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Discussion Paper

by

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on

Vincenzo Cappelletti's

UNITY AND THE HISTORY OF SCIENCE

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ON TWO DIFFERENT NOTIONS OF THE UNITY OF SCIENCE

I

It has been a pleasure to read Vincenzo Cappelletti's paper "Unity and History of Science". He is clearly well-read in both history of science and philosophy, particularly of the late 18th and early 19th centuries. I also share his concern whether recent quantitative reductionist science is capable of leading to a legitimate and satisfactory unity of science. Where we part ways, however, is over his analysis of the problem and his proposed remedy. A major difference is in our philosophical assumptions and categories which tend to lead to very different ways of comprehending the problem.

Dr. Cappelletti, like many Italian scholars, has clearly been strongly influenced by the philosophical ideas of Vico, Hegel, and Croce. This does not mean that he fully accepts their points of view, but that on an unconscious level he tends to take for granted many of their categories and assumptions. He has been influenced by philosophical idealism, that is, by the notion that consciousness is an all-inclusive category or that reality depends upon consciousness or knowledge of it. It is doubtful if modern science is compatible with such a perspective or can even be reliably understood from it. Nevertheless, Dr. Cappelletti's arguments deserve careful study, and within the timelimits allowed I will try to provide that.

If I understand his paper correctly, three points stand out. First, Dr. Cappelletti opposes what he calls "mechanistic science". Second, he thinks that a genuine and truly valuable unity of science must also include not just quantitative but qualitative understanding and not just idealized identities and similarities but real irreducible differences as well. And third, he suggests that what he calls a "structuralist" approach derived at least in part from German nature philosophy and the ideas of the French scientist Georges Cuvier could help bring about this larger unity.

In general, in spite of the radical difference in our epistemological and ontological assumptions, I agree with his second point very strongly and would like to concentrate most of this discussion paper on it. I will only briefly comment on points one and three, which I do not accept at all. Many idealists criticize "mechanistic science" as if in doing so one also refuted epistemological realism and ontological materialism about the external physical world. Needless to say the implication does not follow. Planck and Einstein, the fathers of modern physics, were also epistemological realists and materialists about

the external physical world. Unlike phenomenalists and idealists, both men thought that physical reality exists independently of and beyond both consciousness and knowledge and both men supported the atomic theory of matter and the reality of electrons, atoms, and molecules. Space and time were still absolute with respect to everything except the absolute speed of light in a vacuum. Replacing Newtonian mechanics or reducing it to a special case did not mean rejecting or modifying the philosophical assumptions of Galileo and Newton, though many people of course have imagined the contrary. Furthermore, the rejection of "mechanistic science" has been exaggerated. There have never been more machines in operation today or more students studying Newtonian mechanics. Both are indispensable in the practical world. Indeed, except for very high velocities and very small micro-particles Newtonian mechanics still works. It is still the primary practical way of understanding the macro-physical world, which is why students still have to learn it. And the macro-world of moderate velocities is still the world of greatest concern to the greatest number of people. Physicists do not have to be taught Aristotelian physics, German nature philosophy, or the structuralist approach of Cuvier, but they still must learn Newtonian mechanics, that is, mechanistic science.

Concerning point three, the psychologist Piaget and many others have advocated a so-called "structuralist" approach in science, but unfortunately they tend to mean different things by "structuralism". The expression tends to be ambiguous. Nor does Dr. Cappelletti define what he means by it. Nor is it easy to imagine how understanding the changing processes of the physical and mental worlds by means of either changing or unchanging "structures" can be satisfactory. If some form of holistic or Gestalt theory is intended, then this would have to be spelled out in detail before a proper judgment of it could be made. As a rule, such approaches often blur the distinction between what something is and what it is not. Such ambiguity is scarcely a satisfactory tool to bring about a legitimate unity of science. It is probably better to retain a world of different, not always compatible sciences, than to achieve the impression of unity by blurring real distinctions and differences.

Now let us turn to the strongest part of Dr. Cappelletti's paper, his objection to reductionist science in general and his feeling that legitimate and inclusive unity of science must also include room for both the irreducible existence of qualitative differences and for scientific means of understanding them.

II

Dr. Cappelletti and I both oppose the positivist conception of the unity of science as developed by Otto Neurath and other members of the Vienna Circle. The notion that the methods of theoretical physics in the sense of a mathematical pursuit for natural laws can provide a basis for the unity of all aspects of all sciences seems utopian. Dr. Cappelletti and I can agree on that, but I am not sure he would agree with the following analysis of what is wrong with the positivist picture and a suggested resolution of the problem.

