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MAKING AEROSPACE TECHNOLOGY WORK FOR THE AUTOMOTIVE INDUSTRY - INTRODUCTION

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ABSTRACT

The paper introduces a session that reviews some NASA-derived technology that may be useful in the automotive industry. Several examples in the paper illustrate aerospace technology already at work in that industry. Services offered by NASA to facilitate access to its technology are described.

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THE SESSION "MAKING AEROSPACE TECHNOLOGY WORK for the Automotive Industry" is motivated by an important objective of the National Aeronautics and Space Administration - to ensure maximum value from national aerospace activities.

At its present level of $4 billion per year, the aerospace program is less than a penny out of the Federal budget dollar, but it is a substantial part of the $26 billion that the Federal Government invests annually in research and technology. Federal expenditures for research and technology are more than half of the national total. Thus, it is important that the Nation use the results of all these expenditures as effectively as possible.

The premise underlying the session is that advances made in one technical field can contribute to other fields. Anyone can immediately think of his own examples. For instance, space exploration was made possible by the development of rocket propulsion, the computer, and miniaturized electronics. To continue the example, modern rocket propulsion evolved from rockets developed for military purposes, and it traces its antecedents to Chinese pyrotechnics. But along the way development of rocket propulsion has both advanced and helped create turbopump technology, modern metallurgy, digital control systems, new understanding in fluid mechanics and thermodynamics, and more.

Based on this premise, subjects believed to have relevance and potential usefulness to the automotive industry have been selected from contemporary NASA programs and projects for this session.

NASA's total program is annually authorized by act of Congress, with inputs from NASA; other agencies of government, federal, state, and local; industry; scientific and engineering academies and societies; and other organizations and individuals. Execution of the program is largely conducted through nine major field centers, each with its own technical orientation, or mission; for example, space launches at Kennedy Space Center, scientific satellites and tracking networks at Goddard Space Flight Center, propulsion and power technology at Lewis Research Center, to mention a few.

NASA's program has several major components. One is space exploration, in which new knowledge is being acquired from the laboratory of space itself. This new knowledge is about the physics of the earth-sun environment, about the moon and planets, and about the stars and galaxies themselves with observations across the spectrum unobscured by atmosphere.

A second major component comprises the new services from earth satellites: vastly improved communications, weather data, aid to navigation, and earth observations useful to agriculture, forestry, mining, water management, transportation, urban development, pollution control, geodesy, and mapping.

A third major component in the NASA program is development of aeronautical technology through research and experimental engines to demonstrate the technology.

Also, behind the obvious space speculations and advances for aircraft is a fourth major component, the large body of research and technology both to support current activities and to make future options possible.

Finally, NASA has an objective of disseminating the findings and results of its work as widely as practicable. Some of the technology generated by or for NASA has transferred to other than aerospace activities easily and on its own. But NASA also works at overcoming inherent barriers to communicating technical information between fields, especially when that information is so profuse, so fragmented, and so isolated from potential users by company, by industry, by geography, and by other factors, such as the form in which it appears.

While it is always difficult to pinpoint all of the roots of a technical achievement, there are hundreds of instances in which new ideas or information, new inventions or devices, new methods or techniques from aerospace have flowed into such diverse activities as communications, weather services, transportation, health services, food production and processing, education, electric utilities, petroleum and gas, construction, manufacturing, and consumer goods. Here are some examples from the automotive industry:

- Electronics design, computer systems, and quality control experience gained by an automobile manufacturer managing the facility for the Saturn I/IB systems development at Huntsville, Alabama has been used by that manufacturer to develop both new products and new methods of production line testing for most of its cars and trucks.
- A combustion analysis computer program developed by NASA's Lewis Research Center has been used extensively for automotive engine research and development since 1970.

- An infrared scanner and television display developed for the Marshall Center was converted into a commercial scanner and is regularly used by a tire manufacturer to analyze tire designs and performance, and also to investigate how heat shortens service life for V-belts, shock mounts, brakes, and rubber bearings.
- Exhaust gas analyzers that provide automated testing for production quality control, trouble shooting, and state and federal emissions certification have derived from hazardous gas analyzers developed from Saturn rockets.
- A device for suppressing noise propagated through ducts is being evaluated by a manufacturer of truck mufflers as a way of meeting future truck noise levels.
- A \$10 000 test vehicle designed to measure airport runway skid resistance is providing required measurements for highway skid resistance on an equivalent basis with commercial skid testers costing \$60 000 to \$200 000.

And one could go on listing developments and spin-offs in production processes, design methods, data management systems, materials technology, reliability and safety, and highway improvements that have transferred from aerospace to automotive uses. It is hoped that this session will encourage further technology transfer.

The general subjects of this session include a structural analysis computer program called NASTRAN developed by NASA for use on spacecraft and launch vehicle designs. The program, and variants of it, has had wide application: oil refineries, nuclear plants, buildings, aircraft, ships, rail cars, trucks, tractors, automobiles, - even roller coasters. The rest of the subjects relate to engine research and development. That is not a bias, of this session organizer, who comes from the Lewis Research Center, but rather reflects the national needs of reducing both highway vehicle fuel consumption and air pollution.

