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On the Success and Limitations of Science

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ON THE SUCCESS AND LIMITATIONS OF SCIENCE

By

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I. INTRODUCTION

A. Statement of the Problem

The natural sciences represent one of the most successful methods of compiling and utilizing knowledge of the world that man has ever found. Few people would dispute this since most of the major advances of this century in the fields of industry, technology, medicine, and many others have been made possible by the natural sciences. Respect for the sciences as a method of solving problems and generally dealing with difficult questions has grown tremendously, approaching adulation, in almost all the civilized countries of the world. This respect is almost invariably justified by pointing to the successes already achieved by science, as one might expect. But what one might also expect concerning an area of human life consciously given such importance is intense and widespread reflection on it in an attempt to determine the reasons why it is so successful, and what, if any, are its limitations. Reflection on the method of science has in fact been done by at least two important groups - the scientists themselves and the philosophers of science. It is my contention, however, that they have not for the most part dealt with the questions of why science has had such great
success and what its limitations as a method are. It is those two questions that will occupy the major parts of this paper, but before taking them up I want to give more careful attention to the scientists and philosophers of science in an attempt to see what they have done.

B. Critique of Some Other Approaches

The efforts of the scientists and philosophers of science have varied tremendously depending on the aspect of science they chose to study or the approach they adopted for their study. No one would say that the practicing scientist is not concerned with the method of science, but his concern with it is for the most part very practical and internal. His position as an active, functioning scientist requires that he adopt this approach to his science most of the time. In any given experiment that a scientist conducts he must be concerned with problems of research technique such as control groups, statistical data verification, and so on. The nature of his endeavor is to do science, not just to talk about it. But because of that very fact he may not know much about his science. Talking about something implies getting above it, or at least out of it long enough to see it as a whole entity in relation to other entities. The scientist as a working scientist is not involved in that kind of question. The techniques and methods he uses are not designed for that
type of "meta-inquiry." The scientist could conceivably go through his entire professional career without ever asking what the meaning of his science as a whole is. His approach to his science as an independent research scientist may not vary greatly from what it was as a beginning student of the science.

Thomas Kuhn makes much the same point as I have made here in his discussion of the priority of paradigms in The Structure of Scientific Revolutions. He points out that once a scientist accepts a paradigm as descriptive of his area of science it is not necessary for him to deal with or attempt to justify the first principles on which that paradigm is based. The paradigm of a given science must be accepted by the student of that science if he is to be a student at all, but it is usually maintained throughout his career. As the student proceeds from the freshman level through to the doctorate, the scientific problems given to him become more complex and less preceded, but they continue to be closely modeled on previous achievements as are the problems that normally occupy him during his subsequent independent scientific career. Kuhn is talking here about what he calls "normal" science which he says is what most scientists do. This involves working within an accepted paradigm rather than attempting to develop a new one to ground the science on. Kuhn does not deny that the latter happens, but he does claim that it is rare and that most
science is "normal" science. More than that one can say that scientists are in virtually all cases trained to be normal scientists since their teachers work within a paradigm and teach that paradigm as the proper way to understand that science.

The endeavor of the scientist does not seem to lend itself to questions like "Why has science been so successful?" or "What are the limitations of science?" This is not leveled as a criticism of science, but is merely an observation of the way science functions. "Biology as a science cannot be examined under the microscope," as Theodore Kisiel puts it. I do not intend to suggest that the scientist as a man or philosopher cannot deal with these questions, for he surely can, but the scientist qua scientist cannot.

If this is the case, then, it seems important that philosophy of science deal with questions about science such as the reasons for and limitations on its success as a method. While there is already a very strong school of philosophy of science frequently referred to as "common" philosophy of science, it does not concern itself sufficiently with questions of this nature. An example of a philosopher of science from this school is Israel Scheffler. In his book Science and Subjectivity he describes common philosophy of science as that school whose position on the nature of science has "attained the status of a standard view."
In the first chapter of his book Scheffler makes a number of remarks which reveal what he thinks science is. He describes science as a "systematic public enterprise, controlled by logic and by empirical fact, whose purpose it is to formulate the truth about the natural world." The emphasis in Scheffler's discussion is on the objective truth of scientific assertions. He attempts to support the belief that science does achieve such truth by appealing to "independent and controlling standards" on research. He feels that if the objective truth of science cannot be maintained, then everything collapses into total arbitrariness. While his argument is open to attack on many fronts, my point in mentioning it here is not to criticize it as an argument but to show what common philosophy of science, as it is conceived by Scheffler, concerns itself with. It is an endeavor which aims at examining the structures of scientific explanation with regard to their truth and objectivity. It does not attempt to show why science is so successful, but only wants to prove that it is a true account of nature. Neither does it seek to establish the limitations on science.

