# LEWIS'S ROLE IN SUPPORT OF NASA MISSIONS

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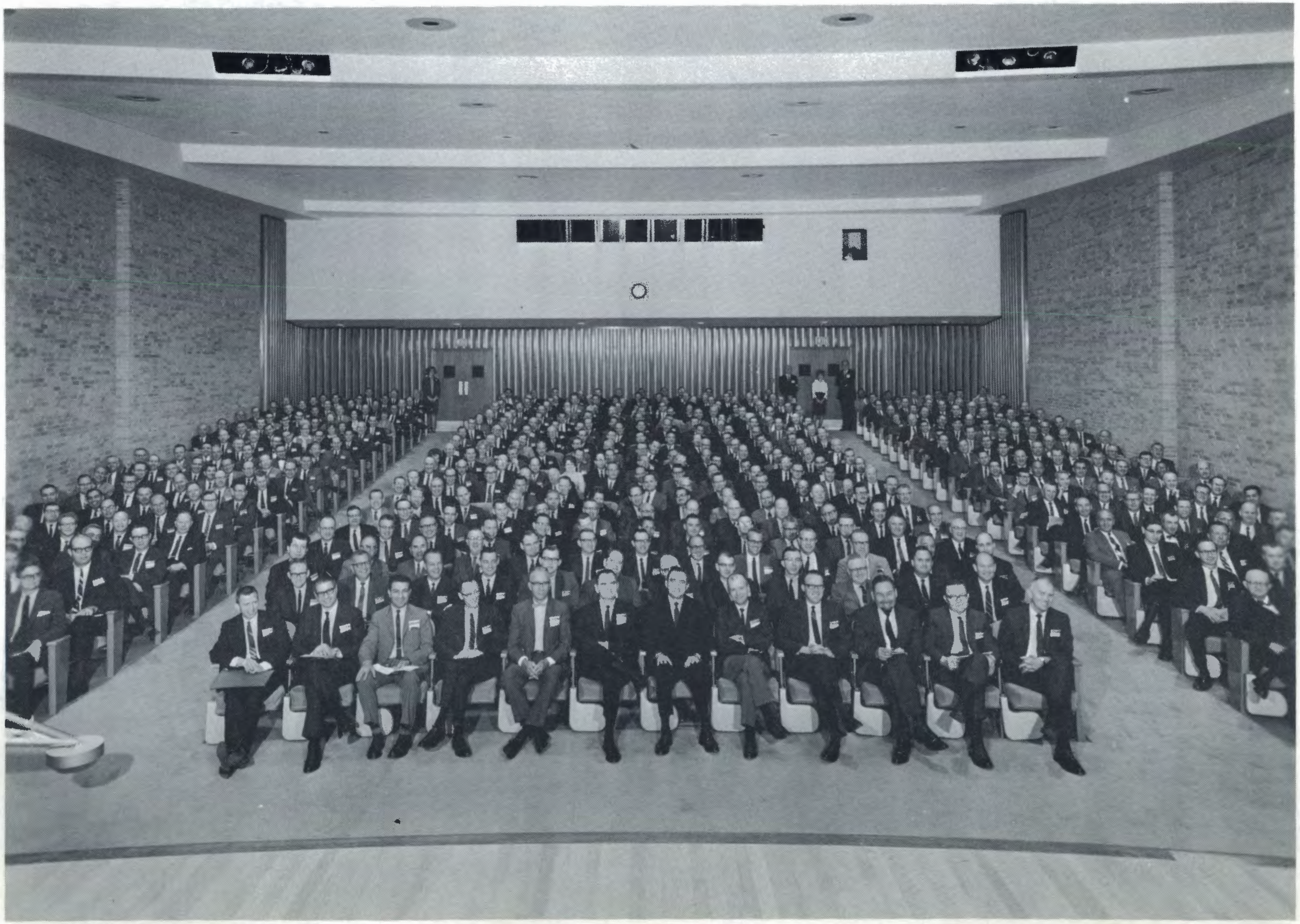

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The last inspection of the Lewis Research Center was held in October, 1957. To state it somewhat mildly, a few changes have occurred in the intervening nine years.

We were then a part of NACA, the National Advisory Committee for Aeronautics, which had been created in 1915 with responsibility for "investigating the problems of flight with a view to their practical solutions." Our part of the overall mission was the powerplant or propulsion end of the business. It was our job to conduct research on materials, fuels, components, and overall systems leading to improvements in performance and efficiency of engines so that aircraft would fly higher, faster, and farther.

