A Working Paper Draft

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A CHECKING CHART FOR THE USE OF COMPUTER ENGINEERS

DEVELOPED FROM A "GENERALIST" DESCRIPTION OF CULTURE: PART I

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Frederick B. Wood

Residence: 2346 Lansford Ave., San Jose, California, U.S.A.
Mailing Address: P.O. Box 85, Campbell, California, U.S.A.

"A Checking Chart for the Use of Computer Engineers
Developed from a "Generalist Description of Culture."

Abstract

Issues 25-A and 26-A are Parts I and II of the third version of SEP No. 1. This version is based upon revisions made after reading Stuart Chase's book: Things Worth Knowing-A "Generalist's" Guide to Useful Knowledge.

This version has been outlined in SEP No. 4 under Problem 4.4: How can the checking chart for developing an analysis of social responsibility be derived more logically from a "generalist" description of culture? The material of Part I is organized under the following sections:

Introduction (See Outline in SEP No. 4)

Divisions of Human Activities

Levels of Phenomena

"Spiral of Culture"

A Checking Chart for Social Responsibility

Example of Steinmetz

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Frederick B. Wood

A CHECKING CHART FOR THE USE OF COMPUTER ENGINEERS DEVELOPED FROM A "GENERALIST" DESCRIPTION OF CULTURE: PART I.

F. B. Wood

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 were discussed. These articles covered a broad range of viewpoints. Some computer scientists felt the social use of their work was not their concern, while others felt there are specified applications of computers which are unethical such as to merit engineers declining to work on some projects. Studies of the social consequences of scientific discovery have been conducted by Richard L. Meier(7) and Edwin Layton.(8)

The Western Joint Computer Conference at Los Angeles, May 6, 1958, conducted a panel on "The Social Problems of Automation".(9)

The various viewpoints appearing in Computers and Automation present an uncoordinated distribution 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.

Someone has to set up a working hypothesis as to a perspective of the development of civilization in order to put these problems in a simplified relationship that can be comprehended easily both by laymen and specialists. My ignorance of the social sciences makes it possible for me to make a stab at these problems, knowing that undoubtedly there are serious errors of detail in what I am saying. In fact when I was an undergraduate engineering student, I once asked my faculty advisor about taking an elective course in philosophy, and he said "Philosophy -- there's nothing in in." I have since learned by experience that philosophy does have an important role in our civilization.

The approach to the study of culture which Stuart Chase calls the "Generalist Approach" is the best approximation which is readily available, in this country. I propose to develop a bird's eye view of the "Spiral of Culture" which he describes in his book Things Worth Knowing.(10) Then I shall take a slice out of this spiral to represent in a simplified way, the section that engineers may reasonably be cognizant of in their attempt to develop a limited, but reasonable sense of social responsibility.

I shall then show how this slice can be considered as a "checking chart" as an aid to the computer engineer in discussing this problem of social responsibility. As examples I shall illustrate three cases: (1) a famous engineer of the past, (2) a talk at a recent computer conference, and (3) a potential use of the chart by the engineer of the future.

