GOD AND THE STATISTICAL UNIVERSE

by Patrick H. Byrne

In the conclusion to his *On Waves, Particles and Hidden Variables* C. W. Reitdijk wrote: "Therefore, our only hope of survival, in the deepest sense of the word, the only hope of the truly religious man, has to be set on determinism, on hidden variables."[1] The hidden variable theory is a fairly recent development within the field of theoretical quantum mechanics.[2] Its aim has been to develop a theory of physical parameters which would both retain the verified discoveries of quantum mechanics and eliminate the ultimately statistical foundation of that theory. It is not my purpose to engage in a critical discussion of the hidden-variable theory. Rather the aim here is to challenge the view, stated so poignantly by Reitdijk, that determinism is essential to authentic religiosity. In particular I will discuss the philosophical contributions of the philosopher-theologian Bernard Lonergan to this subject. Lonergan argues that the existence of an inherently statistical (and therefore nondeterministic) universe is indeed compatible with traditional religious beliefs concerning God. I will explicate his argument.

Lonergan's position stands in opposition to the views of a long line of philosophers and scientists. The idea that genuine religiosity entails determinism of course antedates Reitdijk's appeal to the hidden variable theory. Albert Einstein, who is frequently quoted as having said "God does not play dice with the world," was perhaps the most famous adherent to the basic idea in Reitdijk's statement.[3] Well before Einstein, essentially the same idea stood behind the "argument from design" of the eighteenth-century deists.[4]

Two assumptions lie behind virtually all claims that determinism is necessary to genuine religiosity. The first assumption is that the universe can have an intelligible order only if it is deterministic. The second is that if the universe is inherently statistical then God cannot be omniscient. This second assumption is connected with the idea that the objective randomness of events in an inherently statistical universe would preclude God's knowledge of the future. These assumptions

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seem so necessary it is little wonder that determinism has been so widely accepted as essential to genuine religiosity.

However, the remarkable successes of quantum mechanics, coupled with the almost universal scientific acknowledgment that quantum mechanics is inherently statistical (hidden-variable theories notwithstanding), suggest that it may be rash to claim the "only hope" of religious persons has to be set on determinism. Biblical interpreters of the sixteenth and seventeenth centuries opposed the Copernican system because they insisted than an immobile earth was necessary to the truth of sacred scripture, only to be eclipsed by subsequent scientific developments.[5] The Newtonians too closely associated certain deviations of actual planetary motions from theoretical predictions, only to be by-passed by Pierre Simon Laplace's improvements in theoretical formulations.[6] Even Newton's absolute space and absolute time—the sensorium of God—was eliminated by the development of the relativistic accounts of space and time. If we are to avoid repeating the embarrassing overstatements of the past, it seems prudent to consider the arguments of Lonergan that determinism is not essential to authentic religiosity.

The explication of Lonergan's positions in this essay is divided into three sections. In the first, Lonergan's analysis of "classical" scientific procedures will be discussed. There the central point will be that the laws which scientists seek to discover are inherently abstract. That inherent abstractness both requires that a type of knowledge over and above knowledge of natural laws is essential to the complete understanding of empirical reality, and opens up the possibility that statistical theories have objective reference. The second section is devoted to Lonergan's analysis of statistical scientific procedures. The most important conclusion there is that objective randomness does not entail arbitrariness. The third section briefly discusses Lonergan's account of God's omniscience and how it is compatible with the objective reference of statistical theories.

The Abstractness of Classical Laws

The key to Lonergan's reconciliation of the idea of an inherently statistical universe with traditional ideas concerning God and world order was his discovery that the objectivity of statistical laws does not imply the unintelligibility of world process. In the view of many the truth of statistical laws would imply an element of unintelligible arbitrariness in the occurrences in the universe.

Lonergan on the other hand held that events could occur in a really random fashion, even though each event takes place in accordance with some intelligible order. Lonergan came to this opposing view from his rigorous examination of statistical concepts—including that of randomness. His examination proceeded by way of what he called an "intentionality analysis" of the procedures of modern science.[7]

By intentionality analysis Lonergan meant that he related the procedures of modern scientists to the fundamental acts of human consciousness as set forth in his cognitional theory.[8] In so doing Lonergan could make explicit the epistemological and ontological assumptions underlying modern scientific—and statistical—research.

Within his analysis of the procedures of modern science the examination of statistical procedures came second. It was preceeded by an analysis of what Lonergan terms "classical" scientific procedures. The analysis of classical procedures took priority for two reasons. First, classical procedures are more familiar to practicing scientists because they have been in use for several centuries, whereas statistical procedures are a comparatively recent development. Second, the analysis of statistical procedures requires several preliminary clarifications that are achieved by analysis of classical procedures. Hence it is necessary to follow Lonergan's order of exposition in this essay.

By classical procedures Lonergan meant those related to the kind of thinking most commonly associated with physics—the search for natural physical laws. According to him natural laws are illustrated in physics by Galileo's law of falling bodies, the Gay-Lussac gas law, Maxwell's laws of electromagnetism, or Planck's law of thermal radiation.[9] He focused his attention on the assumptions implicit in the procedures used by physicists as they attempt to discover such laws.

