work. Prescribed tasks are done more efficiently when we act like machines, but always at the risk of losing our humanity. We are aware of the opposite risk, when human behavior becomes completely unpredictable ("Preserve us from hippies and Yippies!"). Learning to know ourselves and each other as persons, not machines, minimizes both risks.

So let us not be intimidated by even gigantic machines. If the cleverest computer crammed with the knowledge of the ages had been asked to write on "Is Man Only a Complex Machine?" would reading the essay bring you any closer to friendship with the computer? These paragraphs of mine are at least a step toward personal encounter between us.

A secretary once complained about having to type my long letters because they were "too personal." I replied that I always write to persons, whatever the business at hand. She knew better. That was no way to run an office. Or an army, or maybe even a government laboratory. It is inefficient non-machine behavior. But how should a university be run? Or the whole human family? And why do you suppose *I* was asked to write this?

Yes, old pal— I know you had a part in it and I'm grateful. Here, let's sign it together:

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Only a Machine, or Also a Living Soul?

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Is a man only a complex machine or is he also a living soul created in the image of God? Upon the answer to this question depends our estimate of the value of each individual personality, our attitude to ethics, morality and religion, and our views regarding the possibility of life after death. Can the uniqueness of the human personality be explained wholly by the laws of physics and chemistry or is there also a spiritual dimension? The human body in a sense is a complex machine and examples of feed-back mechanisms in human physiology, the concept of the brain as a bio-computer and modern views on the biological basis of memory are cited in support of this idea. The effects of disease of or trauma to the brain and the effects of electrical stimulation to areas of the brain upon the personality are also considered. Finally, the philosophy of materialistic monism and the dualistic concepts of psycho-physical parallelism and interaction, are discussed as possible explanations for the nature of man, the last view being accepted by the author who attempts to demonstrate that it is compatible with the Biblical concepts of the nature of man and life after death.

Is man only a complex machine as many would have us believe or is he something more? Is he also a living soul created in the image of God? This is one of the most important questions which face humanity today; upon its answer depends our estimate of the worth and value of each individual human personality, our attitude to ethics, morality and religion, and our views about the destiny of man: annihilation of the personality at death or the hope of a life beyond the grave. Can the whole of human life and personality be reduced to the laws of physics and chemistry or are these laws alone inadequate to explain the uniqueness of man?

The Human Body is a Complex Machine

Certainly the human body is a complex machine,

but more wonderful and intricate than any man-made machine. Self-regulating or feed-back mechanisms, exemplified in the field of mechanical engineering by such devices as governors for regulation of the speed of engines, and thermostats for control of temperature, are important components of the different physiological systems of the human body.

A relatively simple illustration in the human organism is the method by which the hypothalamus controls the secretion of the thyroid hormone (thyroxine) and hence the level of metabolism in the body via the anterior lobe of the pituitary gland. The hypothalamus is believed to secrete a thyrotropin-releasing factor into the vascular system of the pituitary gland which stimulates that organ to increase the output of its thyrotropic hormone. The latter in turn stimulates the thyroid gland to increase its output of thyroxine. The resulting increased level of thyroxine in the bloodstream, including the blood flowing to the hypothalamus, increases the metabolism of that structure; as a result, the hypothalamic stimulation of the pituitary gland is decreased, causing a fall in the production of thyrotropic hormone and consequently a decrease in the secretion of thyroxine. Conversely, decreased thyroxine levels in the bloodstream lead to the opposite effects.

The heat-regulating system of the body, whose thermostat is the hypothalamus, also operates by means of a feed-back system, which causes the body temperature to remain relatively constant despite fluctuations in the temperature of the environment. An increase in the temperature of the blood passing through the hypothalamus will cause that part of the brain to initiate those physiological mechanisms designed to cause a fall in body temperature and vice-versa. The brain itself with its billions of nerve cells or neurones has been likened to a very elaborate and complicated electronic computer mechanism with the individual neurones analogous to vacuum tubes or transistors such as have been used in electronic computers.

As an electronic computer requires a unit for the storage of information to function properly, so in the human central nervous system there is a biological memory storage unit. Dr. Wilder Penfield of Montreal, the world-famous neuro-surgeon has written widely in the fields of neurology, neurophysiology, and neurosurgery and has performed much work on temporal lobe epilepsy, including operative removal of diseased areas of the temporal lobes of the brain. In some of these cases Dr. Penfield has found that stimulation of certain areas of this part of the brain with electrodes has caused the patient to recall vivid memories of childhood days, almost as though the electrical stimulation was like the switching on of a tape recorder. When the electricity was turned off, the memories abruptly disappeared.

As far as the physical basis of memory is concerned it is widely believed that when learning takes place, temporary memory is consolidated into permanent memory which is available for subsequent recall. This "engram" or physical trace of memory is encoded in a macromolecule such as ribonucleic acid (RNA) or protein. In other words memory appears to be stored in a chemical filing system, RNA being an important component of this system. An alternative theory suggests that memories are diffused throughout the brain and depend on the setting of innumerable switches. Certain proteins manufactured by the nerve cells act as switches at the synaptic junctions between nerve cells, thus determining along which particular neuronal pathways impulses flow in processing a particular piece of learned information.

Any kind of damage to the central nervous system, whether due to trauma, infections, tumors, degenerative diseases, or intoxication with various chemical poisons, can produce marked alterations in the personality.

Central Nervous System

Furthermore, we know that any kind of damage to the machinery of the central nervous system whether it be due to trauma, infections, tumors, degenerative diseases or intoxication with various chemical poisons, can produce marked alterations in the personality of the individual concerned. For instance, a normal child who sustains a head-injury, develops encephalitis following one of the infectious fevers such as measles, or contracts a severe form of meningitis, may be left with permanent brain damage manifested by hyperexcitability, restlessness, anxiety, distractibility, impulsive hostile and aggressive behaviour and even delinquency.

Many psychiatrists are now of the opinion that biochemical abnormalities in the central nervous system are important causative factors in the production of certain forms of emotional illness, particularly the major psychoses such as manic depressive illness and schizophrenia. For instance, the depressive phase of manic-depressive illness in which the patient is depressed and miserable, slowed down and retarded mentally and physically, often experiencing feelings of worthlessness, self-reproach and guilt (sometimes to such an extent that the sufferer feels that he or she has committed the unpardonable sin), and sometimes exhibiting suicidal tendencies, is believed to be associated with a diminished concentration of catecholamines, such as norepinephrine, in the region of synapses in certain parts of the central nervous system. On the other hand the manic phase of this illness in which the patient is overactive, elated, and showing pressure of speech and flights of ideas, is believed to be associated with excessive concentrations of these substances in the brain.

Conversely emotional factors such as anxiety, repressed hostility, and unresolved guilt can be important factors in the production of physical symptoms and even of definite diseases such as bronchial asthma, gastric and duodenal ulcers, neurodermatitis and a wide range of other conditions which make up the field of psychosomatic medicine.

It is also an established fact that interference with the machinery of the brain, either by drugs, electricity or psychosurgery can cause alterations in behavior and personality. For instance, anti-depressant drugs can relieve the symptoms of depression and produce an elevation in a patient's mood by influencing the level of catecholamines in the brain. Hallucinogenic drugs such as lysergic acid diethylamide (LSD 25) and mescaline produce striking changes in personality, such as an alteration in the individual's appreciation of time, feelings of depersonalization, and the experiencing of

hallucinations.

Psychiatry

Perhaps even more dramatic is the work of Dr. José Delgado, professor of physiology in the department of psychiatry at Yale University whose research with animals and recent studies with psychiatric patients may have significant and far reaching implications for psychiatry in the future. By means of radio signals sent out from a transmitter, he has influenced the behavior of animals, whose brains he has implanted with fine electrodes at specific sites; the radio signals from the transmitter are received by small solid state radio receivers carried by the subjects. The receivers change the radio signals into the desired electrical stimuli which they send down the implanted electrodes. For instance, an angry charging bull has been stopped by stimulating a point in the basal ganglia of the animal, and stimulation of the red nucleus in the mid-brains of monkeys have caused them to rise from a sitting position and walk around. Stimulation of another part of the mid-brain of a monkey has evoked aggressive behavior directed towards the self.

This method of Dr. Delgado was applied for the first time clinically in the early part of 1968 to four patients suffering from severe psychomotor epilepsy associated with such symptoms as severe episodes of rage, automatisms, and assaultive behavior, with a view to the accurate identification of sites of abnormal intracerebral electrical activity as a guide to the planning of subsequent surgical treatment. Electrodes were introduced into the hippocampus and anterior medial amygdala of each patient and a small radio receiver weighing only 70 g. was strapped to each patient's head bandage. In one patient a single stimulus applied to the left amygdala relieved his emotional tension and assaultive behavior for two days but stimulations of the right amygdala in another patient elicited paroxysms of rage. Radio stimulation of other areas of the hippocampus and amygdala in these subjects produced other effects such as elation, pleasant sensations, and thoughtful concentration.

According to materialistic monism, mind is just a product of biochemical and electrical changes in the central nervous system, and the personality is nothing more than the interplay of these biological forces with environmental forces.

Materialistic Monism

In the light of these scientific discoveries is man nothing more than a complicated biological machine? Many philosophers and scientists, holding the theory of materialistic monism would answer in the affirmative. The monistic philosophy postulates that mind and spirit are merely functions of the central nervous system, just like the secretion of bile is a function of the liver and the circulation of the blood is a function of the heart and blood vessels. In other words, according to the teaching of materialistic monism, mind is just a product of biochemical and electrical changes in the central nervous system, and the personality of an individual is nothing more than the interplay of these biological forces on the one hand with environmental forces on the other. If one carries this philosophy to its logical extreme it leaves no room for the concepts of free will, moral values, and survival of the personality after death. To the monist, therefore, disintegration and death of the nervous system inevitably means the fading and extinction of the mind and personality. Nevertheless this theory fails to answer several important questions. It cannot explain how electrical and chemical activity in the brain can be translated into consciousness, self awareness, and the experience of different emotions. It seems that here is an impossible gulf which science cannot bridge. The phenomena of conscience and the moral and religious nature of man cannot be explained by this theory, nor can the changed lives of countless individuals who have been brought into a radical transforming relationship with the Lord Jesus Christ.

Furthermore, not all philosophers and scientists working in this field subscribe to the monistic philosophy of the nature of man. "The real trouble comes", states Lord Adrian, "from the feeling that there may be an important part of the picture which can never be fitted in however long we work at it." Professor W. E. LeGros-Clark concludes that neither the anatomist nor the physiologist is "able to even suggest how the physico-chemical phenomena associated with the passage of nevous impulses from one part of the brain to another can be translated into mental experience". Dr. Wilder Penfield says "something else finds its dwelling place between the sensory complex and the motor mechanism, that there is a switchboard operator as well as a switchboard." He further states, "The dualist believes that there is in each individual something additional to the body and its living energy. He may call it a conscious spirit which is the active accompaniment of brain activity. . . . He may also believe that this spirit continues its existence after the death of the body. . . . These concepts of the spirit, and of God, are the things a scientist may believe." In his 1963 Eddington lecture, Sir John Eccles, well-known neurophysiologist, is quoted as having said that the possibility of a future existence cannot be denied on scientific grounds.

Philosophically the theory of materialistic monism makes utter nonsense, because if all our thinking and our philosophical theories are merely the result of biochemical and electrical changes in the cells of our brains, then materialistic monism is a mere whim of brain physiology. Its claim to be considered seriously as objective is invalid. In this way this philosophy undermines all objective measurements and standards of truth, including the truth or error of the monistic philosophy itself.

Psychophysical Parallelism and Interaction

The alternative theories of the nature of man which are dualistic in emphasis and which postulate a non-material component to the personality of man, in the form of mind or spirit, are the theories of psychophysical parallelism and interaction. The theory of psychophysical parallelism postulates that body and mind are two separate entities operating in harmony with each other but not affecting each other intimately, much like two railroad trains running at the same speed along

The theory of interaction teaches that body on one hand, and mind or spirit on the other, are separate and distinct phenomena, but yet are intimately and intricately interrelated, affecting each other closely.

parallel railroad tracks and passing along the same points along the route at exactly the same time. This theory does not appeal to the author either from a philosophical or a scientific point of view, because if body and mind cannot affect each other intimately, one would have to postulate a whole series of supernatural events when these two entities appear to act together.

The theory of interaction teaches that body on one hand, mind or spirit on the other, are separate and distinct phenomena, but yet are intimately and intricately inter-related, thus affecting each other very closely. The body, and particularly the central nervous system, is the vehicle through which the spirit of man expresses itself, the latter being the ultimate psychic reality. This theory in the author's opinion is wholly compatible with the established facts and findings of science on the one hand and with the doctrines of Scripture on the other. To facilitate our understanding of this theory, the relationship between the spirit and the body of man can be compared to the relationship between a pianist and his instrument, the interaction of the two producing the melody, which in our analogy represents all the attributes of personality and mind. If we pursue this analogy further it becomes obvious that a discordant and jarring melody may be produced by a defect in the piano or by a faulty technique on the part of the pianist. Similarly, flaws and defects in the personality and disorders of the mind my be due to physical disease, especially disease of the central nervous system, or to spiritual causes, particularly to a wrong relationship with God or to a combination of both. Just as the player striking the keys of his instrument produces the melody, similarly the interaction of body and spirit produces a third and different entity: mind. Thus this theory of dualistic interaction does not necessarily conflict with the widely accepted theological model of man as a tripartite being consisting of body, mind, and spirit.

