THE NATIONAL CARBON FIBER PROGRAM

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I hope my comments will give you a perspective as to how some of us at NASA Headquarters view the graphite phenomenon, not just in terms of the aerospace community but of the total community involved in the use of advanced carbon fiber composites. As Dick Heldenfels has already pointed out, there has been a rapid growth in the use of carbon fiber composites. The growth is quite outstanding. It was only about 15 to 20 years ago that the Air Force, and subsequently NASA, began spending considerable effort in developing the basic materials from which this industry has grown. In the prespective of just the civil aircraft market, which figure 1 addresses, we are talking about an application today of tens of thousands of pounds of graphite annually and one which projects in the 1990's to a million or more pounds per year of graphite fiber usage. This is an exceptional growth for a new material.

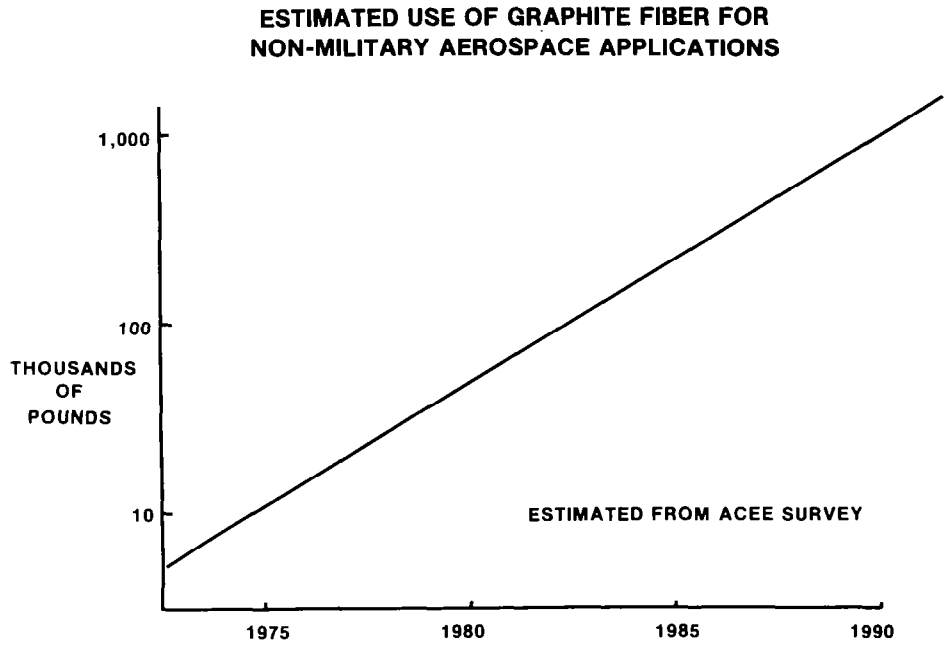

Figure 1

But what accompanies such a rapid growth is the likelihood of surprises, one of the likely perspectives of the rapid growth of any new material. There have been surprises other than the graphite phenomenon during the rapid development

of advanced composites.

Looking further, there is a perspective that requires a certain set of sequences to exist if the carbon fibers that exist in a composite are to escape as free fibers. Figure 2 is a photo from a crash of a U.S. Navy fighter. The fibers are not carbon in figure 2, but the photograph illustrates the potential problem in a crash fire situation in which, under certain conditions, the fibers could become freed from the resin matrix. It is this issue with which this meeting is dealing - the quantification of the risk and associated costs.

FIBER RELEASE IN AIRCRAFT CRASH

Figure 2

About a year and a half ago, the government recognized the rapid growth in the use of graphite reinforced composite materials and also recognized at about this same time that there was a potential for the release of free fibers. Therefore, the Director for the Office of Science and Technology Policy was directed to determine what actions the government should take. As a consequence, there was issued earlier this year a report from the Department of Commerce which described the phenomenon and a NASA technology publication which described some of its technical details.