One assumption which is quite explicit is that the goal of modern science is to explain empirical data.[10] Yet Lonergan discovered that close attention to the actual practices of scientists in the act of seeking physical laws revealed several further assumptions regarding empirical data. According to him scientists seeking to discover such laws do not behave as though every empirical datum requires an explanation. By way of illustration he wrote: "When chemists have mastered all of the elements, their isotopes and their compounds, they may forget to be grateful that they do not have to discover different explanations for *each* of the hydrogen atoms which, it seems, make up about fifty-five percent of the matter of our universe. . . . Every chemical element and every compound differs from every other kind of element or compound and all the differences have to be explained. Every hydrogen atom differs from every other hydrogen atom and no explanation is needed."[11] Empirical individuality—the merely empirical difference between two otherwise identical phenomena—is something which classical investigators implicitly assume requires no explanation, according to him. In his view it is the verity of this assumption which is responsible for the success of scientific generalization.[12]

In a similar fashion Lonergan searched for the basis of another characteristic of classical scientific procedures, namely, the widespread collaboration among investigators at different places and times. He wrote: "Scientists of every place and every time can pool their results in a common fund, and there is no discrimination against any result merely because of the time or merely because of the place of its origin."[13] For example, in 1974 two groups of physicists working independently of each other discovered a new elementary particle. One group, working at the Brookhaven National Laboratory on Long Island, the other based at the Stanford Linear Accelerator Center in California discovered the particle within a few months of each other. Although the Brookhaven group named the particle by the symbol J, while the Stanford group used ψ, the particles were acknowledged to be identical.[14] This general acknowledgment was possible because scientists assume that the difference between the places, Brookhaven and Stanford, and the differences in the times when the experiments were performed are not essential to the theoretical explanation of the particles. Although different influences present at those different times and places had to be taken into account in performing calculations, the mere fact of the difference in time and place was not. The difference in time and place is indeed an empirical difference but, according to Lonergan, an empirical difference which classical investigators assume requires no explanation.

Lonergan discussed further assumptions of a similar kind. For example, following Einstein physicists have developed a method known as invoking invariance and covariance considerations. This method is based on the assumption that merely empirical differences among states of inertial motion do not affect theoretical explanations.[15] All such assumptions, according to Lonergan, point to the fact that classical investigators take for granted that their investigations are affected by certain differences in empirical data but not others. Physical laws therefore do not explain all aspects of empirical data. The aspects not explained are essential to the actual concrete processes which give rise to the data but are not essential to the explanations sought by classical investigators. The elements of data which are assumed to require no explanation belong to what Lonergan calls "the empirical residue," a notion quite similar to the Thomist notion of prime potency.[16]

Lonergan further noticed that not only did classical investigators seek explanations of empirical data but also that they restricted themselves to certain kinds of explanations. In his terms classical investigators seek to understand the "immanent intelligibility" of the universe.[17] He explained immanent intelligibility by contrasting it with questions associated with final, material, instrumental, and efficient causality which "automatically head one away from the data in hand."[18] Immanent intelligibility regards not the ulterior purposes or conditions for the data at hand, but simply the understandable relations among such data. Moreover, he observed, the procedures of classical investigators reveal that they seek a special class of relations among the data—the "relations of things, not to our senses, but to one another."[19] Because of the ambiguities associated with the terms "natural law" and "physical law" he introduced the terms "classical correlation" and "classical law" to stand for the more precise definition, "immanently intelligible relations, not of things to our senses, but to one another." According to him one of Galileo's contributions to modern physics was to focus research on the discovery of a certain type of classical correlation and to turn away from discussing descriptive relations to our senses.[20] The type of classical law now sought by physicists is the correlation of measurements by means of mathematical functions. For example, Galileo's law of falling bodies, $d=\frac{1}{2}gt^2$, is a mathematical function where d represents a measurement of distance and t represents a measurement of time. Again, claimed Lonergan, this is revealed in the procedures of classical investigators in physics, especially their reliance on differential equations.[21]

The fact that classical investigators abstract from certain empirical elements and restrict themselves to certain types of explanation, in Lonergan's view, points to a corresponding abstractness in classical laws taken singly or as a whole.[22] By the abstractness of classical laws Lonergan meant that classical laws alone are insufficient to provide a complete account of the novelties and particularities of the concrete details of events as they actually occur. This follows from the fact that classical explanations intentionally prescind from concrete elements in the data rendered up by actual occurrences. In his view the gap between the abstractness of classical laws and the concreteness of world process provides the region in which statistical investigation operates. In order to establish his contention, however, he had first to characterize the types of processes (sequences of events) envisioned by classical scientific procedures. His conclusions on this point were quite unexpected.

Lonergan came to his conclusions regarding the kinds of processes envisioned by classical investigations by turning his analysis to another classical procedure. According to him "theoretically minded" scientists are seldom content simply to discover classical correlations. They also combine known laws to formulate "ideal or typical processes" which may have never been observed.[23] For example, a very elaborate combination of the classical laws governing electromagnetic waves, the movements of electrons, and chemical reactions yielded ideal processes which subsequently led to the development of the transistorized radio. Again Isaac Newton's second law of motion and his law of gravitation can be combined to yield the ideal process of the elliptical planetary orbit. (The process is ideal because no known planet follows an elliptical path exactly). Such ideal constructions are very common in science.