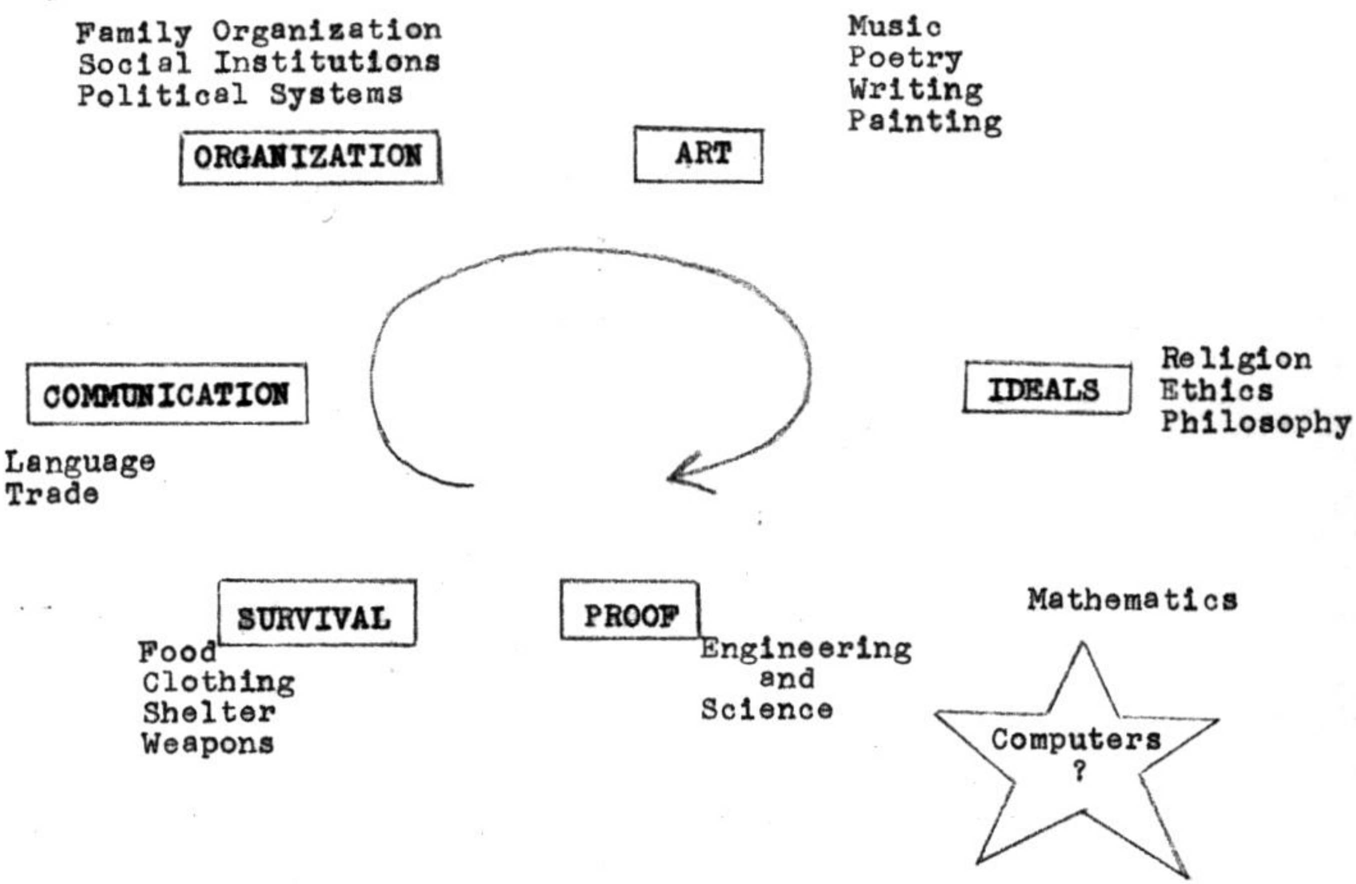
Divisions of Human Activities

Let us first list the rough divisions of human activities into which different sectors of our society are divided. In Table I those activities are listed in clockwise rotation in the approximate order in which mankind at any particular level of development proceeds in the expansion of creative activities. First man is concerned primarily with SURVIVAL, in the procuring of food, clothing, shelter, and weapons. Then his activity expands through COMMUNICATION and the development of language and trading of goods. Then man finds that he can increase the total food and other goods by ORGANIZATION through the development of family organization, social institutions, and political systems.

The more efficient organization permits some people to devote time to ART such as music, poetry, painting, and writing. The artistic developments lead to the expression of goals or IDEALS for which mankind strives to attain a better world. This striving for the expression and realization of ideals is expressed through the development of religion, ethics, and philosophy. The abstract thought from philosophy when coupled with some of elementary counting techniques developed in survival and communication lead to the development of Mathematics which makes possible the theoretical and experimental testing of hypotheses about nature leading to the PROOF of some basic laws of nature which make possible the development of science and engineering.

Table I

DIVISIONS OF HUMAN ACTIVITIES



Where do computers fit into the picture? I have shown Computers as a junction between Mathematics and Proof, the area of their development. Perhaps they have more far reaching effects through the whole range of human activities.

Levels of Phenomena

Our examination of the divisions of human activities gives us two of the three dimensions needed to adequately represent the "spiral of culture" in a graphical way. Let us examine historical sociology to see if we can find a suitable third dimension from the early sociologists' classification of the sciences.

August Comte, writing in France during 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. This new science of sociology was developed by various scholars, and was organized into a more formal system by Herbert Spencer in England, and by Lester Ward in the United States. An adaptation of Ward's classification of the sciences is shown in Table II. Here the sciences are arranged by levels of the phenomena they describe. Sociological phenomena are dependent on the psychological behavior of individuals who constitute the social group. The psychological phenomena are dependent upon the biological organization of the individual, which are in turn dependent upon chemical phenomena, and in turn physical phenomena.