The government study resulted in an action plan for the civil sector which is outlined in figure 3. The agencies

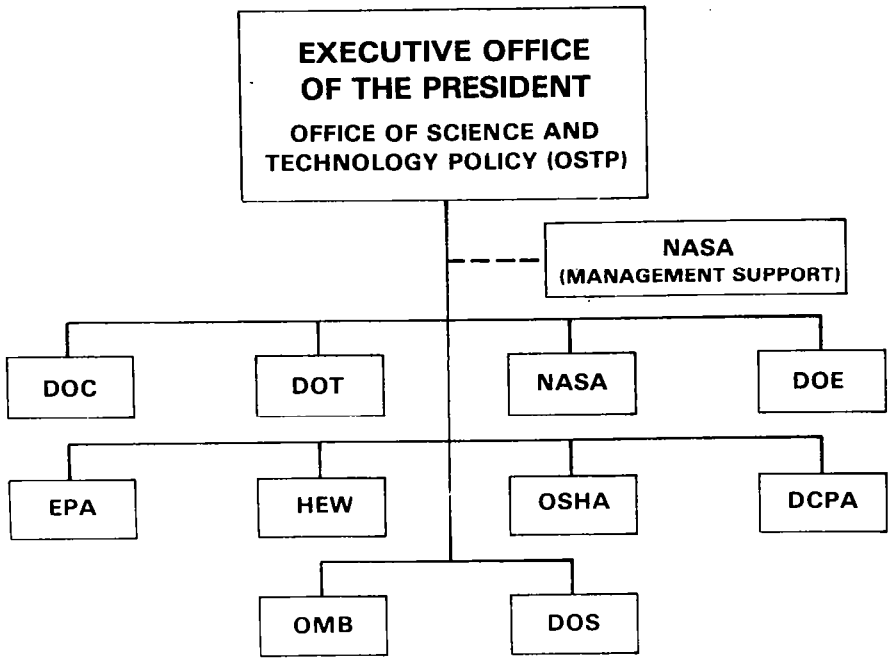

Figure 3

involved, shown in the figure, are those which have specific assignments with respect to the civil sector of the user community. Shown on the top line, the Department of Commerce relates to general civil use, the Department of Transportation to potential automotive or truck applications, NASA to civil aircraft, and the Department of Energy to the production and distribution of power. The second line on the chart represents the agencies that are involved in terms of health and the environment, EPA, HEW, OSHA and the Defense Civil Preparedness Agency. The latter agency has a role in information distribution should a crash occur with a civil aircraft containing carbon fiber. The OMB is involved in budgetary issues and the Department of State in issues related to the foreign market.

Figures 4 and 5 show more explicitly what the assignments are. As shown in figure 4, the Department of Commerce has an overall responsibility for the distribution of data to the total community. They issued the initial press release on the phenomenon earlier this year. The Department of Transportation has obvious interest with respect to the use of graphite in automotive applications and that potential is very great. Our interest at NASA is very straight-forward - we are supporting the aerospace applications and the overall technology associated with what one might do to modify the