Yet, precisely because they are so common, claimed Lonergan, they have suffered from an "oversight of insight."[24] By an insight he meant any instance of the act of human understanding, one of the fundamental acts of human consciousness described in his cognitional theory. Discoveries of classical laws are one type of insight. He asserted that a further distinct type of insight—"insight into concrete situations"—was also needed for the construction of ideal processes. Such concrete insights are required, according to him, in order to select and combine the laws in an orderly fashion and to "particularize" the classical laws by stipulating the appropriate numerical values for the general parameters in the laws.[25] Such combination, selection, and particularization are clearly required when classical laws are used to explain actually observed processes. Moreover, according to him, intentionality analysis reveals that concrete insights are invoked in and are necessary to the theoretical construction of ideal processes which have not yet been observed. The oversight of insight to which he referred is a failure to recognize that concrete insights are needed and actually occur in the procedures of theoretically constructing ideal processes.

Such oversight of insight is somewhat explainable. It is difficult enough to recognize the actual occurrence of an act of understanding. It is still more difficult to distinguish between two different kinds of insight as they occur in consciousness. The problem is further complicated in the case of the theoretical construction of ideal processes for, as Lonergan put it, that procedure is "dominated throughout by human intelligence."[26] In other words, theoretical construction superficially appears to be a homogeneous operation of intellectual creativity, and only a very refined ability to analyze intentional activity could detect such subtle differences as between understanding classical laws and understanding how to select, combine, and particularize them. Perhaps one of the most impressive signs of the potential of Lonergan's intentionality analysis was its ability to detect the presence of two distinct types of insight within the classical procedure of theoretical construction of ideal processes.

The oversight of insight had, in Lonergan's view, a rather profound consequence. Lonergan contended that the kind of ideal processes constructed by theoretically minded classical investigators tended to have the characteristics of notable regularity and simplicity. For this reason he called such typical ideal constructions "systematic processes." In systematic processes, he wrote, "(1) the whole of a systematic process and its every event possess but a single intelligibility that corresponds to a single insight or a single set of unified insights, (2) any situation can be deduced from any other without an explicit consideration of intervening situations, and (3) the empirical investigation of such processes is marked not only by a notable facility in ascertaining and checking abundant and significant data but also by a supreme moment when all data fall into a single perspective, sweeping deductions become possible, and subsequent exact predictions regularly are fulfilled."[27]

Although only such regular, uniform systematic processes tend to be constructed theoretically by classical investigators, these are not the only possible constructions. The inherent abstractness of classical laws—that is, the fact that they must be complemented by insights into concrete situations before they can yield any type of process—provides room for a different kind of ideal construction. The insights which select, combine, and particularize classical laws need only be concrete; they need not be unified. Hence Lonergan claimed that "a quite different kind of process not only can be constructed but also probably can be verified."[28] He called this different kind of process the nonsystematic process. He further noted that, as with the systematic process, the nonsystematic process was to be constructed from classical laws. The insights which select, combine, and particularize laws into a nonsystematic process, however, will lack the unity of the insights associated with a systematic process. In fact, the defining feature of a nonsystematic process—whether ideally constructed or actually occurring—is that the concrete insights which enter into its explanation must lack unity.

One example of a nonsystematic process would be the path of an oxygen molecule in a room. Its movements depend upon its interactions with other molecules in the air, and with molecules in walls, doors, windows, etc. Theoretically each interaction between the molecule and its neighbors could be completely explained through the appropriate application of classical laws. However, a different application—that is, a different concrete insight or set of concrete insights—will be needed for each interaction. Nor in general can it be expected that the series of insights which apply the laws to the successive interactions will fall into a unified perspective. Hence the total path of the molecule—its nonsystematic process—will possess a complete, but not a unified, explanation.

A second illustration of a nonsystematic process can be drawn from the field of evolutionary biology. A cornerstone of the modern synthesis of the theories of evolution and genetics is the notion of a random genetic mutation. It has been suggested that some of these mutations are caused when cosmic rays impinge upon the DNA of reproductive cells. If so, the classical laws of biochemistry and physical chemistry could explain how any given cosmic ray would affect any given section of a DNA molecule. Yet the history of mutations leading up to a given DNA molecule would no doubt reveal that cosmic rays of different energies mutated different sections of the DNA molecule. Given these differences, in each case a different concrete insight would be required to apply the appropriate laws of physical chemistry and biochemistry. Again there is no reason to expect that the series of insights—or the sequence of mutations—form a unified pattern. Even so, this disunified series of insights would provide a complete explanation of the history of the gene's constitution.