As far as the problem of free will is concerned, it is interesting to reflect on the fact that the human brain contains billions of electronic circuits, remotely comparable in both structure and function to the electronic circuits of calculating machines and computers, though infinitely more complex, vastly more intricate, and yet wonderfully condensed in space. The average human brain weighs only about 1400 g. but a man-made electronic brain of something approaching comparable complexity would be so large as to require a building the size of a large house to contain it. Such a structure as the human brain with its countless billions of electronic circuits is an ideal physical instrument upon which an entity of the nature of the human spirit could operate and upon which the function of the free will could be imposed.

Biblical Teaching

According to the Bible there is a dualism of the body and spirit: "I pray God your whole spirit and soul and body be preserved blameless unto the coming of our Lord Jesus Christ". (I Thessalonians 5:23; see also II Corinthians 5:1-10). Indeed the Lord Jesus Christ himself taught such a dichotomy (Matthew 10:28).

Furthermore we are taught in the Bible that God created man in His own image, formed man of the dust of the ground, breathed into his nostrils the breath of life and man became a living soul. (Genesis 1:27 and Genesis 2:27) Thus the Word of God conveys to us the conception that man is a body animated by spirit, the combination of these two entities being necessary for the formation of a complete living personality. In other words the Bible stresses the idea that man forms a psychophysical unity in contrast to the views of Greek philosophy according to which man was regarded as an incarcerated soul, his body merely being a hindrance and encumbrance to the free life of the spirit. In the new testament the Greek word *psuche* expresses the idea of the total living personality, whereas the word *pneuma* denotes the spirit of man. Indeed the body is regarded as a necessary vehicle through which the spirit of man can express itself.

The Bible also teaches the doctrine of the resurrection of the body, rather than the mere survival after death of a disembodied spirit. In the resurrection, the spirit of the believer will be clothed in a spiritual body which will be incorruptible and eternal, and through which this immortal spirit will be able to express itself throughout the endless ages of eternity: a body like the glorious resurrection body of our Lord Jesus Christ, free from mortal frailty and unimpeded by the limitations of space and time (I Corinthians 15, Philippians 3:10, II Corinthians 5:1-10). 'The dead shall be raised incorruptible and we shall be changed, for this corruptible must put on incorruption and this mortal must put on immortality" (I Corinthians 15:51-52). "But we know that when He shall appear we shall be like Him, for we shall see Him as He is." (I John 3:2).

We can be confident that there are no facts of modern science, nothing in psychology or psychiatry, that can deny or refute the fact of the personal resurrection of the individual Christian believer, and therefore we who have put our trust in the crucified and risen Saviour can rejoice in the confidence that one day we shall see Him face to face and dwell with Him forever.

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Mechanism, Naturalism, and the Nature of Social Science

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The arguments for mechanism are undercut by the necessary presuppositions of rational and ethical debate: reason, conscience and awareness of personality cannot arise from matter-in-motion. Mechanism represents only one level of understanding; there must be complementary levels to accommodate all the data. Man's rationality indicates that he is not wholly reducible to nature, and any attempt to reduce man to mechanism denies an essential feature of "social science". Social data are only partially external, objective and quantifiable. Deeper insight results from recourse to internal, subjective data which are not reducible to a mechanistic or naturalistic level, a fact which affects all disciplines that deal with man, including human geography.

Surely it's an obvious fact, so obvious that a mere layman must hesitate for fear of a logical booby-trap, that none can argue that man is but a mechanism without destroying his own case. For the mere attempt to maintain such a thesis must assume the validity of reason, and how can reasoning be either valid or open to validation if it's all a matter of mechanism? Not even the addition of the most complicated of biochemical reactions will save the day, either, for the principle remains the same: how can rationality arise from matter in motion? There's little point in the mechanist making a plea for "the autonomy of human reason," for how could human reason—or any reason whatsoever—be either trustworthy or autonomous if it be wholly dependent on so irrational a source? Can it be generated from cooling lava or the heat of the sun on mindless slime? Is it not a most irrational leap of faith (if "faith" is possible) to make appeal to the presumed byproduct of meaningless matter? Is not the mechanist busily sawing off the lever he's sitting on?

Is Reason So Unreasonable?

Incredible as it may seem, this is surely what is being done. Let us consider, for a moment, the implications of Bertrand Russell's eloquent affirmation that

> Amid such a world, if anywhere, our ideals henceforward must find a home. That man is the product of causes which had no prevision of the end they were achieving; that his origin, his growth, his hopes and fears, his loves and his beliefs, are but the outcome of accidental collocations of atoms; that no fire, no heroism, no intensity of thought and feeling, can preserve an individual life beyond the grave; that all the labours of the ages, all the inspiration, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system, that the whole temple of man's achievement must inevitably be buried beneath the debris of a universe in ruins—all these things, if not quite beyond dispute, are yet so nearly certain, that no philosophy which rejects them can hope to stand. Only within the scaffolding of these truths, only on the firm foundation of unyielding despair, can the soul's habitation henceforth be safely built.[1]

Eloquent, yes, but isn't there more of mysticism than logic in all this? How could such rich fertility be spawned by so barren a source? How could love and fear arise from the purely passionless, and intensity of thought and feeling from that which is thoughtless and unfeeling? Just how could the soul (revealing word!) safely build on so impermanent and desperate a foundation? And why indeed does atheistic naturalism seek to beg so many crucial questions? Could it be that the question of Origin is a haunting one, that the thought of a Personal God makes sense of the personal data? C.S. Lewis put his finger on the nub of the matter:

> The myth [of mindless Evolution] asks me to believe that reason is simply the unforeseen and unintended byproduct of a mindless process at one stage of its endless and aimless becoming. The content of the Myth thus knocks from under me the only ground on which I could

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> possibly believe the Myth to be true. If my own mind is a product of the irrational . . . . how shall I trust my mind? They say in effect 'I will prove that what you call a proof is only the result of mental habits which result from physics.' The fact that some people of scientific education cannot by any effort be taught to see the difficulty, confirms one's suspicion that we here touch a radical disease in their whole style of thought.[2]

A Matter of Ethical Matter

Radical indeed, as Dooyeweerd deduces when he postulates an *a priori* religious commitment, a basic orientation of the heart which determines the pattern of our philosophy. And the same issue emerges in another assumption that (we hope) controls the debating method of the mechanist, the insistence that we ought to stick to the facts and not wilfully pervert them to score debating points with the uninformed—a very unethical practice, sir! And that "ought," a word which springs so naturally from the lips, cannot but give the case away. For where is there any room for an "ought" or an "ought not," for any ethical system whatsoever, if all we say or do is ultimately reducible to the merely mechanical? How can a mechanical or naturalistic process give rise to the moral sense?

Again, the very process of argument seems to involve naturalism in self-destructive circuity. Of course, it may be urged, right and wrong are not really real, they're just matters of human convenience and cultural conditioning. But even the most convinced of moral mechanists and cultural relativists seem to have a curiously unmechanical reaction when they note some cheating in debate or exam room, or see a pick-pocket making off with their money . . . And if "good" is simply that which people are conditioned to believe in, why the condemnation of Hitler for sending millions of Jews to the gas-chamber, or the moral indignation about a massacre, the imposition of racial inequalities, or the pollution of the environment? If our standards have no anchorage outside of matter in motion, and if variant moralities are simply a by-product of mechanism, how can the Nazis or the racists be faulted for behaving according to their "equally valid" lights? And if it be retorted that their standards were retrogressive or inferior, primitive or perverted, is it not clearly implied that there are some known norms that make our moral judgments valid? If they *should* have known better, how can it be argued that there are no common standards, no absolute that gives meaning to our relativities?

And if there are indeed such overarching principles, are we to suppose they are derived from matter in motion? Does it suffice to answer that the common standard is "the good (or survival) of the human race"? Where do we get *that* from? And just *why* should we bother about that pale and remote idea, especially if it competes with the good of Number One? Because it's instinctive? But why should we bother with such an instinct (if there is one) when we've "seen through it all"? And why suppress that strong instinct for self-preservation in favor of that much weaker instinct for the good of the race if it should urge me to risk my life to drag that fellow from the burning house, especially if he's too old and weak to be anything but a burden anyway? And why not applaud acts of cowardice, treachery and torture if they serve to shorten the war and help our side (and of course the human race) in its progress? Because we *ought* not? . . .

Well, let's break off that line of argument before we are accused of being cold-bloodedly mechanical rather than humane, but not before taking note of the fact that Christianity is wholly consistent on this point. For all the confusing relativities and uncertainties of the human situation, rational thought is valid because it is a drop from the ocean of Divine Rationality, and the moral law within derives its ultimate sanction from the wholly moral nature of God. Out of nothing nothing comes, but out of the Moral and the Rational comes the moral and the rational. The river does not rise above its Source.

A Problem of Personality

We are, for that matter, quite aware of the fact of personality. Karl Heim's analysis[3] is so apropo. We are all aware of the ego, the seeing point that is itself not visible, the presupposition that makes all science possible, the non-objectivisable "I" that lies on this side of all objectivity. We are all aware of the fact of decision-making, of the "now" that joins the solidified and already-determined past to the molten and yet-undetermined future. We are all aware that we are knit by flesh and blood to time and place yet simultaneously aware of another undeniable reality, a "second space" in which the "I" can meet the "Thou" and person make meaningful contact with person. There's a quite unexpungable awareness of our distinction from the purely physical and even animate world around us, and an abiding sense of truth, beauty and goodness. We are all aware of responsibility and guilt, what Goethe somewhere called "the kingly crown of mankind," and a score of other archetypal words ring with undeniable resonance in our minds. Why do we strive to reduce all this to "an accidental collocation of atoms"?

In point of fact the very effort to reduce man to mechanism and deny the image of God betrays the deep-rooted tendency of apostasy, the urge of "man in revolt" to deny his Origin. But in so doing how can he but deny himself? Why does he adopt a procrustean method that shears away all of the data that will not fit? Why this strenuous will-to-believe which seeks to reduce the rich and varied range of human experience to mere mechanism?

The Reign of Regularity

Partly, of course, it is not a matter of will-to-believe: it is a matter of method. In one sense of the term, science is a search for "scientific laws," and the seemingly relentless extension of precise laws is no longer confined to physical science. It affects the whole of human life, with a network of lawfulness spreading across the seemingly dissolving divide between the physical and social sciences and into the very depth of the psyche. The patterns of our secret thought seem to be governed by a one-to-one relationship with physico-chemical changes, and the areas of freedom to be narrowing down to the vanishing point.

Small wonder that some have grasped at the almost certainly irrelevant straw of Heisenberg's principle of indeterminacy or sought refuge in ascientific (if not anti-scientific) forms of existentialism.

Fortunately, however, as Gilbert Ryle points out,[4] the case for free and responsible personality does not rest on the "very, very long odds" left us by real or hypothetical holes in the network of lawfulness; it rests on a different level of awareness, a different level of interpretation. "Natural laws" are not to be seen as prescriptive but as descriptive, and, as Coulson points out,[5] determinism and freedom can be better envisaged as two sides of the self-same coin. From the observer's "objective" viewpoint the pattern of development may fit the deterministic framework, but from the participant's "subjective" viewpoint it discloses a sequence of responsible choice. As Gilbert Ryle has underscored the point, an uninitiated observer of a game of chess might deduce that every move was governed by some rule and thereby leap to the conclusion that "heartless necessity dictates the play," but such a conclusion would be based on sheer optical illusion. Every move may be "governed," in one sense of that word, by some law, but not a single one might be so "ordained", even as the rules of grammar may govern every sentence but ordain not a single one.[6]

A Complementary Level

Thus the principle of complementarity must be invoked, not as an escape from the network of scientific law but as an element absolutely essential for interpretation. Mechanism and personalism must both be adhered to and held together. Yet a further point needs to be made; the "lower" may be necessary for the expression of the "higher", but the higher is not thereby subject to reduction.

The point is acutely made by two such different Christian thinkers as C. S. Lewis and Herman Dooyeweerd. As Lewis envisages it[7], it is a notable fact that the self-same flutter in the pit of the stomach can be induced by sea-sickness and evocative music, and the lines the artist pencils on a flat sheet of paper may seem just that and nothing more, or they may capture the essence of a landscape flecked with light and shadow and fading into infinite distance. Something rich and complex is of necessity reduced as it is "transposed" to a lesser medium; the greater may include the lesser but not vice versa, and those who have no eyes to see may see all the facts but none of the meaning.

