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OCCAM'S ELECTRIC RAZOR

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By Lee Loevinger

William of Occam was a Franciscan monk who taught at Merton College, Oxford University in the early part of the fourteenth century. He was something of a sceptic and a philosopher, writing on psychology, metaphysics and theology. He is best remembered today for the maxim attributed to him, "Essentia non sunt multiplicanda praeter necessitatem" - entities should not be multiplied beyond necessity. Among students of philosophy and science this is known as "Occam's Razor" - for it serves to shave the surplusage from the concepts of science. It is also called the Principle of Parsimony and has long been one of the fundamental rules of scientific thinking. In more idiomatic language it commands: Among equally plausible hypotheses, prefer the most simple.

The fundamental significance of this principle is well illustrated by the history of astronomy. Ptolemy of Alexandria, who lived in the second century A. D., brought together the considerable knowledge of astronomy that had been gained by the Egyptians and the Greeks and gave his name to a systematic explanation of the movements of the plants and the sun. The Ptolemaic system described the movements of the planets and sun as cycles, or circular orbits around the earth.

Since observations disclosed that the actual movements did not correspond too closely with simple geocentric orbits, an elaborate system of cycles, epicycles and eccentricities was postulated. The Ptolemaic system did establish astronomy on a sound geometrical foundation and was geometrically defensible. It harmonized fairly well with appearances and conformed to common sense.

About the middle of the sixteenth century Nicolaus Copernicus published his great work (De Revolutionibus Orbium Coelestium) in which he proposed a radical reform of astronomical theory. The Copernican explanation of planetary movement postulated a stationary sun with planets revolving in circular orbits around it. Although by no means perfect, this system was far more simple than the Ptolemaic scheme and yet explained the observed facts as well or better. With modifications in its early years by Kepler and Galileo, the Copernican model has served as the foundation of modern astronomical theory.

It is elementary schoolboy lore today that the earth and other planets revolve around the sun. Although the more sophisticated school children realize that the orbits are elliptical rather than circular, we still use the Copernican model. However, it is not so generally understood that there is no scientific or abstract sense in which it can be said that the Copernican model is true and the Ptolemaic model is untrue. All astronomical bodies are in constant motion in relation

to all others, and the manner in which we describe the motion of any one or any group depends upon the frame of reference of the description. A description of the movements of the bodies in the solar system can be given in terms of the Ptolemaic model with a fairly high degree of accuracy. However, in order to use this model with accuracy it is necessary to devise very elaborate and complex modifications and refinements. The Copernican model, on the other hand, permits description of the movements of bodies in the solar system in a much simpler fashion with greater accuracy. Furthermore, the model itself permits an understanding of the relative movements without reference to complex modifications or mathmetical formulae.

Therefore, the principle of parsimony, or Occam's Razor, indicates that the Copernican model is a better one since it is equally valid and more simple. Thus, the principle of parsimony or simplicity becomes a fundamental standard for the formulation and choice of scientific theories.

The question will probably occur to lawyers as to how simplicity itself is to be determined. There seems little doubt that this is essentially a subjective concept. What we are talking about is not how things behave but how the human mind can best explain and understand the behavior of things. If the human intellect had an infinite capacity for storing, selecting and recalling data, the best method of learning

about and understanding phenomena probably would be by a detailed description of each observable phenomenon. However, the ability of the mind to learn, to store and to recall is far from infinite, and is, indeed, very limited in relation to the range of problems that man seeks to solve. Therefore, we invent formulae, theories and conceptual models to serve as mnemonic devices to enable us to deal with a wider range and larger number of phenomena than unaided memory can encompass.

So the principle of parsimony is itself a mnemonic device. The degree of simplicity is to be judged by the ease of memory and recall.

A popular picture of man's history suggests that the race is steadily progressing from a relatively simple and natural condition of living to an increasingly more complex environment. In this view the progress of civilization involves increasing complications and complexities for civilized man. It seems to me that this view is not necessarily correct. Rather, the progress of culture seems to me to consist of an increasing ability to deal with a progressively wider range of phenomena by devising techniques of simplification. For example, the progress in conceptual refinement of astronomical theories has permitted the understanding, explanation and prediction of celestial movements far beyond any possibility of achievement with earlier views.