Other writers in philosophy of science have similarly limited the issues that they feel philosophy of science should deal with. In his introduction to Readings in the Philosophy of Science Baruch Brody mentions three basic types of problems that he feels should be considered by
philosophy of science. The first that he brings up is the significance that new scientific findings might have for traditional philosophical issues such as the principle of indeterminacy in quantum mechanics. Another type of question would be involved with the analysis of basic scientific concepts such as number, force, and so on. The third that he mentions concerns the goals and methods the scientist should choose, i.e., should the scientist explain or just describe, should he "postulate the existence of unobserved entities...." The significance of questions like these may be very great and, again, I do not wish to argue against them, but only to point out that they do not allow us to examine science as an entity or mode of knowing in relation to other modes of knowing. They do not tell us why science is so successful or what its limitations as a method are.

C. Outline of a new Approach

As I indicated earlier the questions I want to answer are, "Why has science been so successful?" and "What are the limitations of science?" The second and third sections of this thesis are intended to answer those questions. The second section offers an analysis of modern science as research in an attempt to determine its essential structures. This should make easier discovering some of the reasons for the success of science. Many of the arguments in this
section come from an article by Martin Heidegger, "The Age of the World View."

The third section is an attempt to trace the possible development of the scientific or theoretical knowing out of man's everyday involvement with the world around him. This should provide an excellent perspective for comparing these two modes of knowing and being, the scientific and the everyday modes.
II. MODERN SCIENCE AS RESEARCH

A. The Projective Nature of Research

The position that science holds in modern society is one that is greatly respected if not held in awe by most people. Science has that position because of the incredible improvements in living standards, health, working conditions, etc., that it has made possible. Science has the reputation, with good cause, of being the one discipline that successfully and consistently finds solutions to the problems it sets itself. But few people, including scientists and philosophers of science, seem to understand just why science is consistently so successful. Could it have anything to do with it's "setting its own problems?" Or is the method of science appropriate for solving just any problem that might be tossed up to it?

I intend here to give a rather extensive analysis of the nature of modern science following the arguments given by Heidegger in "The Age of the World View." The reason for doing this will be primarily to provide a basis for determining the causes of success in the scientific method as well as the limitations of that method. It will be my contention that the success and the limitations of science are but two manifestations of the same characteristic that
sets science off from other methods of gaining knowledge.

Heidegger begins his discussion of modern science by contrasting it briefly with Ancient and Medieval science. While both of the latter ages had their scientists and observers of nature, it is clear that they did not achieve the success of science in our age. The characteristic of modern science that most positively differentiates it from that of earlier ages, according to Heidegger, is the fact that it functions primarily in the mode of research. If we are to understand modern science and the modern age that is so heavily influenced by it, we must carefully examine this scientific research to see what its nature is.

The basic procedure by which research functions, Heidegger says, is to delineate for study a field or sphere of nature by projecting beforehand what that area will be. The significance of this deciding beforehand or projecting exactly what is to be done will become clearer as the discussion proceeds. Not only does research procedure decide in advance what area is to be studied, but it also determines how that area should be approached.

While practicing research scientists may not overtly recognize their work as a process of projecting, they do refer to individual research endeavors as "research projects." They are fully aware that if their work is to be called "scientific" it must be rigidly controlled from the beginning with respect to what it wishes to investigate, and
how it intends to proceed. Any scientist would be considered unscientific, if not a fool, who described his research project as an attempt merely to "find out about" mice, for example, by "whatever method" occurred to him at any given time. He would be asked precisely what he wanted to know about mice (the particular physiological effect of a given quantity of a certain drug under stated conditions, perhaps), and precisely how he intended to go about getting this information (method of administering the drug, necessary equipment, control group data, for example). If he could not give information such as this and in much greater detail than I have suggested here, his colleagues would simply dismiss what he wanted to do as something other than science or at least as inadequate and unacceptable research procedure. What his plan lacked was precisely what makes "research" of modern science and differentiates it from Ancient and Medieval science. It lacked the definite and precise projection of the sphere of nature that was to be investigated, as well as a definite and precise formulation of how that investigation would proceed. The possibility of his gaining scientific knowledge in such a manner would be minimal if not non-existent.

