"THE NATURE OF THE SOCIAL RESPONSIBILITY OF ENGINEERS: PARTS I & II"

SEP No. 21-A: Preface and Part I
SEP No. 22-A: Part II and Bibliography

PREFACE

These two issues are extensions of the discussion of Problem 1.2 in SEP No. 2, p. 11. The material was outlined as Problem 4.2 in SEP No. 4, pp. 4-5. These problem statements and the outline are reproduced here.

Problem 1.2: What is the nature of the social responsibility of engineers?

The first manuscript prepared on this problem is included in Socio-Engineering Problems No. 1, August 1958. This version included the present codes of ethics used in the engineering profession and also made reference to some of the common principles of the major religious faiths. Some abridgement was needed to reduce the material to the size suitable for use at the Western Joint Computer Conference. The different stages through which the manuscript went as different specifications were developed are stated as separate problems in SEP No. 4.

Problem 4.2: How can the ideas of Socio-Engineering Problems No. 1 be restated with a better historical base? How can these ideas on the social responsibility of engineers be related to the problems of public understanding of science and engineering?

Outline of Part I:

Introduction: Recent articles in Computers and Automation, Lasswell's "Social Planetarium," need for climate in which workers can trust scientists, humanistic sciences being extended by computers.

Art and Public Understanding: Filmstrip on the "Lost Symbols," Abstract art to represent problems of man and computer struggling to solve problems in a complex environment.

Historical Developments: History of human civilization marked by stages of man's striving to achieve higher ethical standards, correlation between aims of major religious faiths, crises in the industrial revolution of a century ago, conditions which sparked Karl Marx to develop a theoretical analysis, August Comte's sociology, classification of the sciences, [illegible] social responsibility in engineering, danger of technocrats, cooperation of specialists in the T.V.A., need for postwar social science research program to protect our democratic concepts, failure of some businessmen to apply the ethics of their religion to business practice, experiments in social responsibility and public education of the atomic scientists.

References for Part I:

(a) Recent References Relating to Computers and Automation
(b) Historical References on Technology, Society, and the Social Sciences, Social Relations of Engineering.
(c) References on the Last Decade of Social Responsibility in Engineering.
(d) References of the last decade on Social Responsibility in Science

Outline of Part II:

Engineering Ethics: Definition of engineering, "[illegible] of the Engineer," how does one interpret [illegible] of ethics

A Perspective of the Sciences: Classification of the sciences, relationship of the special fields of study and science on "skyscraper" type chart.

A Checking Chart Derived from the Classification of the Sciences: Two-dimensional chart showing extent of coverage or "Completeness," relationship to Ward's chart of synthetic creations of nature, usage in particular analyses.

Figures on three-dimensional chart, electrical communication, and biology, and a checking chart by types of phenomena and types of activity.

An Example of a Checking Chart Applied to the Work of a Famous Engineer: Charles Proteus Steinmetz (1865-1923), electrical engineering and mathematics, political activities as Socialist, observations on implications of engineering work, support of large corporations as practical way to bring electric power to the people, idealism of Steinmetz.

Potential Use of Checking Charts by Ordinary Engineers: Devices such as the checking chart may be used by engineers who do not much spare time, sharing of responsibility, determining which organizations are working on the problems, journals and organizations useful to maintain perspective.

Conclusions: Interest in social responsibility is a healthy sign, engineers need some perspective to which they can correlate their own work, a three-dimensional chart has been proposed for this perspective, a two-dimensional form or "checking chart" is proposed for use by individual engineers, engineer has a responsibility to refer questions to management, social scientist, government agencies, and to the citizens at large, President Eisenhower's request for a science of Peace.

Appendix A: Common Ideal

Appendix B: "Faith of the Engineer"

Reference for Part II:

(a) Selected References on Engineering Ethics, Behavioral Sciences, and Social Responsibility.

After review of the manuscript outlined above for possible use at the 1959 Western Joint Computer Conference, it appeared that it would be better if a historian could write about the historical development of the interest in social responsibility on the part of engineers. Then I could build upon a more rigorous base and deal only with the recent developments. After checking upon what historical studies were in process, it was concluded that no historical studies would be published in time for reference in a 1959 W.J.C.C. paper. This led to a restatement of the problem as described in later issues of Socio-Engineering Problems.

Frederick B. Wood

THE NATURE OF THE SOCIAL RESPONSIBILITY OF ENGINEERS

Introduction

Recently there has been some interest in the question of what the social responsibility of engineers is. A series of articles and letters to the editor appeared in the early part of 1958 in Computers and Automation[1]. The Western Joint Computer Conference at Los Angeles, May 6, 1958, conducted a panel on "The Social Problems of Automation".[2] The following quotation is from the abstract on the program of the W.J.C.C. 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.

Dr. Lasswell of the Yale School of Law proposed the development of "Social Planetariums" where analog models and digital simulation programs for different representations of economic, political, and social problems could be tested. He further stated that political models are needed for the survival of popular government. Dr. Lasswell also warned us of the immense pressure for conformity in our industrial society. He said that we may want to maintain freedom so that we will allow novel ideas to develop.

Mr. E.J. Schaffer of the Oil, Chemical and Atomic Workers Union said that trade union people feel that scientists may forget the people. He feels that [illegible] efforts in which workers can [illegible]. Mr. Schaffer stated that the [illegible] union policy of pressing for higher wages is based on a theory of maintaining the stability of our economic system through balancing production and purchasing power. He pointed out some [illegible] of dislocation and hardship in the introduction of automation in the oil industry.

Dr. C.C. Hurd of International Business Machines Corporation pointed out that if we define automation as restricted to information processing then given appropriate foresight, automation extends man's thinking and results in no serious social problems. He states that the humanistic and social sciences are being extended by computers.[x]

The three speakers at last year's panel pointed the way to future cooperation in the constructive use of computers and automation in our complex industrial society. The data processing industry represented by Dr. Hurd offers the possibility of extending scientific and engineering techniques to develop Dr. Lasswell's concept of social planetariums. In turn Dr. Lasswell's concepts offer a potential way of testing the validity of Mr. Schaffer's theory of economic development and stability. Further, Mr. Schaffer offered the important warning that in a democracy a climate must be established where there is mutual trust and understanding between the people and the scientists.

How are we going to attach this problem of developing a better understanding between the scientists and the people? It occurred to me that the artist could help us here. A brief examination of the history of art brought to light the historical use of symbols in the form of paintings, carvings, and stained glass windows to illustrate ideas in a way which would remind people who could not read of the essential ideas contained in the sermons that were given in the churches.

