A Working Paper Draft

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SOCIO-ENGINEERING PROBLEMS No. 23-A

A series of manuscripts on the social relations of engineering and related philosophical questions dealing with the interaction of science and society. Distribution is limited to reviewers and discussion groups for criticism prior to consideration for possible publication.

A CHECKING CHART FOR THE USE OF COMPUTER ENGINEERS IN DEVELOPING SOCIAL RESPONSIBILITY: PART I*

*Part II is in SEP No. 24-A.

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Problem 4.3/12.0: How can the idea of the social responsibility of engineers be developed or be restated in a way that is based upon:

(a) historical sociology, and

(b) recent papers such as the panel on the social consequences of automation given at the 1958 Western Joint Computer Conference?

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ABSTRACT

Some recent papers on the social responsibility of computer scientists and the social problems of automation are reviewed. A classification of the sciences derived from the work of early sociologists is used to develop a simplified perspective for the engineer. This classification table is transformed into a "checking chart" for use by engineers in determining the extent to which the social problems relating to their work are being covered. This leads to a limited concept of social responsibility that is believed to be easier for the average engineer to take on as an obligation. Namely, the social responsibility of the engineers is to be a kind of coordinator to make certain that the social problems related to his physical engineering work are being studied and that there are provisions made by our society to explain the basic principles and significance of science to the voters in our democracy.

Introduction

Recently there has been some interest in the question of the social responsibility of engineers. A series of articles and letters to the editor appeared in the early part of 1958 in *Computers and Automation*.(1-6) These articles dealt first with whether a journal such as *Computers and Automation* should publish articles on the social responsibility of computer scientists. Then specific topics such as the possibility of the destruction of civilization due to some component failure in the computer linked to a missile warning radar network. A range of viewpoints from conscientious objection to working on a computer system that might be used for destructive purposes to a viewpoint of no concern with the use of one's work has been presented.

This apparently sudden interest in the social responsibility of computer scientists was preceded by a long and fluctuating development of concern for social responsibility in science and engineering. Dr. R. L. Meier has reviewed the status of social consequences of scientific discovery and has made specific recommendations concerning the social responsibility of administrative scientists.(7) Dr. Edwin Layton has studied the history of the idea of social responsibility in the American engineering profession.(8)

The Western Joint Computer Conference at Los Angeles, May 6, 1958, conducted a panel on "The Social Problems of Automation".(9) The following quotation is from the abstract on the program of the WJCC Panel:

"Electronic computers are being employed in steadily widening areas of activity. The outlines of these areas are now discernible. In the scientific and engineering fields, computers have proven to be powerful design and analysis tools. Computer design and application disciplines are having extensive effects on the very mathematical and engineering fields from which the techniques are drawn. These devices have become an integral part of the weapons, machines, and organizations building for wartime. The computer and its descendant, the data processor, are now being applied increasingly to business and industrial activities, in the office and in the factory.

"The total effect of this body of equipment is compounding rapidly, due to the daily discovery of new uses and the sharply increasing quantities of computers and data processors going into action. The impacts of these powerful new tools will be sufficiently great to create discernible changes and reactions in the American society. The adjustments and responses may well create difficult problems in the American business, scientific, and social systems."

The various viewpoints appearing in Computers and Automation present an uncoordinated spectrum of differing ideas. The views of the 1958 WJCC Panel on "Social Problems of Automation" have a certain amount of coherence. It would be desirable, if we could, to find some way of reviewing these different viewpoints in a more logical manner. Perhaps there is some order to these problems analogous to the orderly arrangement of the elements in the form of the periodic table in chemistry.

A Checking Chart Derived From a Classification of the Sciences

Let us examine historical sociology to see if there are any concepts that might be of use to us in establishing a perspective from which to evaluate ideas on the social responsibility of engineers and scientists.

August Comte, writing in the first half of the nineteenth century, looked at changes in society as parts of an evolutionary development. He considered that the sciences which man developed to understand nature and society were of different levels of complexity, the more complex fields of science being dependent upon the earlier, more basic sciences. He identified these concepts as "positive philosophy" and started the field of science known as "sociology".

This new science of sociology was developed by Herbert Spencer in England and by Lester Ward in the United States. The organization of the sciences proposed by Ward[10] is shown in Table I.

TABLE I
CLASSIFICATION OF THE SCIENCES

SOCIOLOGY
PSYCHOLOGY
BIOLOGY
CHEMISTRY
PHYSICS
ASTRONOMY

As we go from the bottom to the top of this table we follow the historical order of development of the fields of science and to some extent the level of complexity.