Because of their inherent abstractness classical laws are indifferent to both systematic and nonsystematic processes. On the basis of classical laws alone, neither type of process can be constructed or explained. With their aid, either type of process can be constructed. Yet, because of theoretical construction of systematic processes, scientists and philosophers have tended to believe that classical laws automatically imply systematic processes. Indeed the remarkable advances in the discovery of classical laws have led many to believe that the totality of the universe (world process) is a systematic process.[29] Lonergan contended, on the basis of his analysis of classical scientific procedures, that such a belief was mistaken. He claimed that abstract classical laws were equally open to the possibility of both systematic and nonsystematic processes.

Furthermore, the existence of nonsystematic processes in no way implies that particular events are indeterminate. Each event in a nonsystematic process is completely explainable by classical laws in combination with circumstances given in each concrete situation. For example, each change in the motion of the gas molecule would be completely understandable, given the correct classical correlations of movements of gas molecules and a concrete understanding of how to apply those laws to each different collision. Each event in a nonsystematic process has, so to speak, its own "story line." Its story line is intelligibly related to some parts of the story lines of some other events in the universe but not to all parts or all events. Each different motion of a single gas molecule is intelligibly related to the motions of other gas molecules. However, the total movement of a gas molecule will not be intelligibly related to the total motion of any other gas molecule and may not be in any way related to any part of the motion of some gas molecules. There is no absence of intelligible patterns weaving in and out of the story lines of a nonsystematic process. What is lacking is a single unifying pattern for an entire nonsystematic process.

Nonsystematic Processes and Statistical Procedures

Lonergan's introduction of the idea of the nonsystematic process was based solely upon his analysis of classical procedures. Nevertheless he claimed that nonsystematic processes were in fact the objects of statistical, not classical, investigation. Thus the analysis of classical procedures formed a necessary preliminary to the study of statistical investigations.

Lonergan introduced the connection between statistical investigation and nonsystematic processes by noting a set of problems associated with the scientific investigation of nonsystematic processes. According to him there are significant obstacles to scientific explanation of nonsystematic processes, obstacles which are not encountered in efforts to explain systematic processes. Because all of the changes in space and time associated with a systematic process possess the intelligibility that corresponds to a single insight or a single set of unified insights, "any situation can be deduced from any other without an explicit consideration of intervening events."[30] Furthermore, that unified intelligibility gives rise to the possibility of systematic classification and generalization of such processes. On the other hand, attempts to provide explanatory accounts of nonsystematic process do not enjoy the advantages bestowed by unified intelligibility. The explanatory account of a nonsystematic process expands rapidly with the number of unrelated insights into concrete situations required to apply classical laws to its events.[31] He enumerated the problems associated with this rapid expansion:

> For even if one grants that classical inquiry leads to the laws that explain every event, it remains that classical science rarely bothers to explain the single events of non-systematic process and, still less, does it offer any technique for the orderly study of groups of such events. Moreover, there are excellent reasons for this neglect. The deduction of each of the events of a non-systematic process begins by demanding more abundant and more exact information than there is to be had. It proceeds through a sequence of stages determined by the coincidences of a random situation. It has to postulate an unlimited time to be able to assert the possibility of completing the deduction. It would end up with a result that lacks generality for, while the result would hold for an exactly similar non-systematic process, it commonly would not provide a safe basis for an approximation to the course of another non-systematic process with a slightly different basic situation.... How could non-systematic processes be classified? How could one list in an orderly fashion the totality of situations of all non-systematic processes? Yet without such a classification and such a list, how could one identify given situations with situations contained in the extremely long deductions of the extremely large set of non-systematic processes?[32]

According to him such difficulties led Aristotle to deny that any sort of scientific account of terrestrial events was possible.[33]

Nevertheless Lonergan claimed that the procedures of modern statistical investigations were able to overcome these difficulties because they implicitly operate with assumptions different from those of classical investigation. His analysis of the difference in assumptions began by recognizing a difference in the "mentalities" or intentional attitudes of classical and statistical investigators. He wrote:

> ... there is a profound difference in the mentality of classical and statistical inquirers. Had astronomers been content to regard the planets as a merely random affair, the planetary system would never have been discovered. Had Joule been content to disregard small differences, the mechanical equivalent of heat would have remained unknown. But statistical inquirers make it their business to distinguish in their tables of frequencies between significant and merely random differences. Hence, while they go to great pains to arrive at exact numbers, they do not seem to attempt the obvious next step of exact explanation. As long as differences in frequency oscillate about some average, they are esteemed of no account; only when the average itself changes, is intelligent curiosity aroused and further inquiry deemed relevant.[34]

This gross characterization of the statistical mentality led him to a more exacting analysis of the assumptions and implications of statistical procedures. When he focused his intentionality analysis on these procedures, he achieved a significant clarification of the assumptions and implications of the statistical sciences. In order to explain his clarification of these assumptions and implications one must first explicate his use of four fundamental terms. The first, nonsystematic process, has already been discussed. The remaining three are "randomness," "coincidental manifold," and "probability." The definitions and interrelations of these four terms are essential to his clarification of statistical investigation.

Although Lonergan stressed a "profound difference" between classical and statistical investigation, there is also a broad similarity. Just as classical investigators go to great lengths to explain many aspects of empirical data only to ignore differences in place, time, and individuality, so also statistical investigators focus on significant differences while assuming that random differences are to be given no statistical explanation. The most basic assumption of statistical investigation then is that there is such a thing as objective randomness.