The point raised by the philosophical school linked with Kuyper and Dooyeweerd is a different but related one. As the total reality which we confront in naive experience passes through the prism of thought, we inevitably analyze it into different law-spheres or modalities which display a cosmic order; and some, such as the numerical, spatial and physical, necessarily "precede" and undergird more complex and richer modalities including the biological and psychical, the social and ethical. But no single aspect of reality is reducible to the others; to absolutize one is to relativize the others and distort the overall pattern, and this, as Spier summarizes it, is precisely the downfall of non-Christian philosophies. By deifying the physical modality, "the materialist seeks to anchor his heart in matter. He disavows the sovereignty of the post-physical modalities and would reduce all existence to force and matter". Others deify the psychical, economic or historical modalities, but

> all succumb to the error of *functionalism*: the view that one modal function is the origin of all the others. Only Christian philosophy can avoid this error. It alone knows the true religious center of the cosmos, which transcends all temporal modal functions.[8]

Where is there any room for an "ought" or an "ought not," for any ethical system whatsoever, if all we say or do is ultimately reducible to the merely mechanical?

The Natural Man?

This warning against the absolutization of any single aspect of human experience is a timely one, and this seems to be the basic intent of Jeeves' statement that the "Christian view of nature insists upon seeing man himself, including his mind and his capacity for rational thought, as an integral part of nature.'[9] Maybe, though not all of us would necessarily agree with that statement.

It could, in fact, be argued that it is precisely the refusal to immerse man in nature that characterizes the Christian view. After all, if it is a Christian affirmation that man was made of the dust of the earth, it is also a Christian affirmation that he was inbreathed with the breath of God and stamped with the divine image. To this writer, at least, it seems preferable to follow C. S. Lewis in his assertion "that God and Nature have come into a certain relation, almost in one sense a common frontier, in every human mind", and to repudiate all thought of a Naturalism which strives to reduce all to the closed system of a spontaneous and purely self-sufficient Nature. If we read the situation aright, Lewis is emphatically correct when he affirms that man's "rationality is the little tell-tale rift" that reveals that Nature is not all, and that

> if we continue to make moral judgements . . . then we must believe that the conscience of Man is not a product of Nature. It can be valid only if it is the product of some absolute moral wisdom . . . not a product of non-moral, non-rational Nature.[10]

And best also to note Langmead Casserley's warning that the current tendency to engulf man in nature is creating both semantic and spiritual confusion. To extend the term "nature" to mean everything is to dilute its meaning to the point where "the assertion that man is part of nature will mean no more than . . . man exists" and obscure the fact that for all his links with the natural world there are notable discontinuities. Reversing the primitive "pathetic fallacy" that elevated even inanimate nature by the infusion of life and personality, modern man now embraces the more dangerous "apathetic fallacy" which "puts the living to death" and "reduces nature and man alike to mechanism."[11]

Subjective Insight and Social Science

In point of fact, if Casserly is right, this also confuses a very valid distinction between the natural sciences and the social sciences. Mathematical or statistical formulae may have a certain ultimacy and finality in physical science where the observer cannot penetrate beyond an exterior and "objective" analysis of his

data, but not in the social sciences. Of course, as Polanyi insists and as Sizoo and other reaffirm, the division between the objective and the subjective sciences is far from complete; they manifest not so much a cleavage into discrete entities as a series of varying positions along a continuum terminating in objective and subjective poles.[12] But the point that seems relevant here is a somewhat different one; the natural or physical sciences are necessarily objective in the sense that the data are viewed overwhelmingly from the outside, while the social sciences are necessarily subjective in that inside data are both available and essential to comprehension. As Vico perceived centuries ago,[13] the "social sciences" are ignoring a most crucial source of data if they seek a radical objectivity which is foreign to their nature. Man's relation to external nature could never be more than that of an external observer and manipulator, but his relationship to the data of the social sciences is both internal and external, both subjective and objective. The observer stands within the social complex, a vantage point from which

> we have an insight into our data, an immediate experience of human and social phenomena as they are in and for themselves in the light of which to check our theories and formulae.[14]

No amount of objectivization, quantification and model-building can or should bypass that crucial fact; we have an inside awareness, a special, introspective knowledge of what it means to be human. Thus, in any truly social science the statistical phase is merely the prelude. The investigator can and must press on beyond such formulations to a deeper understanding of the human situation.

Rational thought is valid because it is a drop from the ocean of Divine Rationality, and the moral law within derives its ultimate sanction from the wholly moral nature of God.

Maps, Models, Mechanism and Meaning

This principle, of course, impinges on every discipline that deals with man, including human geography. At one level of investigation, we can and must stand outside our data and view it objectively, sifting out the relevant areal facts and plotting the patterns on the map, or expressing them in models and mathematical formulae. But for all the illuminating areal correlations that may thus emerge, maps and models are abstractions, covering only selected facets abstracted from reality; it takes human insight to see the significance. Real life is more than the model.

Bound up with this fact are certain presuppositions regarding the nature of man and the relationship of man to nature, and here the cloven hoof of naturalism is all too often evident. Admittedly, there were once errors in the other direction. Geographers shared in the misguided effort to fit the shape of the earth to dubious exegesis of Scripture, and teleological interpretation was sometimes interjected at the factual-scientific level, a basic methodological error, as Hooykaas has pointed out:[15] there is no "Christian geography." But perhaps the pendulum has swung the other way: a necessary *methodological* separation is sometimes pressed into an *ontological* separation, and man is presumed to be wholly "natural" in origin and characteristics. Even at the methodological level this may not be wholly healthy; as de Jong suggests, it is true that in geography, of all disciplines, we must hold man and nature in cohesion, but the implied distinction of nature from culture is also a prerequisite "if we wish to define the various factors with which geography is concerned."[16]

Nor is it necessary for geographers to reduce their understanding of religion to a purely cultural, indeed a purely naturalistic, level. As de Jong again points out, it is a Christian conviction that religious truth is rooted not in nature but in revelation, and truth is ultimately independent of varying environments. This is neither to deny a legitimate and indeed essential place for an "objective" geography of religions which treats them all on a level, but it is to query any trend towards ultimate naturalism and cultural relativism in human geography.

These trends are not peculiar to geography, however. In fact their roots (though not all their fruits) seem to lie outside of the discipline. But. as Tatham wrote in his summation of the history of geographical thought, "probably the most interesting aspect of the whole story is the sensitive way in which geographical ideas at all periods have reflected contemporary trends in philosophic thinking."[17] And, as we see it, this interaction will be the healthier if it reflects Christian presuppositions, presuppositions which surely include the conviction that "the chorological (areal) diversity of the earth is one of the treasures of the creation,"[18] and an awareness that man's dominion over the world and its resources must be viewed not in the framework of naturalism or mechanism, but in the light of the primal cultural mandate to subdue and replenish the earth.

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No single aspect of reality is reducible to the others; to absolutize one is to relativize the others and distort the overall pattern, and this is precisely the downfall of non-Christian philosophies.

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APPENDIX

The question of the adequacy of Mechanism and Naturalism to account for the data also involves the question of miracle, which C. S. Lewis (*Miracles*, p. 15) is surely right in defining as "an interference with Nature by supernatural power", a definition which this writer would prefer not to dilute. We may rightly challenge the consistency of Hume who sought to replace the regularity of natural causation with observed sequence and yet appealed to the regularity of natural law to "down" miracles, but there does seem to be a current tendency to merge the miraculous and the natural in a way which could confuse the layman.

It is, of course, true that God is not "a God of the gaps," that He is immanent as well as transcendent. In a sense, C. A. Coulson is surely right in affirming that "either God is in the whole of Nature, with no gaps, or He's not there at all." (*Science and Christian Belief*, p. 35) and in a sense, Robert Boyd is emphatically right in saying that "God gives us our daily bread and that is natural, and Christ fed the multitudes, and in the circumstances that was natural too." (D. M. Mackay, *Christianity in a Mechanistic Universe*, Chicago: Inter-Varsity Press, 1965, p. 117). But use of a word with double meaning could be confusing, and it is equally necessary to emphasize that what was "natural" for the Lord of Nature was not necessarily "natural" in the commonly accepted meaning of that term. Surely we must boldly face the fact that all who believe in a transcendent God believe in the "Supernatural," and that belief in miracle involves belief in something which does not wholly flow from previous natural patterns but flows into them from "something other." The foundational miracle of the Incarnation surely implies that Something without natural precedent, Something from "outside" spatio-temporal Nature, flowed into and interlocked with time and place to modify the subsequent flow of events. That which followed was all of a piece; such mighty "signs" as the raising of a decaying corpse signified the presence of a Power beyond the normal powers of Nature.

The Man Who is There*

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C. S. Lewis, the British scholar and author, wrote a series of children's fairy tales concerning a land called Narnia. Narnia is in another world, one which can be reached from our own only by magic. Several English children had the great fortune of making a few magical trips to Narnia. In one of their adventures, three of them sail on a Narnian ship to the End of the World (the Narnian world being flat). The ship reaches an island at the Beginning of the End of the World which is inhabited by a 'retired star' in human form. Finding this hard to believe, one of the children questions the star. 'In our world,' said Eustace, 'a star is a huge ball of flaming gas.' The star replies, 'Even in your world, my son, that is not what a star is but only what it is made of.'

Few of us would venture to say whether or not a star is, essentially, more than its mere physical manifestation. However, the question does arise for man himself: although we may eventually understand totally the physical components of which man is made, and how these work together, will we then know definitively *what man is*? Is man merely a complex machine, or is there a human essence beyond physical existence?

Historical Answers

Historically, the answer to this question has often been given in terms of a flesh-spirit dichotomy. There was believed to be an intrinsic difference between the flesh and the spirit. In religious terms, the flesh is worldly, weak, and corrupt, while the spirit is 'otherworldly,' the part capable of reaching out to 'higher things.' Both elements are present in man, but he is to subdue the body and concentrate on the things of the spirit. This idea is one interpretation of Paul's letters, is certainly present in Augustine, and is exemplified in an extreme form in some aspects of the Puritan ethic. In philosophy this dichotomy has been expressed in similar terms (although such dire attributes were not necessarily included in the concept of the flesh), the most familiar being the Cartesian dualism of mind and matter.

Let us make the assumption that man is no more than a determined, complex machine and consider some of the possible conclusions based on that premise.

We still tend to think in such categories today. We see thought, emotion, dreams, and so on, as the manifestations of the spirit or mind. The material body, on the other hand, is that which executes the designs of the mind and is under the influence of the spirit.

*With apologies to Francis Schaeffer.

Such simplistic distinctions are becoming blurred, however, as a result of advances in areas such as biology and psychology. Intimate and intricate relationships exist between body and mind: physical malfunction may cause mental and emotional aberrations, and some diseases are certainly psychosomatic. It has been known for a century that destruction of the frontal lobe of the brain causes definite personality changes. Thought is believed to be mediated physically in terms of electrochemical impulses in the brain; perhaps emotion (if it can even be distinguished from thought) has the same type of physical pathway. Does the progress of science in these areas mean that we will soon be able to describe man and all of his functions as completely as we can describe a computer circuit? Will we also find, then, that man is programmed, and thus totally determined, as are computers?

(It is interesting to note that some computer technologists predict that artificial intelligence may someday be capable of creative thinking; on the other hand, some behavioral scientists feel that man is so totally determined that he may be incapable of creative thinking, that is, of thinking other than what he is programmed to think. Or, to look at it from another viewpoint, physics accepts the Uncertainty Principle while some people would postulate a Certainty Principle for man.)

The logical conclusion of a determinist philosophy is that whoever has power, whether it be economic, political, physical, or anything else, has the right to exploit other people.

Suppose Man is Only a Complex Machine

Let us make the assumption, then, that man is no more than a determined, complex machine and consider some of the possible conclusions based on that premise. Man as a machine is programmed and can do nothing to change that program. This view implies certain things about God, about moral standards, and about man's individual worth.

God

The term 'personal God' is used in the sense of a God who relates to man. Relationship, in a personal sense, implies change and interaction between two personalities; if there is no relationship, there can be no knowledge of personal attributes. If man is a determined machine, he cannot be affected by, nor can he interact with, the personality of God so as to know God as a person. This means that, at most, man can be aware of God only as a Master Watch-Maker who set the universe in motion and retired to some remote vantage point to contemplate his handiwork.

But some not only reject the concept of relating to a personal God; they would go even farther and totally discard the idea of a God. For many, the concept of evolution provides the framework in which the development of the universe, up to and including the human mechanism, is to be understood. They may simply remain agnostic about the origins of the energy and basic matter that began the process. In some ways, the Christian is no better off logically in explaining the origin of the universe: he attributes it to God, but he is unable to explain the origin of God. Instead he "weasles out" by saying that God is an eternal being. If there is an eternal and infinite God, the Christian is not begging the question; he is merely acknowledging the fact that he, as a finite being, is incapable of dealing with a concept of the infinite. If, on the other hand, God as the Christian 'understands' him does not exist, the Christian is more deceived than the honest agnosic who admits his inability to answer the question of the origin of the universe a step or two earlier in the argument.

Moral Standards

If there is no God personally concerned with the world, the traditional source of moral standards vanishes. But then, how can man, if he is a programmed machine, be held accountable for his actions? Who is to say that one action is right and another is wrong? If man is determined, he could not change his actions to fit some arbitrary standard, so there is really no point in discussing morality. Francis Schaeffer points out that this is the conclusion reached by the determinist philosophy of the Marquis de Sade. What is, is right. Thus, for example, a man may do whatever he wishes with a woman because he is stronger than she is. Male physical superiority obviously exists to be used.