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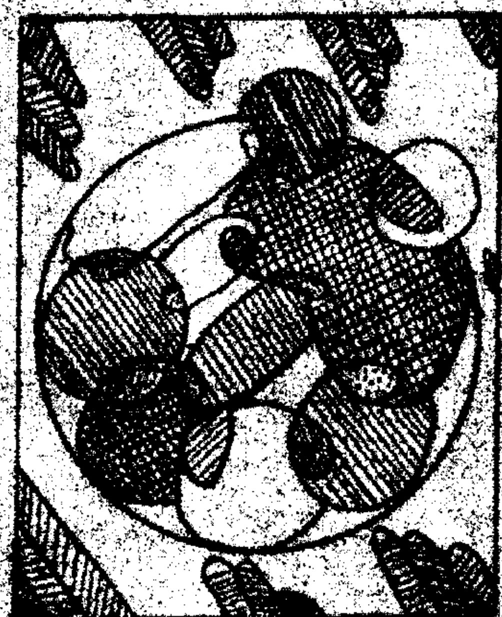
[x]The references to statements of the speakers at the 1958 W.J.C.C. are to be checked for accuracy with the speaker's quoted or with the printed proceedings when they become available. The present draft is based upon incomplete notes taken at the W.J.C.C. See Ref. 2 for printed proceedings.



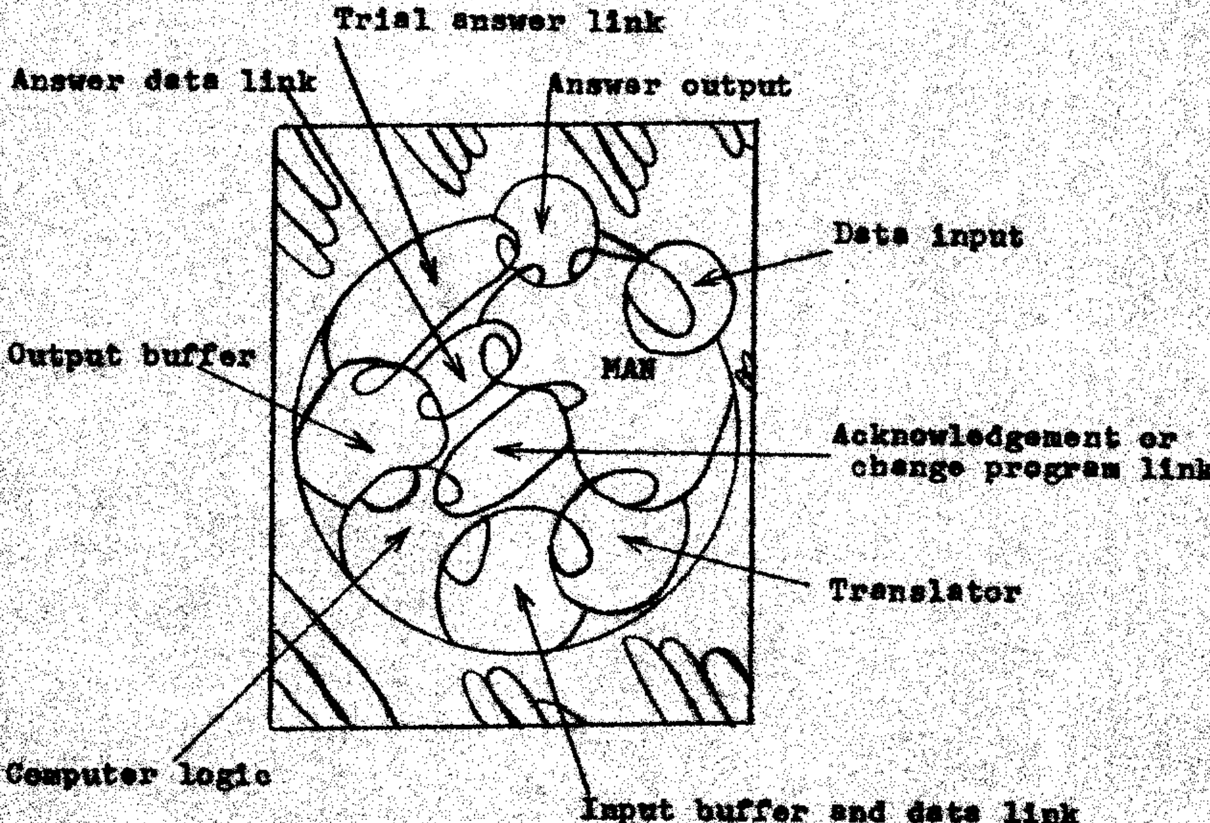
= YELLOW

= BLUE

= RED

Figure 1. Man and Computer Struggling to Solve the Problems in a Complex Environment.

A Man and Computer Struggling to Cope With the Problems of an Increasingly Complex Environment



The stalactites and stalagmites represent the problems closing-in upon man.

Figure 2. Explanation of Symbols in Figure 1.

Art and Public Understanding

A filmstrip entitled "The Lost Symbols" is available which illustrates the symbols which were used to explain the lessons of the church in terms of "natural science" or "bestiaries" to the common people of the middle ages.[3] These symbols were discarded when the development of science showed much of the "natural science" upon which the stories were based to be incorrect. A brief study of the art forms available for the modern equivalent indicates that our complex society is difficult to represent by the simple symbols used in past eras. Abstract art, although it requires some learning on the part of the people, offers a prospect of symbolizing the problems of our cojplex society and reminding the people that the computer scientists have not forgotten their needs.

A preliminary attempt to develop some representation of the problem is shown in Fig. 1: The red, brown, and black stalacites and stalagmites represent the threatening problems of our complex industrial society closing in on man. The red sections within the sphere represents the elements performing logical operations: the large one being man; and the smaller one being the computer logic.

The upper yellow circle represents the input data reaching man from his environment. Man selects appropriate data to send via the blue input keyboard through the yellow buffer storage to the red computer logic. The computer stores trial data in the blue output buffer which is displayed to man through the short yellow link. Man acknowledges or changes the program variables through the central blue control link. The computer sends the results through the output buffer through the long yellow output link to the output printer and man.

The simple animals, trees, and other common objects of the "lost symbols" were easy for the people to recognize in the symbols developed during the middle ages. We are at a higher level of civilization, where practically everyone can read. Therefore, we can use a two stage symbolic representation in which a second representation is used to explain the basic symbols. To illustrate this a black and white line drawing with a few significant labels is shown in Fig. 2. Since we have dealt with the historical use of symbols for conveying concepts impinging upon the idea of social responsibility, to be followed by a more specific relationship to engineering ethics.

Historical Developments

The history of human civiliation is marked by successive stages of man's striving to achieve higher ethical standards by which men can more fully develop their own potentials while permitting less interference with the development of other men. Examination of important quotations from the major religious faiths of the world listed in Appendix A* shows a high degree of correlation. For this discussion I shall give a typical quotation from the Bible, since Christianity is the

*Appendix A is in SEP No. 22-A.

predominant influence in Western European civilization:

"All things whatsoever ye would that men should do to you, do ye even so to them, for this is the law and the prophets." Bible, St. Matthew 7, 12.

