

Society of Rheology 1957

THE Society of Rheology held its 1957 Annual Meeting, November 7-9 in Princeton, New Jersey, on which occasion the Bingham Medal of the Society was presented to Clarence M. Zener, Director of the Research Laboratories of the Westinghouse Electric Corporation. Dr. Zener's response is printed below.

The presentation was made by Arthur S. Nowick of the IBM Watson Laboratory at Columbia University. A former colleague of Dr. Zener at the Institute for the Study of Metals of the University of Chicago, Dr. Nowick reviewed the scientific contributions that had been made by Dr. Zener, including his work on the viscoelastic behavior of metals for which the 1957 Bingham Medal was awarded.

Technical sessions and the Society's business meeting were held at the Textile Research Institute. The technical program consisted of six half-day sessions and was marked by having the largest attendance in the history of the Society—122 members and 43 guests. Papers presented covered a wide variety of rheological

subjects ranging from descriptions of the flow properties of polymer systems to considerations of the creep of snow under conditions of stress.

At the Business Meeting, held Friday afternoon, November 8, after the technical session, plans were announced by F. D. Dexter to hold the 1958 Annual Meeting on November 5-7 at the Franklin Institute in Philadelphia, Pennsylvania. The results of the Society's election of new officers for 1957-59 were also announced at the meeting. J. H. Dillon, Textile Research Institute, was elected president, succeeding F. D. Dexter of the Bakelite Company. J. H. Elliott, Hercules Powder Company, was elected vice president; W. R. Willets, Titanium Pigment Corporation, was elected secretary-treasurer; and R. D. Andrews, Dow Chemical Company, was elected editor. R. S. Marvin, National Bureau of Standards, and R. S. Rivlin, Brown University, were elected members of the executive committee, which also includes the officers and the immediate past president.



Clarence M. Zener, Bingham Medalist for 1957, is director of the Westinghouse Research Laboratories in East Pittsburgh, Pa. Prior to joining Westinghouse in 1951 Dr. Zener was professor of physics at the University of Chicago where he was also associated with the Institute for the Study of Metals.

Bingham Medal Address

Princeton, N. J., November 7, 1957

By Clarence M. Zener

THE Oxford Dictionary refers to "theoretical" as having a meaning opposite to that of "practical". Unfortunately this connotation of "theoretical" is prevalent among the lay public. As one who has devoted his entire working life to theoretical physics, I resent this popular view of the theoretical man. The most satisfying aspect of my present job is the opportunity it offers of demonstrating to the so-called "practical" business man that theory is in fact the most practical pursuit of man. I am grateful for the present opportunity of expounding my philosophy of the role of theory in science and technology.

Annual Meeting

The number of facts in nature is truly infinite, or more correctly, the number of facts in nature constitutes a high order infinity. A striking example of the nonfiniteness of the number of facts has been given by Hartree. In his early work on calculating self-consistent atomic wave functions, Hartree asked himself how large a book would be required to tabulate the exact wave function of a typical atom such as argon, the coordinates of each electron having 100 tabulations. Hartree calculated that such a tabulation would require more matter than is contained in the entire universe.

The number of known facts is increasing at a prodigious rate. It has been estimated that knowledge is doubling once every twelve years. In view of the above mentioned boundless nature of knowledge, mankind can look forward to a continued exponential increase in knowledge.

The rate at which knowledge is increasing has worried some people whose job is the cataloguing of books and journals. Proposals have been made to do away with journals, to put all information in machines, and considerable effort has been expended on developing means of ready access to these machines.

The rate at which knowledge is increasing has worried professional educators. They talk of extending the years a student spends in college so that he may better assimilate the increased information.

One of the roles of a theorist is to correlate facts. Once a mass of data has been successfully correlated by a theory, the data may be relegated to a memory machine. If the theorists keep pace with our increase in knowledge, technical schools need not increase their training period. What is now taught as a mass of isolated uncorrelated facts will in future years be replaced by a simple easily comprehended theory.

The most gifted theorists introduce correlations by changing our formulation of the basic laws of nature. The most recent example is the change in our concepts about the parity of nature. Whereas changes in our formulation of the basic laws of nature have far-reaching consequences, such changes are very infrequent. The great bulk of correlations are made with the aid of models. In searching for an appropriate model to represent a phenomenon, we attempt to ferret out the most important factors influencing the phenomenon, and to neglect the many complicating but irrelevant factors. We should never ask whether a model is correct. A model is always an approximation, and hence can never be correct. Rather we should judge a model by the number of apparently unrelated phenomena which it is able to correlate. As an example of a successful model in the field of rheology, I shall mention the model of viscous grain boundaries in metals investigated by Ting

Sui Ke. Such a model is able to correlate the temperature dependence of internal friction, of creep, of stress relaxation, and of elastic moduli. I personally find rather meaningless the question "are grain boundaries really viscous?"

Most models are successful only for a limited period. As time passes phenomena are found which contradict the model. A classic example is the concept of the ether. The ether furnished a very useful model for many years. It enabled physicists to understand electromagnetic phenomena. As pointed out by Einstein, the Michelson-Morley experiments required us to abandon this model. Fortunately, by this time physicists had become sufficiently sophisticated that they no longer needed the prop of a model. They were satisfied by the descriptive equations.

Theorists would justify their keep if they merely correlated facts. Actually, theorists have an even greater impact on science and technology. In science the correlations introduced by theorists themselves suggest further experiments which will be correlated with either the same change in basic ideas, or with the same model. Those fields of science advance most rapidly where experimentalists and theorists work closely together. I am personally grateful for the close association with many experimentalists in the field of the rheology of metals. This association has of course given intense satisfaction whenever a prediction of a model was verified. More importantly, this close association has enabled faulty models to be discarded because of conflict of experiment with prediction.

In technology the guidance of theory is of even greater importance than in science. Here one's experiments are aimed at obtaining definite results. The manpower expended in reaching the end goal is inversely proportional to the wisdom of the theoretical guidance. It is because of my faith in the value of theoretical guidance that I place so much emphasis on theoretical physics and on mathematics in my laboratory.

Let us now return to the unsavory definition of "theoretical" in the Oxford Dictionary. This definition is no doubt a reflection of the attitude of the layman. I personally have a high respect for the attitudes of laymen, and have therefore been curious as to why their attitude towards theory is so skeptical. In the fields of human endeavor most familiar to the layman, namely business, politics, economics, sociology, theory plays the same role as it did in pre-Galilean science. In these familiar fields of endeavor crucial experiments are not performed in order to check a theory. In these fields one who bases his actions or decisions on theory is bound eventually to come to grief.

In closing, I wish to emphasize that each of us in a physical science is to some extent a theorist. It was in fact the beauty of nature, as manifested by unifying theories, that attracted us into science. The closest coordination of theory and experiment occurs when both are advanced by the same individual. I hope to have encouraged the theorist in each of you to grow a wee bit at the expense of the experimentalist.