CARBON FIBERS ACTION PLAN
AGENCY ACTIONS AND RESPONSIBILITIES

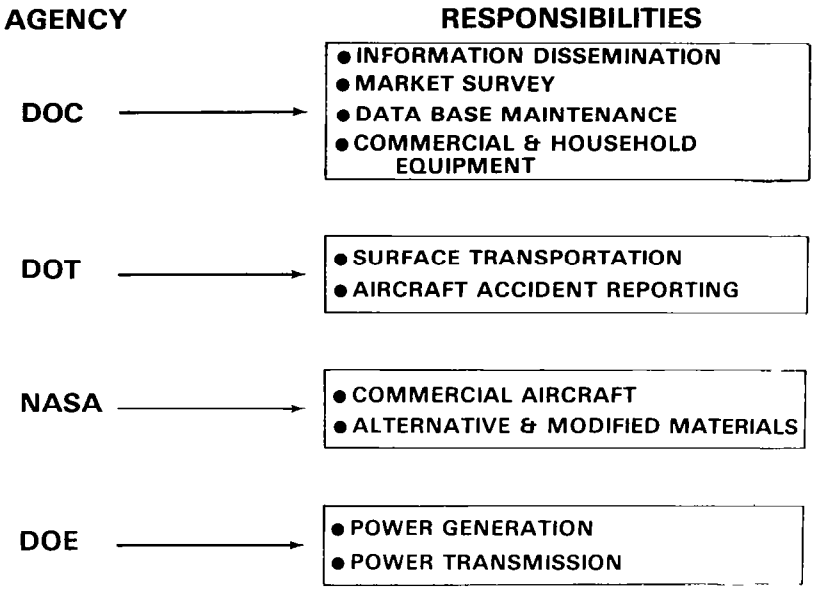

Figure 4

CARBON FIBERS ACTION PLAN
AGENCY ACTIONS AND RESPONSIBILITIES

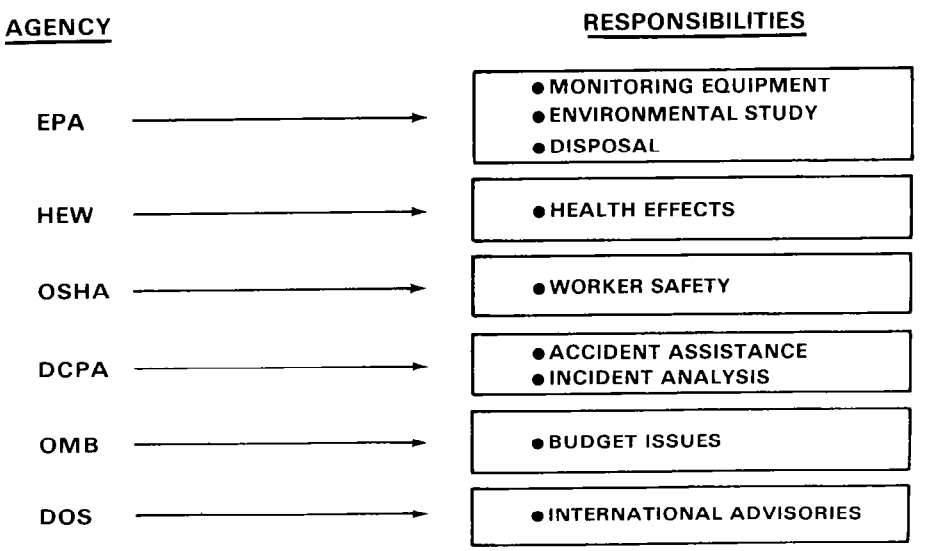

Figure 5

material to alleviate the problem. The Department of Energy is concerned with possible effects of fiber release on power generation and transmission systems. Figure 5 shows the responsibilities of the other involved agencies.

The NASA responsibilities are further defined in figure 6. The first is the subject of this meeting - to quantify the risk associated with the use of graphite bearing composites, in particular with respect to their use in aircraft. In addition, we have an explicit responsibility for research on materials modification which would eliminate the potential for the release of free graphite fiber from composites. NASA is also responsible for management support of the national program.

CARBON FIBER ACTION PLAN
NASA RESPONSIBILITIES

- **RISK ASSESSMENT/AIRCRAFT PROTECTION**
  - LANGLEY RESEARCH CENTER
- **MATERIALS MODIFICATION AND ALTERNATE MATERIALS**
  - AMES RESEARCH CENTER
  - JET PROPULSION LABORATORY
  - LANGLEY RESEARCH CENTER
  - LEWIS RESEARCH CENTER
  - MARSHALL SPACE FLIGHT CENTER
- **OSTP MANAGEMENT SUPPORT**
  - NASA HEADQUARTERS

Figure 6

Let me amplify for a moment that portion of the study which we will not discuss further in this meeting. That is the material modification program which is being conducted jointly by the five NASA Centers indicated on figure 6 and amplified on figure 7. There are two portions to the program. The first has to do with what one might do for relatively simple changes to existing materials systems so that the risk would be significantly reduced. These tasks are predominantly being performed at Ames, Lewis and Langley Research Centers in an in-house program supplemented with industrial