Our present international situation has deep roots in the industrial revolution which developed into full swing in the middle of the nineteenth century. When the spinning and weaving mills were established in England, the development of water power and then the invention of the steam engine made possible a more rapic industrialization. 4,46.

With the rapid expansion, more workers were needed in the cities. In England laws were passed which expedited the eviction of many farm laborers from the farms on which they worked. In many cases their cottages were destroyed, so that these families had no choice but to move to the cities and work in the factories. 5.

The initial cruelty of the industrial revolution intensified Karl Marx's questioning of religion. It is easy to see that any sensitive person observing the eviction of people from the farm lands by industrial leaders who professed to believe in the above quotation from the Bible would be puzzled. Karl Marx reacted strongly to this and other injustices of the industrial revolution to the extent that he rejected religion as being "the opiate of the people." The violence of Marx's reaction to the injustices in society accelerated the development of his philosophy of dialectrical materialism which is an important factor in our present international crises. I shall not attempt to evaluate his theories, but acknowledge that the failure to understand and take care of the human needs in the industrial revolution of a century ago has left tremendous problems for our generation.

In France, August Comte looked at these 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."

August Comte later tried to found a new religion based on his philosophy. The new religion did not take hold, but the ideas he developed have been used by the established religions to help understand the problems of society so that the churches can do more to help people bring their ideals closer to realization.

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, 6, is shown in Table I.

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.

TABLE I CLASSIFICATION OF THE SCIENCES
SOCIOLOGY
PSYCHOLOGY
BIOLOGY
CHEMISTRY
PHYSICS
ASTRONOMY

After reviewing the later history of questions of social responsibility and in particular engineering ethics, I shall show how a modified version of Ward's organization of the sciences has a present value.

In the early part of the twentieth century in a wave of optimism based the rapid advance of science and the potential use of the knowledge of sociology being used to improve society, some books appeared using the term "social engineering" to represent the application of sociology to practical problems.[7] This optimism was shown to be unsound after World War I materialized. The sociology of the time had not heeded the warning of fiction writers like Jack London,[8] nor understood the significance of the psychiatric research of Sigmund Freud.[9] A more balanced account of historical sociology is given Harry Elmer Barnes.[10]

During the economic depression of 1932 an interest in the social responsibility of engineers developed in the form of a movement known as Technocracy.[11,45] This was founded on the sound proposition that social phenomena are measurable and that laws of social control may be derived from the measurements. The technocrats made two assumptions which were probably oversimplifications of complicated economic problems: namely that mass production had destroyed the price system, and that credit expansion had upset the balance of the relative claims of capital and labor to the goods produced. A fourth view held by the Technocrats were inherently dangerous to our democratic traditions: the assumption that economics is too complicated to be understood by politicians and therefore control should be placed in the hands of the engineers and scientists. The delegation of control might lead eventually to a dictatorship like the fictional account of George Orwell's Nineteen Eighty Four.[12] A more recent analysis of the trend of social use of cybernetics and automation has some alarming predictions for society of the future run by an elite group of "cyberneticians".(12A

We have in the United States an outstanding example of a public enterprise where electrical engineers, biologists, foresters, highway engineers, city planners, politicians, small businessmen and large industries, have learned how to cooperate. This is the Tennessee Valley Authority.[13] Although a more widely advertised reason for the TVA is the "yardstick" of electric power costs, I believe the development of techniques of cooperation between specialists of different fields and between public and private agencies to be a more important contribution.

During World War II before the United States entered the conflict, Frank B. Jewett of Bell Telephone Laboratories and Robert W. King of American Telephone and Telegraph Co. made an analysis of engineering progress and the social order.[14] They analysed the dangers to our democratic concepts in the way world civilization was developing and concluded that a tremendous research program in the social sciences would be necessary when World War II was completed to develop the necessary understanding of social problems so that we could continue our democratic traditions. In 1946 a retured engineer, John Mills, published a book on the engineer in society.[15] This book is a mixture of his autobiography, pointers on engineering report writing and some important observations on the social responsibility of engineers.

Various well-known engineers such as M. L. Cooke, R. Flanders, C.F. Kettering, W.C. Mullendore, P. Sporn, and many others have written articles on various aspects of the social responsibility of engineers.[16-29A] Dr. Edwin Layton, an historian, made a study of the idea of social responsibility in the engineering profession.[29B] A recent article by a business management consultant, Theodore Levitt, attacks some of the current ideas of social responsibility in business.[30] Mr. Levitt makes an important contribution through his concept of the importance of maintaining separability of the different function in our society. At the same time a recent article by

Rabbi Finkelstein deplores the failure of businessmen to apply the ethics of their religious background in the day-to-day practice of business.[31]

The references included at the end of this paper are not complete, but are intended to give one a reasonable sampling of the articles on the subject. The next step in our study is to consider what the codes of ethics of the engineering societies have to say about the social responsibility of engineers.

During the last decade the published papers on the social responsibility of engineers have been more of the nature of commemorative speeches which have not been translated into action except for a few special cases. Perhaps we have some lessons to learn from the basic scientists, particularly the atomic scientists who had a concern for the social implications of their work. A sample list of references of papers by Albert Einstein, J.Robert Oppenhiemer, Edward Teller, Henry D. Smyth, Bertrand Russell, Norbert Wiener, and many others included in the bibliography.[32-64] The basic scientists have achieved more results through public education and appearing before congressional committees.

"THE NATURE OF THE SOCIAL RESPONSIBILITY

OF ENGINEERS: PART II"

Engineering Ethics

Each engineering society has its own code of ethics. For a start let us examine the definition of an engineer used by the Engineers Council for Professional Development which represents all the major engineering societies:

"The engineer may be regarded, therefore, as an interpreter of science in terms of human needs and a manager of men, money, and materials in satisfying these needs."[65] The mention of "human needs" raises many sociological questions.

First, the above definition implies the necessary development of a better understanding on the part of the engineer himself and the general public of the basic principles and significance of science and engineering.

This study neglects the second phase of the engineer as "a manager of men, money, and materials," since many engineers have developed into managers; but little concrete analysis of the role of the engineer "as an interpreter of science in terms of human needs" has appeared, although numerous articles on the social responsibilities of engineers have been published.

The next stage is to examine the "Faith of the Engineer," a statement prepared by the E.C.P.D., for which the complete statement is included in Appendix B.[66]

The following section: "As an Engineer, I will participate in none but honest enterprise. To him that has engaged my services, as employer or client, I will give the utmost of performance and fidelity," is easy to interpret in respect to specific contracts and relations with client, employer, and government agencies. However, the section:

"When needed, my skill and knowledge shall be given without reservation for the public good" is difficult to interpret.