The above example of the way working scientists approach their research projects is given to help ground many of the assertions I will make at the functional level of science.
B. The Mathematical Nature of Research

Heidegger recognized, as Kant had before him, that the uniqueness of modern science as well as the key to its success lay in its method. As a method modern science aims at gaining knowledge of nature, but not just any knowledge. It knows before it begins to examine nature what it wants to know from it. It is this fact that prompted Heidegger to call the sciences "mathematical" in a sense that was not applicable to Greek and Medieval science.

Both Greek and Medieval scientists studied nature. They made careful, often precise observations and some even employed mathematical measurement in their observations. But they still were not mathematical as sciences the way Heidegger claims modern science as research is. He clarified this assertion with a discussion of the meaning of the mathematical as it arose with the Greeks. The mathematical essentially is "that which man knows prior to his observation of things: of bodies - the corporal; of plants - the vegetative; ...." etc. 10

Heidegger further discusses the mathematical in What is a Thing. There he points out that while numbers are commonly identified with the mathematical, they are only one example of it. Numbers are indeed mathematical, but only because they represent something we can know about things prior to our observation of them. 11 If we encounter
three objects together we know immediately that there are three of them. We may have no idea what they are, but prior to experiencing them this possibility of knowledge about them was open to us.

The mathematical is that which allows us to experience things as things at all, or as these particular things. This is relevant to all types of knowing, but the sciences have grasped it as a presupposition of knowing more deliberately than any other field of knowledge. Science as research does not "merely observe" nature in order to know it. It recognizes that in order to know nature with certainty it must observe nature from this or that precise point of view, but no other. Mere observation allows for the collection of unlimited amounts of random data, but random data is precisely what science does not aim for. All research scientists, in their laboratory work, are concerned with the variables that may effect their results. Those variables must be reduced to an absolute minimum if the results are to be reliable. Often the only variable left in the experiment is the one that the project was designed to determine. But merely observing the world would be to see everything that occurred as yet another variable. In scientific research mere observation simply has no place.

Heidegger chooses modern physics to demonstrate what he means by the "mathematical" nature of natural science.
Physics, he says, projects nature as the "self-sufficient kinetic relation of points of mass in space and time."\textsuperscript{12} This constitutes what Heidegger calls a "blueprint of nature,"\textsuperscript{13} and given this blueprint all natural events are "determined in advance as spatiotemporal kinetic magnitudes."\textsuperscript{14} The projection of natural events in terms of magnitude makes the use of number and calculation appropriate as a mode of describing those events. But, as indicated above, the use of number and calculation is not what gives physics its mathematical nature. The fact that physics projects nature as the realm of numberable and calculable events and studies it only under that aspect makes it mathematical. The projection of nature could have involved entirely different categories that had nothing at all to do with number, and it would still have qualified for the title of mathematical physics.

The concept of "exactness" in the mathematical sciences follows from their mathematical nature understood in the sense above. The advantages in learning that the sciences gained by projecting nature under a certain aspect in order to achieve certain knowledge within the bounds of that projection would have been lost if the procedure of their actual research had not adhered strictly to the projection or blueprint with which it began. This strict adherence to the initial projection of nature is what exactness meant in this context for Heidegger. The exact calculations
of physics do not of themselves make it an exact science. It is exact because it proceeds precisely as it says it will in the blueprint or ground plan of nature it lays down initially.

Exact measurement and exact calculation are, incidentally, exact for the same reason that physics as a science is exact. A measurement is exact if it appeals to a definite standard and does not deviate from it; a calculation is exact if its method is clearly stated and adhered to in practice. In each case what is to be done (measuring or calculating) is understood in advance, and if this is strictly adhered to the process is exact. While the Greek or Medieval scientists may have employed exact measurement in their science, their science as a whole was not exact. The measurement itself employed a standard and adhered reliably to it, but the science as a whole did not. It merely observed.

