OVERVIEW OF NASA CTOL PROGRAM

James J. Kramer
NASA Headquarters

It is a pleasure to be here today to help kick off this Conference on CTOL Transport Technology. I commissioned this activity to provide a forum for early dissemination of the new technologies being generated by NASA, both in-house and under contract to industry, specifically oriented toward advanced commercial air transports. The program has been laid out to bring you the latest results in our Aircraft Energy Efficiency (ACEE) program and in related disciplinary areas.

Before getting on with the technical papers and discussions, I would like to put our CTOL efforts into perspective relative to the total NASA aeronautics program. The prismlike chart shown in figure 1 breaks the aeronautics program by our budget categories on the left and by vehicle specific categories on the right. Our R&T Base activities are designed to maintain a strong research base in the technology disciplines. These activities are basic and exploratory in nature and, in CTOL, are characterized by the disciplinary papers which will be presented at the end of each of the sessions of this conference.

When ideas and concepts in the R&T Base reach a state of maturity and are ready for more focused activity, Systems Technology and Experimental Programs are employed to bring the technologies to a state of readiness where they can be applied in the commercial sector. In CTOL, the Aircraft Energy Efficiency programs are in these categories.

Although the R&T Base, Systems Technology, and Experimental Programs categories are useful for budget purposes, we find it more effective to think of the aeronautics program along eight vehicle-specific lines with a backdrop of generic research and technology activity. There are some obvious difficulties in categorizing some technology efforts along rigid vehicle types. In some efforts there is substantial fallout from one category to another, particularly from CTOL to General Aviation. However, we try very conscientiously to identify which of the vehicle types benefit primarily from our various technology efforts.

Looking at the aeronautics budget as a whole in figure 2, the pie charts show how our total R&T program of $228 million in FY 1978 is divided — on the left by budget category and on the right by the various vehicle-specific types. The R&T Base represents about 40 percent of our total aeronautics program; Systems Technology programs about 30 percent; and Experimental Programs 25 percent, with a small continuing effort devoted to Systems Studies. By vehicle-specific categories, CTOL efforts represent nearly 50 percent of our total aeronautics dollar investment. The balance is split, as shown, among the other categories from General Aviation to Supersonic Cruise Aircraft Research

(SCA), with Generic R&T being the second largest category. The CTOL share will remain a significant part of our budget for the foreseeable future as the ACEE program reaches its funding peak and as we continue to identify new technology advancements for this major segment of the air transportation system.

Figure 3 delineates the CTOL FY 1978 funding by the budget categories. Whereas the overall aeronautics program contains 40 percent R&T Base activities, CTOL contains only about 15 percent R&T Base. This is not because of a lesser interest in CTOL-related basic activities but because of the large funding requirements of most of the ACEE focused elements, which are all in the Systems Technology and Experimental Programs categories. The ACEE programs currently represent nearly 70 percent of the CTOL budget.

The CTOL program disciplines around which this conference has been structured are

Propulsion
Materials and Structures
Aerodynamics and Active Controls
Safety and Operating Systems

Figure 4 splits the FY 1978 CTOL activities by these discipline areas in terms of funding and personnel. To support the expenditure of over $100 million in CTOL, NASA has over 1000 in-house direct personnel assigned. Nearly half of these people are working on aerodynamics and controls, so that when the salaries and overhead associated with the in-house staff are included in the total resource expenditures, there is a fairly even balance among the three largest disciplinary areas.

Since a large part of this conference is devoted to the ACEE program, I would like to spend a few minutes describing the process which was used to initiate this major program. Three years ago, the Senate Committee on Aeronautical and Space Sciences requested NASA to establish a special program to develop technology for more energy-efficient aircraft. The Senate letter stressed the importance of a program which would facilitate the technology transfer process and recommended that the plan be developed in consultation with industry. The objective was to make technically possible a new generation of fuel-efficient aircraft which could be flying in the 1980's.

NASA spent the next 7 months working closely with the major engine and airframe manufacturers, the airlines, other Government agencies, and universities to develop a comprehensive technical program plan for improved aircraft energy efficiency. Involvement of the industry both in the development of the plan and in the conduct of major portions of the research is necessary for assurance that the technology is reasonably likely to be implemented. It is also an important first step in the implementation process itself.

The plan was submitted to the Senate in September 1975. It called for the expenditure of additional resources of more than $600 million over 10 years for the aggressive development of aeronautical technology in the areas of propulsion, aerodynamics, and structures. The schedule and phasing of the six technology programs underway is shown in figure 5. Funding for FY 1976 was provided by reprogramming ongoing activities, and additional resource authority was provided in NASA's FY 1977 and 1978 budgets for the first phases of the program.

The ACEE program is directed at modest but significant improvements in the near term, considerably greater gains for the mid- to late 1980's, and still more ambitious advances for the 1990's.