Our next step is to combine the coordinates of Tables I and II in order to trace a few cycles of the "spiral of culture."

Table II

LEVELS OF PHENOMENA
SOCIOLOGICAL
PSYCHOLOGICAL
BIOLOGICAL
CHEMICAL
PHYSICAL

"Spiral of Culture"

A Coordinate system is laid out in Figure 1 to illustrate the "spiral of culture." The sectors in the horizontal plane represent the Divisions of Human Activity, while the vertical levels represent the levels of phenomena of nature. Let us start with what we can suppose as one of the elementary physics experiments made by pre-historic man. Early man discovered that he could be more effective in stopping wild animals for food and fighting his enemies by using the momentum of rocks which he threw at his adversaries. This is marked as point 1 in Figure 1. This starts a spiral of development beginning with improved means of gathering food and improved weapons. This led to the development of signals and some form of organization to form groups of men to take advantage of the rock throwing techniques. The spiral at this early stage may have skipped a few stages such as ART and IDEALS.

The stage marked 2 is the discovery of another physical law, namely the use of a stick as a lever to pry up useful rocks. The stage marked 3 is the use of fire, a chemical reaction, for the benefit of man. It is more likely that the use of fire led to more pronounced developments throughout the whole cycle of human activities, including the appreciation of Art and the development of religious ceremonies.

I shall not attempt to develop the full "spiral of culture." I have listed twelve important stages in Table III. If we trace these stages through the spiral we will find that the spiral is