The work of Comte, Spencer, and Ward will be of some use in organizing a representation of the relationship of the special fields of science which will be help to the specialist in relating his own work to other fields and to the layman by providing a simplified view of the complexity of special fields of science.

The fields of knowledge are arranged in order of increasing complexity; with the study of energy and the basic particles of matter as the foundations in physics; the study of the relations betweenthe fundamental particles and energy to make compounds of the elements in chemistry; the study of more complicated compounds which form living matter in biology; the study of more complicated living things as animals in zoology; the study of man as the most advanced of the animals in physiology; the study of man's mental and emotional processes in psychology; and the study of man's relations with the rest of humanity through social institutions in sociology.

The checking chart of Fig. 1 is designed to help man carry his creative ideas into practice in a balanced way. The blank rectangular areas on the chart are to be used to indicate areas covered by a particular analysis, project, or individual. Certain basic types of natural phenomena are arranged in horizontal rows in vertical order such that each is dependent upon the types of phenomena below it. The basic types of activities required for the meeting of human needs in an industrial society are arranged in order such that the accomplishment of an objective

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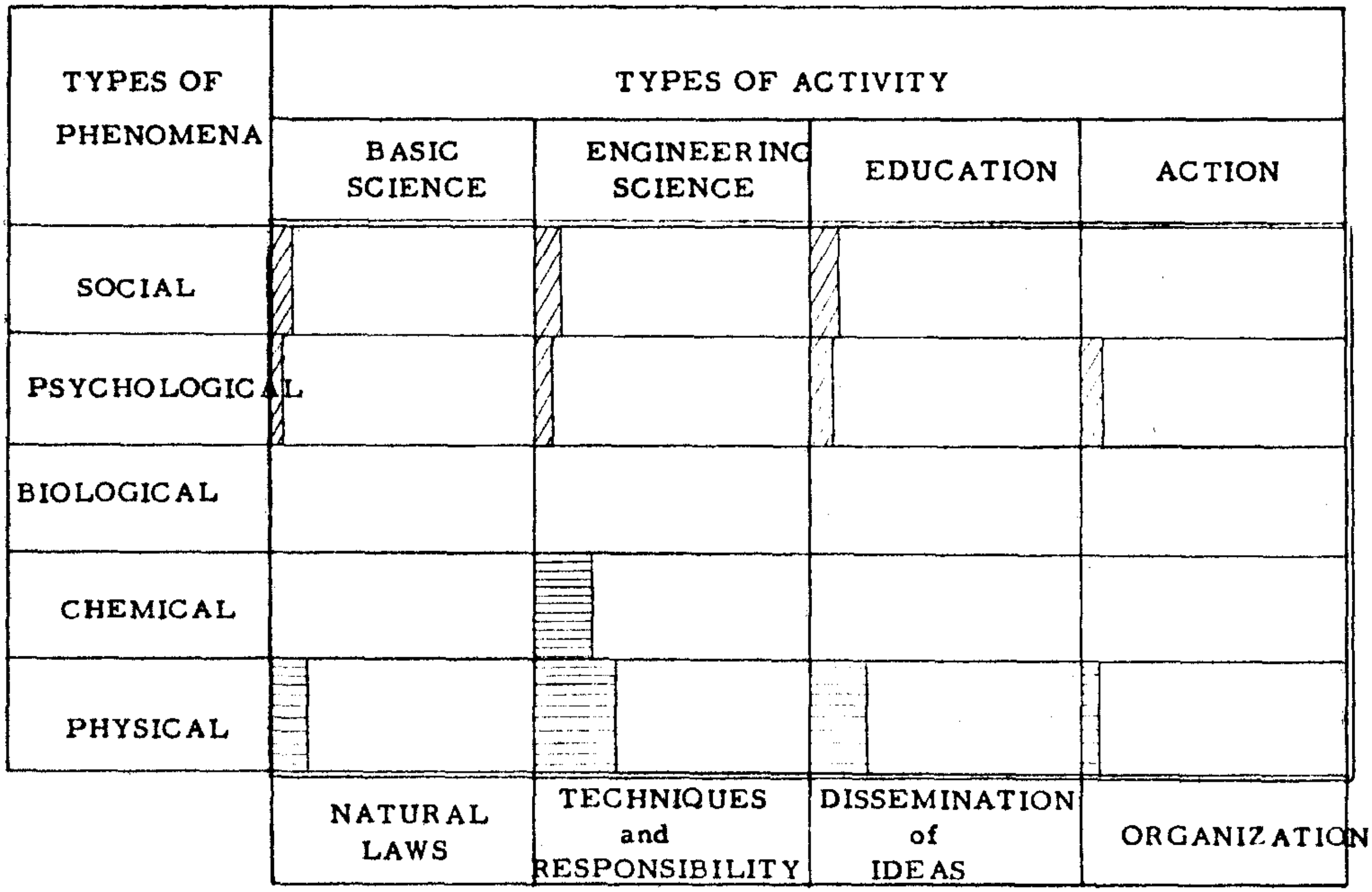