The logical conclusion of a determinist philosophy today is that whoever has power, whether it be economic, political, physical, or anything else, has the right to exploit other people. Indeed, it would seem that such a highly complex organism as man would continue to use every means available to insure his survival (that is, to preserve himself at least long enough to reproduce), for survival is, in effect, the goal of evolution. It is unlikely that man would evolve standards of morality that demand self-sacrifice, as opposed to self-preservation, to maintain those standards.

But this is exactly opposite to what people are saying today. Students claim the 'military-industrial complex' is wrong; the 'older generation' crusades against the evils of Communism; Communists castigate 'imperialists.' All of them are claiming that there is a definite right and wrong, and that their actions (demonstrating against war research, continuing the war in Vietnam, or invading Czechoslovakia) are justifiable according to certain moral values. If there is no such thing as morality, we certainly don't live like it.

Schaeffer uses Jean Paul Sartre as an example of one who definitely has an amoral philosophy but is unable to live with it. Sartre's existentialism calls for action since it is only by acting that anyone can authenticate his existence in an absurd and meaningless universe. Because there is no ultimate meaning, however, any action is allowed: nothing is right or wrong. Schaeffer points out Sartre's inconsistency in signing the Algerian Manifesto. It is also evident in his recent participation in 'trials' held in Sweden condemning the United States for criminal actions in Vietnam. By claiming that other people are acting immorally, and thus acknowledging a standard by which to judge them, Sartre is rebelling against the logical conclusions to which his world view leads.

Worth of the Individual

If there is, then, no basis for determining right or wrong, one man can destroy another with impunity.

This leads to a third repercussion of the man-as-machine theory: the individual has no intrinsic value. There is no standard by which to evaluate the worth of a human being. The idea that we can express our appreciation of the value of another person through love loses some of its appeal if we recall that, according to our mechanistic theory, the feeling of love is merely a manifestation of chemical reactions. I think most of us would rebel against such a denial of human worth.

Schaeffer points out that to deny a special essence in man (the mannishness of man, he calls it) is to deny the history of 30,000 years in which man has affirmed that special essence. This is dangerous ground for a Christian to be treading, however. The Christian believes that man's basic problem lies in his struggle, since the dawn of human existence, to be something he is not, namely God. No matter how hard he tries, man can never become God, and he only alienates himself from the Creator by rejecting his creatureliness. Thus to say that man rejects the idea of being a machine is in no way proof that he is not just a machine, just as his rejection of creatureliness does not mean that he is not a creature. As with so many other things, the solution lies in finding out what things are really like, not what man would like them to be.

Reflection

In searching for an answer to the problem, man has noticed that he has the ability to reflect upon himself to a degree not observed in other animals or machines. Teilhard de Chardin defines reflection in *The Phenomenon of Man*:

> From our experimental point of view, reflection is, as the word indicates, the power acquired by a consciousness to turn in upon itself, to take possession of itself *as of an object* endowed with its own particular consistence and value; no longer merely to know, but to know oneself; no longer merely to know, but to know that one knows.

Of course, we don't know to what extent animals are aware of their own existence, nor is it unreasonable to expect machines to monitor and maintain (to some degree) their own activities. But man's capacity for organizing and analyzing objective studies of himself appears to be unique. Objectivity is never fully achieved, of course, but the fields of biology, anthropology, sociology, and psychology have succeeded in developing a detached enough view of man so as to arrive at meaningful and useful conclusions concerning the human condition.

But even the argument from reflection is weakened if we don't have *enough* objectivity. How can we be sure that we are looking at ourselves from the right perspective? The Christian says at this point that the only true source of objectivity speaks about and to man through revelation. Consider the Biblical claim concerning the nature of Jesus Christ. He was fully God and yet fully man. As man, he was able to communicate clearly with us. As God, the instrument and sustainer of Creation (Col. 1:15-17), he was able to take an objective view of his creatures, just as an artist, being separate from his art (and yet vitally concerned with it as an expression of his own personality), can consider it objectively. Thus, Jesus Christ as God was able to discern and state clearly what is wrong with man, was able to see what the solution should be, and indeed provided it himself. This is what man has been unable to do. He has provided partial explanations and partial solutions, but the problem remains. It has brought some to the conclusion that there is no true answer to be found; man *is* nothing more than a complex machine. This is a conclusion of despair which denies that man has the ultimate meaning and value that he hopes to have.

To say that man rejects the idea of being a machine is not proof that he is not just a machine, just as his rejection of creatureliness does not mean that he is not a creature.

Conclusion

Christianity, on the other hand, claims that man does indeed have a true essence other than his existence. This essence has been twisted so that it no longer represents what it was intended to be, but that does not mean that it cannot be restored. As Schaeffer puts it, man is not dead, he is fallen. But if man is merely a machine, surely he is dead as far as the possibility of achieving higher human aspirations is concerned.

Is man just a machine, or is there something special in the human essence that sets him apart from the rest of the created universe? Ultimately, this question calls for a faith response; no one has yet found a way to prove conclusively to another person the truth of either alternative. The most that can be done is to examine the evidence other people claim to have used as a basis for their own decisions. This, after all, was the motivation for writing the Gospels (John 20:30, 31). It is the reason philosophers have written and taught. It is what leads one man to tell his experiences to another. Man has a tremendous capacity for communication. His dilemma is discovering whether or not there is anything truly worth communicating.

Spirit: God and Man

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In his book, "The Gospel According to Peanuts," Robert Short[1] speaks of that which is much discussed today: the language barrier between the Church and the world. He says,

> The Church's missionaries to its 'cultured despisers' need to be as well acquainted with the languages of culture as the Church's missionaries to foreign lands are acquainted with the languages of the area into which they are sent.

Bishop John Robinson in "Honest to God"[2] and others have observed that Christian concepts need to be restated for today's world[3,4]. They, in their efforts to shed light on the difficulty, may have gone far afield from the truth as held by historical, evangelical Christian theologians. But anyone who thinks seriously on the problem will have his difficulties.

What Is Spirit?

I have my beliefs inherited from my early years and crystallized after study of the Scriptures and writings on the Scriptures, and as I have trusted the Holy Spirit for guidance. However, I must confess doubts. "How", I wonder, "can I conceive of a God who can be described only as Spirit, omnipresent, omniscient, omnipotent? What is Spirit? Can I formulate an image which fits my faith, yet which is acceptable to my mind? One which helps, rather than hinders my spiritual growth? One which will help others to understand and which will lead them to be open to the ministerings of the Holy Spirit and to accept Jesus Christ as the Son of God and as Savior?"

A world enamored with intellectualism and materialism, as is ours today, finds the postulation of a Spirit realm unacceptable. Instead it turns to science which tells it that the brain consists of billions of cells which are capable of storing information much as a computer memory stores information.[5] Everything which happens to us from even before birth to right now puts an impression in a pattern of these cells. As life goes on there is built an ever-growing pattern which controls every future move and thought. In this concept "thought" is simply the "firing" of the cells in the brain memory units in some pattern which is controlled by previous patterns, all established by our encounters with the world around us or built-in instinct patterns. Truly, then, we are strictly the product of our environment. What we become is determined by our past. Even, we are told, our Christian experiences are established by our home life, Sunday School lessons and personal contacts. We just follow the easiest pattern in our memory.

Some of us become existentialists or follow some other philosophy which does not require a spirit or Spirit realm. We can accept no God "up there or out there." All we will admit is that which is experienced in our life encounters. Pondering on the meaning of life from this viewpoint we see no future, no hope of truly lofty thoughts, literally nothing. We become gloomy Sartres or Kierkegaards. We even say "God is dead!"

But, somehow, deep inside us we know this is not right. We must be more than our electrochemical selves. So, we establish a concept of other than the nothingness this gives us and call it our "ground of being,"[6] still trying to avoid what we "know" is true. We will not admit God and the Spirit realm.

A Scientific Approach

It is at this point that I feel that we abandon the science we seem to hold in high regard. Almost no (if any) scientific gain is made without postulating some entity or law. A theory is built upon that postulate or hypothesis and tried. If it works, good! If not we try again. The method is sound and we learn even the innermost secrets of the atom by its use. Why will we not apply the method to the spiritual phenomena which Christians accept?

As an example of the scientific method, consider the following example. In the early days of nuclear research, certain reactions never came out as calculated. A little bit of energy was lost in some unaccountable manner. Some researcher suggested that a small particle having negligible mass, and no charge, but capable of carrying energy must be the culprit. Thus was postulated the neutrino. Some years later, still having faith in the postulate, physicists proved the existence of the neutrino as a real energy-carrying particle.[7] Can we not so postulate the spirit realm and God and put it to the test? True the test will not be in the laboratory of physics, but in the laboratory of life.

Instead of such an approach to the question of God or the problem of the Spirit or just what is the true concept of our "being", man always seems to go to one extreme or the other. He says, "since God has spoken to us, it is no longer necessary for us to think"; or "The divine law requires man to seek God by the rational methods of philosophy." (Tertullian vs. St. Augustine).[8,9] Neither is true. God does speak, but man must think, e.g., Prov. 25:2[10]). On the other hand, man's thoughts cannot find God (Job 11.7)[11] or the deep things of God (Job 11.7).[10] His ways and thoughts are far above ours (Isa. 55:6-8 and Prov. 16:1),[10] yet He is always available to us (Isa. 55:1-9).[10] This is Barth's thesis in his work *Credo*, Chapter 2.[12]

Let us then try to be scientific and reasonable about

God. Let us make a postulate and test it. Let us devise a scheme we can understand in words and patterns we can visualize and try to use it to help us explain what our reason doesn't seem to want to accept.

Professor Richard H. Bube[13] of Stanford University has attempted to do this in his intriguing article "The Whole and the Sum of its Parts." He suggests that the spirit of man (and of animals) is the result of the manifold interactions between the many parts of the complex biochemical machine we know as the body. He thus moves a step beyond the purely mechanistic concept mentioned above. He maintains that the spirit is real and different from his body but that it does not exist apart from the body. It is at this point that a big question arises: What then is God? He is Spirit but He is not Body, at least of the human sort. Of what interactions does He consist?

In the following remarks, I have attempted to use some of the techniques of engineering analysis, the analog or analogy, and systems analysis and "black bodies" or block diagrams. I can only hope the results will be as helpful to others as they have been to me.

A scientific approach should be objective. It is to be hoped that objectivity is in what follows but that it is not so overriding as to be irreverant. My God is beyond understanding, else He is not God, thus spoke Augustine centuries ago (*"Si comprehendis, non est Deus"*). And so it is today. I stand in awe of God and worship Him in reverence. To Him is due all glory and honor. I seek to learn more of Him that I may wonder the more at His majesty, and that I may somehow know something more of His way. Yet I can never fully fathom Him.

My Postulate

This, then is my postulate. From all eternity, the Eternal Godhead was: the all pervading, infinitely, extending, omnipotent Spirit. In that Godhead was all knowledge, mercy, perfect judgment, and holiness. And in that Godhead, three Persons—Father, Son and Holy Spirit, each equally infinite, each omnipresent, yet each distinct in that which distinguishes persons. Here we again face a problem which we shall try to resolve later: "What is a person?" For the present I should like to use a mathematical term, viz., a singularity. *A person is a singularity, or singular point in the spirit realm.* So then I may say that the Trinity is a set of three singularities of the infinite Spirit of God. The influence of each is unlimited (or unbounded to use the appropriate mathematical term).

Possessing all Infinity, the Persons of the Trinity can be characterized neither by time, nor space, nor any other concept of man, yet they know both time and space. They created the time and space in which we live and seek to understand. In their common knowledge and wisdom They know the eternal verities of Themselves.

Our human mind is not capable of putting such thoughts into words, nor can we conceive, even abstractly, what we may feel. Is it any wonder that the Scripture says majestically and simply "In the beginning, God—"? (Gen. 1:1).[10]

An Analogy of the Spirit Realm

How can we describe this concept of the Spirit realm, of God, when it is beyond our understanding? Dare we use an analogy? Let me try to explain what I mean.

Once, to explain electromagnetic radiation and its propagation, late 19th century physicists postulated an ether which permeated all space, inter- and intra-molecular space, intergalactic space. Waves could be supported in this ether and propagated through it. Long waves were radio waves; short ones were light and still shorter ones were X-rays. Experiments were designed to test whether the earth moved relative to the ether.[14]

Slowly, prompted by Einstein's theory of relativity, the concept of the ether gave way to field theory.[15] Electromagnetic radiation could be explained without postulating a medium. Yet there remained something comforting about a medium through which the waves moved, at least to the minds of some of us for whom abstractions are difficult. However, we bowed eventually to the theorist and abandoned our ether. Such is the progress of scientific thought.

Now I ask the question again: "Dare we use an analogy to the Spirit realm? Can we get a better grasp of an understanding of God by using a field concept as an analog?" To be sure, we can never understand God, and we shall eventually yield to the abstractionist, but maybe we can be helped by the analog to accept that which is beyond understanding.

So then, returning to our postulate of the eternal, all pervading infinitely extending Spirit, let us assume that it is like the electromagnetic and gravitational field. Our concept doesn't really explain anything, but helps us believe that such a Spirit is possible just as electromagnetic radiation exists and is propagated. Our next step is to examine the character of the Spirit "field," the "substance" of the Spirit of which some of the catechisms speak.