The idea of randomness has posed major problems for mathematicians who have attempted to formulate the foundations of probability theory.[35] These problems arise from the essentially negative character of randomness, a negativity which seems to defy direct, explicit, conceptual formulation. Lonergan was nevertheless able to provide an accurate statement of the notion of randomness implicit in the procedures of statistical investigators. He wrote: "A situation is 'random' if it is 'any whatever provided specified conditions of intelligibility are not fulfilled'."[36]

Lonergan's definition of randomness was not a direct, but an indirect, formulation. His definition was more of a metalanguage definition, employing not the concepts of a direct mathematical or scientific theory but the indirect concepts of a cognitional theory about theories. Thus a random situation was said to lack "specified conditions of intelligibility," while intelligibility was defined as the content of an insight. In other words, randomness was given a general definition in terms of Lonergan's cognitional theory.

Lonergan's definition of randomness is formally precise, but in order both to make the definition more comprehensible to the reader and to show its connections with procedures of statistical investigation Lonergan introduced the term, "coincidental manifold." He defined it as a collection of events or things which are united by means of spatial juxtaposition or temporal succession or both but for which "there is *no* corresponding unity on the level of insight and intelligible relation."[37] For example, the rain which falls on a locality in a year would have a unity in virtue of the spatial boundaries of the locality and the temporal boundaries of a year. However, there would be no single, unified explanation encompassing every rainstorm hitting that place during that time. The lack of corresponding intelligibility is what Lonergan already defined as randomness. The rainstorms at a single place in a given year would form random collection because there is no single intelligible reason for all of them to occur there and then.

Lonergan connected the concepts of randomness and coincidental manifold with that of nonsystematic process in the following manner. A coincidental manifold of events has spatiotemporal unity but no corresponding intelligible unity. If one applies appropriate classical laws to each event in the coincidental manifold, the result will be an unfolding series of events in space and time. Each event in the resulting series will be connected with one or more events in the original coincidental manifold in a completely determinate fashion by the appropriate classical laws. On the other hand, because there is no intelligible explanation for the spatiotemporal unity of the original coincidental manifold, the spatial juxtapositions and temporal sequences which follow from it will also lack intelligible unity. Since a nonsystematic process is defined as a sequence of events which lack unified explanation, it follows that a nonsystematic process is the spatiotemporal unfolding of a coincidental manifold in accordance with classical laws. As Lonergan put it, a coincidental manifold—or under the more general specification, a random situation—supplies the "basic situation" of a nonsystematic process, the situation from which a nonsystematic process originates.[38]

Thus far Lonergan's uses of "nonsystematic process," "randomness," and "coincidental manifold" to explicate the statistical procedures of modern scientists have been discussed. His treatment of the idea of probability and its relation to statistical investigation remains. Lonergan noted that the procedures of statistical investigators—sampling, classifying, counting, tabulating—all tended toward a common goal, namely, the determination of probabilities.[39] He explained that from their tabulations statistical investigators proceeded to determine numerical ratios called "relative actual frequencies."[40] A relative actual frequency is formed by dividing the actual number of occurrences of a specified type by the total number of occasions. For example, if it rained 127 days in a city during the year 1978, the relative actual frequency of rain in that city during 1978 would be $^{127}/_{365}$. Next, according to him, statistical investigators note that actual frequencies vary from year to year. Hence, over four years, the relative actual frequencies of rain in the city might be $^{133}/_{366}$, $^{24}/_{73}$, $^{114}/_{365}$, $^{127}/_{365}$. On the basis of the assumption that these variations are random, statistical investigators seek an ideal numerical ratio, such that the differences between the ideal ratio and the relative actual frequencies are always random. In the case of rain on the city, $^1/_3$ might be suggested as the ideal frequency. The actual frequency of rain might be more or less in any given year, but the pattern of differences would be random. The succession of differences between the ideal and actual ratios form a coincidental manifold, for they are ordered temporally according to the yearly sequence but lack intelligible order.

Lonergan claimed that the ideal fractions arrived at through such procedures were what was meant by the term "probability." He went on to explain how intentionality analysis revealed that probabilities were grasped by insights. Just as classical laws add intelligible correlations to empirically given data by abstracting from the concreteness of that data, so also statistical probabilities add an intelligible, normative fraction to the merely coincidentally related empirical data by abstracting from the normlessness of the merely empirically determined relative actual frequencies.[41]

Having clarified the meanings and relations of these four terms, Lonergan turned to show how the statistical investigators' discoveries of probabilities solved the problems associated with the scientific study of nonsystematic processes. He wrote: "There results the solution of two outstanding methodological problems. Because the probabilities are to hold universally, there is solved the problem of reaching general knowledge of events in non-systematic processes. Because states are defined by the association of classes of events with corresponding probabilities, there is by-passed the problem of distinguishing and listing non-systematic processes."[42] Furthermore, he asserted that the combination of classical and statistical laws by means of concrete insights provided just the desired scientific account of nonsystematic processes. In his words, "classical laws tell what would happen if conditions were fulfilled; statistical laws tell how often conditions are fulfilled."[43]