A word about the Lewis Research Center in Cleveland, NASA's center for propulsion and power research, might be useful. At present it is a 350-acre complex of laboratories and environmental test facilities (altitude chambers, wind tunnels) with a 3000-person staff. Opened in 1942 as a laboratory of the National Advisory Committee for Aeronautics, the Center contributed to fuels technology, supercharging, and engine cooling during World War II. From immediately after that war, the Center conducted research and advanced technology on aircraft gas turbines, jets, props, and fans. Every United States turbine flying today - and they comprise about 80 percent of the world's commercial fleet - bears some mark of Lewis' work. Aircraft propulsion systems currently comprises about half of the work of the Center.

Lewis work in space propulsion, dating from experiments with high energy liquid propellants in the late 1940's, helped create the capabilities for the rewarding venture into space; that work, including Centaur, the first hydrogen-fueled rocket, and electric rockets, continues, along with work on space power systems such as fuel cells, batteries, solar cells, and small gas turbines.

And increasingly, the facilities, experience, and capabilities at Lewis are being brought to bear on terrestrial problems, for example, management of projects for the Department of Energy on assessment of power generation cycles for central electric power generating stations and cogeneration, large wind turbine-generators, and solar cell tests and applications.

Recently, the Lewis Research Center was asked by the Department of Energy to manage projects for alternative propulsion systems for highway vehicles. These projects are part of a broad Department of Energy program aimed at reducing highway vehicle fuel consumption and broadening the fuel options for such vehicles.

One of these projects is directed at advancing technology so that a gas turbine engine and a Stirling engine might each become a possible alternative to the conventional spark ignition engine. Implementation will be through a joint effort between the United States government and the U.S. automotive industry. Goals include providing the requisite technology base within the industry by 1983 for the gas turbine and by 1984 for the Stirling engine to permit a decision by the automotive industry to enter into production development of an improved version of such an engine. Further, enough technology should be in hand then to allow a programmatic decision on whether to pursue a more advanced version of either engine; a more advanced version would incorporate significant advances in technology and would offer major improvements in several system performance indices such as fuel economy, driveability, alternative fuels, low emissions, cost, and marketability.

The second project is for electric and hybrid vehicle propulsion systems. The objective is to develop and demonstrate the overall propulsion systems technology required to provide electric and hybrid vehicles with the performance life cycle, and operating costs required for broad public acceptance. Included within this project is an effort to provide performance data and improvements for existing commercial components in the next two years both to support the industry and to be a base from which to measure improvements. Also, the project is to develop and demonstrate advanced components and propulsion systems by late 1983 and to provide fully developed components and systems based on new propulsion concepts by late 1986.

Specific choice of content for the session today was guided by correspondence and consultation with technical representatives of the automotive industry. In particular, a working group assembled by Emmett E. Hixon, Hercules, Incorporated, discussed and rated for possible interest to automotive engineers 15 different technical topics suggested by NASA as possible presentations. The group included Harold N. Bogart, Director, Manufacturing Engineering and Technical Systems Office, Ford Motor Co., Robert G. DeGrazia, Manager, Rubber and Plastics Dept., Crysler Corporation, Jerry J. Harvey, Superintendent, Industrial Engineering, Chevrolet Pressed Metals Division, General Motors Corporation, and Aaron D. Rosenstein, Supervisor, Advance Materials, Rubber and Plastics Department, Chrysler Corporation. We are grateful to them for their helpful advice.

The session papers include one on the use of NASA technology, especially NASTRAN and fracture mechanics, by engineers of Eaton Corporation to improve fatigue life for truck axles, and a presentation on the current and future content of the NASTRAN Computer program by the NASA manager of the NASTRAN systems office. "Technology for Gas Turbines", "Instrumentation for Propulsion Systems Development", and "Bearing, Gearing, and Lubrication Technology", all from the Lewis Center, comprise the rest of the session.

The Department of Energy studies managed by NASA on gas turbine, Stirling, and electric propulsion technologies for highway vehicles are too new for thorough reporting yet. But the gas turbine paper in this session is an overview that depicts the technology from aerospace that can assist the development of the automotive gas turbine engine.

It is, of course, impossible to predict exactly what item of technology an engineer will need at any instant. So rather than attempt to convey transferrable technology all "packaged up", the session is intended to convey an impression of the kinds of technical information available from NASA programs. Potential users are invited to acquire it.

To facilitate access to its technology, NASA operates a Technology Utilization program.

There are a number of services offered in this program.

NASA Tech Briefs is a quarterly publication available free to any U.S. citizen or organization. Its one-page descriptions of new technology cover potential products, fabrication processes, lab and shop techniques, electronic circuits, computer programs, and technical data, and are categorized and indexed to make a useful current-awareness document.

Technical support packages that more fully describe a Tech Brief subject when necessary are available on request.

NASA sponsors six Industrial Applications Centers (Table I). These Centers have access to some 2 million documents in many major data banks, and offer clients such specialized services as literature searches, custom-designed current-awareness abstracts, evaluation and applications of literature search results, and consultation with NASA field centers.

An extensive library of computer programs is available through the Computer Softwear and Information Center (COSMIC), Suite 112, Barrow Hall, University of Georgia, Athens, GA 30602. COSMIC staff will help customers identify their computer softwear needs, follows up to determine successes and problems, and provides updates and corrections. Charges are nominal.

A Technology Utilization Officer at each NASA field center will assist you directly (Table II) when necessary.

NASA inventions that have been patented are available for licensing in the United States, both exclusively and non-exclusively. The Patent Counsel at the NASA field center that sponsored the invention can advise and assist on patent status and licensing.

Thousands of spinoffs of NASA research to virtually every area on the economy attest to the successful workability of this 15-year-old program. Try it.

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