We have already spoken of the infinite knowledge of God and will refer again to the omniscience of the Godhead. In addition, He possesses the character of energy. That is, this is the best human explanation of the concept of Omnipotence. Especially is this true if we undertake to relate our analog to the theories of the creation of the physical universe. One of the more acceptable theories is that which Gamow calls the "Big Bang".[16] A large amount of energy was converted to matter in some sort of explosion which sent the matter thus produced hurtling through space at tremendous speeds. At least one bit of the matter cooled over the eons and that bit is our Earth. Others remain hot and we see them as our sun and the stars. Some of them continue to move through space at speeds which made them appear to be receding from our earth at nearly 140,000 miles per second.

Once more let me say, the above concepts are no real explanation. They are theories, analogies, man's feeble attempts to put into words which he can understand the Infinite Creator and His acts. They simply say, "We don't know how it came about, but if God were Energy and if He can control Himself, then by our understanding of nuclear processes, we can calculate to some extent how it is true that "In the beginning God created the heavens and the earth," and "He is before all things and in Him all things hold together." (Col 1:17)[10].

Person as Singularity

In a very real sense, one can say here with Bube

and Paul that the Spirit is the binding force which holds all matter together, the Spirit of God and the spirit of man. However to limit it to this is pantheism of the first magnitude. God has become energy and the first or prime mover of the universe and the origin of all. Thus He is impersonal and, it would seem, ruled either by the "laws of nature" or chance.

Earlier we mentioned that it is possible to think of the idea of "Person" even in the context of the all-pervading Spirit realm. We used the word "singularity". Once again, however we try, the analogy we use will, at best, be crude and unsatisfying. Yet, also once again, it may be that the analogy gives a picture for us to use until faith builds a stronger framework.

When a mathematical description is written for some systems, it is found that the description fits everywhere except at certain special cases.[17] Take a simple example from trigonometry: the tangent of an angle. As the angle starts at zero and increases, the tangent also increases until its value goes to infinity at 90°. Such a value is called a singular point for it has an unusual characteristic. Some mathematical relationships can be represented as a sheet. If we represent the relationship as an elastic sheet and imagine the picture we get if we push a sharp pointed stick up, lifting the sheet at one point to some height and stretching it from its normal level we have another sort of singular point.

Now if we can imagine that something like a singularity occurs in the Spirit realm for each member of the Trinity and that each singularity has the character of a person, then we have our analog a little bit further developed. We may extend the analogy still more if we imagine that for the Trinity the influence of each singularity is felt to infinity, and inversely that anything occurring anywhere within the Infinite Spirit is immediately sensed by each Person represented by a singularity. A still further extension is to give to the Spirit the property of containing in some fashion all knowledge of all events in all time. Perhaps we might assume that all knowledge of all time is stored in the Spirit in a manner like an infinite computer memory. Thus each of the singularities becomes not only Omnipotent but Omniscient and in a real sense Omnipresent, for the Spirit was postulated to be the all pervading "field."

By the postulates of "storing" of knowledge in the "Spirit field," there is no need for an anthropomorphic brain for the members of the trinity. Neither is it now difficult for us to think of postulates to "explain" other characteristics of God without resorting to the physical features of man. The concepts of love, holiness, righteousness, justice, judgment and others of this sort can be attributed to the special characteristics of the singularities. Thus we will have built an analog of the characteristics of God, the Triune Creator, Controller and Judge of the whole of the Universe. Obviously, as we have said before, any analog usually leaves much to be desired and this one more than any. By a limited concept we have tried to represent the Infinite, but perhaps the attempt will help to bring the reality of the revelation of the Presence of God given by the Holy Spirit to us who name the Christ of God as Savior.

Man's Spirit

It seems reasonable to speak of the spirit of a man as of the same substance as that of God, but bounded and centered around the finite singularity which is the person of the man. The influence of this singularity is limited and its contact with the Infinite is somehow restricted to certain areas defined by a finite time and space. We have already spoken of the fact that the Spirit of God is not limited but is infinite. Such a concept permits an indefinite number of "islands" or finite singularities making any number of men to exist from some beginning for each and extending eternally.

Let us try to develop this analogy to the place where it includes the relationship between man—the body (the animal, if you please) and man—the spirit (the image of God) and the Spirit of God. The analog must provide for the perfect relation between man and God at creation, for the Fall and the re-establishing of that relationship in Christ through the atoning work at Calvary (and man's faith).

I am certain that no one really begins to know the Holy Spirit by a logical argument. Rather, at some time He comes, the Convictor and at once also, the Wooer. And man yields in faith. For any of several reasons, man acknowledges Jesus as the Christ and the Savior. He accepts this Savior as his own and in the Spirit is born again, a son of God. If he grows in his Christian life, man comes to know the presence of the Holy Spirit in a variety of experiences, sometimes cataclysmic, sometimes through long years of gentle persuasion.

For the purposes of this paper, it will be necessary at times to argue in a mechanical manner. But it will also be necessary to make our picture coincide with the Scriptures. Therefore the logical starting place is Genesis 1:26 where we read, "Then God said 'Let us make man in our image, after our likeness; . . .' And again 'Let us make him with the breath of life in him' (Gen. 2:7). And in paraphrase "Let us make him to live forever. Let us make him for the glory and pleasure of his Creator, the Everlasting God. Let us make him to be loved of God, and to love." (I Cor. 15:35, Rev. 4:11, John 3:16, I Jn. 4:8)[10].

We cannot deny that man is a biological system very much like the animals. He is bone and flesh and blood. He has a nervous system with sensory perception. Through this system he has contact with the world. He has a brain which has control over his body —both the housekeeping part and his motor action. He has a memory. In his memory are stored his encounters with the world and in it and his nervous system are his instinctive actions. The babe doesn't need to be taught to nurse; that is there when he is born, it is instinct. He learns to do some things by habit. All this is the physics and chemistry we've spoken of before, and all of this is animal.

But God breathes the Breath of Life into man. In this act He made man not a bit above the tadpole, but a bit less than God. He gave man a bit of Himself. This is the bounded part of the "spirit stuff" around the singular point which is the person of man.

Tournier has described the person as not what we see of each other but as the real living being[18]. The real you, the real I. The person is the immortal spirit, the concept we have expressed above. Wrapped around the person is the body, but also the impression you make on me, your personage (or personality). The real I (or you) is the sinner, thought we may be saved by grace through faith in Christ, sinner none-the-less. The personage is the Church Chairman, the Sunday School teacher, the good man in his community. This is the

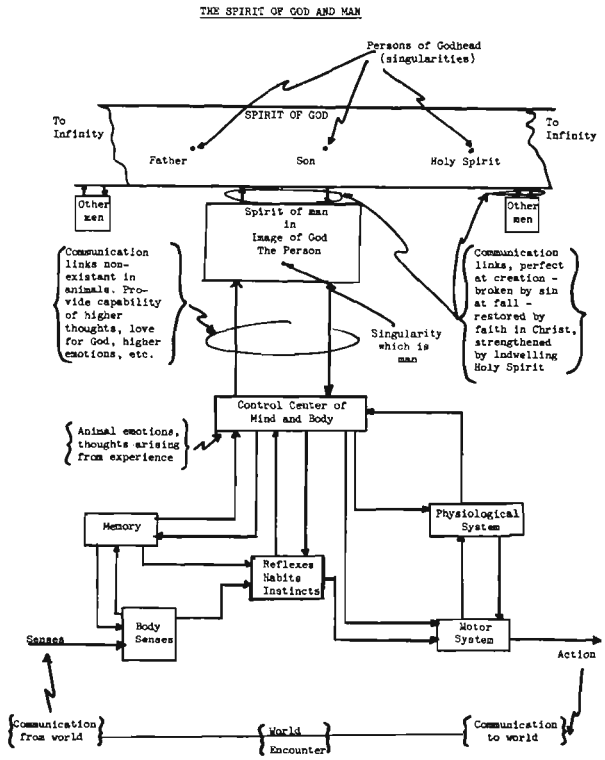
holy masquerade, all too often. Yet the real person, whatever he is, is loved of God for He created it; He breathed the breath of life into it and made it not just a bundle of bones and nerves but a living person whom He loved enough to die for at Calvary. And that person is in His image.

In his paper, Bube suggested that the idea of the spirit of man resulting from interaction made easier the description of when the fetus becomes a living being in the human sense. When the fetus is complete it has its spirit. The idea is an excellent one and can be incorporated in the concepts presented here. However, an extension is needed. When the Spirit of God has brought together and binds together the fetus, the spirit "stuff" forms the singularity described above. Once formed, it can be postulated the singularity exists eternally. Thus there is an explanation of the spirit's existence after destruction of the earthly body.

This concept in no way precludes the possibility or desirability of the "celestial" body of which Paul speaks in I Corinthians 15:40[10]. In fact, it provides a center around which the new or resurrection body is formed, and a continuity of the person. It provides for the perfected, glorified man who lives in joy with God in eternal life. It also provides for the spirit of the unregenerate man to continue in the eternal death of hopeless isolation from God.

A Block Diagram

Now let us try to display this as a block diagram, drawing on the previous concepts and also the concepts of engineering systems. We sometimes call the "blocks" black boxes[19]. We don't always know just what goes into the boxes, but we know something about what they do. So then the following is an attempt to help us see the whole picture of our relationship to God.



Some of the ideas of the diagram are self explanatory. Some refer to the physical life of man. We shall not spend time on them, but turn directly to the spiritual concepts.

Our diagram does violence to the Infinite God in that it represents the Spirit as a bounded region. This immediately points up the fact that analogs are seldom, if ever, able to represent the actual system. But I believe the idea is understandable within this limitation.

The spirit of man is not definable in terms of the physical or chemical activities of the body. Although it is separate from them it is able to affect these physiochemical activities. This means cannot be defined, but the effects are clearly observable. Tournier in *The Healing of Persons*[20] cites case histories showing the interplay between man's spiritual and physical welfare. This we have shown in the diagram by lines of communication between the brain and the spirit. Disturbances of the spirit reflected in the nervous system affect the "housekeeping" part of our body. Hence it becomes impossible for us really to separate the parts. We are body, mind and spirit; and for the Christian, merged or joined with the Spirit of God.

This concept is important to us for when we accept the spirit of man as a real part of him, not a part of his physico-chemical system but just as real, we reduce the problems of understanding in a vague way the existence and nature of God. It is the unwillingness of the materialist to admit the spirit which also makes him unwilling to accept God. It is reasonable to say that if one must choose between God and science, science which is observable to our physical senses must take first place. However, the Christian has, through the ministerings of the Holy Spirit, unshakable proof of the Spirit realm and the reality of the spirit of man.

To return to the model of man, we have noted that the spirit of man is able to affect the brain. It is able to establish patterns in the memory and to control the interchange of "nerve" impulses between the active or control portion of the brain and the memory. This is thought on the abstract level, i.e., without resultant body action and without reference to world encounters alone. This is, of course, the mind of man, these nerve impulses called thought.

From the complexity of the loops, it is obvious that any analysis of the system is not simple. The nature of the contents and responses of the "boxes" are not known and the interactions are far from understood. Even more beyond understanding is the nature of the Holy Spirit and His relation to the spirit of man.

For example, prayer is usually thought of as thoughts of words, even spoken words, which God "hears". But is this not conveyed through the spirit of Man? And then, is it not possible to commune with God in the spirit only, without using the mind? Is not this part of Paul's thinking in I Cor. 14,[10] for example? Is it not possible that speaking in tongues is communication between the Spirit of God and the spirit of man, transmitted to the motor part of the brain and on to the speech mechanism without reference to the memory and the stored or learned method of speech, or learned language?

Dahlstrom[21] discusses conscience as something unique to man. He implies it is not necessarily connected with religion nor is it a learned characteristic. Does this not imply that conscience and spirit are related? The nature of spirit includes righteousness since

it is of the nature of God. In man the "amount" is limited, but it nonetheless gives man a base from which he works even though he has had no standards established by his encounters with the world.

A model such as ours gives some sort of feel for the indwelling Holy Spirit. It is He who provides the link between man's spirit and the Spirit of God. And it is He who makes it possible for that link to be strengthened as we turn over the control of our lives to the Spiritual part of us. Perhaps a better analog of this is found in the automatic computer. Man's mind, in the picture we've drawn, is not the electrochemical action in the brain. It is the program in the logic of the computer as built there by the Creator and as modified by the programmer, the spirit of Man, and also as modified by outside disturbances, world encounters. For the Christian there is the Master Programmer, the Spirit of God, to whom the spirit of the Christian man is yielded, who can offset the effects of the world, the enticements to sin, and the nature of man's own sinful way.

Corollaries of the Model

Many ideas can be expanded by the use of these concepts and models. For example, if I have been reared in a "humanistic" society, I am moved to the desire to assist the needy. To the training I've had I may also add from my memory my own experiences in needing and receiving attention, food, clothing, etc. So I react as a humanist in society and give to the needy one. I offer my human love. However, if I am a Christian and am sensitive to the ministering of the Holy Spirit, I can now act in *agape* love. I will be moved with the compassion of God. The presence of the Holy Spirit and the communication links between Him and man's spirit makes man what he was created to be. It gives him what Luther called the "alien dignity of Man" for now his life is related to the glory of God.