Such then are the results of Lonergan's reexamination of the meaning of statistical investigations by means of his analysis of the intentional activities and assumptions implicit in the procedures of modern science. The analysis of the genesis of laws of science in the ordinary sense—what Lonergan called classical correlations—revealed an abstractness to those laws. That abstractness implied that knowledge of concrete processes requires the addition of further insights into concrete situations. Despite the spontaneous tendency to regard such additional insights as unified, nothing in the nature of classical laws themselves contradicts the possibility that these further insights lack immanently intelligible unity. This gap between the abstractness of classical laws and insights into the concrete makes it possible to conceive of nonsystematic processes. Every individual event in a nonsystematic process would be completely in accord with classical laws even though the total sequence of events constituting the process (and the correlative combination of classical laws explaining that sequence) would lack immanently intelligible unity. The basic situation from which a nonsystematic process originated would be a coincidental manifold exhibiting objective randomness. However, randomness does not mean "lacking in reason." Rather it means that the spatio-temporal unity of a set of events does not have a corresponding immanently intelligible unity. Finally statistical investigators provide a scientific account of nonsystematic processes by searching for the probabilities with which events occur, while abstracting from the random differences from those probabilities.

From Lonergan's analysis it follows that if statistical laws were verified there would have to be objective probabilities (i.e., that the intelligibility of probability is constitutive of the reality of the universe). More significant, it also follows that there would have to be objective randomness, for the definition of probability is dependent upon that of randomness. Moreover, since such verified probabilities and randomness pertain to events in space and time, the verity of statistical laws would imply the objective occurrence of coincidental manifolds. Finally, since classical laws are intended to be universally true, they would apply to the events in such objective coincidental manifolds in such a way as to guarantee the objective existence of nonsystematic processes. Such are the implications of statistical procedures.

Does it follow that verified statistical laws imply the unintelligibility (arbitrariness) of the universe? It would certainly not imply that classical laws are violated or do not exist, for the events in nonsystematic processes occur according to the dictates of the relevant classical laws.

Nevertheless Lonergan clearly holds that a nonsystematic universe is not completely knowable by human beings. The crux of the problem lies in the expansion of nonsystematic processes across vast ranges of space and time. Nonsystematic processes are known by the selection, combination, and particularization of classical laws by insights into concrete situations. Yet, as larger ranges of space and time are taken into account, the number of concrete situations multiplies. Furthermore, the required number of insights into concrete situations grows dramatically. Lonergan claimed therefore that human knowledge "cannot be both comprehensive and concrete."[44] In other words, complete knowledge of a nonsystematic universe is humanly impossible. But is the nonsystematic universe which is implied by statistical investigation absolutely unintelligible? For Lonergan's answer to this it is necessary to consider his approach to the problem of human knowledge of God.

God and the Nonsystematic

Lonergan's treatment of the possibility and content of human knowledge concerning God, and especially his argument for the existence of God, is far too involved for a thorough discussion in the context of the present essay.[45] For present purposes, discussion must be restricted to the way Lonergan's characterization of God as "unrestricted act of understanding" relates to traditional beliefs about God and to the statistical procedures of scientific investigation.

In his chapter on general transcendent knowledge in *Insight* Lonergan proceeded to show how it is possible to extrapolate to the notion of an unrestricted act of understanding. Lonergan's extrapolation proceeded by means of this analogy: human question:act of human understanding::human unrestricted desire to know:unrestricted act of understanding.[46]

Lonergan claimed that the sense of the first three terms in the analogy had been established in his cognitional theory and given full reference by means of the verification of that theory in the act of self-affirmation.[47] The relationship between the first two terms—that human understanding answers and satisfies human question—was determined by the same means. Thus the fourth term—unrestricted act of understanding—could be given a determinate meaning. The unrestricted act would be that act which stood in the same relationship to the unrestricted desire to know as human understanding stands to human question. The extrapolation by way of analogy enabled Lonergan to speak meaningfully about the unrestricted act of understanding without actually knowing its content (i.e., without actually understanding in an unrestricted fashion). The analogy yielded therefore a kind of second-order determination of the meaning of the term "unrestricted act of understanding."

Lonergan proceeded from his extrapolation to show that the unrestricted act of understanding would possess all the qualities traditionally attributed to God.[48] However, since the problems raised by modern statistical investigators center on the issues of God's omniscience and God's knowledge that the universe possesses an intelligible order, it will be necessary only to explain Lonergan's claim that an unrestricted act of understanding so conceived would grasp "everything about everything."[49]

In Lonergan's cognitional theory the pure, unrestricted human desire to know provides the creative, dynamic tension. According to Lonergan every human being by nature desires to understand everything about everything correctly.[50] This desire can be noticed in the way human thinking answers one question only to raise another. Human consciousness is not satisfied with understanding which is less than correct and total. Lack of satisfaction is commonly associated with a desire. Therefore there is a desire intrinsic to human consciousness to understand correctly everything about everything.