Figure 1. Checking Chart Designed to Indicate the Extent to Which a Particular Analysis Covers the Possible Phases of a General Problem.

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is dependent upon stages reached in activities to the left. The cross-hatched sections in Fig. 1 show the extent of coverage of the material of this particular paper.

In Fig. 1 two types of cross-hatched areas are shown. The horizontal sections relate to the primary technological development of computer technology. The diagonally-hatched area shows the relation of the secondary fields of activity where the development of computer technology causes social changes which require the help of social scientists.

An Example of a Checking Chart Applied to the Work of a Famous Engineer

Charles Proteus Steinmetz (1865-1923) was an electrical engineer whose extensive knowledge and broad interests enabled him to contribute in many areas. He specialized in mathematics, electrical engineering, and chemistry. His major contributions to science were: (1) investigations of magnetism resulting in the discovery of the law of hysteresis; (2) the development of the symbolic method of calculating alternating current phenomena; and (3) his investigation of lightning phenomena resulting in his theory of electrical transients, leading to the development of lightning [illegible] (11) He had some 200 patents on electrical apparatus.

An example of some of the work of Steinmetz is marked on the checking chart of Fig. 2. Steinmetz's basic work involved research and development in the understanding and application of physical and chemical phenomena to electrical engineering design with extensive use of the tools of mathematics. This basic area is marked as Section 1 in Fig. 2.

Section 2 illustrates the example of his political activities as a Socialist in which he held various city offices in Schenectady such as Chairman of the Board of Education and Chairman of the Common Council. (12) Under his leadership the Socialists instituted many reforms which we accept as commonplace now [illegible]