Further the unity of the believer with Christ is now established in this pattern. When we have this relationship to Him, then truly we are aware that He has "The Whole World in His Hands," as the spiritual goes. When we are yielded to Him, the link between us and Him is so strong that we can say with Paul, "I have become absolutely convinced that neither death nor life, neither messenger of heaven nor monarch of earth, neither what happens today nor what may happen tomorrow, neither a power from on high nor a power from below, nor anything else in God's whole world has power to separate us from the love of God in Christ Jesus our Lord." (Rom. 8:38-39)[22].

We can say as a German sailor in World War I wrote his family, "If you should hear that I have fallen, do not weep! Remember that even the deepest ocean in which my body sinks in death is only a pool in the hand of my Savior."[23] Even in the remotest space, He is there and if I am in Him, nothing can take me from His love.

The Coming of Sin

At this point we would do well to review the course of the separation of Man from God, the breakdown of the communication channel between the spirit of Man and the Spirit of God. We review the coming of sin to man through his willful disobedience of God's law.

We begin by recalling the absoluteness of God's creation of the Universe, including Man. Man was created a body into which God "breathed the breath of life." He gave him a spirit; He made him a singular spirit with a bounded influence field in the Infinite Spirit of God. This was his person, and it was capable of a perfect relationship with God. Its communication link was fully active. In a very real sense, Man was created body and spirit and *in* the Spirit of God. This was the creation upon which God looked and saw "it was very good," very beautiful. Man's blessedness was complete. He was in the image of God and in God.

However, God had created man with a will, patterned after His own, centered in his spirit perhaps, but also arising out of the mind. So Man chose to go His own way without regard to God, and this is sin. In His Infinite Righteousness God could do no less than cut off communications with Man in the perfect sense in which it had existed. No more was the link so strong that Man could be said to be in God. And this is death in the most horrible, real meaning of the word.

God, in His Love and Mercy provided a means of repairing the break in communications, the death on the Cross of the Eternal Son of God, Jesus Christ. To Man, the sinner, was offered the repair as a gift to be chosen by Man of his own will even as he has chosen to go his own way, to sin. Thus the barrier separating the person of Man, his spirit, from its right relation with the Spirit of God, was lowered and the unity with Christ of which Paul speaks is made possible for him who will. This is the new birth.

Many other relationships could be described by our model, but space requires that we end our discussion here.

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BOOK REVIEWS

MECHANICAL MAN

by Dean E. Wooldridge, McGraw-Hill, New York (1968)

(See also *Journal ASA* 21, 56 (1969))

Review by J. T. Morrison, Department of Chemistry, Butler University, Indianapolis, Indiana.

Two men sit down to write. They are evangelists, persuaders; their gospel is nothing less than the truth about truth. Each has hit upon the ordering principle of all reality and wants to share this insight with us. Yet each considers the other hopelessly, incurably wrong and lost, off on the wrong scent entirely.

The first writer, Dr. D. E. Wooldridge sees all existence as beautifully contained and completely described in just one set of axioms, the laws of physics and chemistry. His goal is to convince us that these few foundational principles explain everything from inanimate matter to conscience and value systems. He even charts the future for us on the basis of the welcoming by men of this new awareness that we are machines.

Carefully selecting his data, he has skirted controversial and disputed areas and ignored whole areas of data of non-technological nature.

The other writer, Dr. M. Polanyi tells us explicitly that the attempt to describe all reality, especially that outstanding part of it called the mind of man, as merely physics and chemistry is "nonsense". For him an ascending order of principles exists, each dependent on, but not bounded by, the laws of the set of principles under it. He too looks into the future, but he sees a "society of explorers" not at all limited to the laws of physics and chemistry.

It would be unfair for me to try to disguise my bias for Dr. Polanyi's views and against those of Dr. Wooldridge. But I will try to show the beauty and comprehensiveness of Dr. Wooldridge's effort, which must be one of the most daring and complete treatments of the naturalistic and materialistic worldview ever attempted. He attempts all questions and capably marshalls the facts to give answers within his chosen framework. And therein lies the problem. Carefully selecting his data, he has skirted controversial and disputed areas and ignored whole areas of data of

(*Continued on page* 154)

Review by C. Daniel Geisler, Departments of Electrical Engineering and Neurophysiology, University of Wisconsin, Madison, Wisconsin.

In *Mechanical Man* by D. E. Wooldridge, a completely mechanistic model, or more exactly a system of interdependent mechanistic models of living creatures including man, is given. The book is written for the layman and as such cannot hope to cover the details of the work in all of the various fields involved, which range from molecular biology through neurophysiology to sociology. Hence, it is not surprising that the book contains over-simplifications, tenuous conclusions and important omissions. What *is* surprising is the fact that this particular book also contains some viewpoints which can only be described as scientifically outmoded. Hence, *Mechanical Man* is vulnerable to criticism on several counts. It would be a mistake, however, to evaluate it solely on the merits of the accuracy and completeness with which the various models are described, because these models are fitted together into a whole system. This system, which has important implications for the Christian, must also be considered. One word of caution: the author has not been careful to maintain a clear distinction between the models and the physical world, with the result that the two entities are blurred together in the book. Because the accuracy with which many of the models describe physical reality is not known, the author is forced to state that these models "must" or "probably" describe reality. These statements of faith are part of the literary style and world-view of the author and should not be considered as fundamental to the models or systems involved.

What *is* surprising is the fact that this particular book contains some viewpoints which can only be described as scientifically outmoded.

The book itself is composed of 19 rather brief chapters, grouped into five main sections: The physical properties of organisms, Behavior, Intelligence, Consciousness, and Implications of the physical explanation of biology. As indicated by the section titles, Dr.

(*Continued on page* 156)

Morrison

(*Continued from page* 153)

non-technological nature. Nonetheless one can learn very much from this book and can even be lifted by the noble sweep of the effort to encompass all reality on this simple basis. Surely such an attempt must fire any scientist's imagination. Inasmuch as my task is primarily to review *Mechanical Man,* I will describe it and use only selected portions and ideas from two works of Polanyi, specifically *The Tacit Dimension* and *Science, Faith and Society,* to illuminate any particular discussion. By extensive use of quotations at length, I hope to give sufficient material for readers to form their own judgments of both works.

Dr. Dean E. Wooldridge, cofounder and formerly president of Thompson Ramo Wooldridge Inc. has won awards for science writing, specializing in the interrelationships of technology and the life sciences. He does write well; with very little background in either computer technology or biology I had no difficulty following his thoughts wherever they ranged.

The book begins with a clear formulation of the author's philosophy followed by an equally clear description of his quest. We are then treated to a hurried but complete answer to the question of man. Yes, that's right, in this slim volume our whole development past and future is firmly sketched. In quick flowing paragraphs we solve the problems of origins, of man's biological heritage, of the nature of our thought and finally we see the future, the intelligent life we will lead when we realize that we are machines.

Wooldridge has skillfully cemented together the latest and best findings of certain kinds of research with plausible imagination-created missing links and bright guesses. And there's the rub, his case is much stronger than his data warrant. Indeed he goes so far beyond what is known that even one who shared his materialistic presuppositions was forced to comment in reviewing a predecessor book to this one,

> "Experimental evidence is lacking here and henceforth the explanations are based on premise built on premise, all mechanistically sound to be sure, but the inexorability of the argument is gone. One can make other premises based on other models . . . . ."[1]

Thus a reader uninformed of the real state of knowledge in these areas is likely to be grossly misled.

Physicists may be pleased with the underlying axiom, ". . . there is but one ultimate science, and that is the science of the physicist." (p. 3) Contrast this with Polanyi's statement:

> "Yet it is taken for granted today among biologists that all manifestations of life can ultimately be explained by the laws governing inanimate matter. K. S. Lashley declared this at the Hixon Symposium of 1948, as the common belief of all participants, without even consulting his distinguished colleagues. Yet this assumption is patent nonsense. The most striking feature of our own existence is our sentience. The laws of physics and chemistry include no conception of sentience, and any system wholly determined by such laws must be insentient."[2]

Clearly we have a choice to make between these irreconcilable viewpoints.

Dr. W.'s working hypothesis is again demonstrated in his chapter "The Chemistry of Life" where he asserts that modern research is strengthening an already convincing case for the belief that nucleic acid/protein enzyme mechanisms are responsible for those properties we call lifelike. If this were so then life could possibly be explained in material science concepts. However he has not adduced sufficient evidence to cause us to concur in his belief.

As we follow Dr. W. up the ladder of life it is interesting to note that accidental occurrences are his necessary causes, yet he cannot free his language from ideas denoting intelligent, willful, purposeful actions. (cf p. 47)

The real heart of *Mechanical Man* is found in those chapters dealing with analogies between computer operations and the workings of human minds and nervous systems. I suppose expertise with these electronic marvels is the major qualification Dr. W. brings to his study. I learned very much about that field from this book and indeed very much about modern concepts of nervous system operation. Nevertheless the author's pitfall is evident here. Just as many a bench scale reaction in chemistry is found to be much more complicated than originally thought when scaled up to plant size operation, so the possibly correct elucidation of some operations of parts of the nervous system does not warrant the conclusion that we now have the keys to total brain/mind performance.

It was so pleasant to read, so genuinely informative and imaginative that I was angered by the page after page presence of non-sequiturs arising out of the author's faith and fervor, not out of logical reasoning based on data at hand.

An illustration of this overstepping of evidence is shown in his mid-argument summary (a device that again demonstrates the high quality of Dr. W.'s writing and his insight into a reader's needs):

> "It was finally decided that such evidence constituted a powerful argument for the conclusion that all intelligence, whether of computer or brain, is the natural consequence of the powerful symbol manipulating capabilities of complex switching networks and that therefore the ordinary laws of the physical scientist are adequate to account for all aspects of what we consider to be intelligent behavior." (p. 128)

Unfortunately the evidence presented here is quite insufficient to allow this conclusion.

In order for a man to be consistently reduced to a machine his "highest" faculty must be shown to be explicable on the basis of the laws of physics and chemistry alone. Dr. W. proceeds to give his thesis that consciousness is almost totally a product of such laws. From experiments with human subjects relating electrical impulses to operations of the mind such as memory or even moral judgments (cf. p. 139), he draws the conclusion that all conscious activities of the mind will be shown to be merely electrochemistry. Although he is more cautious here he does clearly believe that he has given sufficient evidence to warrant his final conclusion:

> "Thus we have failed to discover any aspect of life—whether related to the origin of organisms, to their physical properties, to behavior, to intelligence, or to consciousness—whose explanation appears today to lie beyond the ultimate capabilities of physical science. In the late 1960's we seem justified in the broadest

possible application of what may be called the central thesis of physical biology that a single body of natural laws operating on a single set of material particles completely accounts for the origin and properties of living organisms as well as nonliving aggregations of matter and man-made structures. Accordingly, man is essentially no more than a complex machine." (p. 166, 167)

This is triumphant naturalistic materialism. As a philosophic system it has been sufficiently answered by many, such as C. E. M. Joad[3] and C. S. Lewis[4].

The book concludes delightfully enough with Dr. W.'s sketch of the expansion of this Faith into realms of social and moral interactions and even to a readmittance of God—although He is simply the name for whatever we feel is forever beyond "scientific" explanation, a sort of "God of the Gaps".

Frequently my emotional reaction to the book was one of irritation. It was so pleasant to read, so genuinely informative and imaginative that I was angered by the page after page presence of non-sequiturs arising out of the author's faith and fervor, not out of logical reasoning based on data at hand. So many worthwhile insights, so many valid areas for continued research and even philosophic inquiry were provided that it is a shame that the central tenet is so weak. It is in fact his philosophy of science as much as anything else that is at fault. And it is here that the conflicts between views such as his (very popular today) and those held by Dr. Polanyi (not so popular) can be most clearly seen.