The unrestricted act of understanding was defined as that which would satisfy the unrestricted desire in the way a limited insight satisfied a limited question. From this definition Lonergan concluded that the unrestricted act of understanding would, in a single, simple act, understand everything about everything.[51] This was Lonergan's way of formulating the notion of divine omniscience.

There was, however, a significant objection against the possibility of an omniscient God—an unrestricted act of understanding which grasps everything about everything—which Lonergan had to consider. The objection arose from the fact that nonsystematic processes lack a unified explanation. He wrote: "Now, the non-systematic is the absence of intelligible rule or law; elements are determinate; relations are determinate; but there is no possibility of a single formula that is satisfied by the sequence of determinate relations. It *seems* to follow that the non-systematic component in the actual universe and in other possible and even more probable universes excludes the possibility of an unrestricted act that understands everything about everything."[52]

However, according to Lonergan, the objection rests upon a hidden assumption. The assumption is that an intelligible rule, law, or single formula represents the only kind of intelligibility—the only kind of object of understanding. Yet the understanding of rules, laws, or single formulae typifies only the kind of understanding associated with classical investigations and systematic processes. Lonergan had already shown that events in a nonsystematic process could, within limits, be understood by means of a different type of understanding, namely, a set of disconnected insights into concrete situations. It follows that any nonsystematic process is intelligible, but "its intelligibility lies not on the level of abstract understanding that grasps systems of laws but on the level of concrete understanding that deals with particular situations."[53] Each event in a systematic process is concretely intelligible. Furthermore, any event in a nonsystematic process is situated within an intelligibly related pattern of events (story line), although the event is not intelligibly related to every other event in the nonsystematic process.

Lonergan grants that the nonsystematic component in the universe cannot be completely grasped by human understanding, for human understanding "cannot be both comprehensive and concrete."[54] However, the same does not hold for an unrestricted act of understanding. The unrestricted act would understand everything about everything and would therefore be both comprehensive ("about everything") and concrete ("everything about"). Unrestricted understanding would grasp at once each event in each intelligibly related pattern of a nonsystematic process. In a sense then God's understanding of the universe is more like an insight into a concrete situation than like a theory.

Furthermore, from the viewpoint of unrestricted understanding, even the coincidental manifolds which form the basic situations of nonsystematic processes would, in a certain sense, be intelligible. That is, an act of understanding which understood everything about everything would grasp why spatiotemporal juxtapositions occur. Human understanding cannot grasp such a "why" because, as Lonergan noted, classical investigations—even when complemented by statistical investigations and insights into concrete situations—methodically restrict themselves to understanding the immanent intelligibility of data. The why of coincidental spatiotemporal juxtapositions would not have the immanent intelligibility of classical correlations, probabilities, or insights into concrete situations. Rather the why would be cast in terms of an ultimate plan or purpose of the universe—"final causality," in traditional terms. Such an ultimate plan or purpose would necessarily escape understanding restricted to immanent intelligibility but would be understood by an unrestricted act which understands everything about everything.[55] Therefore Lonergan's discussion leads to the conclusion that an inherently statistical, nonsystematic universe would be completely intelligible to an unrestricted act of understanding, which understands everything about everything, that is, to an omniscient God.

Conclusion

Lonergan has set forth a formidable synthesis of traditional beliefs concerning God and the implications of modern scientific methods. He was able to do so by analyzing scientific procedures in detail and from within. In so doing he was able to circumvent common assumptions about the nature of modern science, such as that modern science is deterministic, materialistic, or pragmatic. By discovering the gap left by the inherent abstractness of classical laws, Lonergan could show that statistical investigations could have objective reference and that the objects of those investigations—nonsystematic processes—could have an intelligibility associated with insights into concrete situations. He could show that God, conceived of as an unrestricted act of understanding, would have complete knowledge of the entirety of world process which, apart from sin, is completely intelligible.[56] Furthermore, by showing that nonsystematic processes are reducible to the basic situation of a coincidental manifold, he could show that objectively statistical occurrences were possible without requiring God to "roll dice" in order to determine what the next moment should bring. Indeed, by conceiving of God as an unrestricted act of understanding, Lonergan could show that God was "outside the totality of temporal sequences," grasping that totality in a single act of understanding.[57]

The implications of Lonergan's reconciliation of the statistical sciences with God's omniscience are impressive. Over a century ago Laplace was quick to recognize that in a deterministic universe mere human intelligence could have complete knowledge of the universe, past, present, and future. For that reason he could respond to Napoleon's question about the place of God's interventions in the universe: "I have no need of that hypothesis."[58] However, if the universe is inherently statistical, then it is completely knowable but only to a God whose understanding is infinite. Modern scientific investigation in a universe which is intrinsically statistical has the potential of leading us into the ultimate mysterious presence of God. One might be tempted therefore to invert Reitdijk's statement and say that the only hope of truly religious persons lies in the statistical, nonsystematic universe.

NOTES

1. C. W. Reitdijk, *On Waves, Particles and Hidden Variables* (Assen, Holland: Van Gorcum, 1971), p. 130.

2. For a historical survey of hidden-variable theories, see Max Jammer, *The Philosophy of Quantum Mechanics* (New York: John Wiley & Sons, 1974), pp. 253-339.