MATERIALS MODIFICATION PROGRAM

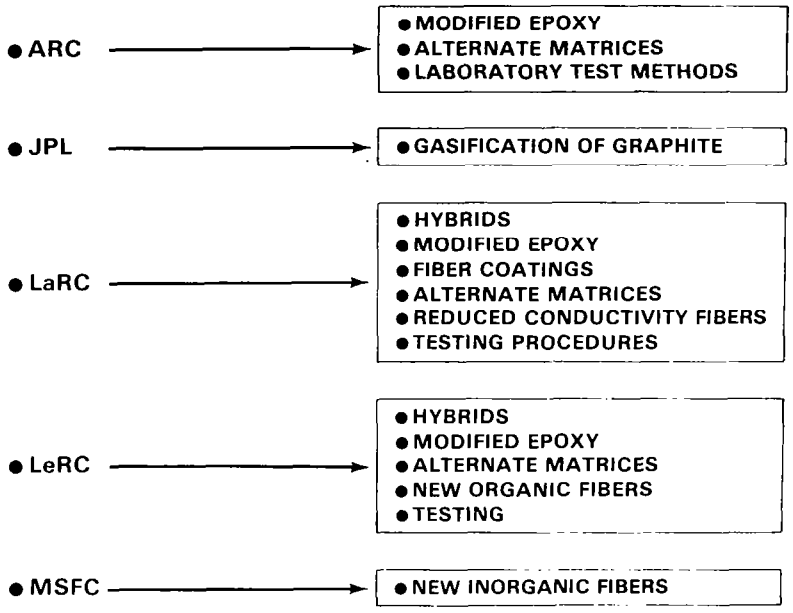

Figure 7

and university contracts. In addition, we have a program which involves all five Centers and is searching for longer term solutions which might use different materials. These latter approaches inherently have a longer lead time and might provide new materials with different structural performance, as well as alleviation of free graphite fibers.

In perspective then, the NASA roles are to quantify the risk with respect to the commercial aircraft use of composites and at the same time to find methods of modifying the materials so that the problem is not inherent with their use. But there is a further perspective, since by and large the development of composites and their early industrial utilization were fostered by government participation, particularly by the DOD and NASA. Our obligation transcends the limited view of aerospace. A way of envisioning this is shown in figure 8, which is a forecast of the potential market for advanced composite materials. When first used, aerospace, particularly DOD, applications clearly predominated. In contrast, sporting goods clearly make up the larger part of the current market. In the future, there will be an interim period in which aircraft applications may again become predominant, but in the long run, non-aerospace applications will vastly exceed their use in aerospace. So we need to leave a legacy of knowledge that assures the user that he

PREDICTED USE OF CARBON FIBERS

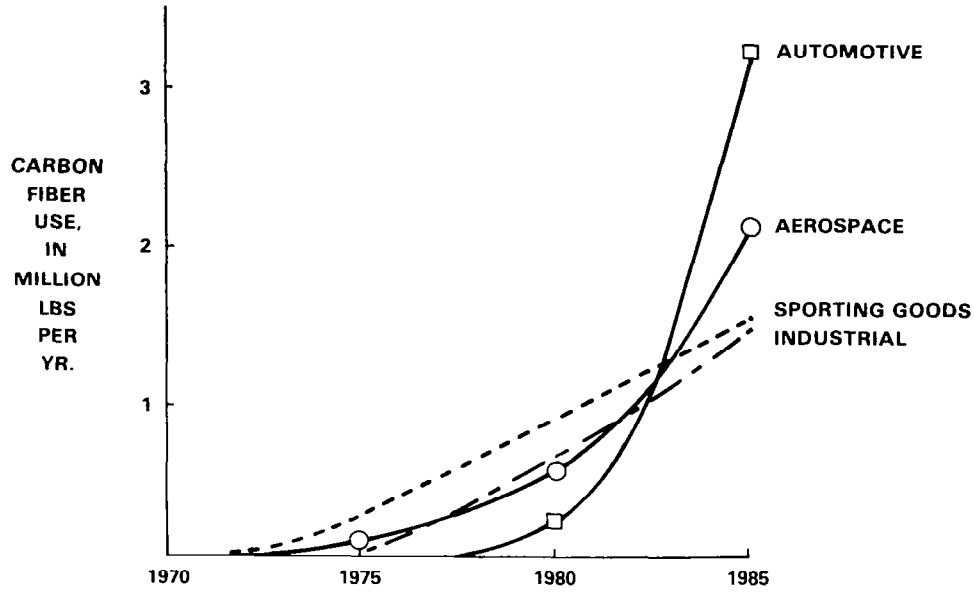

Figure 8

can use the material, that it has a benefit that is substantial, and that the risk is low in utilization of the material. In perspective, this legacy is what this meeting is about.