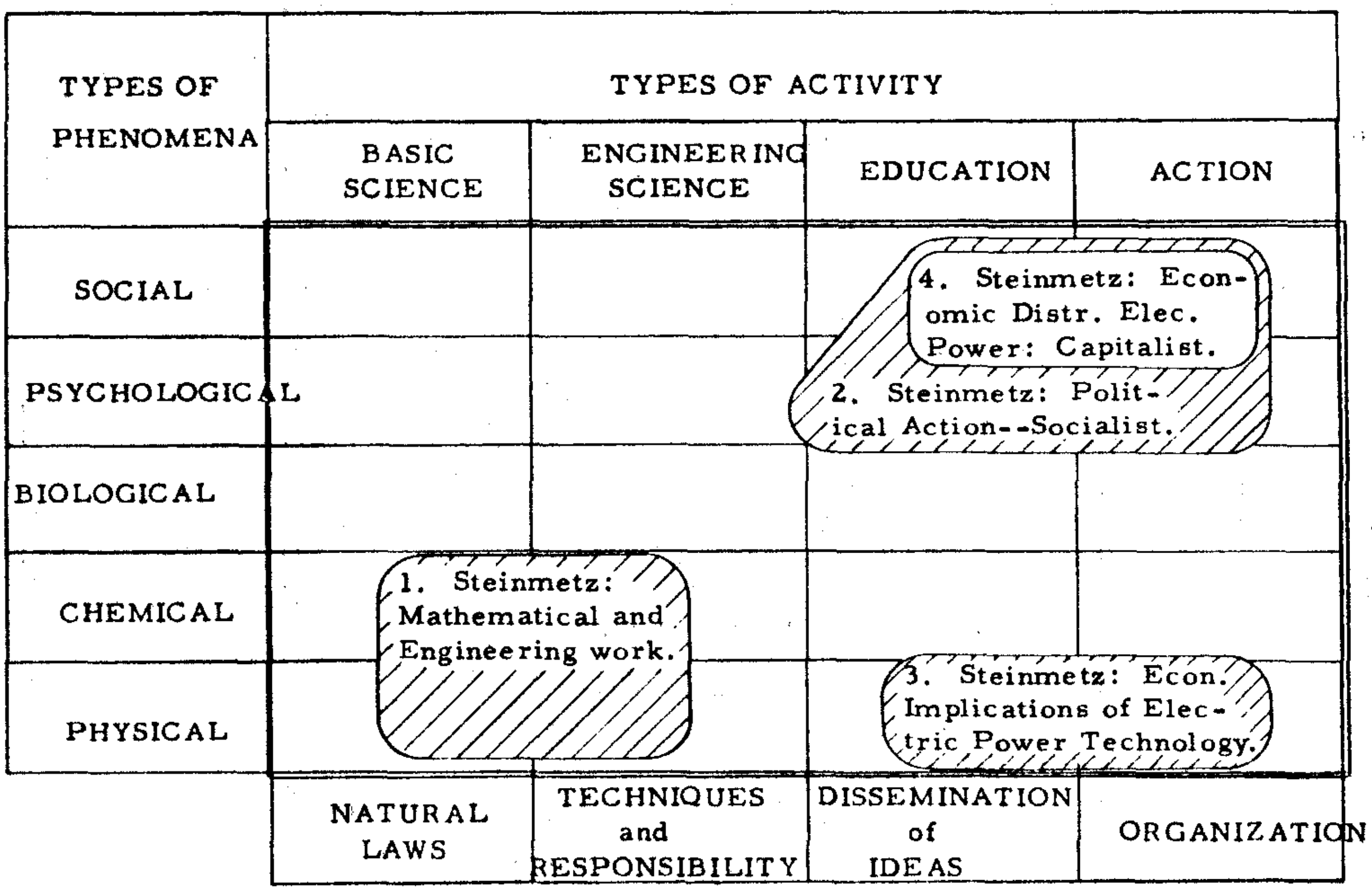

Figure 2. An Example of a Checking Chart Illustrating the Major Areas of Work of C. P. Steinmetz.

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ties for tubercular and disabled children.

Section 3 shows the domain of his observation of the implication of his engineering work for how the benefits of electric power might be brought to the common people everywhere. Steinmetz concluded that to make electric power available at cheap rates required integrated electric power systems covering large sections of the country. He felt that under the conditions existing in the United States the best practical way to achieve the more general distribution of cheap electric power to the people was to support the trend toward large corporations which could acquire sufficient capital to build efficient power distribution systems.

The support to large corporations given by Steinmetz as a practical step was on the surface a contradiction with his direct political action in the Socialist Party, as is illustrated by Section 4 of Fig. 2. If we examine the situation more carefully, we find that the Socialist Party was performing the role of experimentation and pioneering. The reforms in school operation tested by the Socialists of Schenectady under the leadership of Steinmetz became accepted as standard practice. In the past the radicals such as the Socialists have provided ideas for social progress which have gradually been accepted and put into practice by the more conservative groups in our society. The existence of a foreign government using the word "socialist" in its name has made it more difficult for a socialist party to function in our country on account of the introduction of the question of "loyalty" in regard to groups suggesting new ideas. (13)

The following quotation from Steinmetz's biography is particularly significant: "And Steinmetz was an idealist. It was pure idealism that shaped his social philosophy. He sincerely desired a 'better world,' socially and morally, as well as materially. He never hated his fellow-men; he always loved them and sought to do them good. His life had much of the pathos of the idealist -- the pathos of sometimes being misunderstood, and the pathos of sometimes entering the lists on behalf of a cause foredoomed by existing conditions to defeat."

It is rare that an individual genius such as Charles P. Steinmetz is able to cover such a broad range of activities to carry into practice work of social responsibility in addition to his engineering work. Modern engineering work requires the cooperation of hundreds of engineers and scientists for any major step forward in engineering. K. K. Paulev has made a detailed study of the cooperative effort of electrical engineers, mechanical engineers, metallurgists, and many other types of engineers and scientists in developing the spirakore transformer, (14) a design in which the core is wound from a single strip of steel. As our industrial research directors don't wait for geniuses to occur, let us see how this checking about can be used to help clarify the significance of cooperative efforts in the social problems resulting from technological change.

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SEP-12: (11)

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*Note to Editor: While abstract only is available, institutions of participants are to be listed as shown. When _Proc. of WJCC_ are available this reference is to be changed to refer to _Proc._ in standard style.

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