It would be an oversight to discuss modern science as research without making reference to scientific experiment. The actual, individual experiment is not something over and above research, but is in essence the primary vehicle of it. A given experiment may be designed to either confirm or deny some particular aspect of the larger projection of nature accepted by the science as a whole, or it may be intended to "flesh-out" that projection in the sense that Kuhn uses when he speaks of puzzle solving in
In any case the individual experiment will invariably have the characteristics described for research thus far. It will rely on the general projection of nature accepted by this discipline, and it will adhere very strictly to that projection in its procedure. Otherwise it would neither be considered exact nor scientific.

Heidegger points out that while the ancient Greeks were very keen in their observation of nature they did not do experiment in the sense of modern research. They may have used measurement or instruments to assist in their observation, but they did not begin their observation with an assumed blueprint of nature that was to be verified or denied through their observations. Merely observing nature, regardless of how careful or accurate those observations are, does not constitute science as research.

C. The Institutional Nature of Research

Another characteristic of science that follows from the procedure of research as it has been described thus far is called "busy-ness" by Heidegger. A science can be said to have acquired the character of busy-ness when it becomes necessary to establish institutes to control the research that goes on in that science. Once the science in question has adopted a particular projection of nature as the area of knowledge appropriate to it, it
must control the research that is done if it is to master that area. But the work that is to be done in the future will always be dictated by the results of research done in the past.

The point to be emphasized is that the projective nature of science as research ultimately becomes the architect of the organizational whole of the science involved. Institutes, foundations, publications, and conferences must all be created in order to facilitate the exchange of information on what research has been done, and to determine and control the research that must be done in the future.

The fact that institutes, publications, etc., develop for any given science is an indication that it is "taking possession of its own real nature."18 By "its own real nature" Heidegger means the projective nature of research. The deliberate use of past results to determine new areas for research amounts to adopting the procedure of projection as virtually the only guiding force for the science. This means that the procedure of research as the projection of nature under a certain paradigm, to use Kuhn's term, has reached its logical conclusion. The purpose of the science in question is to fully understand all of nature under this paradigm. In order to do this it must determine and direct all future research on the basis of past and present research that were also controlled by the paradigm. In
order to accomplish the task of completely "fleshing-out" the paradigm some overriding structure for directing the science must be adopted, and this usually takes the form of the conferences, institutes, and so forth mentioned above that facilitate information exchange and dictate what is to be done in the future.

At this point, Heidegger asserts, the procedure of research has been "granted definite precedence over Being..., which research makes objective."\(^{19}\) Nature, which constitutes the realm of being for the natural sciences, is now understood by those sciences as the totality of objects available for study according to an acceptable projection. The being and individuality they once had is lost to the science that now treats them as "objectifiable entities" only.

D. The Applicability of Research to Other Areas of Knowledge

The determination of the being and truth of nature for the natural sciences can only be accomplished thru the procedure of research which is their method of knowing. In order for understanding to be achieved at all, nature must be subsumed under the categories provided by the paradigm or projection accepted by the science involved. In no other way can the objects of nature even be said to exist. "Only what thus becomes an object is, is recognized as existent. Science as research occurs only when it is in this objectification that the being of the existent is

17
sought.\textsuperscript{20} With this quotation and sentences immediately following it Heidegger makes two points. First he wants to say that existence for science lies in objective representation of a thing, and secondly that truth lies in the certainty of that representation.

He further suggests that this conception of being and truth was first found in the metaphysics of Descartes. The following will be an attempt to show the relationship between the method of modern science as projection and Descartes' metaphysics. Some Heideggerian points will be used.

Early in Descartes' investigation of being and truth in the \textit{Meditations} he determined that the only thing of whose existence he could be absolutely certain was himself, the ego. Once that determination was accepted he began to investigate the possibility of determining the existence of other things in the world. Only those things would be accepted as existent whose being he could know with certitude. Through this process Descartes had effectively placed man at the center of all that is as that entity who could bestow "the seal of being\textsuperscript{21} on other entities.

The significance of this approach to being and truth is that for Descartes the world was not something to which he opened himself, but, rather, it was something that he determined \textit{for} himself. If a thing can be represented with certitude to \textit{man-the-ultimate-subject} it can be said to
exist. If it is not available to such representation its existence remains open to doubt.