To put this in concrete, rathern than theoretical, terms consider the life of the average person today and in prehistoric or early historic times. Throughout much of man's earliest history the entire effort of the individual was devoted to the rudimentary tasks of providing for his own immediate physical needs for food and shelter. Certainly it was not easy for the caveman, or even for many of those living in early historic times, to secure food, to provide themselves with clothes, or to erect adequate shelter. On the other hand, modern man need only perform some specialized work that he has been trained to do, and he is provided with a medium of exchange that permits him to secure food, clothing and shelter with scarcely any physical effort and no personal ingenuity.

While we think of modern physical devices of transportation and communication as complex, which they are, consider them in relation to man's place in his environment. An ordinary citizen today needs no more than his ignition key, a credit card and an ability to manipulate a minimum number of levers in order to transport himself rapidly and comfortably across thousands of miles. Similarly, he requires no more knowledge than the ability to turn one or two dials in order to listen to messages or see pictures transmitted to him from the antipodes. These represent achievements that were completely beyond

even the aspirations of any man only a few years ago as history is measured. Certainly modern man finds it a far more simple matter to control and manipulate aspects of his environment than any of his predecessors.

Let me pose one more example. The earliest engine developed by man for furnishing substantial amounts of kinetic energy from fuel, or inanimate sources, was the reciprocating steam engine. This involved building a fire in a device that heated water to steam which was then let into a cylinder where it exerted pressure upon a piston that pushed upon a crank which turned an axle. The next development in engines was the internal combustion engine. This involved essentially the same mechanical arrangement but eliminated the external combustion of fuel and permitted the combustion to take place in the cylinder. This arrangement was somewhat more simple, but still involved the reciprocating piston as a means for changing reciprocating into rotary motion. The next development was the turbine. This is an engine in which gas or liquid acts directly upon a wheel to create circular motion. The most recent development is the jet engine which involves virtually no moving parts at all, but simply a device in which the combustion of fuel imparts movement to the entire engine itself as well as the vehicle to which it is attached. In principle, this is by far the simplest form of

engine yet devised. Although at present it seems adaptable to airplanes but not to automobiles, we may anticipate that far simpler forms of engines for automobiles will be developed. Beyond the gasoline turbine, which is already in experimental operation, probably lies the fuel cell. This is a device by which fuel reacts without mechanical movement within a honeycomb structure to produce electricity, which in turn may be used to activate simple electric motors to drive the vehicle.

In all fields, both intellectual and physical, it seems to me that the progress of man's achievements and knowledge has been toward the comprehension of a wider range of phenomena within his understanding or control by the development of successively simpler and more embracing principles or devices.

In the field of data organization we have now developed devices with almost unbelievable range and ability. These are the electronic computers. Although their construction and operation is beyond the comprehension of most of us, their principle of operation is quite simple. The most generally employed type of computer (that is, the digital computer) is essentially capable of discriminating between only two choices; that is, the computer can answer only "yes" or "no." However, it can answer "yes" or "no" to a fantastically large number of questions in an incredibly short period of time. Thus, a large

computer can perform literally millions of operations in a fraction of a second. This enables it to handle data of great complexity and great volume by this very simple operation.

There is, as you know, much discussion going on at the present time concerning utilization of electronic data retrieval techniques in the law. It seems fairly clear that this is not only possible but quite practical, and a number of projects have already been undertaken either to utilize electronic data retrieval for legal purposes experimentally or to devise systems for such utilization. This possibility poses a new challenge to the law.

It is an old complaint that the law, far from becoming simpler, has become increasingly complex as its volume has increased. There is certainly some foundation for this complaint. We need no better witness than the great legal technician and one of our greatest judges, Learned Hand, who has posed the problem in these poignant words:

> In my own case the words of such an act as the Income Tax, for example, merely dance before my eyes in a meaningless procession: cross-reference to cross-reference, exception upon exception--couched in abstract terms that offer no handle to seize hold of--leave in my mind only a confused sense of some vitally important, but successfully concealed, purport, which it is my duty to extract, but which is within my power, if at all, only after the most inordinate expenditure of time. I know that these monsters are the result of fabulous industry and ingenuity, plugging up this hole and casting out that net, against all possible

> evasion; yet at times I cannot help recalling a saying of William James about certain passages of Hegel: that they were no doubt written with a passion of rationality; but that one cannot help wondering whether to the reader they have any significance save that the words are strung together with syntactical correctness. Much of the law is now as difficult to fathom, and more and more of it is likely to be so; for there is little doubt that we are entering a period of increasingly detailed regulation, and it will be the duty of judges to thread the path--for path there is--through these fantastic labyrinths. Any facility in doing so is of the utmost importance; I envy its possessors, among whom my brother stands in the front rank. Again and again I have found myself utterly bewildered by the involution of phrase with phrase and of term with term, ...

