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THE FIELD OF MATERIALS IN RELATION TO ENGINEERING

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With the growing acceptance and importance of materials to engineering, most engineering fields are, or are considering, establishing materials groups. As a result, the terms Materials Science and Materials Engineering are becoming more popular and, unfortunately, also more confusing in their coverage. It thus becomes desirable to explore the field of materials to indicate the natural interfaces, to determine the areas of educational and professional responsibilities, and to identify the areas of overlap or commonalty. This effort to scope the field of materials in relation to the overall field of engineering has no official standing and represents only the author's viewpoint. It is being presented to serve as an introduction to the discussion at a Materials Division session scheduled for the forthcoming Annual Meeting of the Society.* This session could thus serve as a means of identifying the principal areas of

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* The session on "The Field of Materials in Relation to Engineering" at the Annual Meeting of ASEE at Ohio State University in Columbus, Ohio, is scheduled for Thursday, June 25, 1970 at 8:00-9:45 a.m. The participants are David K. Felbeck, Department of Mechanical Engineering, University of Michigan; A. G. Milnes, Department of Electrical Engineering, Carnegie-Mellon University; Walter S. Owen, The Technological Institute, Northwestern University; Joseph A. Pask, Department of Materials Science and Engineering, University of California at Berkeley (Chairman of Session); R. M. Thomson, Department of Materials Science, University of New York at Stony Brook.

responsibility for the Materials Division of ASEE which includes both producers and users of materials in its membership.

The scoping approach presented here is based on currently recognized activities and on professional traditions related to materials. It becomes logical to determine how well established definitions and professional activities fit into such a scoping after the various interrelationships are established.

The overall field of engineering, as indicated by the attached chart, includes the field of materials (which involves the processing and fabrication of materials parts) and the field of materials applications (which involves the traditional fields of engineering). The manner or organizational listing in the chart was followed in order to show that the character—property/behavior coupling is a common theme that runs, or should run through all the materials fields concerned with the processing and fabrication of material parts. This coupling also acts as a common field of interest and an overlap with the fields of engineering that use or apply materials, e.g., civil engineering, electrical engineering, mechanical engineering, etc.

The character*—property/behavior coupling is recognized as an engineering science. It was discussed in a Report on the Engineering Sciences prepared by an ad hoc Committee on Evaluation of Engineering Education in 1958 under the auspices of A.S.E.E. The subject area of

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* Character refers to a complete description of a material on the basis of composition and structure (atomic micro and macro). (Characterization of Materials, MAB-229-M, Materials Advisory Board, National Research Council-National Academy of Sciences/National Academy of Engineering, 1967.)

interest was then defined as "Nature and Properties of Materials," and constituted a study of the interrelationship among properties, environment, and structure. This area is now popularly referred to as Materials Science.

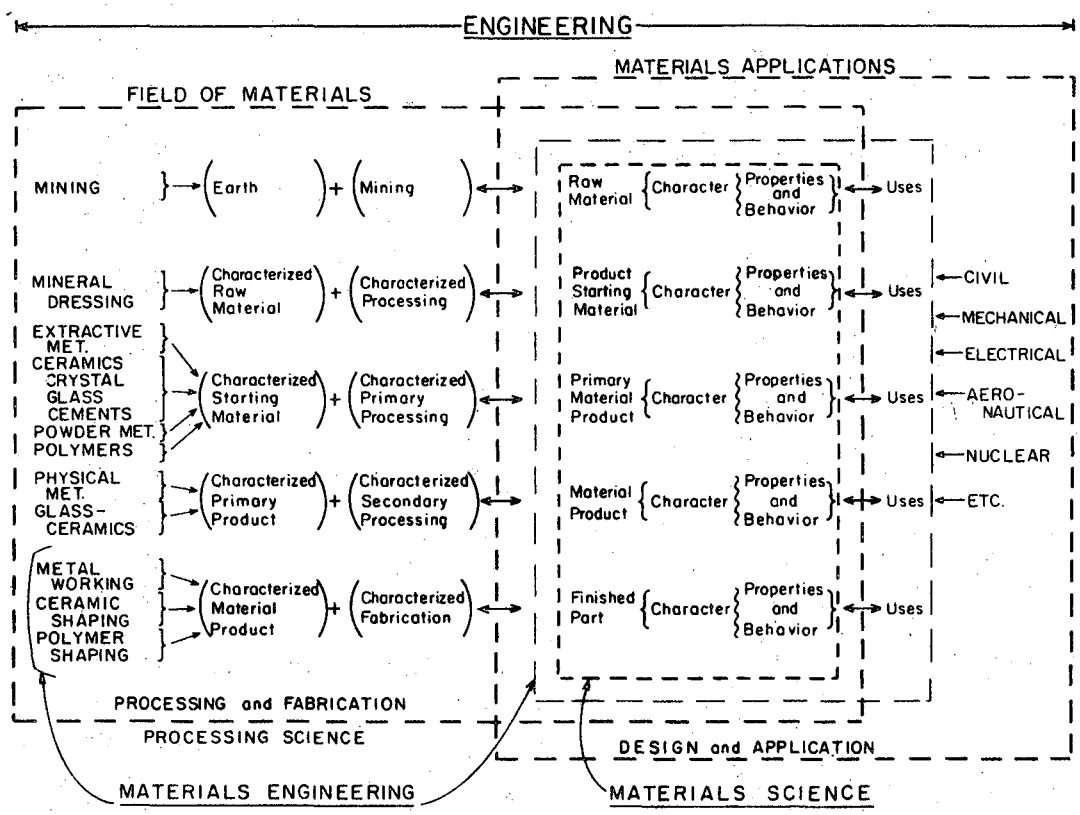
It thus becomes somewhat confusing also to refer to the scientific aspects of processing as Materials Science which is done frequently. It would possibly be less confusing to refer to this activity as the science of processing. Here, processing is differentiated from fabrication on the basis that the objective of the former is to obtain a certain material character with a preliminary size and shape while the latter is concerned primarily with the problems of achieving a final finished shape and size by machining, drawing, grinding, etc.

