A STUDY OF THE SIMILARITY BETWEEN ENGINEERING AND SOCIOLOGY; THE USE OF ENGINEERING METHODOLOGY TO UNDERSTAND SOCIOLOGICAL PHENOMENON

By: N. STEPHAN KINSELLA
439-31-6097
DECEMBER, 1986

For: DR. [redacted]RAN, SOCL 3601
DESERAN,

For Dr. Shrum

INTRODUCTION

In this paper several examples are presented which show how engininеering and sociology are closely related, in order to help demonstrate the multiple theses of this report. One of these suggests that many of the methodological ideas behind engineering (indeed, in science and technology in general) are not really different in kind from sociology, but only in degree. Assuming the validity of the first thesis, another asserts that this point of view can be used to help bridge the gap between the "hard-" and "soft-" scientists' points of view. Also, the idea is put forth that certain people of the engineering discipline may use some of their methodological framework to help them understand sociological theories from a different perspective than sociologists do. Additionally, the perspectives presented herein may be viewed as useful, or, at least, as a nontrivial, fresh way to look at sociological phenomenon, by sociologists themselves.

EXAMPLES AND RELATIONSHIPS

Among the many different perspectives employed by various sociologists are analogies to characteristics of engineering. The idea of Biological Determinism, for instance, attempts to explain human social nature (and human nature in general) in terms of inherited, animalistic instincts. Man is viewed as a complex biological machine, a physiological contraption put together somehow by the unpredictable whims of nature. He is a predefined network of interacting parts, which will react in a certain, definite way to the environmental inputs he is exposed to. In other words, man's structure, not chosen of his own volition, determines completely how he will react to any external stimuli, which are also beyond his control. In engineering this is very similar to something called the "black box approach". When, for example, an electrical circuit is viewed using black box ideas, the engineer is concerned with the inherent characteristics of the system--it's built-in qualities which reveal how it will react to any input.

Looked at in a more basic way, Biological Determinism can even be related to something as seemingly alien to sociology as physics. Instead of merely looking at a person as being described by "instincts", which are still somewhat vague, complex and non-literal entities, one could take this idea a step further and explain man as a **machine**, a collection of atoms and sub-atomic particles described solely by Newtonian or Einsteinian physics. With vision, one should be able to see the possiblity of reducing man--his actions, feelings and emotions--to one specific, albeit complex, mathematical formula. This is certainly how an engineer looks at a physical system, at least to have an ideal model, in order to be successful at predicting and understanding the system.

Mead's mechanical model of man, the view that man is cybernetic--part human, part machine--incorporates both the human aspect and the strict, engineering aspect of looking at man. This cybernetic model also includes ideas about feedback. In other words, man is a machine constantly using sensory input from the environment to appropriately modify his behavior to achieve his goals. Of course, feedback is an idea that is very deeply ingrained into engineering's methodological rigor. An anti-lock braking system, now being installed on many cars for safety reasons, uses a feedback mechanism to sense when the wheels of the car are about to stop, or lock up. When this happens, the anti-lock mechanism reduces pressure on the brake pads by opening a valve to let some of the brake fluid out of the lines. This is a very simplified comparison to a human being's feedback and interaction with his environment.

The Gestalt approach in sociology is also similar to the black box approach. A Gestalt is a complete collection, a finite, well-defined ensemble of related members. Sometimes, for example, in analyzing a circuit, an engineer will break the circuit up, mentally, into separate, discrete chunks, each of which may be composed of any number of individual elements, in order to get a better mental picture of the whole--a more intuitive feeling for the way in which the circuit will work. Georg Simmel believed that understanding group nature is more important than understanding individual human nature in predicting their interaction, mainly because it is the existence of **groups** which makes possible social interaction and society.

The perspective of Ethno-methodology seeks to understand society from the point of view of the individual. Social structure is viewed as problematic, being continually reconstructed. In order to understand sociology, we must **disrupt** parts of society in order to understand what is really going on. There is merit in engineering in looking at things as individual elements. In a complex circuit, with thousands of elements, one can look at things as groups of interacting black boxes, as discussed previously, or one could take each individual element into account. With a large number of elements, this is facilitated by using a digital computer in the analysis. But a more direct analogy is the afore-mentioned idea of disrupting to understand. In mathematical and practical analysis of a system, engineers wish to know the characteristics of a system. In other words, they wish to know what outputs will result for any given input. It can be proven mathematically that if one uses something called an **impulse function** as an input to a system, then by observing the output one can obtain a complete description, and therefore acquire a good understanding, of the system. A good example would be to strike a large, metal frame (the system) with a hammer (the impulse), and observe the output (possibly the resonant frequency of the ringing sound produced).

Another perspective, Pragmatism, which states that the only reality that really is or that really matters is external reality, is a common-sense approach to sociology. Engineers being people, too, they also tend to use common-sense methods from time to time. For example, some of the reactions that go on in the chemicals inside of a chemical battery are not fully understood by chemists and physicists, yet the phenomenon observed are predictable **enough** so that reliable batteries can be made and used, which is all that is truly necessary to know when it comes to using a flashlight or portable radio at the beach. John Dewey stated that society is too complex internally to fully understand, and that we must develop our theories by making external observations. This seems to be a method that **all** scientists use, whether they be sociologists, engineers, chemists or physicists.