How is one to interpret "when needed" in respect to giving skill and knowledge for the public good? In a less complex society the "when needed" could be easily determined by obvious wars and economic crises. In our increasingly complex society there may be a continuous need for social concern on the part of the engineer so that crises will not reach such magnitudes of severity. Perhaps we need to know something about the social sciences and in particular, sociology, in order to make these ideas more concrete.

A Perspective of the Sciences

The work of August Comte, Herbert Spencer, and Lester Ward of the last century 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 to society and to the layman in providing a simplified view of the complexity of special fields of science.

The above classification of the sciences with some modification is useful in developing a new chart which is intrinsically simpler yet is capable of representing any complex field of science or engineering, since it is a three-dimensional code for representing a field of knowledge or experience.

The objective of making charts like this is to help people see the relationships of the different specialized fields. Perhaps some chart or table analogous to the periodic table of the elements in chemistry and physics could be developed for sociology and related fields. The "skyscraper" type of chart of Fig. 3A is proposed as a useful tool in the analysis of the interrelationship of different fields of different fields of knowledge in respect of society.

The horizontal 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 between the 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 vertical columns represent different modes of treating basic phenomena. For the scientist is interested in why; the

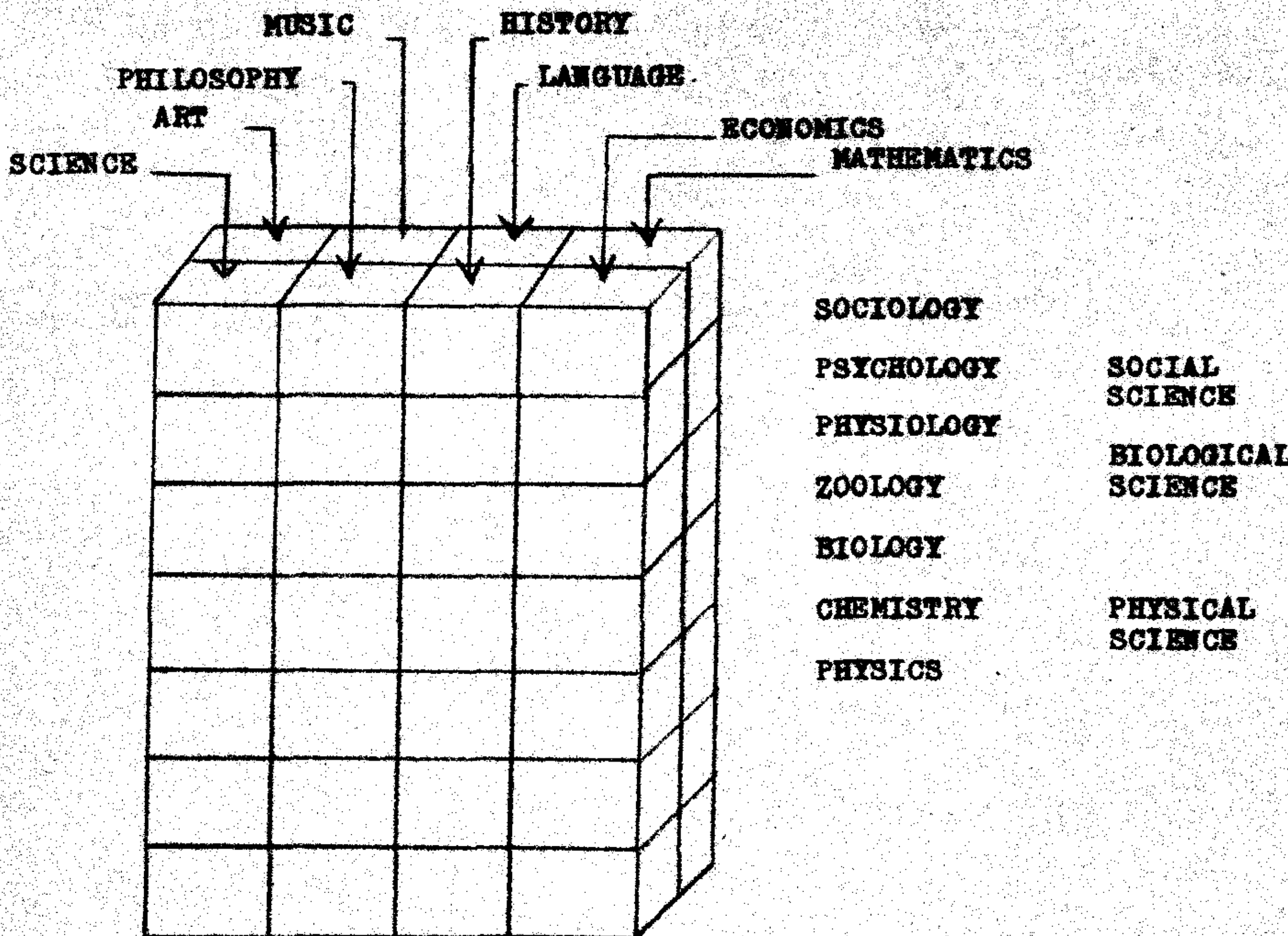


Figure 3A A Three-Dimensional Chart

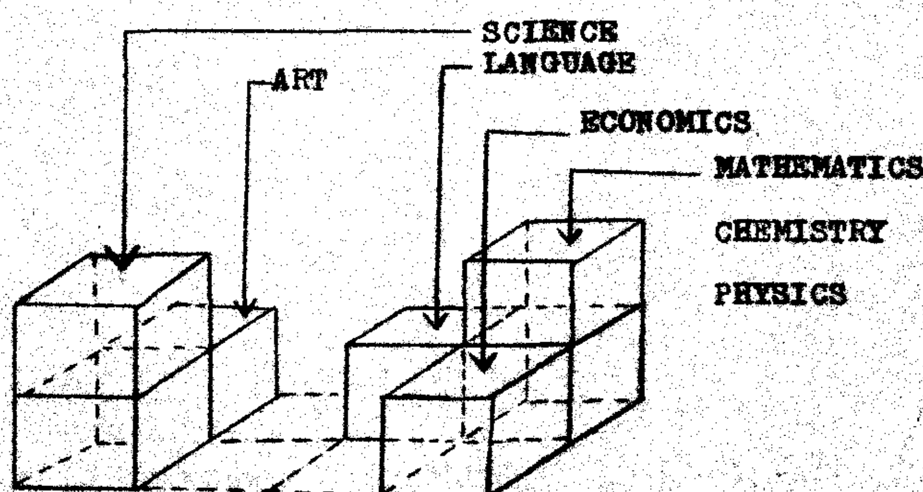


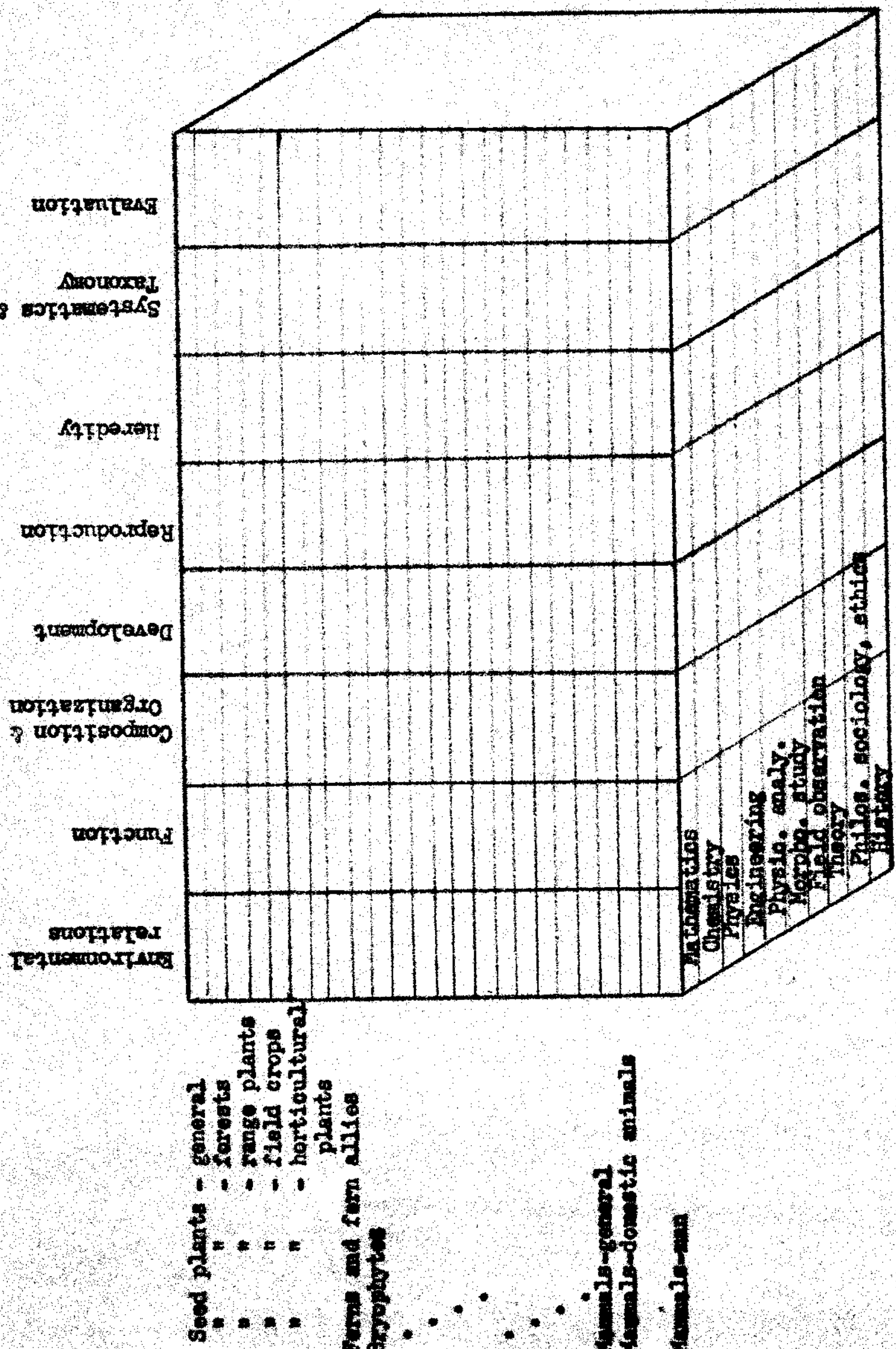
Figure 4. Electrical Communication

artist in the effect of the form and the colors; the philosopher in the meaning; the mathematician in the equations; etc. The individual blocks are assumed to be further subdivided by the specialists in the respective fields. An example of such a subdivision in the field of Biology is shown in Figure 3B. The classification used by the biologists is different than mine, but has some basic similarities.

A third group, not shown on the "skyscraper" model of Fig. 3 is made up of the fields of knowledge which are formed by the intersection of vertical and horizontal columns and/or combinations of parallel columns. An example of the field of electrical communication is shown in Fig. 4. In using Lester Ward's classification I have dropped Astronomy as a basic level, since it can be represented as the intersection of physics and chemistry with science, history and mathematics.

These "skyscraper" type models of the fields of science may be useful for obtaining a general perspective of the relationship of the different fields of science. For the individual engineer or a group working on a particular problem there is a need for some kind of a simple blank form upon which they can plot the extent of coverage of their particular work. Next I shall discuss such a simplified form which I call a "checking chart."

Reprinted from "Concepts of Biology" **Behavioral Science**
Vol 3; No. 2, April 1958 p. 196.



