OPENING ADDRESS

by

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Mr. Chairman, Fellow Conferees:

I would like to add my welcome to those of the previous speakers. I would first like to express my thanks and that of the Air Force to Professor Lazan and his able associates and to Mr. Trapp and Mr. Forney of our Materials Laboratory for the fine program and arrangements that they have evolved. Having been associated in a number of symposia and conferences of this magnitude, I can well recognize the tremendous efforts that are necessary and the myriad of details that must be taken care of to assure the success of this undertaking. I think that the finest tribute that can be given to all of those who have participated in the arrangements of this conference is that it has brought together in one place the individuals who have made the greatest contributions to our store of knowledge in the acoustical fatigue area, both in this country and abroad. From where I sit, this conference achieves an objective that we have been striving for -- that of bringing together the available industrial, academic, and Government competence to attack a serious and perplexing Air Force problem.

I have heard it said that acoustical fatigue is the world's second oldest profession, dating back to Biblical times to the Battle of Jericho. In terms of its criticallity and applicability to Air Force weapon systems; however, it is relatively new, but will become progressively more severe as the performance of our vehicles increases.

After looking over your fine program and the long list of internationally recognized authorities who will present papers and participate in seminar discussions, I feel that it would be presumptuous of me to even attempt to add any comments in the area of acoustical fatigue. I would like to concentrate, rather, on the trends in technology which may have an important bearing on your future work together with some of the more philosophical approaches being considered in the overall materials area.

The history of air power could easily be entitled "The Battle Against Environments." The earlier phases of this history concentrated on conquering the elements or the natural environments such as rain, snow, sleet, extremes of atmospheric temperature -65° to +160°F, atmospheric corrosion, and biological attack such as that experienced in the South Pacific during World War II. In fact, our major research and development efforts during 80% of the time since the Wright Brothers' historic flight were aimed at materials and devices that could exist and operate under the extremes of natural environments. It has only been since the late forties or during the last 20% of the short history of aviation that the induced environments, that is, thermal, chemical, sonic, nuclear, and space, have become critical. I think that it would be fair to say that the rapid development and exploitation of new concepts of propulsion have been the primary motivating force which lifted us into a new environmental regime. In fact, advances in aircraft gas turbine technology brought to the fore the very problem you are here to discuss at this conference.

These technological advances have had a most profound effect upon the position of materials in the overall scheme of air weapons. We have reached a point in time where the availability of materials, usable in these new and severe environments, together with basic knowledge about their interaction with the environments, have become the primary basis for performance advances in air weapons and vehicles. To put it another way, the lack of materials or lack of knowledge about their response to the severe, induced environments has become the most severe bottleneck in improving the performance of our weapons.

This battle against the environments has introduced new and dynamic developments which may have a profound influence on the type of programs that all of you may undertake in the future. For example, the thermal environment has forced designers to look at the more refractory materials for structural applications where aluminum, magnesium, titanium, and, more recently, steels, have been the primary structural materials of the past and the present. Now no one seems to raise an eyebrow when we hear that the nickel and cobalt based alloys, long associated with the hot sections of gas turbine engines, are being used for hot structure applications, at least experimentally. As the thermal environment becomes more intense as in the case of hypersonic and glide re-entry vehicles, the interests of designers must extend to the higher melting materials, both metallic and non-metallic. Up to now, in the more conventional structural metals, we have had available a degree of notch insensitivity so that some discontinuities acting as stress concentrators could be tolerated. In the more brittle metallic and non-metallic substances that must be considered for these higher temperature applications, we may not be so fortunate. Stress concentrations in brittle materials are more likely to cause premature failure of a component or structure than with the conventional structural materials. Is the knowledge that we have accumulated, to date, adequate to cope with designs based on brittle materials? Are new design concepts needed? Must they await new theories and data on the behavior of brittle materials?

This "brute force" approach to the thermal environment has its drawbacks also. The higher melting materials being considered have densities three to four times that of magnesium and aluminum. All of you who have been associated with air weapons recognize the tremendous penalties one pays for added structural weight. In aircraft, a one pound increase in structural weight normally results in a ten pound increase in take-off weight. In missiles, it could mean a thirty pound reduction in payload weight. Thus, paralleling the brute force approach, a new field of technology has opened up which as time goes on may have a profound effect upon our approach to materials of construction for future air weapons. While this approach is not entirely new, it is now reaching its flowering stage. This is the field of composite materials.

The term composite materials means different things to different people and for the purpose of this discussion, I would like to use the following definition:

> "A material intentionally fabricated of dissimilar materials. It is bonded together by some means so that the component materials can act together in response to external conditions. Each of its components retain its original macro and micro identity."

Examples of these are (1) fine particle dispersions (sap type of aluminum), (2) strong brittle particles surrounded by layers of ductile metal (cemented carbides), (3) fibrous reinforce materials (fiber reinforced plastics, metals, and ceramics), (4) sandwich and honeycomb constructions, inorganic and metallic laminates, and many other materials combinations.

Certainly the application of honeycomb construction to the B-52 wing trailing edge and flap structure has been an excellent stop gap fix from an operational point of view when compared with riveted construction. Optimization of damping through the use of viscoelastic composite materials is seen by many as a most promising approach to problems.

I believe that with composites we have a new tool with which to attack confidently many of the problems facing us. We are now on the threshold of being able to tailor-make a material for a specific set of conditions or applications.

Because composites may be composed of widely different classes of materials, the technologies applicable to each are likely to be involved in the overall technology of the composite and interaction of these technologies needs considerable study. For example, a laminate of the future may involve metallic, non-metallic, inorganic, and organic materials all in one complex and these must be made to act together.

There is a serious lack of knowledge on the response of composite materials to external conditions, such as applied loads, low and high temperatures, high vacua, high pressures produced by gases and liquids, and severe ultra violet or nuclear radiations, either individually or in combinations.

The trend toward composite materials has only served to intensify a basic deficiency in the materials sciences area. The future advances in materials may well depend upon greater interaction among the disciplines of physics, chemistry, metallurgy, mathematics, and the various branches of engineering. Recognition of this urgent need has resulted in a recommendation by the President's Federal Council for Science and Technology that interdisciplinary laboratories be established to produce scientists skilled along interdisciplinary lines. This is evolving as a joint program of the Advanced Research Projects Agency (ARPA), the AEC, NASA, and the National Science Foundation. A 47 million dollar national program is envisaged with an objective to establish interdisciplinary laboratories both in large and smaller universities. ARPA has committed 17 million dollars to this program in 1960. It is anticipated that such laboratories will produce a substantial increase in PhD's trained in the materials sciences.

While this trend of events is applicable to the materials field in general, those associated with acoustical fatigue have recognized the need for interdisciplinary cooperation for some time. This conference has brought together those skilled in biophysics, solid state physics, the mechanical and metallurgical domains. We are entering a new era, however. Many of the more familiar materials that we have worked with and have lived with for decades may be supplanted for many applications with strange, unfamiliar, and complex materials. The day has arrived where single materials can no longer satisfy most of the more severe requirements facing us.

Those of you in this field have accomplished a significant amount of pioneering work on the response characteristics of composite materials to vibratory excitation and there is good evidence that you are on the right track. But much remains to be learned not only about new materials, but also how to best exploit their properties.

I am confident that working conferences of this type, in which we have seen a merging of the several appropriate branches of science, will make a substantial contribution toward the technological advancements so urgently needed in this field.

I really feel privileged to have been given the opportunity to help open, what I feel will be a most significant event, the First International Conference on Acoustical Fatigue.