It is obvious that if the great legal mind of Learned Hand was frustrated and bewildered by the statements of the law the average lawyer, and certainly the average citizen, is even less able to cope with such complexities. On the other hand, as more and more subjects are encompassed by legal regulation it becomes increasingly important that the citizen should be able to understand the principles of law.

It may be that the changes required by the adaptation of electronic data retrieval techniques to the legal field will involve a rationalization and simplification of legal principles. The necessity of organizing and programming data for electronic retrieval forces a specification of the relationships which are to be utilized or found significant. This may be remarkably enlightening. Thus, modern symbolic logic, which is the abstract counterpart of electronic data programming, has

demonstrated that of the classical sixteen Aristotelian moods of the syllogism, several were invalid and others were tautological.

There is neither the time nor the occasion here to suggest the possible conceptual changes that may be involved in adapting legal taxonomy to electronic computer storage and retrieval. However, it may be observed that the traditional rigid hierarchical system of classifying legal rules will probably have to give way to a more flexible system established on a coordinate or a correlative basis. If this proves to be the case, the computers will have served us well by functioning as an electronic Occam's Razor. If the computers are used merely to store up greater quantities of data than we have had, then they will have compounded confusion and magnified ignorance.

The point that seems to me to be important is that lawyers must recognize, with or without the compelling spur of electronic computer utilization, that one of the great needs of contemporary law is for clarification and simplification. To the degree that the law is a procedural establishment of concern to lawyers it may be kept as obscure and confused as the profession itself is willing to tolerate. However, to the very considerable extent that the law is suppose to be a guide to the conduct of citizens in a free society it must be made intelligible to the citizens.

There is no inherent obstacle to this other than the inability

or unwillingness of the lawmakers themselves to cope with the problem. Some of the legal principles of widest and most important application are relatively simple and easily comprehensible. For example, the principle of negligence, whether articulated or not, is widely recognized by most people. Nearly everyone realizes that careless conduct which injures another exposes the actor to legal liability. The lawyers may litigate specific applications of this principle, as they do, in thousands of doubtful situations. But the principle is easily understood and widely applied.

Similarly, in the antitrust field the basic principles are relatively simple and easily understood. Any combination among businessmen to limit or lessen competition is illegal, as is conduct which creates or seeks to create a monopoly. As in the application of the principle of negligence, there may be, and are, situations in which the application of these principles is doubtful and requires or creates litigation. Yet these basic principles summarize the substance of the Sherman Act and constitute the foundation of our antitrust laws. Most of the litigation in this field consists of application and specification of these principles.

It would be invidious to mention other fields of law in which there are no such relatively simple and broad principles. Each of you can probably think of at least a half a dozen fields where the law corresponds to Judge Hand's eloquent description of language expressin

some "vitally important, but successfully concealed, purport." Certainly an important task of the lawyer, as an agent of the court, a servant of society and a counsellor of his clients is to discern, formulate and articulate the principles of the law. Ultimately this can and must involve clarification and simplification of the rules.

So it is not only in the fields of science that "Occam's Razor" has validity. The wisdom of the fourteenth century Franciscan monk speaks to us today more powerfully than it did when William of Occam first warned against the unnecessary multiplication of entities. The quill pen has been replaced by the electronic computer. But the ultimate objective of the symbol, whether inscribed in rock, written by pen on paper or recorded on magnetic tape, is the human mind. Basic capacity of the human mind has not significantly enlarged within any period known to man. If man is to cope with the increasing range of physical and social phenomena that confronts him today, the need is greater than ever for the application in the field of law of that guiding rule of science--the principle of parsimony.