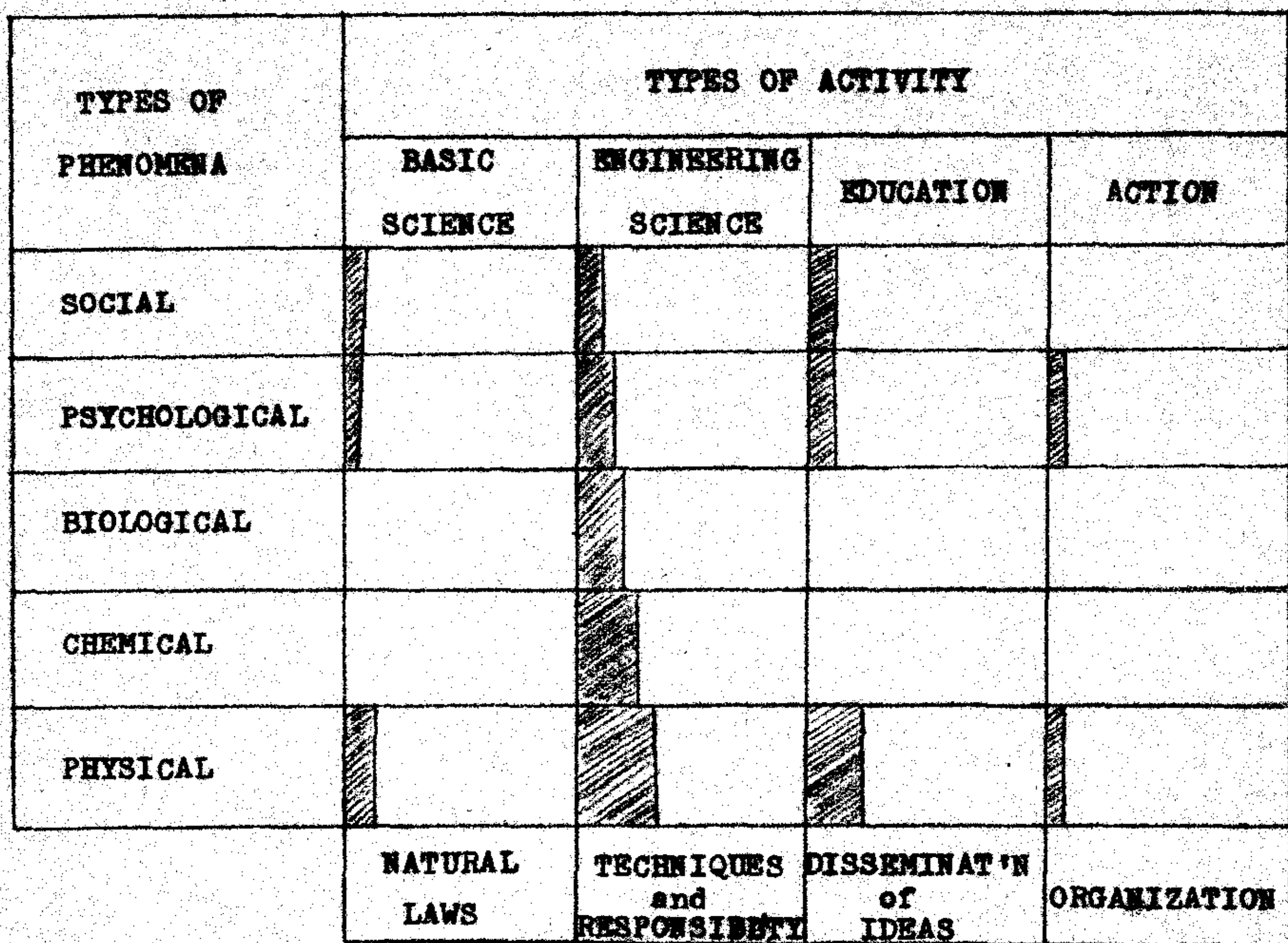
OUTLINE OF SUBJECT MATTER, METHODS, AND LEVELS OF BIOLOGY - Figure 4B

A Checking Chart Derived from the Classification of the Sciences

From the classification charts of Fig. 3 a simplified two-dimensional chart of Fig. 5 has been derived for use in checking the extent of coverage or "completeness" of a particular analysis of a problem. This simplified form is intended to show more clearly the stages of development in different fields of knowledge that are required for the balanced application of some idea in society. Although there is a close resemblance between this checking chart and Lester Ward's chart of the synthetic creations of nature,[67] there is an important distinction: his chart was designed to help understand different attributes of nature; while my checking chart 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 depending 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 is dependent upon stages reached in activities to the left.

The cross-hatched sections in Fig. 5 show the extent of coverage of this particular paper.



Cross-hatched areas on chart 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 is dependent upon stages reached in activities to the left.

Figure 5. Checking Chart Designed to Indicate the Extent to Which a Particular Analysis Covers the Possible Phases of a General Problem.

An Example of a Checking Chart Applied to The Work of a Famous Engineer--Steinmetz

Charles Proteus Steinmetz (1865-1923) was an American electrical engineer born in Breslau, Germany. He specialised 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 using complex numbers, and (3) his investigation of lightning phenomena, resulting in his theory of electrical transients, leading to the development of lightning arresters. He had some 20 patents on electrical apparatus.[6]

An example of some of the work of Charles P. Steinmetz is marked on the checking chart of Figure 6. 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 Figure 6.

Section 2 illustrates the domain 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.[69] Under his leadership the Socialists instituted many reforms which we accept as commonplace now such as mid-morning milk for the school children, the construction of sufficient school buildings so all the