For the first time in the history of human thought man was in a position to challenge and interrogate nature. He was no longer merely open to experiencing it. He had become the ultimate subject with whom nature had to be in some relation in order to exist at all. He would ask of nature the questions he wanted answers to instead of accepting the random data offered to him by nature.

For the first time man began to realize what value the "if-then" hypothetical statements could have if applied to the investigation of nature. He saw that if he viewed nature from a particular perspective, then he could reach conclusions about nature that would be conditioned only by the limitations of the original if. Thus was the "hypothesis" of modern scientific research born.

The men of science began to see that if their conclusions were to be in any sense certain, they had to exclude any evidence or factors which were not certain or reliable. This consideration required that they project in advance precisely what types of evidence they would admit, and systematically exclude all others in the course of their investigation. Through this procedure they were able to obtain from nature exactly the answers they wanted and no others.

The reasons for the success of this method should be
made as clear as possible. There can be no doubt that the success is limited, but it is precisely because it is limited that it is successful at all. The genius of the method lies in the fact that it deliberately chooses a perspective and systematically investigates nature from that perspective and no other. Only data appropriate to that perspective is collected, and the conclusions reached are valid within the limits of the initial projection or perspective (assuming, of course, that the projection is rigidly adhered to throughout the investigation).

But, since few people of the modern age question the fact that the scientific method is successful, we should here emphasize the limitation of that success. And the limitation of any science lies in the projection of nature that it starts with. It is a hypothetical endeavor. Given this projection of nature certain things follow. But that projection may be of limited use for many areas of human life and entirely inappropriate for others. Science has not discovered any absolute truths, and any scientist who claims that science has understands neither the limitation nor the genius of his science. Within the limits of its applicability as defined by its projection of nature a science may be valid. More than that it cannot claim.

The above paragraph deals with individual sciences and the applicability of their respective projection to various human problems, but more can be said about the sciences in
general from the standpoint of their underlying metaphysics. The natural sciences, as we have said, conceive of being and truth as objectivity of representation and certainty of representation, respectively, following the lead of Descartes. Such an understanding literally denies "the seal of being" to vast areas of human life and experience which cannot be fully objectified and represented with the certainty demanded by science. Music, art, poetry, and many other areas of life are excluded from the realm of science, but more than that, the understanding of being maintained by science can not make provision for them even to exist in a limited sense. The limited ability of such a metaphysics to deal with human experience is apparent, then, and such a metaphysics can be accurately evaluated only as one among many ways of understanding being and truth. The realization must be firmly and clearly established in order that the significance of the further task of defining precisely the limits of science in dealing with human problems can be recognized and more deliberately dealt with.

My purpose, then, has clearly not been to say that science is evil. It is obviously very valuable for man and to deny this value would be absurd. The purpose has been to say that science as a method of dealing with human problems is limited, and that the limitations of it must be clearly defined if we are to avoid misusing it.

Men must see that the understanding of being and truth
implied in science is not appropriate for solving all human problems. Attempting to use science to solve problems inappropriate to it can only lead to further difficulties. Theodore Kisiel's article, "Science, Phenomenology, and the Thinking of Being," deals at some length with this problem, and since he treats it as an evaluation of the sciences, a discussion of his article is appropriate here.

Kisiel attributes to Heidegger the position that modern technology, while not being merely applied science, does manifest the hidden character of modern science. As such it calls for careful study. The path for its development was laid out by modern physics in which the forces of nature were calculated in advance and then verified through experiment. Technology was to develop as an overt manifestation of the same method of dealing with nature. It gives us a procedure by which to deal with nature in order to accomplish a predetermined goal. The goal in this case is not the acquisition of knowledge as it is in scientific research, but the method is the same in terms of projecting beforehand what needs to be done and how it can be done most efficiently.