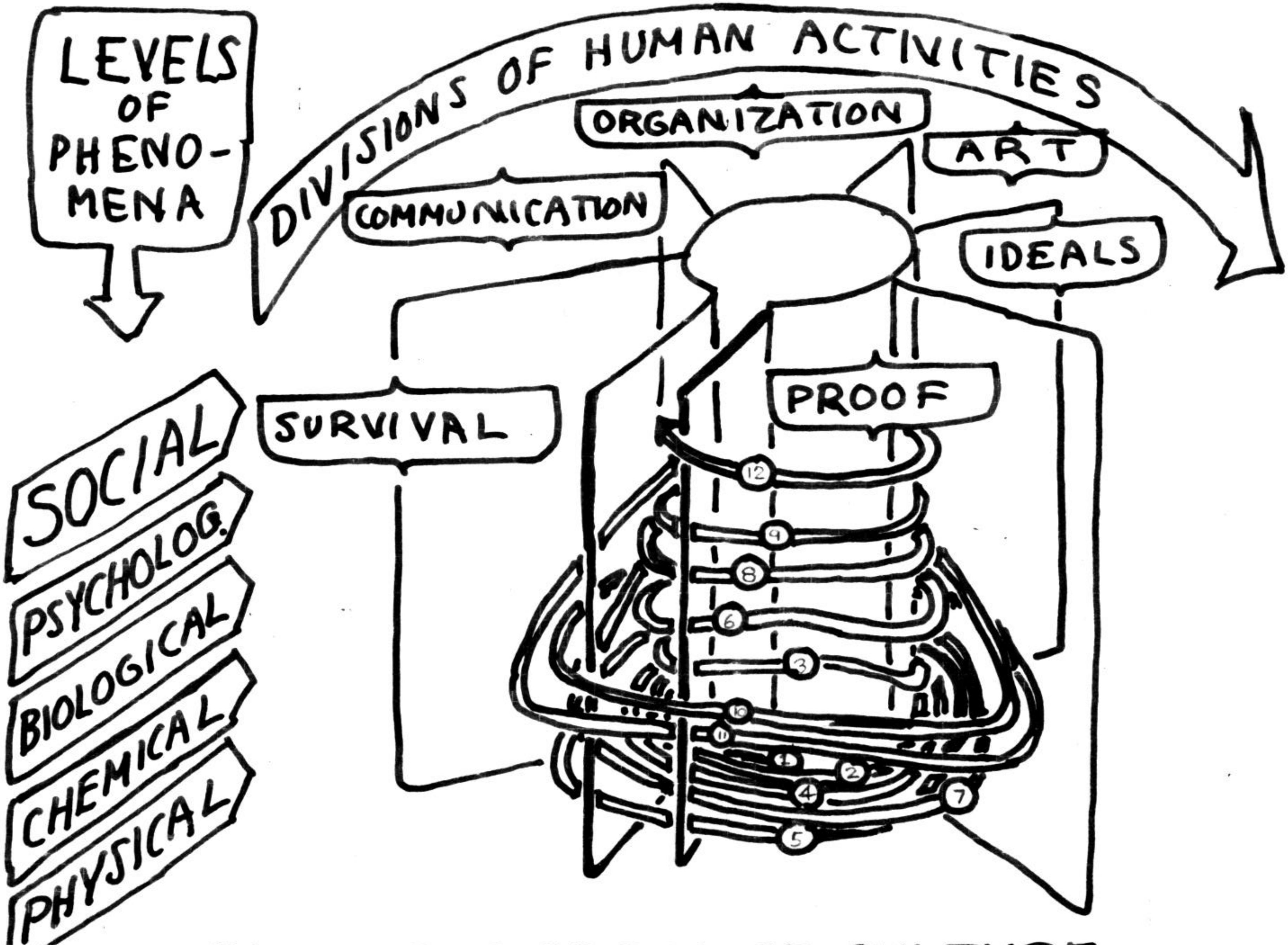


Fig. 1 - THE SPIRAL OF CULTURE

not always a spiral, in that it goes up and down and in and out. The choice of stages in Table III is somewhat arbitrary. I expect that some social scientist can pick out a more representative set than I have. I invite critics to make these corrections, so I can concentrate more on my engineering work.

Table III

An Incomplete List of Stages in The Spiral of Culture.

1. Rock Throwing
2. Lever
3. Fire
4. Iron
5. Bronze
6. Gunpowder
7. Pulley
8. Understanding of Circulation of Blood
9. Elementary Anatomy
10. Electromagnetic Theory
11. Theory of Atomic Structure
12. Theories of Personality Development

If we contemplate this "Spiral of Culture" we are likely to conclude that this is too complicated a problem for us engineers to get involved with. Let us see if there is a piece or slice of this complicated cultural space which we can isolate in a limited way to use in developing a reasonable sense of social responsibility.

TYPES OF PHENOMENA	TYPES OF ACTIVITY			
	BASIC SCIENCE	ENGINEERING SCIENCE	EDUCATION	ACTION
SOCIAL				
PSYCHOLOGICAL				
BIOLOGICAL				
CHEMICAL				
PHYSICAL				
	NATURAL LAWS	TECHNIQUES and RESPONSIBILITY	DISSEMINATION of IDEAS	ORGANIZATION

Figure 2. The Basic Checking Chart

A Checking Chart for Social Responsibility

If we examine Figure 1 we see that we, computer engineers are involved when the spiral of culture makes new spirals through the activity area of Proof. Let us take this one slice and add to it the shorthand columns of Education and Action which represent the stages through which the results of Basic Science and Engineering Science must go in order to have their influence around the spiral.

The checking chart of Fig. 2 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 meeging 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.

If we can successfully use a chart like this as the spiral of culture winds through our particular field of specialization, we can help prevent future difficulties of the nature described by Stuart Chase below:

Stuart Chase says "....technological progress, while steady, is not an unmixed blassing. Waste of natural resources and degradation of human resources have often offset the advance of knowledge. The social sciences have not kept pace with the natural sciences, and innovations, like the steam engine and atomic power, have been loosed on a world unprepared to cope with them. The difficulty is not too much science, but unplanned application."

Our checking chart of Figure 2 is left blank at this stage as a tool to be used by the individual engineer in examining how his own work interacts with the process of the spiral of culture. If the individual engineer can develop an abbreviated view of the potential social influence of his work, he can then ascertain whether suitable agencies in our society are studying the social problems related to his work.

As a first use of the chart, let us examine the work of a famous engineer to see how his handling of his social responsibility can be pictorially represented on the "checking chart."

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 arresters. He had some 200 patents on electrical apparatus.(13)

An example of some of the work of Steinmetz is marked on the checking chart of Fig. 3. 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 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 growth of large corporations was accompanied by an increasing concentration of people in large cities with many social problems resulting. The area where new problems arose as a consequence of the changing social structure required to distribute the benefits of technology is marked as section 3 in Figure 3. For example school systems were slow in expanding and adjusting to the needs of the children in some of the growing cities.

Steinmetz devoted much time to social reform activities to insure that his home city Schenectady made the changes necessary to meet human needs under the changing conditions. This is shown as Section 4 of Figure 3. The Socialist Party invited him to run for various offices in Schenectady. He was elected at different times to the position of Chairman of the Board of Education and Chairman of the Common Council. (14) Under his leadership many reforms were instituted which we now accept as commonplace, such as mid-morning milk for the school children, the construction of sufficient school buildings so all the children of the city could attend school, and provision of special teachers and facilities for tubercular and disabled children.