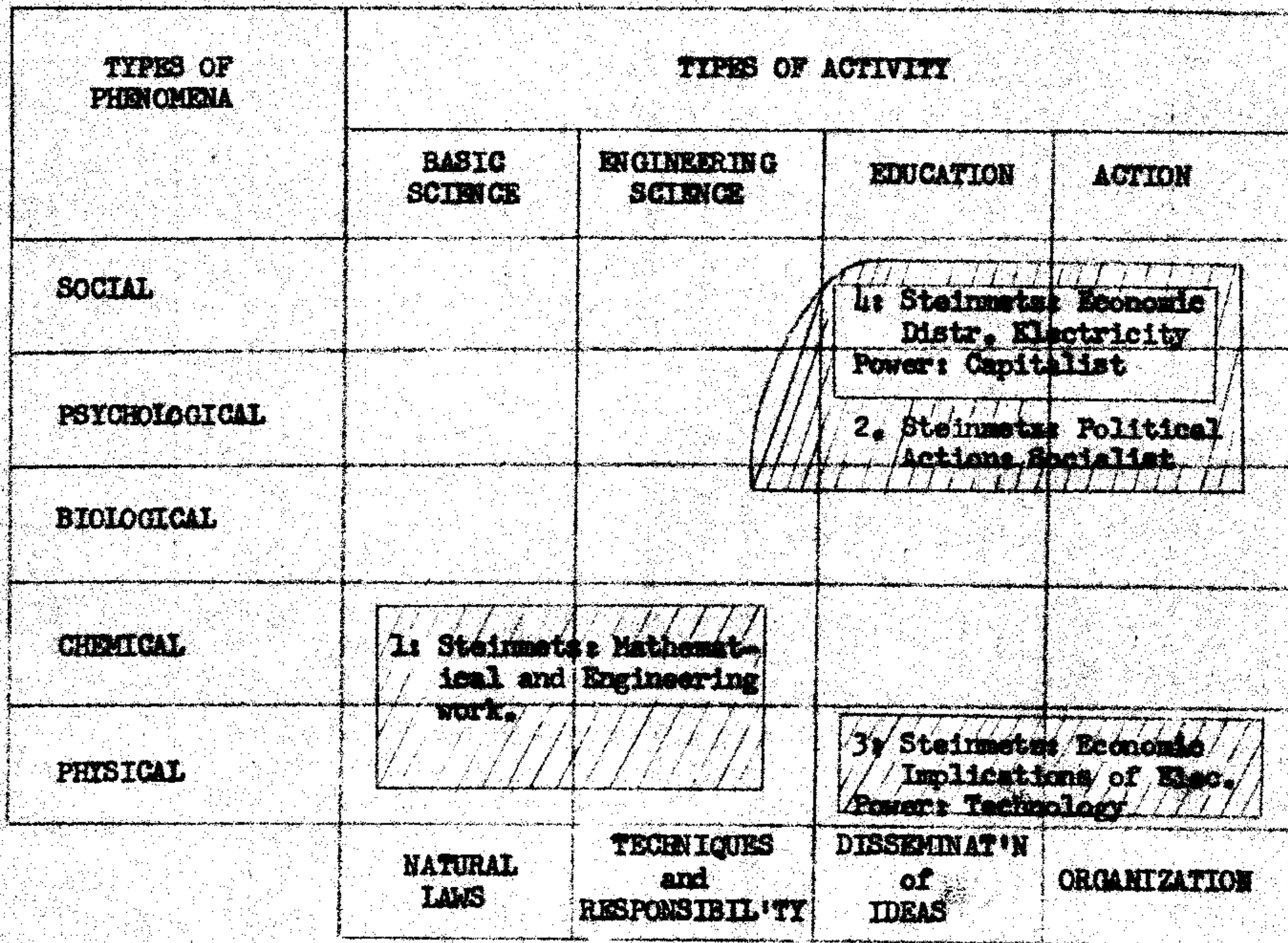


Fig. 6 - An Example of the Checking Chart Used to Show the Fields Covered by Steinmetz.

children of the city could attend school, and provision of special teachers and facilities for tubercular and disabled children.

Section 3 shows the domain of his observation of the implication of 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 Figure 5. If we examine the situation more carefully, we find that the Socialist Party was performing the role of experimentation and being pioneers. 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

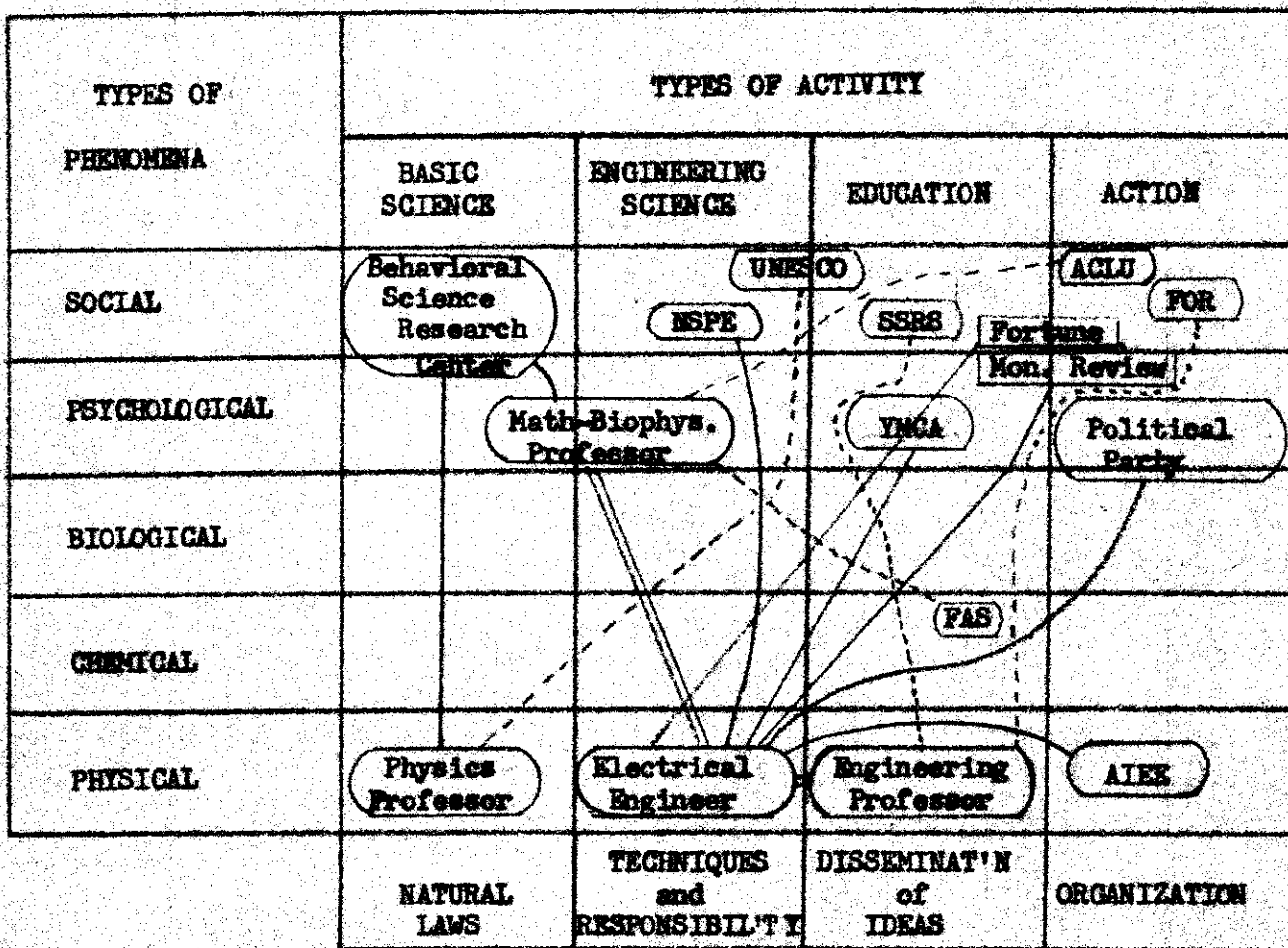


Figure 7. Example of Checking Chart Used to Show Coverage of the Areas of Social Responsibility

"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.

The following quotation from Steinmetz's biographer[70] 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."

Potential Use of Checking Charts by Ordinary Engineers

People may argue that Steinmetz was a genius and how can you expect the ordinary engineer to deal with both the engineering and the sociological aspects of his work. Furthermore, some people point out that Steinmetz was a bachelor without family responsibilities. My thesis is that any new discovery in science or invention in engineering has far-reaching implications throughout all human activity. Further I claim that the ordinary engineer, who does not have much spare time on account of his basic engineering work and his family responsibilities, can find short cuts to understanding the social implications of his work through devices such as the checking chart of Figure 5. I have faith that the engineer can fulfill his social responsibility to help make the results of his work be utilized in tune with mankind's highest aspirations as they are exemplified in my quotation from the world's principal religions in Appendix A.

To fulfill his social responsibility the engineer must understand that it is a responsibility he shares with many people both inside and outside his profession. He may not need to devote a tremendous amount of time and energy to the social implications of his work. The key to success lies in developing a fruitful perspective of the relationship of his work to the society in which he lives. The checking chart of Figure 5 is suggested as an aid to each engineer in developing his own perspective. The ordinary engineer need not expect his activity to encompass the range of Steinmetz marked on Figure 6. He may have a group of friends and correspondents who cover different areas of the checking chart or he may maintain contact with different organizations which cover different areas of the chart. A sample chart is shown in Figure 7, which illustrates the case of an electrical engineer who has established a network of communication channels which enable him to discharge his social responsibility with a minimum of effort. In this example of an hypothetical engineer, he does not by himself cover the whole area, but has friends who cover parts of the area and share with him their understanding of the problems of our complex industrial civilization.