3. On the factual background of this saying see Ronald W. Clark, *Einstein: The Life and Times* (New York: Avon Books, 1971), pp. 414-23.

4. See, e.g., Alan Richardson's discussion in *The Bible in the Age of Science* (Philadelphia: Westminster Press, 1961), pp. 36-39. The eighteenth-century deists, like Einstein and Reitdijk, held that a deterministic world order was divinely ordained but did not have to cast their arguments in opposition to twentieth-century developments of quantum mechanics.

5. For a discussion of the problems of biblical exegesis see Jerome J. Langford, *Galileo, Science and the Church* (Ann Arbor: University of Michigan Press, 1976), pp. 34-78.

6. Richardson, p. 28.

7. Bernard Lonergan, *A Second Collection*, ed. W. Ryan and B. Tyrrell (Philadelphia: Westminster Press, 1979), pp. vii-x, 223, 277, and *Method in Theology* (New York: Herder & Herder, 1972), p. 340.

8. Bernard Lonergan set forth the basic elements of his cognitional theory in *Insight* (New York: Philosophical Library, 1958), pp. 272-75, 319-57 and in "Cognitional Structure," in *Collection*, ed. F. E. Crowe (New York: Herder & Herder, 1967), pp. 221-39.

9. Lonergan, *Insight*, pp. 37, 45, 53, 106, 443.

10. Ibid., pp. 71-74.

11. Ibid., p. 28.

12. Ibid.

13. Ibid.

14. The question of which group was first to discover the particle may never be settled. The Stanford group apparently collected the first data on the new particle, while the Brookhaven team seems to have been first correctly to interpret their data. The two groups became certain of their findings within days of each other, and agreed upon a joint announcement. See William D. Metz, "Particle Search Ends in an Amazing Coincidence," *Science*, 186 (1974): 910.

15. Lonergan, *Insight*, pp. 39-43, 142-48.

16. Ibid., pp. 442-43, 516-19.

17. Ibid., pp. 33, 76-78.

18. Ibid., p. 77.

19. Ibid., p. 78. See also pp. 36-46.

20. Ibid., p. 38.

21. Ibid., p. 38-39.

22. Ibid., pp. 89-93.

23. Ibid., pp. 46-47.

24. Ibid., p. 46.

25. Ibid.

26. Ibid., p. 47.

27. Ibid., p. 48.

28. Ibid., p. 47.

29. Lonergan cites besides the complicated problems of distinguishing types of insights, the philosophical doctrine he calls "mechanist determinism" as a source of the belief that world process is systematic (ibid., pp. 130-31, 254-55).

30. Ibid., p. 48.

31. Ibid., p. 51.

32. Ibid., pp. 56-57.

33. Ibid., pp. 57, 129-30.

34. Ibid., p. 54.

35. For a survey of these efforts and their limitations see Philip McShane, *Randomness, Statistics and Emergence* (Notre Dame, Ind.: University of Notre Dame Press, 1970) pp. 14-130, 149-69. See also J. Alberto Coffa, "Randomness and Knowledge," in *Proceedings of the 1972 Biennial Meeting, Philosophy of Science Association*, ed. Kenneth F. Schaffner and Robert S. Cohen (Dordrecht, Holland: D. Reidel Publishing Co., 1974), pp. 103-15. An outline of the development of mathematical problem of randomness is presented on pp. 103-7. The remainder of the article, devoted to "physical randomness," is vitiated by what Lonergan would call counterposition.

36. Lonergan, *Insight*, p. 51.

37. Ibid., pp. 49-50.

38. Ibid., pp. 50-51.

39. Ibid., pp. 59, 64.

40. Ibid., p. 58.

41. Ibid., pp. 59-60.

42. Ibid., pp. 58-59.

43. Ibid., p. 108. This idea is expanded on p. 110, where Lonergan wrote: "What concerns the statistical inquirer is, then, neither the purely systematic, nor the purely non-systematic, but the systematic as setting ideal limits from which the non-systematic cannot diverge systematically."

44. Ibid., p. 278.

45. Lonergan published his positions in *Insight*, pp. 634-86 and in *Philosophy of God and Theology* (Philadelphia: Westminster Press, 1973). For an excellent discussion of Lonergan's approach to the problem of human knowledge of God see Bernard Tyrrell, *Bernard Lonergan's Philosophy of God* (Notre Dame, Ind.: University of Notre Dame Press, 1974).

46. Lonergan, *Insight*, pp. 641-43. See also Tyrrell, pp. 134-40.

47. Lonergan, *Insight*, pp. 319-35.

48. Ibid., pp. 644-46, 655-69.

49. Ibid., p. 644

50. Ibid., pp. 348-53, 637.

51. Ibid., p. 645.

52. Ibid., p. 649 (italics added).

53. Ibid., p. 650.

54. Ibid., p. 278.

55. Lonergan argued in detail that knowledge of such a plan and purpose was indeed implied by the existence of an unrestricted act of understanding (ibid., pp. 655-57, 661, 663-64).

56. Ibid., pp. 666-69.

57. Ibid., p. 651.

58. Richardson (n. 4 above), p. 28.