The value of the checking chart in this instance is to show how a leading engineer of the first part of the twentieth century found ways to use his creative ability both in his technical field and in the related social problems that accompanied the application of the new technology in society.

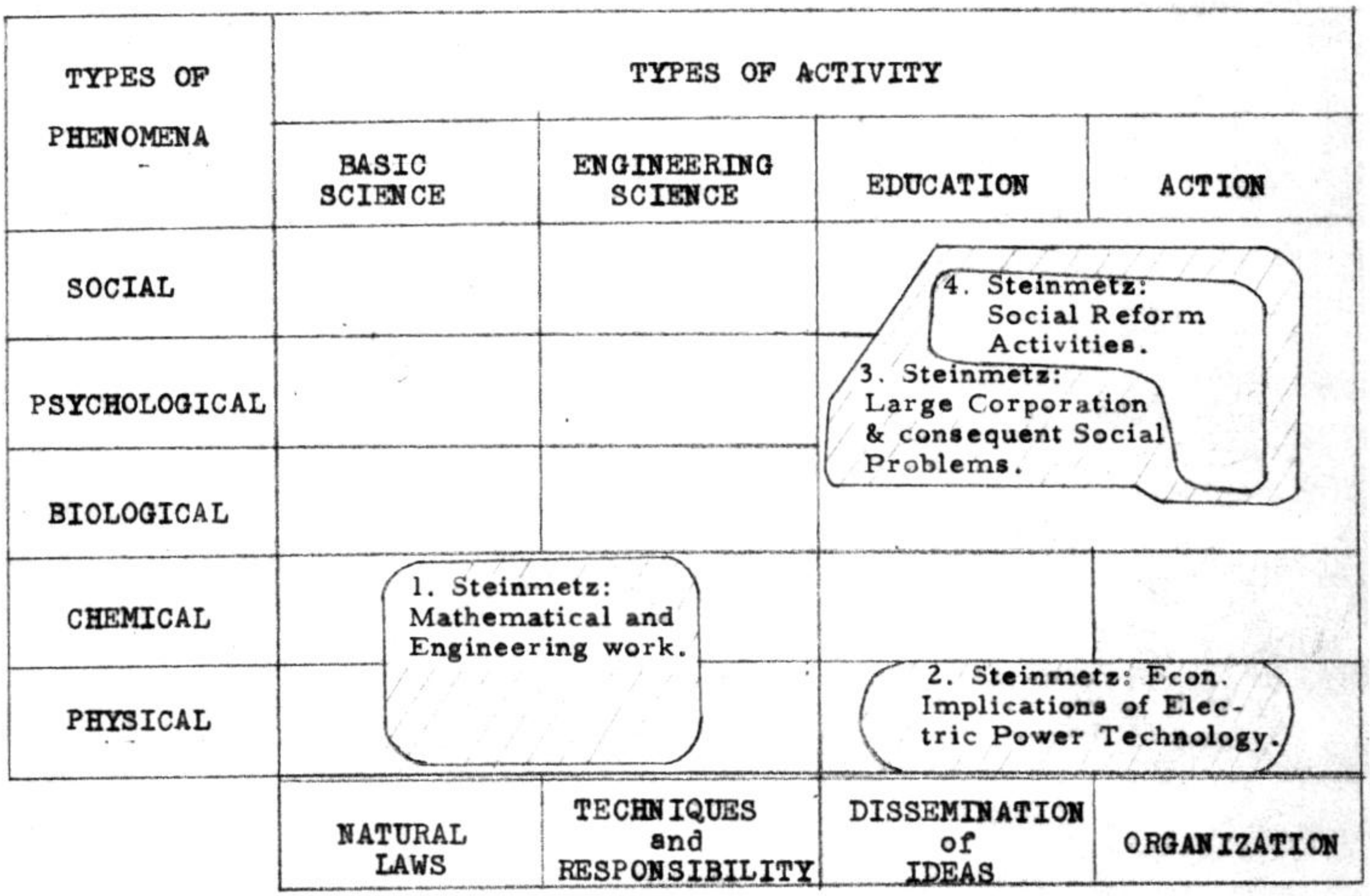


Figure 3. An Example of a Checking Chart Illustrating the Major Areas of Work of C. P. Steinmetz.

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