The actual goals of most technological projects involve the control and disposition of "nature" for whatever predetermined purpose man desires. Such projects almost inevitably become highly complex - imagine the difficulty of finding, procuring, and ultimately using all the materials...
needed to build an automobile - and all of the things needed for the accomplishment of the given end become mere components in the greater system. One of the primary reasons this becomes a problem is that man himself is a natural resource that is necessary to the functioning of this system. Individual men have little or nothing to do with the fact that the system is there, but they must be drawn into it, trained, and distributed into the "manpower" system which serves it. In short, man himself who is involved in the system of "disposing the actual into a system of calculable and reliable components" has become one of the disposable components of that system.22

The understanding of being accompanying modern technology reflects the "method" discussed above. Being has become the "stockpile of natural resources" subject to the demands or needs of modern man.23 All other ways of understanding being are ignored when this happens. The result is a tremendous impoverishment of man.

Kisiel suggests that the only way out of the problems inherent in our current technological epoch lies in careful deliberation on the presuppositions which govern it. But the mathematical, calculative method necessary to it works against any such deliberation since it can admit only certain types of questions as important and accept only certain types of evidence as relevant. Everything else is systematically excluded in order that the ultimate and
apparently unquestioned goal of total planetary domination can be achieved as quickly and efficiently as possible. So taken up with its own method is technology that it tends to allow even its own presuppositions to be lost. "Even the forgetting is forgotten," as Kisiel puts it.\(^\text{24}\)

The danger in all of this is not so much from the so-called "demonic" nature of technology, but in the exclusive way in which it understands the world, being and truth. The possibility of coming to a more primordial understanding of these three things is reduced by the bias of the technological/scientific age, and it is in this that the danger lies.
III. SCIENCE AS A FOUNDED MODE OF KNOWING

A. The Dependence of Scientific Knowledge on More Basic Modes of Knowing

The purpose of this section of the paper is basically twofold. Using a Heideggerian example, I want first to demonstrate how it is possible for scientific or theoretical knowing to develop from more basic modes of knowing that exist in an prior to his development as a scientist. Once that is accomplished I will try to show what the major differences are between the two types of knowing and offer an evaluation of scientific knowing in terms of its limitations in comparison to the more basic knowing from which it developed.

Manipulation and use of a tool for the achievement of some particular end is the general circumstance I will use as my example. My treatment of this point will not be a mere paraphrase of Heidegger's argument (see Being and Time, pp. 410-414), since much of his motivation was to give a temporal characterization of everyday involvement with the world. That, specifically, is not my concern here. The tool may be a hammer and the end for which it is used may be the production of a shoe, but the importance
of the example lies in understanding the type of relationship that exists between the user of the tool and the tool itself. There is more to this relationship than merely the user and the tool since they more than likely exist in a greater equipmental context as well as a greater being context. By equipmental context I simply mean that the shoemaker who is involved here may be sitting on a bench with an anvil under the shoe which he is working on and nails lying to one side ready for use. He is aware, in a sense, of all these things even though his action at this instant is that of pounding on the shoe. His goal is part of what is referred to by the phrase "greater being context" above. He is working within a particular context of being and beings in the world, but he is working toward the production of something different from his immediate context, yet growing out of it. This point is used by Heidegger as a demonstration of temporality but it also shows that the shoemaker is intimately involved with the beings of the world around him. He is functioning within it and as a part of it. He controls it in the sense that he changes part of it, but it controls him from the standpoint of the possibilities of being that it offers to him. i.e., it offers him the possibility of making a shoe out of leather but not out of water.

The fact that the shoemaker is working within the
possibilities offered to him by the things of the world around him indicates a certain attitude on his part toward the existence or being of that world. The being of the world is not something totally or for the most part determined by him. He works on it and with it, but according to the nature that he finds in it. It is possible, however, for that attitude to change or shift to a theoretical or scientific approach to the world and it is that change which will elucidate through further development of the example.

Suppose that the shoemaker has more than one hammer on his work table and that one of them is much heavier than the others. He lays the lighter hammer down in order to do something without it, and then reaches for it to continue the initial task. But he has accidentally picked up the much heavier hammer which he ordinarily would not use for this work. Immediately his consciousness of his work is broken. He is no longer working within the context of this original equipmental totality because his consciousness has shifted from that context and is now dominated by the heaviness of the hammer.