Let us list two radically different theories about what we should mean by the unity of science. The first theory is the positivist one and fits closely with the common English and American definition of "science" as a systematic mathematical and empirical endeavor which excludes history and philosophy. The second theory defines science in a broader sense roughly corresponding to the German word for science "Wissenschaft" which includes history and under some circumstances may even include philosophy and common sense.

1. UNITY OF SCIENCE	2. UNITY OF SCIENCE
The mathematical methods of physical science are appropriate for understanding all branches and types of rational wisdom.	Regardless of how different their methods, all forms of rational wisdom are logically compatible with each other.

I think that the basic error in the positivist and analytic conception of the primary goal of science and of the unity of science consists not merely in their restrictive definition of science but in a false identification of natural laws with universal claims and a false theory that claims about real particulars can be subsumed under or deduced from natural laws. The theory which identifies natural laws with universal claims is sometimes called "the deductive approach" and sometimes "covering-law theory", and many philosophers who are not normally considered to be positivists or friends of linguistic analysis also appear to accept it.

As an historian of science it has become clear to me that what physicists and chemists call "necessary laws" (as opposed to em-

pirical and many statistical laws) are almost invariably equations which describe a necessary relation between a limited number of variables. Furthermore, such necessary laws either imply other laws or are implied by other laws or both. The price paid for such necessary relations, however, is that the laws only describe idealized behavior under idealized conditions. They do not describe the real world of real historical processes, unless severely qualified.

It was Galileo's law of falling bodies which has become the model or "paradigm" of a necessary law. It only holds for idealized behavior under idealized conditions. If we want to understand why any particular iron ball rolls down an incline in the particular way it does, then in addition to time and distance we also have to take into account friction, wind direction, air resistance and to be strictly accurate a great many other factors as well. In short, claims about real particulars cannot be subsumed under or deduced from necessary laws. The particulars always include variables not covered by the law, hence they cannot be deduced from them.

What Galileo did was to find a way to give a reliable understanding of idealized types of behavior. How do we understand real particulars? If they can be influenced by human behavior, human commission or omissio we normally understand particulars in terms of causal forces treated as means to help accomplish particular ends. Universal claims may be taken for granted and among those familiar with necessary laws some of them may be used to help understand causal forces, but in general the type of explanation is historical with the focus on how appropriate particular forces or processes are as means to help further or accomplish particular ends. In short, most understanding of real particulars is based on common sense, memory, trial-and-error, and in the case of laboratory scientists on experimental procedures based on experience and textbooks. All of these methods were in existence before Galileo and the Scientific Revolution. Indeed, if we remember that the compass, gunpowder, printing press, books, universities, microscope, and telescope, LARGELY [redacted] preceded the Scientific Revolution and helped make it possible, then perhaps we can gain more perspective on the magnitude of human progress before the development of theoretical physics and mathematical science and well before their practical application on a significant scale.

Not only does understanding real particulars require different methods than understanding idealized behavior under idealized con-

ditions (since real particulars and claims about them cannot be deduced from necessary laws) but it is these "primitive" methods (which are actually highly complex and sophisticated) which are necessary in order for Galileo's idealized method to be possible at all. Common sense and history were well-developed as reliable methods of understanding well before the Scientific Revolution. Nor has it been possible to replace them. They still exist, and where understanding particulars are concerned under real or historical conditions, they still provide more reliable understanding than exclusive reliance on any merely idealized or mathematical approach.

Many positivists and analytic philosophers want to think that idealized mathematical methods can not only solve idealized types of problems but also real historical problems, and to be sure they can under selected circumstances serve as an indispensable aid, but they are never sufficient where there are more important variables than the necessary laws take into account, as there almost always are in the real world.

All universal claims are not necessary laws, and nothing about what is real can be deduced from what merely holds under idealized conditions. The positivist dream of the unity of science is an attempt to unify science by means of necessary laws, but necessary laws only apply to what is idealized. Nor does it help to substitute empirical or statistical laws since ONLY RARELY CAN THEY [redacted] imply other laws, thereby preventing any full or necessary unity of the sciences.

What is the solution? One possible answer is to redefine science in a broader sense to include common sense, history, and rational philosophy and admit that they employ different methods and types of generalization, but that the discoveries of each method may still be compatible with each other. Another possible solution is to retain a narrow definition of science but switch the goal from the unity of science to the unity of all forms of rational wisdom, with reason being understood not just in terms of pure or mathematical reason but also in terms of means-end logic and practical reason, where mathematical reason itself becomes used as a means to help accomplish long-range human ends and aspirations. If we comprehend the unity of science or of rational wisdom in these last two senses, then I think that Dr. Cappelletti, myself, and many other people will agree that we may well have helped establish a much better context for understanding and solving the problem than was possible using the positivist or reductionist approach.