AN INTRODUCTION TO THE HISTORY OF ELECTROMAGNETIC THEORY FROM AN ENGINEERING VIEWPOINT

I. The Engineering Viewpoint

Since this study of the history of electromagnetic theory is from an engineering viewpoint, it is necessary to clarify what is meant by engineering. A dictionary definition of engineering is as follows:

> The art of making, building, or using engines and machines, or of designing and constructing public works or the like. [1]

This definition must be modified by the following statement from the Encyclopaedia Britannica to arrive at the engineering viewpoint of this study:

> ... the engineer is under obligation to consider the sociological, economic and spiritual effects of engineering operations and to aid his fellowmen to adjust wisely their modes of living, their industrial, commercial and governmental procedures, and their educational processes so as to enjoy the greatest possible benefit from the progress achieved through our accumulating knowledge of the universe and ourselves as applied by engineering. [2]

If Mr. Flinn's statement regarding the obligations of the engineer is to be taken seriously, a study of the history of electromagnetic theory from an engineering viewpoint should include consideration of the relationship of electromagnetic

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1. The Practical Standard Dictionary (Funk and Wagnalls Co., 1931).
2. Alfred Douglass Flinn, "Engineer, Professional," Encyclopaedia Britannica (1945), VIII, 443b.

theory to social problems. A comprehensive study dealing with both physical and social phenomena requires a synthesis that would be very difficult to achieve in an age of extreme specialization.

Figures 1-5 illustrate some aspects of the problem of the attempt to obtain a synthesis in a situation where extreme specialization is necessary in order to make advances in our scientific knowledge of natural phenomena. The plotting of a measure of one's specialization against type of phenomena utilizes some of the ideas of Auguste Comte, Herbert Spencer, and Lester Ward[3] together with some of P. A. Sorokin's[4] criticism of their classifications of the sciences.

In figure 1 consider a case where an engineer (a) working on problems in which he is applying our knowledge of physical phenomena to the design of instruments for human use. If he assumes the responsibility of considering the related social problems he must consult a social scientist (e) or take time out from his primary work to study social phenomena himself. Usually he does not take time to study social phenomena himself,[5]

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3. John Edward Bently, Visual Outline of Philosophy (Longman's Green, 1939); Lichtenberger, Development of Social Theory.
4. Contemporary Sociological Theories.
5. For a discussion of the failure of our educational system to resolve this problem, see Elton Mayo, The Social Problems of an Industrial Civilization (Harvard, 1945), p. 120. "As a consequence we are technically competent as no other age in history has been; and we combine this with other [illegible] social incompetence."

with the exception of some phases of economics. If he consults with a social scientist there may be difficulty due to each specialist not knowing enough about the other's field to efficiently consider the problems.[6] If one person tries to spread the time usually spent in studying in one field over the whole range of natural phenomena, one would not know very much about any class of phenomena as illustrated in figure 2. To become an expert in all fields as illustrated by figure 3 would require so much time that one would not be able to make very much use of one's knowledge after acquiring it.

These problems suggest a solution which may be already practiced in some fields, but not in others. An ideal set-up might be to have a certain number of basic scientists who specialize in narrow fields like figure 1. In addition there might be a certain number of engineering scientists similar to the physical engineering scientist shown in figure 4. These engineering scientists would have training based upon a specialized study in one field, but not as specialized as the basic scientists, combined with an elementary training in several

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6. Mayo, op. cit., 115. "We had not sufficiently realized the truth and relevance of A. N. Whitehead's assertion that there is no substitute for firsthand knowledge (Aims of Education and Other Essays, p. 79). Nevertheless the theory that the meeting in conference of a sufficient number of eminent specialists drawn from widely different fields will in some fashion produce the firsthand knowledge required is still widely held, even in universities."

other fields. Then committees of engineering scientists (physical, chemical, biological, social, etc.) might be more adequately prepared to apply the discoveries of the basic scientists to social use as illustrated by figure 6.