At the 1957 Inspection, we discussed our work relating to turbojet engines for flight up to three, and possibly four times the speed of sound, and ramjet engines for flight up to seven times the speed of sound. We also reviewed our research on high-energy chemical rocket engines, which then were aimed at ballistic missile application. We described our efforts on aircraft nuclear propulsion and, in a very minor key, we discussed and demonstrated operation of an electric propulsion device for space application.

On this last item there hangs a tale which, in retrospect, is somewhat amusing or embarrassing, depending on your viewpoint. For several years prior to 1957, NACA had a very small exploratory effort on space flight, primarily of a study nature. This effort was not publicized because space was not then quite a respectable word and we were rather hesitant about including even a mention of it in our Inspection for fear that taxpayers might object to having even a few of their dollars spent on science fiction. Well, the Russians orbited Sputnik I just three days prior to our Inspection which, although alleviating our concern about mentioning space propulsion, certainly did nothing for our pride.

You are familiar with the succeeding events. After a year of private and public debate, NASA was established with NACA as a nucleus. Shortly, the Jet Propulsion Laboratory came aboard as a contract operation, Marshall Space Flight Center was transferred in from Army Ordnance, and, over a period of time, additional Centers were established.

The resulting NASA record of space flight accomplishments is well known and requires no embellishment here; let me continue, however, with a broad-brush review of the Lewis Center's role in the NASA overall picture.

During the first few years of NASA, research was maintained separate from development operations. The former NACA Centers, Langley, Ames, Flight Research, and Lewis, were assigned the advanced research and technology responsibility and the other Centers were given the responsibility for hardware development and the immediate space flight operations or missions. The contributions of advanced research and technology to the overall NASA mission divide into two parts. First, there is the direct support and benefits to current flight projects and to the nation which flow from the reservoir of understanding and competence achieved through research; second, there is the laying of a technology base and groundwork to provide the options or choices for future aerospace missions. Our part of the advanced research and technology area is propulsion and power generation, or essentially a continuation and extension of our traditional or historical powerplant activities. In a manner of speaking, we merely raised the altitude limits of our investigations; however, it was, of course, an order of magnitude or quantum jump rather than a mere percentage increase in altitude. Furthermore, because of the then advanced state of the art of the aircraft propulsion research business combined with the national necessity for moving rapidly in the space program, we directed the major portion of our energies to space with a concomitant reduction in our efforts on aeronautics.

The original early decision to separate research from development was based on concern for protecting research from the deemphasis and erosion that it was believed would inevitably result from direct competition with the urgent and rigid time schedules of flight programs. However, with the rapid buildup and multiplication of space projects, it soon became desirable, if not necessary, to utilize the technical and management capabilities of the research centers for handling some of the development activities. Hence, starting in 1961, we and our sister research centers were given responsibility for a variety of development projects appropriate to our talents and areas of competence. Currently, then, the NASA field centers rather than being either exclusively research or exclusively development are either predominantly research or predominantly development, that is, rather than black or white they are light or dark grey.

Next, a few words about the organizational and programmatic relations of the field centers in the overall NASA structure. NASA Headquarters is organized into three major program offices: Manned Space Flight, Space Science and Applications, and Advanced Research and Technology. Each field center reports administratively to one of these program offices, but performs work under cognizance of any or all of the offices. For example, a substantial share of our efforts are devoted to support of the programs of the Office of Space Science and Applications in addition to our principal activities for the Office of Advanced Research and Technology to whom we report administratively. Our sister centers operate in a correspondingly multiple program mode.

But just what does Lewis do specifically? During today's inspection, we will attempt to answer this question by reviewing some of the work we have in progress and are planning in our various areas of interest. A brief introductory discussion, at this time, may provide background and a framework of reference to help you understand and associate the various researches, facilities, and techniques you will see during your tour.

The chemical rocket has been and continues to be the workhorse propulsion system for space operations. Our early work with hydrogen fuel provided much of the technology which led to the successful development of several currently operational upper stage engines - the RL-10 engine used in Centaur and the top stage of Saturn 1 and the J-2 engine used in several stages of the Saturn 1B and Saturn V vehicles. We have continued our researches with hydrogen-oxygen, hydrogen-fluorine, Flox, and other high-energy propellants to improve rocket performance and combustion stability. In addition to in-house effort, we have been managing a considerable amount of contractor effort, not the least of which is the M-1, a $1\frac{1}{2}$ million-pound-thrust hydrogen-oxygen engine. Another facet of our contractor work is the 260-inch solid rocket program, which is exploring the technology problems of the large solid boosters that could provide low-cost basement stages for the next generation of large launch vehicles. We will discuss the status of these chemical rocket projects and researches at our Propulsion Systems Facility.