I am reminded also of the Eddington Lecture of Dr. James Conant. In contrast to Dr. W.'s strong belief in the methodology of physics, this respected scientist observes, "The success of the natural scientists . . . , is not due primarily to their methods but to the *aim* of their efforts".[5] In the course of this intriguing lecture Dr. Conant divides experience into three categories: the realm of nature, the realm of human nature and the realm of religious experience. Each realm he insists has its own proper methods and tools for truth seeking. Bases, tactics and conclusions proper to one realm do not necessarily have any power in another realm, nor can ideas pertinent to one area necessarily discount those of another. While he is unimpressd by any unifying world hypothesis he does welcome cross fertilization between realms of man's life.[6] One would expect Conant and Polyani to be brothers-in-arms in their rejection of much of the thesis and argument of *Mechanical Man.*

Dr. Polanyi's approach to science is much less dogmatic than that of many scientists writing today. Look at *Mechanical Man* for instance, where Dr. W. says "Within a calculable and frequently very narrow range of uncertainty, the future is completely determined by the past. Given the laws and the particles, all else follows inexorably." (p. 3) Again, in frankly stating his own feelings and driving force,

"We find great appeal in the notion that all we can observe or feel is caused by the operation of a single set of inviolable physical laws upon a single set of material particles. This seems to us to be a logical extension of the unbroken chain of brilliant successes of physical science in accounting for one aspect after another of human experience. Therefore, to us, the evidence examined in this book seems right; we believe it easily, ..." (p. 203)

In clear contrast Dr. Polanyi writes:

"The declared aim of modern science is to establish a strictly detached, objective knowledge. Any falling short of this ideal is accepted only as a temporary imperfection, which we must aim at eliminating. But suppose that tacit[7] thought forms an indispensible part of all knowledge, then the ideal of eliminating all personal elements of knowledge would, in effect, aim at the destruction of all knowledge. The ideal of exact science would turn out to be fundamentally misleading and possibly a source of devastating fallacies."[8]

Or elsewhere

". . . . all these levels [of existing things] are situated above that of the inanimate, and hence they all rely for their operations—directly or indirectly—on the laws of physics and chemistry which govern the inanimate. If then we apply the principle that operations of a higher level can never be derived from laws governing its isolated particulars, it follows that none of these biotic operations can be accounted for by the laws of physics and chemistry."[9]

I found it cheering to have Polanyi quote the scholastics' "believe in order to know" approvingly[10] and adopt it as a foundation for viewing epistemology in the sciences. He even points out from his own laboratory experience that a residue of personal judgment is required in the decision to give a certain weight to any particular set of evidence in regard to establishing the validity of a particular proposition.[11] I must say that this appears to be a much more effective and serviceable philosophy of science than the ones most popular in print today.

Wooldridge and fellow technolatrists see physical sciences as the sources of infallible truth. They believe science shows them all that is true. Thus they are like the blind men clustered around the elephant in the old story, completely convinced that their insights (useful and true as they may be) are all there is to know. Others of us in science would like them to see the other parts of the elephant too. In fact, thinkers such as Dr. Polyani would help us all to see that not only is there a whole elephant before us to be examined but that we the examiners are also in the picture. No real insight to reality can occur unless we happily admit we are in the picture and that this event is part of the data.

Neither God nor man exists in the materialist's universe. Part of the weakness of a treatment of science such as *Mechanical Man* in its failure to come to grips with the data of a Christian's life in communion with God. What simple law or physics does such a thing as that fall under?

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7. In Dr. Polanyi's thought the key concept is the "tacit" dimension to knowledge and thinking. Thus, he distinguishes between a sort of inner, nonformalized knowledge and an outer knowledge, indicating that we must use the inner, tacit knowledge to reach and deal with the outer explicit knowledge. Elsewhere he sums this up by saying that we always *know* more than we can *tell.*
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Geisler

(*Continued from page* 153)

Wooldridge's basic thrust is centered in the neural and behavioral sciences. Briefly speaking, he first shows by some well-chosen examples that our understanding of the brain and our ability to mimic its mechanisms have grown rapidly in recent years through the use of the physical and biological sciences. Extrapolating, he then states that there is no reason to believe that these sciences will not eventually be able to describe the entire workings of the brain, any brain, on completely mechanistic grounds. This process of describing or modeling the brain mechanistically has already gone so far in Dr. Wooldridge's estimation that he endorses this system of models as being the "*only* simple, direct and uncomplicated interpretation of these results that anyone has been able to devise."

Let us proceed to the book itself, directing our attention during this review to the central parts, those involving neurophysiology and computers. The overall model presented in Part 2, "Behavior" (Chapters 5-6), and Part 3, "Intelligence" (Chapters 7-11), is that the animal brain is simply a computer, closely related to the digital computer. On the first point, Wooldridge is right to a certain extent; almost all brain scientists, Christians or not, treat the brains, or parts of brains, of experimental animals as if they were computers. Illustrative of this treatment is the title of Nobel-laureate John Eccles' latest book *The Cerebellum as a Neuronal Machine,* which concerns the part of the brain known as the cerebellum. Just how far this type of approach can be carried is not clear, but it presently is fueling a spectacular growth in our ability to describe brain mechanisms. As a benchmark, it seems likely that the complete modeling of the tiny brains of simple invertebrates will soon become possible. Before even that can happen, however, a much better understanding of many brain processes will be necessary; for instance, the mechanisms of memory, learning, attention and consciousness are almost completely unknown. The complete modeling of vertebrate brains, with their billions of nerve cells, is entirely out of sight. Contrary to the impression given in the book, there is little evidence to suggest that the animal brain has any but a superficial resemblance to the modern *digital* computer. The building blocks of the two systems are fundamentally different from each other, and the systems as a whole seem to use completely different mechanisms. For instance, many brain functions are best described in probabilistic terms, while a digital computer is a completely deterministic device. Moreover, since the brain's memory mechanisms are almost completely unknown, they cannot even be compared with those of a digital computer. Finally there are theorems in the field of symbolic logic which can be interpreted to mean that at least the human brain is definitely *not* a mechanical computer of any sort now understood.[1] Therefore, the considerable accomplishments of digital computers in mimicking certain aspects of brain function, some of which are reviewed in Chapters 9 and 10 ("The Intelligence of Computers" and "Machines that Imitate the Brain"), cannot be taken as supporting Wooldridge's contention that there is a family resemblance between brains and modern computers.

Part 4, "Consciousness" (Chapters 12-15) is the weakest section of the book. Current understanding about consciousness is too skimpy to provide a firm theoretical base for Wooldridge, or anybody else. Moreover, the section is scientifically outdated in many respects, with most of the technical references 10 to 15 years old. Nevertheless, this section is important: it forms an introduction to the large and growing body of experimental evidence which indicates that many aspects of human and animal behavior and sensation can be dramatically modified and controlled by electrical, chemical or surgical alteration of the brain. The author takes these findings as being consistent with his basic brain/computer analogy.

In the final section of the book, the implications of the Wooldridge system of mechanistic models are very briefly explored. Some of these implications, while dramatic, do not follow from the model system presented. For instance, the author concludes that "there is obviously no room for a personal God in a world that is rigidly obedient to inexorable physical laws." Yet the postulated physical laws need not outlaw God; they may in fact be found to include him explicitly. Another of Wooldridge's unsupported conclusions is that an afterlife is impossible. God, however, could bring a dead mechanistic man back to life simply by reassembling the parts.

The book, in summary, presents a completely mechanistic model of life. It's usefulness is limited: some of its arguments are incomplete, some of its facts are outdated, some sections make unwarranted conclusions, and theorems regarding the possible limitations of such an approach are not even mentioned. Contrary to the implications of the book, an unimaginable gap exists currently between human behavior and our ability to describe it mechanistically. It is true, however, that the general models used by most brain researchers are of a mechanistic nature. As the book correctly indicates, the results of these models are extremely impressive, demonstrating that many of the approaches used in the physical sciences can be successfully applied to the biological sciences as well.

In spite of its weaknesses, the significance of the present book must not be underestimated; it is a harbinger of an invasion that is to come. The general system of models outlined by Wooldridge is a natural and plausible one, and we can expect many more such systems. Because the component models are being continually improved and expanded by the many scientists now working on the brain,[2, 3] these future systems promise to model a greatly increasing amount of animal and human behavior with rapidly increasing vigor and sophistication.

It would be hard to overestimate the threat to Christianity that such mechanistic model systems present. The existing and expected successes of these systems in describing animal and human behavior will lead, indeed already are leading, many to conclude that the "only simple . . . interpretation" of our world is a mechanistic one.

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INDEX, VOLUMES 20-22, 1968-1970

The Index for Volumes 1-15 *is to be found at the end of Volume* 15. *The Index for Volumes* 16-19 *is to be found at the end of Volume* 19. *Numbers refer to volume, issue, page, and year. The letter is the initial of the month (March, June, September, and December).*

A

Albert, Jerry D. — Contribution to "Bible-Science Symposium," 21, 4, D, 104 (1969)

Anderson, V. Elving — Chromosomes and Human Behavior, 21, 2, J, 48 (1969)

Ashwin, J. G. — Poem: Dialogue, 21, 2, J, 59 (1969)

B

Barkman, Paul T. — The Relationship of Personality Modes to Religious Experience and Behavior, 20, 1, M, 27 (1968)

Bass, William — Topics to be Used as Dithering Devices in the Classroom, 20, 1, M, 24 (1968)

Benson, Purnell H. — Theory Formulation and Validation in the Social Sciences, 20, 1, M, 17 (1968)

Berg, Marie — Contribution to "Bible-Science Symposium", 21, 4, D, 104 (1969)

Berney, James E. — Needed: A New Look at Christian Eschatology, 21, 4, D, 133 (1969)

Boardman, Donald — Comment on "Fundamentalism and the Fundamentals of Geology," 21, 3, S, 75 (1969)

Bube, Richard H. — The President Speaks, 20, 1, M, 1 (1968)

Bube, Richard H. — The Relationship between the ASA and the Scientific Community, 20, 1, M, 2 (1968)

Bube, Richard H. — Christian Responsibilities in Science, 21, 1, M, 2 (1969)

Bube, Richard H. — Contribution to "Bible-Science Symposium," 21, 4, D, 105 (1969)

Bube, Richard H. — Man on the Moon, 21, 4, D, 125 (1969)

Bube, Richard H. — The Foolish Alternative, 21, 4, D, 134 (1969)

Bube, Richard H. — A New Decade, 22, 1, M, 2 (1970)

Bube, Richard H. — Asking the Right Questions, 22, 2, J, 49 (1970)

Bube, Richard H. — Is Man Only a Complex Machine? 22, 4, D, 122 (1970)

Bube, Richard H. — Do Life Processes Transcend Physics and Chemistry? 22, 4, D, 125 (1970)

Bube, R. H., Lindquist, P. F., Mantik, D., Simons, G. and Simpson, P. — A Set of Christian Theses on Violence and War, 22, 1, M, 21 (1970)

Bullock, Wilbur L. — Contribution to "Bible-Science Symposium," 21, 4, D, 106 (1969)

Bullock, Wilbur L. — The Coming Castrophies: Causes and Remedies, 21, 3, S, 84 (1969)

C

Calhoon, Stephen W., Jr. — Contribution to "Bible-Science Symposium," 21, 4, D, 106 (1969)

Camping, Harold — The Biblical Calendar of History, 22, 3, S, 98 (1970)

Camping, Harold — Rebuttal to Critiques of "The Biblical Calendar of History," 22, 3, S, 106 (1970)

Christian Medical Society — A Protestant Affirmation on the Control of Human Reproduction, 22, 2, J, 46 (1970)

Coleson, Edward P. — From Deism to Deicide: Why God "Died", 20, 4, D, 114 (1968)

Collins, Gary R. — Contribution to "Bible-Science Symposium," 21, 4, D, 107 (1969)

Collins, Gary R. — The Manipulation of Human Behavior: A Psychologist's Perspective, 22, 1, M, 8 (1970)

Collins, Gary R. — Three Perspectives on Men and Machines, 22, 4, D, 135 (1970)

Cuffey, Roger J. — Comment on "Fundamentalism and the Fundamentals of Geology," 21, 3, S, 71 (1969)

Cuffey, Roger J. — Contribution to "Bible-Science Symposium," 21, 4, D, 108

Cuffey, Roger J. — Critique of "The Dying of the Giants," 22, 3, S, 93 (1970) (1969)

Cuthbertson, William W. — Christianity and the Military Establishment, 22, 1, M, 18 (1970)

D

Dayton, Edward R. — Research, A Key to Renewal, 21, 1, M, 15 (1969)

Dolby, James R. — Determinism, Degrees of Freedom and the Christian, 20, 2, J, 33 (1968)

Duriez, Colin — Do Life Processes Transcend Physics and Chemistry? 22, 4, D, 128 (1970)

F

Feenstra, E. S. — The Spiritual vs. Material Heresy, 21, 2, J, 44 (1969)

Frair, Wayne — Ignorance, Inertia and Irresponsibility, 21, 2, J, 43 (1969)

G

Granberg, Lars I. — The Christian College: Its Tasks and Opportunities, 20, 4, D, 120 (1968)

H

Hardin, Garrett — The Tragedy of the Commons, 21, 3, S, 83 (1969)

Hartzler, H. Harold — Contribution to "Bible-Science Symposium," 21, 4, D, 109 (1969)

Hatfield, Charles — Presidential Greetings, 21, 1, M, 32 (1969)

Hearn, Walter R. — Current Challenges for Christian Professors in the Physical Sciences, 21, 3, S, 87 (1969)

Hearn, Walter R. — Three Perspectives on Men and Machines, 22, 4, D, 136 (1970)

Heddendorf, Russell — Religious Values in the Vocation of Science, 20, 4, D, 118 (1968)

Heddendorf, Russell — Social Problems and Social Issues, 21, 3, S, 81 (1969)

Heddendorf, Russell — Contribution to "Bible-Science Symposium," 21, 4, D, 111 (1969)

Horner, George R. — Contribution to "Bible-Science Symposium," 21, 4, D, 110 (1969)

Howe, Frederick R., and Howe, George F. — Moses and the Eagle: An Analysis of Deut. 32:11, 20, 1, M, 22 (1968)

Howe, George F. — The Raven Speaks, 21, 1, M, 22 (1969)

Hubbard, David A. — Poem: The Creative Power of God, 22, 1, M, 22 (1970)