The delineation of the activities of Materials Engineering is even less specific. The industries which may potentially use all types of materials are interested in having Materials Engineers, who have design responsibilities, that are familiar with the properties/behavior of all materials relative to their particular interests (represented on the chart by a vertical assemblage encompassing uses). These engineers are knowledgeable in the correlation of character with properties/behavior, but are not directly concerned with development of the character of material or the characterization of the material. In today's technology, the term Materials Engineering is also acceptably applied to the activities dealing with the fabrication of materials parts as indicated on the chart. The name Materials Engineering normally is not applied as an overall term to the processing fields. The professionally established fields, such as ceramic engineering, metallurgy and polymer

engineering, cover the production of the different types of materials.

In a general way, from the viewpoint of the producer, the scientific or research objectives are more concerned with the application of science to processing in order to achieve a desired character (i.e., going from right to left on the chart). On the other hand, the engineering objectives are more concerned with the application of engineering principles to the mass production of uniformly repetitive reliable products with a given predetermined character (i.e., going from left to right on the chart). The user, however, is primarily concerned with the problems arising in design and application of materials.

The area designated as Materials Science on the chart provides a natural overlap between the materials producers and users, and thus a means of communication. It should serve as the principal objective of the Materials Division. Educationally, it is apparent that three types of courses are possible in this area: those concerned with techniques of characterization, those concerned with testing and inter-relation of properties/behavior, and those concerned with the correlation or evaluation of character with properties/behavior--the heart of Materials Science. It becomes evident that the materials producers have the primary objective of developing and modifying characters to achieve certain properties and behavioral characteristics. Specialized and more advanced activities dealing with properties/behavior of materials as correlated with their use in a given field of engineering become the primary objective of groups concerned with materials applications.


ENGINEERING
MATERIALS APPLICATIONS
FIELD OF MATERIALS
MINING
Earth
Mining
MINERAL DRESSING
Characterized Raw Material
Characterized Processing
EXTRACTIVE MET.
CERAMICS
CRYSTAL
GLASS
CEMENTS
POWDER MET.
POLYMERS
Characterized Starting Material
Characterized Primary Processing
PHYSICAL MET.
GLASS-CERAMICS
Characterized Primary Product
Characterized Secondary Processing
METAL WORKING
CERAMIC SHAPING
POLYMER SHAPING
Characterized Material Product
Characterized Fabrication
Raw Material
Product Starting Material
Primary Material Product
Material Product
Finished Part
Character
Properties and Behavior
Uses
CIVIL
MECHANICAL
ELECTRICAL
AERO-NAUTICAL
NUCLEAR
ETC.
PROCESSING and FABRICATION
PROCESSING SCIENCE
DESIGN and APPLICATION
MATERIALS ENGINEERING
MATERIALS SCIENCE

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