ENGINEERING AS ACTION AND SCIENCE EPISTEMOLOGICAL IMPLICATIONS

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INTRODUCTORY

This paper embodies the results reached beyond those included in the writer's address under the title: "Empirico-Logical and Axio-Teleological Factors in Engineering," presented before the Fifth International Congress for the Unity of Science, held at Harvard University, September 3-9, 1939.

The *abstract* of the address was published in October, 1939, by the Engineering Experiment Station at the Oklahoma Agricultural and Mechanical College—Stillwater, Oklahoma, under the title: "Engineering as Action and Science," Publication No. 41, 1939. The topics considered in that abstract fall under three headings:

1. Composite character of Engineering Science (p. 3)
2. Axiological and Teleological Factors in Engineering (p. 5)
3. Empirico-Logical Factors in Engineering (p. 7).

The present paper adds to the above discussion the new article as follows:

EPISTEMOLOGICAL IMPLICATIONS

Two opposite poles in a variety of epistemological doctrines stand out as the extremes: The Platonic structure of knowledge built primarily on the principles of generality, stability, permanency—the doctrine of ideas, on the one hand, and the pragmatic standpoint with its emphasis on the perceptional, concrete, particular and individual—the radical empiricism of William James and the "Grammar of Science" of Karl Pearson, on the other.

In its less original part the science of engineering uses and applies general laws, propositions, postulates, hypotheses borrowed from physical and social sciences; there the universal reigns supreme.

Yet, where and when engineering starts on its own because other sciences are not in a position to obtain and convey necessary knowledge, as explained before, its pragmatic nature becomes obvious, to the extent that synthetic judgments and empirical correlations are sometimes no more than pragmatic beliefs, especially if adequate empirical material or time or both are lacking to put judgments to a thorough test.

Engineering boldly invades the fields unexplored or not sufficiently explored by other sciences, for instance: radio communication, automotive industry, aeronautics and aviation, building of extremely large edifices and structures, etc., and in so doing it is fully justified; for development would be sluggish or even arrested if engineering had to wait for an accumulation of adequate data in some urgent cases; of course, it is realized that a penalty for this daring may appear in a form of a wider margin of safety and higher costs.

We conclude this paper by presenting illustrations of the two attitudes in engineering: platonic and pragmatic.

Thus Professor Vladimir Karapetoff writes: "The routine engineer may well say: 'Mine are simple engineering problems which can be more quickly solved without tensor analysis.' This is true and there are many others which can be solved without even plane geometry or algebra. Does this fact detract from the majesty, beauty, and tremendous educational and practical significance of these disciplines?"* He says further: "The sons of those who could not see Heaviside's fractional derivatives or Steinmetz's link between practical electricity and the square root of minus one will likely balk at the idea of n-dimensional non-Riemanian spaces as a useful tool in the design of the housewife's vacuum-cleaner motor." Yet, also Thomas Edison would probably have done the same in the past and Henry Ford would likely balk now; for the latter two are the prominent representatives of pragmatism in engineering: Thomas Edison as the genius-experimenter and Henry Ford as the extraordinary resourceful organizer of multiple factors into one well-balanced engineering system.

The epistemological dualism in engineering science can hardly be denied.

Engineering appears as a scientific edifice built in two different styles: Platonic and Pragmatic; it may lack epistemological elegance; yet it is and will be proficient and efficient because of this dualism—at least at the present time and in the near future.

* Foreword, "The Application of Tensors to the Analysis of Rotating Electrical Machinery", by Gabriel Kron.