At this point it is possible that the shoemaker would stop his work and begin to examine the hammer from this new perspective, to "know" it from the standpoint of its heaviness. Surely he knew it before, he used it for long periods of time, but he now is coming to know it in a
different way. The important thing to notice about this shift in "ways of knowing" is that he now considers it to have a different kind of being. The tool-character of the hammer has essentially been lost. The aspect under which it is studied now could as easily be studied if it were any other thing whose weight was noticeable in a similar manner. But this is not the only change that has occurred. The place, the position of the hammer (the heavy object) no longer has any real significance. It could be studied under this aspect here, over there, or anywhere else. The hammer prior to the shift was involved in a particular equipmental totality being used to achieve a particular end. None of that has any meaning now. It has been objectified and universalized such that it is freed from all the characteristics that previously were used to identify it and give it meaning.

At this point the ontological stage has been set for the definitive shift to the scientific or theoretical treatment of being. The hammer is no longer a tool, but is only a thing which can be studied under the theme of heaviness or weight. That weight can be calculated and compared to other heavy things indiscriminately. In fact, a character has been discovered here that can be applied a priori to all physical objects. The whole of physical nature can be projected for study as the realm of heavy bodies or things with measurable weight. The type of
knowledge that is had when this is done is surely different from that which the shoemaker had of his hammer, and the kind of being attributed to things is equally different. They no longer have the individuality they once had— that was all traded for calculable weight. But man now has something he did not have before—an a priori ability to deal with physical nature. Literally anything in the realm of physical nature can now be approached with some prior knowledge of it. If one adds to this projection other equally universal and calculable factors such as motion, force, location, and time one has developed some factors for a science of nature, a physics. And this is, in fact, roughly the way mathematical physics now projects the realm of physical nature. Only those aspects of physical nature that are universalizable and measurable are considered for study. The discipline clearly has an established bias for what it will accept as knowledge of nature (the factors mentioned are some of the things it seeks) and subsequently a bias for what really constitutes being.

B. Consequences of the Derivative Nature of Scientific Knowledge

It is precisely this bias for what constitutes being that exists as a problem. The bias is in science as an integral part of its method but our age seems to have
developed a blind respect for science which in too many cases gives too little importance to significant human realities because they are "unscientific," i.e., not universalizable or capable of being captured in a formula.

Science is, indeed, an important mode of knowing, but it develops from more basic modes and exists alongside other important modes as well.

Further light may be shed on our question about scientific knowing by examining this type of knowing from the standpoint of the subject-object dichotomy which seems to be implied in it. The very nature of the scientific method carries with it the necessity of objectifying the things of nature that it deals with. The particularities of the hammer we discussed above which gave it its individuality have no significance for the physicist. It may be the shoemaker's favorite hammer, it may have a good "feel" and proper balance, but no such facts are relevant to know it scientifically. In order to be handled scientifically it must be objectified and categorized with other similar objects under a limited number of headings such as weight, length, density, etc. As indicated earlier this treatment is valuable and useful under certain circumstances, but it is not exhaustive in its treatment of the hammer, and neither is it necessarily the best way to deal with it. Shoes, we would all agree, are valuable for man, and if the shoemaker knows only the weight, length
and density of his hammer (and not how to use it), then he cannot make shoes.

Heidegger's treatment of this question in Being and Time is very much to the point. He describes the subject-object dichotomy implicit in scientific knowing as a superficial-formal interpretation of the phenomenon of knowing the world. Man is first and foremost a being who is in-and-toward-the-world. To say that man is "in-and-toward" the world is to say that he has, as a matter of fact, developed with the world and as a part of it. He comes to know himself initially in relation to the world; as he gets to know the world he gets to know himself. Man does not get to know the world initially as something that is opposed to him but almost as something that is part of himself. Early in life, for example, a small child does not distinguish parts of his body from parts of the world. The relationship that exists between the child and the world is not, at this stage at least, predominately one of opposition.

The subject-object approach to knowing the world which is essential to the scientific mode remains blind, Heidegger says, to what is already tacitly implied by the phenomenon of knowing itself. Knowing is itself a mode of being for man, and man is first and most primordially a Being-in-the-world. Knowing is a mode of being toward the world as well, and if man's knowing the world is a
mode of his being in and toward the world it cannot also constitute a relationship of isolation between a knower and a world-as-object. Knowing is the being-together of the knower and the world, not their separation as the subject-object dichotomy would have it.