The concept of stratification, that people are sometimes grouped into discrete, separate units, could also be called discretization. Discretization, when referred to electrical engineers' concepts of digital signals and information, represents the process of taking an analog, continuous signal, and breaking it up into a finite number of discrete values.

An interesting idea in sociology is the subtle difference pointed out between motivations and motives. It is believed that true motivations cannot be known, while a motive is that which is seen as a explanation for human actions which is satisfactory to both observers and actors. While, on the surface, the physical sciences and engineering may seem to be delving into the "motivations" behind natural phenomenon, it is obvious with a little introspection that all any science can hope for, at least for this age, is to find an acceptable "motive" behind nature and the world.

Engineers use a much higher amount of strict mathematical expressions than sociologists do. This frequent usage affects, in some ways, the way the engineer thinks. He tends to view things very often in his mind as having some sort of mathematical explanation, some sort of functional description, even if he doesn't explicitly **know** what that function is. It is a different type of thinking, a different mental organization, altogether. When sociologist, for example, state that a person's behavior depends upon motivation (the **true** driving factor), an engineer may immediately picture in his head the mathematical expression

$$B(M) = ?$$

which means that behavior, the dependent variable, is a function of motivation, the independent variable, although the explicit mathematical description of the function is unknown to him.

The very fact that the Documentary Method is used in both the "hard-" and "soft-" sciences illustrates another common bond between them. In making relationships with other social elements (people), individuals try to place and understand others by trying to construct a reasonable history, or "biography", which can explain others' purposes and actions. Similarly, the documentary method being a major facet of the scientific method, scientists and engineers observing physical phenomenon try to construct a reasonable "biography" of an event or substance which explains its characteristics and constitution.

There are some fundamental differences, of course, between engineering and sociology. There are some parts of both academic worlds which simply have no parallel in the other. How can emotions be seriously related (at least in a fashion that is worth the trouble) to a complicated mechanical system? But even some sociologists have used examples similar to the ones mentioned above, which is another demonstration of how different perspectives--in specific, those of engineering--can be useful to understand Society.

Presented in class were the examples of the cybernetic man (already discussed), feedback, and Maxwell's demon. This helps show that the two fields do have some common ground. Indeed, what is the true difference between the two, except matter of degree? **While engineering has a much higher use of mathematical and physical methods, it has a lower degree of the human element.** Sociology places far more emphasis on the common sense, **understanding** approach to solving its unique problems. If a **totally** engineering approach was used to understand society, it would be unsuccessful because, for all practical purposes, society is far too complex to be reduced to a set of equations to be solved by a computer. It could be attempted, though. By looking at society in common sense, practical ways, using the human viewpoint, imagination, and creativity, a sociologist is very successful at his analysis of society. It is suggested that some of engineering's methods might be useful as another way of helping engineers, or even sociologists, understand sociology in a different light.

Sociology could be called predominately **qualitative,** while engineering could be labeled **quantitative.** But the only difference between "qualitative" and "quantitative" is one of degree. This is because quantizing--numerically describing--something is simply a very precise way to describe certain aspects it possesses, but some generality and intuitiveness is lost in the process. Qualifying something also describes and classifies it, although not as precisely as the other approach. One could give a precise numerical value for the Farenheit temperature of, say, a piece of metal, as being, for example, 36 degrees. One could use this figure in calculations. But simply saying the metal is "cold" also imparts a certain knowledge of the state of the metal, and one can imagine a cold piece of metal better than one that is 36 degrees Farenheit.

One important thing to know about qualitative observations is that they are meaningful **only in context.** This idea is embedded in sociological theory. Since physics is a very strong backbone of engineering, a comparison between physics' **Theory of Relativity** and the idea about qualitative observations in question can be luciferous. One tenet of Relativity is that no measurements or specific quantitative knowledge is meaningful unless compared to something else. This is because Relativity has established that there **are no absolutes** when it comes to things such as time, speed, and distance. Tamotsu Shibutani's autokinetic effect, for example, illustrates this point nicely. The position of the light was very unsure since there was no reference in the dark room. Relativity also holds that by observing any event, one inevitably affects the event under scrutinization. This is, of course, something all scientists, sociologists included, must be aware of.

CONCLUSION

Engineering and sociology do have many things in common. Causality pervades both--that is, both types of scientist assume there is a reasonable, understandable **cause**, a motive, if you will, behind the observed effects under question, be they the outputs of a radar tracking device or the actions of shoppers in a shopping mall. Sociologists' goals are totally different from engineers', save for the basic idea that they are both, somehow, done for the good of mankind (or, at least, that will be an end result). But even so, engineers do acquire--along the way to becoming engineers and on the job--skills which can be useful as an additional sociological perspective. Since sociologists do employ many different perspectives, and since engineers come from another end of the scientific spectrum, hopefully the ways in which engineers have been trained to think about and view problems can lead to a fresh understanding, a new perspective from which to view the social world.