I mentioned earlier the demonstration of a primitive electric propulsion device at our 1957 Inspection. This type of propulsion, because of its high thrust efficiency or low propellant consumption, is a potential contender for the large impulse requirements of the ambitious space exploration missions of the future. It also offers promise for providing efficient minute thrust for satellite attitude control and station keeping duty.

We have expended substantial effort in electric thrustor research and have made considerable progress since our initial experiments some nine years ago. We will review this work and show you two of the large vacuum tanks utilized in its conduct at our Electric Propulsion Laboratory.

In the power generation area, we do work in both direct energy conversion devices such as batteries, fuel cells, solar cells, and thermionics, and in indirect conversion or dynamic systems where electricity is generated by rotating machines using a mechanical power cycle such as the Rankine or Brayton cycle. We concern ourselves with low-power systems ranging from a few watts to tens of kilowatts for on-board auxiliary power and with high or megawatt power ranges for supplying the requirements of primary electric propulsion. Chemical, solar, and nuclear energy sources are involved in some or all of the systems. We will devote two of the tour stops to a review of this field. Some of the associated experimental facilities which you will see are nostalgically and economically interesting in that they have gone through several metamorphoses since their original use for reciprocating engine research many years ago.

The areas of work I have outlined so far involved both in-house and contract effort, and they also include a number of development-type projects. These later are oriented toward the development of technology rather than specific end-point hardware. We are, however, also engaged in several specific hardware development and engineering-procurement projects, which, incidentally, represent the largest portion of our development activity, both in manpower and dollars. These are the Atlas-Centaur and the Atlas- and Thor-Agena launch vehicles, which we will discuss at our new Zero Gravity Facility along with a review of our investigations of some propellant problems in space.

I mentioned the reduction of our aircraft propulsion research to a relatively low level during the early years of NASA. Reversing this trend during the past year and a half, we have increased our activity in aeronautics and have rapidly rebuilt a substantial research effort in support of advanced airbreathing engine systems. We have refurbished and modernized some of our facilities for doing this type of work and are designing additional facilities to enhance our capabilities. We will describe some of this activity at the 10- by 10-Foot Supersonic Wind Tunnel stop. In addition, we will demonstrate our very recently reinstituted work on the jet engine noise problem at our Hangar stop.

As you are well aware, the performance of our propulsion and power generation systems, launch vehicles, spacecraft, and indeed practically all hardware is paced by physical limitations of available materials. Over the years we have maintained a substantial materials research effort to raise these limitations and hence to improve component and system performance. We will discuss some of our current efforts in this field at our Materials Processing Laboratory stop.

Most of what you will hear and see today is applied, or engineering, research and/or actual hardware development. We do, however, also carry on an extensive fundamental, or basic, research program in a number of disciplines appropriate to our propulsion and power generation interests, e.g., nuclear physics, physics of solids, plasma physics, chemical kinetics, etc. We will review some of this basic research at our Energy Conversion Laboratory.

Today we are showing you as large and representative a sample of our work and facilities as permitted by time, distance, and operational limitations. In an attempt to overcome, or extend in part, these limitations, we are also augmenting the primary technical presentations with two ancillary techniques. One is the use of static exhibits, which you will have opportunity to inspect at several appropriate locations. Included in these exhibits are various hardware items and models of manned and unmanned spacecraft which represent some of the responsibilities and accomplishments of our NASA sister centers. Most of them are also directly related to Lewis efforts, e.g., many of the spacecraft on exhibit were lofted into space by launch vehicles under our management. The other technique we will use is the showing of motion pictures of areas you will not be able to visit today. The first film sequence provides a quick look at our Plum Brook Station, located in the Sandusky area 50 miles from here, where we have our nuclear reactor facility and a variety of chemical and nuclear rocket component and system test stands. The second sequence takes us a little farther away to the Nuclear Rocket Development Station at Jackass Flats, Nevada, which is managed by the joint AEC-NASA Space Nuclear Propulsion Office. This office maintains a branch here in Cleveland which, although separate from Lewis management responsibility, receives substantial direct administrative and technical support from us.

We hope that today's inspection will prove interesting and profitable to you. We appreciate this opportunity to show you our laboratory and we will welcome any comments or suggestions you may care to send us after your visit.

And now for the film, or illustrated report as it is listed on your schedule.

Motion pictures:

"Research at the Plum Brook Station." Lewis Research Center Film MPD-851. 16 min, color, sound.

"Test Operations at the Nuclear Development Station." Space Nuclear Propulsion Office, Nuclear Rocket Development Station, P.O. Box 1, Jackass Flats, Nevada 89026.