If it is the case that scientific knowing necessarily involves the subject-object dichotomy as it has been discussed here, then it is a limited mode of knowing the world. We cannot deny that in many cases it is useful, but if it is in any sense seen as the only way of knowing the world, then it becomes a perversion of man's relationship to his world since it requires man to be radically separated from his world. Such a position would also necessarily exclude a very wide range of human problems and concerns that do not lend themselves to scientific objectification or formalization.
IV. CONCLUSION: THE SUCCESS AND LIMITATIONS OF RESEARCH

The purpose of this paper has been to examine science from a perspective that has gone largely ignored by most scientists as well as philosophers of science. The perspective itself differs from other perspectives in that it concerns itself with understanding the reasons behind the tremendous success of science and with seeking out the possible limitations of science as a method. Most other perspectives, as I mentioned earlier, leave these questions unasked and prefer to deal with questions about the internal nature of science.

The significance of my examination of science grows out of the incredible significance of science in terms of the influence it had had on man. Science embodies a method of coming to know about the world and a method of dealing with it that has succeeded in solving the problems it set for itself with probably greater regularity than any other method man has known. Through that method science has achieved amazing progress and it shows no signs at this point of slowing down.

The problems of defining precisely the reasons for success in science as well as determining the limitations...
on it as a method are intriguing ones and deserve more emphasis than they have had. Whatever the reasons for its neglect now, it was discussed in the *Critique of Pure Reason* by Kant. His understanding of the problem was much the same as the one I have traced out here with the help of people like Heidegger and Kuhn. His explanation of the genius behind scientific success is both insightful and appropriate to concluding remarks on this problem.

Modern science came into its own, Kant says, when the scientists realized that their reason was capable of gaining insight only into those things which it produced according to its own plan. Reason cannot develop laws of nature or anything of that kind by accepting "Accidental observations, made in obedience to no thought-out plan,..." The student of nature must approach nature "not in the character of a pupil who listens to everything that the teacher chooses to say, but as an appointed judge who compels the witnesses to answer questions which he has himself formulated." Heidegger would call this activity of the scientist who forces nature to answer his own questions rather accepting merely random data the process of projection. Kuhn would say that the scientist in this case was working within a previously accepted paradigm. But all three of them are talking about the same thing.

Science became successful because it stopped "just looking"
at nature and began to interrogate nature from a particular standpoint in an attempt to get just this information from this perspective and nothing else. Therein lay the genius of science and the explanation of its steady progress. It is for this reason that Kant could use the phrase "the secure path of a science." Science was on a secure path because it no longer depended on random proping.

This insight also provides us with a key for determining the limitations on science as a method. It was successful and secure because it adopted a well-defined perspective and sought answers to only certain questions that it had chosen. But any question that lay outside the scope of that perspective clearly could not be answered by that science. This point was made earlier in the discussion of physics. Physics is the science that studies those things coming under the heading of "spatio-temporal kinetic magnitudes." If a thing does not fit under that heading, physics is not interested in it. This is the limitation of physics and of the natural sciences together, but it is also their genius.

The sciences have not been able to achieve objective truth as people like Scheffler claim since their knowledge is applicable only within the range of their initial perspective or projection of nature. But, within that range the knowledge they achieve is reliable.

The only point remaining to be emphasized concerns the appropriateness of scientific projections for dealing with
human problems. If some aspect of human life finds itself excluded from the projection of a given science or the collective projections of all the sciences, then that area must be dealt with by some means other than science.

2 Ibid., p. 47


5 Ibid., p. 8.

6 Ibid., p. 7.


8 Ibid.

9 Ibid.


13 Ibid.

14 Ibid., p. 272.

15 Kuhn, The Structure of Scientific Revolutions, p. 23 and following.


17 Ibid., p. 275.
18 Ibid., p. 276.
19 Ibid.
20 Ibid., p. 277.
21 Ibid., p. 281.
23 Ibid.
24 Ibid., p. 183.
26 Ibid., p. 87.
27 Ibid., pp. 88-89.
28 Ibid.
30 Ibid.
31 Ibid.
32 Ibid., pp. 20-21.
33 Ibid., p. 21.
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The thesis submitted by William S. Hill has been read and approved by members of the Department of Philosophy.

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Arts of Philosophy.

May 21, 1973

Date

Signature of Advisor