In this example shown in Figure 7 our electrical engineer belongs to his technical society: American Institute of Electrical Engineers and his professional society: National Society of Professional Engineers (NSPE) or an affiliated state society. In addition to the normal newspapers and magazines he reads two magazines having opposing viewpoints: Fortune, representing the viewpoint of business management, and the Monthly Review, representing an independent socialist viewpoint. Our idealized "ordinary" engineer might also contribute financially to the Student Y.M.C.A. program or some equivalent group of his particular religious faith so that some engineering students having advisors of the "philosophy there's nothing-in-it school" might some communication channels available for contact with the history of mankind's cultural achievements and aspirations. He might subscribe to a news bulletin of the Democratic or Republican Party to gain a sense of what kind of issues the practical politicians are prepared to discuss.

Our electrical engineer could rely upon a physics professor friend who follows the activities of the United Nations Educational, Scientific, and Cultural Organization (UNESCO), and follows some of the projects at a neighboring behavioral science research center to tell him about special developments in these areas dealing with the application in society of new engineering products. Our engineer might also know a professor of mathematical biophysics who also maintained contact with the behavioral sciences and was a source of information on civil liberties and radiation fallout problems through his membership in the American Civil Liberties Union (ACLU) and the Federation of American Scientists (FAS).

Our electrical engineer in industry might maintain contact with an engineering professor whose conscience causes him to take a pacifist stand. From this friend our engineer could occasionally get information about how organizations such as the Society for Social Responsibility in Science (SSRS) and the Fellowship of Reconcilliation (FOR) are tackling the problems of our society.

Conclusions

The recent interest in the social problems of automation and the application of computers in our civilization is a healthy sign that some engineers are developing a perspective of how their special field relates to the activities of mankind in general. Engineers need some kind of a framework or coding scheme to present an abstract but significant view of human activity to which they can correlate their own work. The traditional codes of engineering ethics do not fully grasp the complexity of our industrial civilization.

A series of diagrams have been proposed as ways to tackle this problem of social responsibility. The most fruitful type of diagram so far is one based on the historical classification of the sciences developed by the founders of sociology. The three-dimensional version is essentially a "code" for representing the different fields of knowledge which has some utility in helping specialists in one field realize the extent of overlapping of their special field with certain elementary phenomena and types of activity.

The two-dimensional form or "checking chart" is proposed as a way individual engineers may evaluate the completeness of the coverage of social problems related to their work. I do not suggest that the engineer should be responsible for solving the social problems of automation. The engineer's responsibility is more of a coordinator to alert the people of our country to the status of our coverage of the problems. If the engineer finds that a social problem relating to his engineering work is not being adequately investigated, he has a responsibility to refer questions to management, social scientists, government agencies, and to the citizens at large to stimulate the investigation of such problems.

If engineers could develop practical techniques for assuming social responsibility in a coordinating way as has been suggested by these checking charts, we might materially contribute to the fulfillment of President Eisenhower's request for a "science for peace."[71] These techniques could expedite the achievement of the proposal published last year by a group of fifteen social scientists in <u>Behavioral Science</u>.[72]

> "Immediate efforts toward natural defense should be paralleled by research to discover methods of achieving more permanent and satisfactory means of international agreement. Such discoveries would provide greater security for peoples generally than the invention of any new weapons systems."

Appendix A:

The following editorial from THINK Magazine, October 1952, gives us an excellent example of how there is much in common in the teachings of the major religions of the world:

COMMON IDEAL

"The United Nations, celebrating its Seventh Anniversary this October, is the emobdiment of the highest ideals of peace and justice which have been the inspiration of the faiths, the philosophies and laws of many nations. This great international organization brings men of many different lands and faiths together to work for the betterment of mankind everywhere. Throughout the ages, this expression of the common brotherhood of man has been proclaimed in the following words from the sacred writings of many faiths:

BUDDHISM: "Hurt not others with that which pains yourself." Udanavarga, 5, 18.

CHRISTIANITY: "All things whatsoever ye would that men should do to you, do ye even so to them, for this is the law and the prophets." Bible, St. Matthew 7, 12.

CONFUCIANISM: "Do not unto others what you would not they should do unto you." Analects 15, 23.

HEBRAISM: "What is hurtful to yourself do not to your fellow man. That is the whole of the Torah and the remainder is but commentary." Talmud.

HINDUISM: "This is the sum of duty: do naught to others which, if done to thee, would cause pain." Mahabharata, 5, 1517.

ISLAM: "No one of you is a believer until he loves for his brother what he loves for himself." Traditions.

TAOISM: "Regard your neighbor's gain as your own gain, and regard your neighbor's loss as your own loss." T'ai Shang Kan Ying P'ien.

ZAROASTRIANISM: "That nature is only good when it shall not do unto another whatever is not good for its own self." Dadistan-i-dinik, 94, 5.

The goal of the great ideal expressed above in the language of many faiths is justice--to give to every man his due. This principle is the only possible foundation for lasting peace."

Appendix B:

"Faith of the Engineer" *

"I AM AN ENGINEER. In my profession I take deep pride, but without vainglory; to it I owe solemn obligations that I am eager to fulfill.

As an Engineer, I will participate in none but honest enterprise. To him that has engaged my services, as employer or client, I will give the utmost of performance and fidelity.

When needed, my skill and knowledge shall be given without reservation for the public good. From special capacity springs the obligation to use it well in the service of humanity, and I accept the challenge that this implies.

Jealous of the high repute of my calling, I will strive to protect the interests and the good name of any engineer that I know to be deserving; but I will not shrink, should duty dictate, from disclosing the truth regarding anyone that, by unscrupulous act, has shown himself unworthy of the profession.

Since the Age of Stone, human progress has been conditioned by the genius of my professional forbears. By them have been rendered usable to mankind Nature's vast resources of material energy. By them have been vitalized and turned to practical account the principles of science and the revelations of technology. Except for this heritage of accumulated experience, my efforts would be feeble. I dedicate myself to the dissemination of engineering knowledge, and, especially to the instruction of younger members of my profession in all its arts and traditions.

To my fellows I pledge, in the same full measure I ask of them, integrity and fair dealing, tolerance and respect, and devotion to the standards and the dignity of our profession; with the consciousness, always, that our special expertness carries with it the obligation to serve humanity with complete sincerety."

*Engineers' Council for Professional Devplopment.

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