Hummel, Charles E. — The Scientific Revolution of the Sixteenth and Seventeenth Centuries, 20, 4, D, 98 (1968)

J

Jekel, James F. — Poverty and the Adolescent Parent, 22, 2, J, 59 (1970)

Jennings, George J. — An Ethnological Study of Glossalalia, 20, 1, M, 5 (1968)

Jennings, George J. — American Culture and Drug Use, 20, 4, D, 104 (1968)

Jennings, George J. — Cultural Factors Affecting Human Fertility, 22, 2, J, 53 (1970)

Jewell, Robert D. — Validation of Scientific Theories, 20, 3, S, 65 (1968)

Johnson, Walter C. — Only a Machine, or Also a Living Soul? 22, 4, D, 137 (1970)

K

Knobloch, Irving W. — Thinkers Thought on Religion and Science, 20, 4, D, 119 (1968)

Knobloch, Irving W. — Some Personal Reflections on 1968, 21, 2, J, 50 (1969)

Knobloch, Irving W. — Contribution to "Bible-Science Symposium," 21, 4, D, 111 (1969)

Knobloch, Irving W. — Three Perspectives on Men and Machines, 22, 4, D, 136 (1970)

L

Leith, T. H. — Contribution to "Bible-Science Symposium," 21, 4, D, 112 (1969)

Lewthwaite, Gordon R. — Contribution to "Bible-Science Symposium," 21, 4, D, 114 (1969)

Lewthwaite, Gordon R. — Mechanism, Naturalism, and the Nature of Social Science, 22, 4, D, 141 (1970)

Lindberg, David O. — The Scientific Revolution Misconstrued, 20, 3, S, 87 (1968)

M

Maatman, Russell — Biological Evolution, 20, 4, D, 119 (1968)

Maatman, Russell — Contribution to "Bible-Science Symposium," 21, 4, D, 115 (1969)

Mavrodes, George I. — Contribution to "Bible-Science Symposium," 21, 4, D, 117 (1969)

McIntyre, John A. — Contribution to "Bible-Science Symposium," 21, 4, D, 118 (1969)

McLaren, J. Philip — From the Creation of the World, 20, 3, S, 70 (1968)

Mills, Gordon C. — The Evolutionary Significance of the Species Variation in Structure of Cytochrome C, 20, 2, J, 52 (1968)

Mixter, Russell L. — Contribution to "Bible-Science Symposium," 21, 4, D, 119 (1969)

Mixter, Russell L. — Other Literature (Birth Control), 22, 2, J, 51 (1970)

Mixter, Russell L. — Materialism and Modern Man, 22, 4, D, 132 (1970)

Moberg, David O. — Religious Perspectives of Students, 21, 4, D, 126 (1969)

Moberg, David O. — The Manipulation of Human Behavior: A Sociologist's Perspective, 22, 1, M, 14 (1970)

Montgomery, John W. — Contribution to "Bible-Science Symposium," 21, 4, D, 121 (1969)

Moore, James R. — Charles Lyell and the Noachian Deluge, 22, 3, S, 107 (1970)

Moore, John N. — Evolution: Required or Optional in a Science Course? 22, 3, S, 82 (1970)

Munro, Donald M. — Indifference to Exploitation Unjustifiable, 21, 2, J, 46 (1969)

N

Neidhardt, W. Jim — Faith and Human Understanding, 21, 1, M, 9 (1969)

Neidhardt, W. Jim — Contribution to "Bible-Science Symposium," 21, 4, D, 120 (1969)

Newton, Mary Jeanne — The Man Who is There, 22, 4, D, 145 (1970)

O

Oakland, James A. — Contribution to "Bible-Science Symposium," 21, 4, D, 122 (1969)

Oliver, C. Herbert — Black Power: What Does It Mean? 22, 2, J, 44 (1970)

P

Pannell, William — The Americanization of Sambo, 22, 2, J, 42 (1970)

Pattison, E. Mansell — Behavioral Science Research on the Nature of Glossolalia, 20, 3, S, 73 (1968)

Polanyi, Michael — Life's Irreducible Structure, 22, 4, D, 123 (1970)

Pollard, William G. — Man on a Spaceship, 21, 2, J, 34 (1969)

Pollard, William G. — The Unreasonable Effectiveness of Mathematics in the Natural Sciences, 21, 2, J, 62 (1969)

R

Ramm, Bernard — The Relationship of Science, Factual Statements, and the Doctrine of Biblical Inerrancy, 21, 4, D, 98 (1969)

Reeves, Earl J. — An Evangelical Position on Birth Control, 22, 2, J, 50 (1970)

Ruark, Arthur E. — Where Do We Go From Here? 22, 1, M, 4 (1970)

S

Seely, Paul H. — The Three-Storied Universe, 21, 1, M, 18 (1969)

Seely, Paul H. — Adam and Anthropology: a Proposed Solution, 22, 3, S, 88 (1970)

Showalter, Richard Lee — My Philosophy and Experience Concerning the Practical Application of the Christian Fundamentals in Psychology, 20, 2, J, 48 (1968)

Skinner, Tom — What's the Next Move? 21, 3, S, 66 (1969)

Springstead, William A — The Dying of the Giants, 22, 3, S, 91 (1970)

Stanley, Paul E. — Spirit: God and Man, 22, 4, D, 148 (1970)

Stigers, Harold G. — Critique of "The Biblical Calendar of History," 22, 3, S, 102 (1970)

Stipe, Claude E. — Some Theological Issues (Birth Control), 22, 2, J, 47 (1970)

T

Torjesen, Leif — Evaluation of Dolby, 20, 2, J, 36 (1968)

V

van de Fliert, J. R. — Fundamentalism and the Fundamentals of Geology, 21, 3, S, 69 (1969)

Verno, C. Ralph — Mathematical Thinking and Christian Theology, 20, 2, J, 37 (1968)

W

Wald, George — A Generation in Search of a Future, 21, 4, D, 129 (1969)

Walker, C. Eugene — Contribution to "Bible-Science Symposium," 21, 4, D, 122 (1969)

Watt, Kenneth E. — Environmental Control, 21, 2, J, 39 (1969)

Weaver, Gilbert — An Examination of a Proposed New Religion Based on Science, 20, 2, J, 41 (1968)

Weisiger, Cary N., III — Yes, There is a Future, Stephanie, 21, 4, D, 136 (1969)

White, Lynn, Jr. — The Historical Roots of Our Ecologic Crisis 21, 2, J, 42 (1969)

Wilson, Robert Lake — Contribution to "Bible-Science Symposium," 21, 4, D, 123 (1969)

Y

Yamauchi, Edwin M. — Critique of "The Biblical Calendar of History," 22, 3, S, 99 (1970)

BOOK REVIEWS

(Reviewer's Name Given in Parentheses)

Anderson, J. N. D. (*Richard H. Bube*) — *Christianity: the Witness of History* 22, 2, J, 71 (1970)

Berger, Peter L. (*Richard H. Bube*) — *A Rumor of Angels* 22, 2, J, 70 (1970)

Borgstrom, Georg (*Russell L. Mixter*) — *The Hungry Planet* 21, 3, S, 91 (1969)

Bronowski J. (*Richard H. Bube*) — *The Identity of Man* 21, 2, J, 56 (1969)

Bube, Richard H., Ed. (*Jerry Albert*) — *The Encounter Between Christianity and Science* 21, 3, S, 89 (1969)

Cauthen, Kenneth (*Irwin Reist*) — *Science, Secularization and God* 21, 2, J, 53 (1969)

Chestnut, D. Lee (*Stephen W. Calhoon, Jr.*) — *The Monkey's on the Run* 22, 1, M, 23 (1970)

Clark, R. E. D. (*Richard H. Bube*) — *The Christian Stake in Science* 21, 2, J, 58 (1969)

Clinebell, Howard J. (*C. Eugene Walker*) — *Basic Types of Pastoral Counselling* 20, 3, S, 94 (1968)

Clouse, R. G., Linder, R. D., and Pierard, R. V., Eds. (*Claude E. Stipe*) — *Protest and Politics: Christianity and Contemporary Affairs* 22, 2, J, 66 (1970)

Collins, Gary R. (*Richard H. Bube*) — *Search for Reality* 22, 2, J, 70 (1970)

Crespy, G. (*Bruce Phillips*) — *From Science to Theology* 22, 1, M, 23 (1970)

Davidheiser, Bolton (*Richard H. Bube*) — *Evolution and Christian Faith* 22, 1, M, 28 (1970)

Dayton, Edward R. (*Richard H. Bube*) — *Medicine and Missions* 22, 2, J, 69 (1970)

Dye, David L. (*Charles E. Hummel*) — *Faith and the Physical World: A Comprehensive View* 20, 2, J, 62 (1968

Ehlers, V. J. and Griffioen, R. D., Eds. (*Richard H. Bube*) — *The Christian and Science* 22, 1, M, 28 (1970)

Frair, Wayne and Davis, P. William (*J. Frank Cassel*) — *The Case for Creation* 20, 2, J, 64 (1968)

Friends (American) Service Committee (*Richard H. Bube*) — *Who Shall Live?* 22, 2, J, 68 (1970)

Gallup, George H., Jr. and Davies, John O., III (*David O. Moberg*) — *Gallup Opinion Index: Special Report on Religion* 22, 2, J, 67 (1970)

Gilkey, Langdon (*Richard H. Bube*) — *Maker of Heaven and Earth* 21, 2, J, 59 (1969)

Green, Michael (*Richard H. Bube*) — *Runaway World* 21, 2, J, 57 (1969)

Homans, Peter, Ed. (*Orville S. Walters*) — *The Dialogue between Theology and Psychology* 21, 2, J, 53 (1969)

Jeeves, M. A. (*Richard H. Bube*) — *The Scientific Enterprise and the Christian Faith* 22, 1, M, 27 (1970)

Jones, D. G. (*Richard H. Bube*) — *Teilhard de Chardin* 22, 1, M, 26 (1970)

Katter, R. L. (*Irving W. Knobloch*) — *History of Creation and the Origin of Species* 22, 1, M, 23 (1970)

Kenyon, D. H. and Steinman, G. (*John W. Haas, Jr.*) — *Biochemical Predestination* 22, 3, S, 117 (1970)

Kitchen, K. A. (*Edwin M. Yamauchi*) — *Ancient Orient and Old Testament* 20, 3, S, 94 (1968)

Kraft, R. W. (*Bruce Phillips*) — *The Relevance of Teilhard* 22, 1, M, 23 (1970)
(*Richard H. Bube*) — 22, 1, M, 25 (1970)

Kraus, John Louis (*Charles Campbell*) — *John Locke* 22, 2, J, 68 (1970)

Langford, Jerome J. (*James W. Sire*) — *Galileo, Science and the Church* 20, 4, D, 127 (1968)

Lee, Alfred McClung (*Marlin Kreider*) — *Multivalent Man* 20, 1, M, 30 (1968)

Moberg, David O.
(*E. M. Pattison*)
Paddock, William and Paul
(*Wilbur L. Bullock*)

Rust, Eric C.
(*Irwin Reist*)

Schaeffer, F. A.
(*Richard H. Bube*)
Schaeffer, F. A.
(*Richard H. Bube*)
(*David L. Dye*)
Schaeffer, F. A.
(*Richard H. Bube*)
Schonfield, H.
(*Edwin M. Yamauchi*)
Smart, J. J. C.
(*Peter A. Pav*)

Inasmuch 21, 1, M, 26 (1969)

Famine—1975! America's Decision: Who Will Survive? 20, 4, D, 126 (1968)
Evolutionary Philosophies and Contemporary Theology 22, 3, S, 116 (1970)
Escape from Reason 21, 2, J, 54 (1969)
The God Who is There
21, 2, J, 54 (1969)
21, 2, J, 55 (1969)
Death in the City 22, 2, J, 72 (1970)
The Passover Plot 21, 1, M, 27 (1969)
Between Science and Philosophy 21, 3, S, 89 (1969)

Spitzer, W. O. and Saylor, C. L., Eds.
(*Richard H. Bube*)
Taylor, Gordon R.
(*Donald Munro*)
Taylor, Hebden
(*Stephen W. Calhoon, Jr.*)

Valle, M. M.
(*J. O. Buswell, III*)

Wilder-Smith, A. E.
(*Stephen Coupland*)
Wildiers, N. M.
(*Bruce Phillips*)
Wooldridge, D. E.
(*Richard H. Bube*)
(*J. T. Morrison*)
(*C. Daniel Geisler*)

Birth Control and the Christian 22, 2, J, 68 (1970)

The Biological Time Bomb 21, 3, S, 90 (1969)
Evolution and the Reformation of Theology 22, 3, S, 117 (1970)
Two Concepts of Race. Human Life Zones: The Road to Academic Integration 20, 3, S, 95 (1968)
Man's Origin, Man's Destiny 22, 3, S, 117 (1970)
An Introduction to Teilhard de Chardin 22, 1, M, 23 (1970)
Mechanical Man
21, 2, J, 56 (1969)
22, 4, D, 153 (1970)
22, 4, D, 153 (1970)

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Helmut Thielicke
How the World Began, Fortress Press, Philadelphia, Pa. (1961)

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