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4.2 Propeller Blockage Research Needs

R. R. Tumlinson
Beech Aircraft Corp.

If the general aviation industry is to produce the most efficient airplanes, it is important that the best technical tools which can be economically used be employed. That is the business of this workshop. One of the technical tools that is needed and which is currently not available is a means to accurately determine propeller blockage.

Propeller blockage refers to the effect of mutual propeller-nacelle or fuselage interference on the propulsive efficiency. The interference of the body on the propeller arises from the retardation of the airflow through the propeller disk and the resulting change in advance ratios. The interference of the propeller on the body stems from additional drag on the body because of the slipstream effect on local pressure and boundary layer. This effect has been understood for many years, and there are many reports in the literature. In the interest of brevity, the present body of information will not be explored in this presentation except for the bibliography included and to note the important parameters of advance ratio, body shape, and the propeller-diameter-body-diameter ratio.

However, while the sources of the propeller body interference have been understood for some time, the experimental data available to allow accurate estimation is long out of date. Current configurations with horizontally opposed engines outdate the data available which was determined with radial engine and in-line engine configurations as well as RAF -6 and Clark -Y propeller blades.

Performance data provided by propeller manufacturers is either provided on the basis of an isolated propeller, or at best, with approximate correction factors based on experimental data on data of 20-year old configurations. The most recent propeller efficiency computer program compiled by Hamilton Standard under NASA contract (References 8 and 9) provide only isolated propeller information. This view is understandable for a propeller manufacturer; but for the airframe manufacturer, an important gap remains.

Current information is needed to provide a basis to determine accurate drag levels from flight-test data. The drag determined from flight can be only as accurate as the installed power basis. Improvement over the presently available data would also provide an improvement in accurately estimating installed thrust and drag and the resulting aircraft performance. Finally, improvement would provide a rational basis to determine an accurate trade off between net propeller thrust and body drag in determining new configurations.

So, specifically, what is needed? First, a current body of empirical data is needed which covers the important parameters -- on current configurations with asymmetric shapes. Second, a mathematical model of this data with current computational fluid mechanism techniques is needed to provide a way to easily generalize data for specific cases.

Test programs could be conducted in a large-scale wind tunnel where thrust and drag can be accurately separated. As an alternate, flight test programs could also be used with special engine-propeller installations so that independent determination of installed thrust can be made. One such program has been proposed utilizing a separately driven propeller in the nose of a twin-engine airplane. With different nose body shapes and separately determined thrust, propeller-body interference effects could be determined. Perhaps a by-product of a flight test program would be a practical thrust-meter. This may be a little wishful thinking, but these recommendations for large-scale wind-tunnel tests and flight tests were proven practical by the testing performed many years ago on the obsolete configurations. So it is felt that these can be improved upon today, and I hope that such a program will be seriously considered.

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