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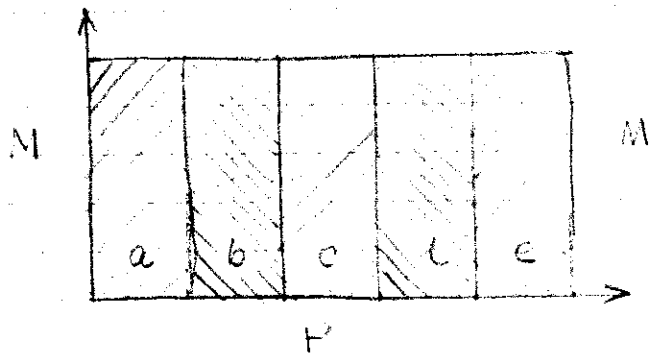

Fig. 1

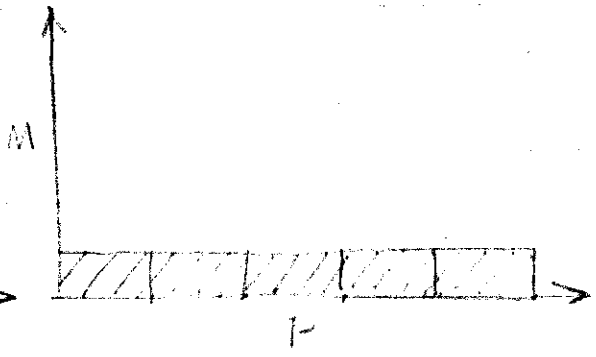

Fig. 2

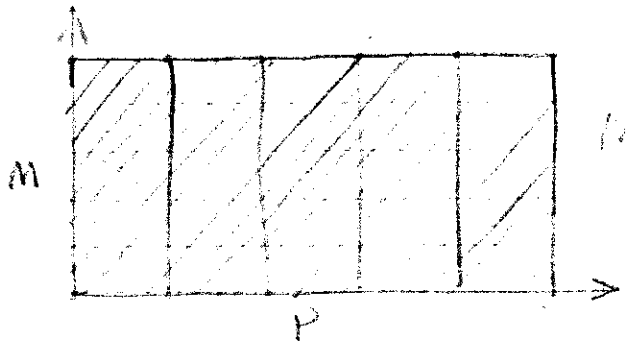

Fig. 3

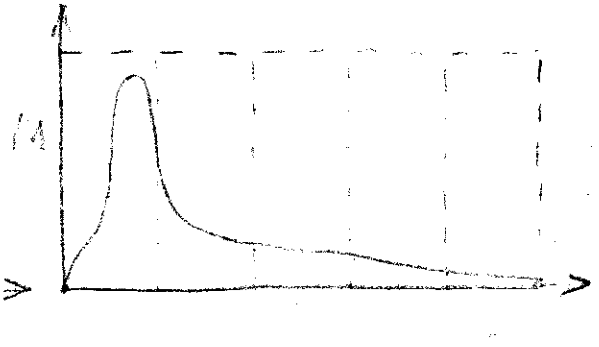

Fig. 4

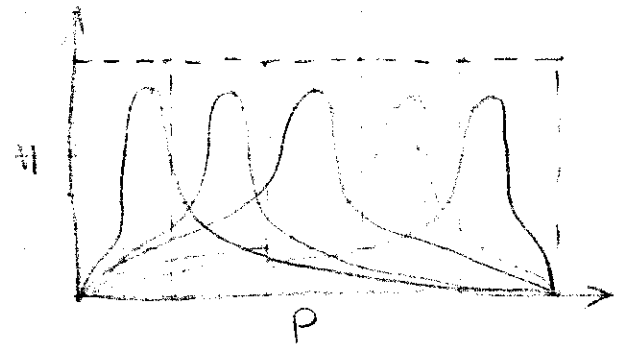

Fig. 5

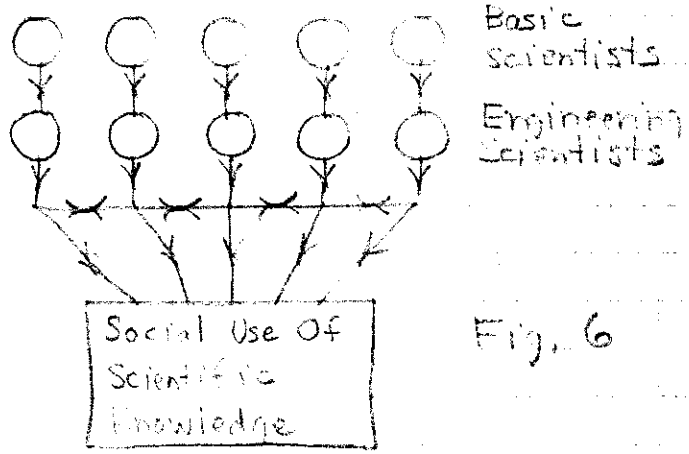

Fig. 6

M = A measure of one's specialization in study of phenomena P.

P = Type of phenomena, varying from left to right, from physical through chemical, biological, psychological, and social phenomena.*

* Note: This is an over simplification for approximate discussion. In practice many phenomena are mixtures of the types specified here.