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#### *About the Institute*

The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.

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# research review

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## THE EFFECT OF AERODYNAMIC CONTROL SURFACES ON HIGH-SPEED VEHICLES

MAJOR JOHN P. THOMAS, Hypersonic Research Laboratory, ARL

A study of the effect of aerodynamic control surfaces on hypersonic vehicles has been in progress for some time at ARL. The investigation encompasses various shaped fins on a blunt flat plate. Figure 1 shows the experimental test model. The fins as well as the blunt flat plate were tested at different angles. Chordwise pressure distributions were recorded on the surface of the blunt flat plate for the various configurations. An analytical approach to the same problem was conceived, and its results were compared to the results of the experimental work.

The need for this type of study becomes apparent when one realizes that the next generation of re-entry vehicles, HL-10, SV-5, and scramjet, are lifting configurations with aerodynamic control surfaces for guidance in the earth's atmosphere. Figure 2 gives an artist's conception of such a vehicle. In addition, before too long, the USAF will be flying aircraft at hypersonic speeds. With these two important advancements in flying vehicles just over the horizon, a study of the flow patterns, pressure distributions, and heating on the vehicles caused by the movement of control surfaces assumes great

significance for the aerospace engineers and scientists.

Problems are encountered in the hypersonic speed range which have not affected vehicles flying at slower speeds. Some of the minor problems which are present at lower speeds become magnified as the vehicle increases its flight velocity. One of the problems which becomes more pronounced at hypersonic speeds is the separation of the flow about the vehicle due to adverse pressure gradients caused by shocks in the flow field. If the position and magnitude of the adverse pressure gradient may be estimated, then the effect on the over-all vehicle performance can be approximated. The present study was undertaken to examine the possibility of predicting the pressure gradients caused by control surfaces as well as to gain experimental data needed by the designer.

The experimental work was accomplished in one of ARL's 4-inch hypersonic wind tunnels. Four different fins were tested on a blunt flat plate. The fin yaw angle and plate angle of attack were varied during the testing. Pressures at the surface of the flat plate were mapped for some distance on either side of the fin and from the leading to the trailing

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