In propulsion, the near-term concentration is on engine component improvement, both to reduce the fuel consumption of current engines and to identify methods to minimize the performance deterioration of current and future turbofan engines. The work is being carried out largely under contract by Pratt & Whitney and General Electric, with support by the transport aircraft manufacturers and the airlines.

For the mid- to late 1980's, the Energy Efficient Engine (E^3) program is under way with the two major U.S. manufacturers of commercial aircraft engines. The goal of this program is to provide the technology advancements which will permit a reduction in fuel consumption of 10 to 15 percent over current high-bypass engines, while simultaneously improving direct operating costs, emissions, and noise levels.

A program on advanced turboprop technology is included to establish a basis for potential 1990's aircraft powered by advanced turboprops which can operate at speeds and altitudes comparable with today's turbofan aircraft. An advanced turboprop propulsion system offers a minimum of 15 percent additional fuel savings over advanced turbofan engines with equivalent core technology. The efficiency goal appears to be achievable, but considerable research is still required to assure reliability and acceptably low external and internal noise levels and to develop a data base for optimized propeller design.

Advanced aerodynamic and active controls technology is being pursued in the Energy Efficient Transport program for application to both derivative and new aircraft, with technology readiness in the early to mid-1980's. The goal is up to 20 percent improvement in aerodynamic efficiency for new transport designs. The commercial air transport manufacturers are heavily involved in this activity, in efforts aimed to both derivative and next-generation transport aircraft.

Laminar Flow Control, which promises fuel savings of from 20 to 40 percent, is potentially the most productive of the fuel-conservative technologies. It is also the most future-oriented and highest-risk element of the ACEE program. We have a long way to go, but the potential payoff appears well worth it.

The remaining element is the Composite Primary Aircraft Structures program. Here too the approach is a step-by-step progression in size, weight, and complexity with time, with the technology expected to be proven for the smaller components in the early 1980's. The present emphasis is on the design, development, and extensive structural testing of three composite secondary structural components and three moderate-sized primary structures. Each of the three commercial transport companies is responsible for one of the secondary and one of the moderate-sized components, to ensure that a wide diversity of structural concepts is investigated and to facilitate subsequent implementation.

We have very recently modified the composites program to deal with the problem of the high electrical conductivity of free carbon/graphite fibers which might be released accidentally. The research is being expanded to assess fiber effects and protective techniques and to reduce the risk of fiber release. The structural evaluation, fabrication technology, and ground testing of full-scale components and large subcomponents will continue as planned. Flight-service testing of the new components is not contemplated at this time, and the development of a composite wing is being deferred until we understand better the potential electrical problem and its solution. Composite materials are considered to hold great promise for major weight, fuel, and cost savings in future transport aircraft, and we intend to pursue the research vigorously to successful completion.

It is clear that the ACEE technology advances will be maturing over a span of years, as is typical of research results in any high-technology field. In fact, we can expect continuing advances in aircraft energy efficiency even after the ACEE program itself is completed.

In closing I would like to stress that, in addition to providing a good mechanism for disseminating our technology results to the aviation community early, a Conference such as this, even possibly more importantly, provides an opportunity for the kind of dialogue with industry that we need to assure that our efforts are relevant. I hope the discussions here have produced a significant amount of such dialogue.

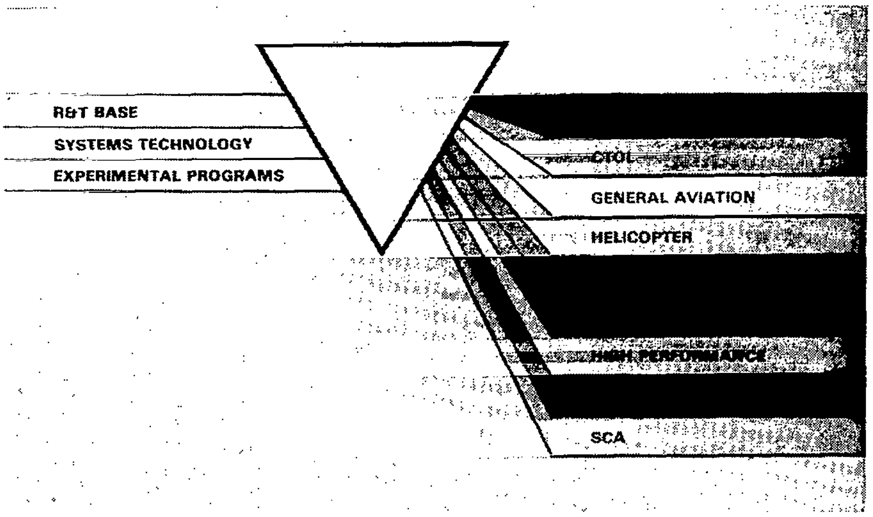

Figure 1.- Aeronautics program.

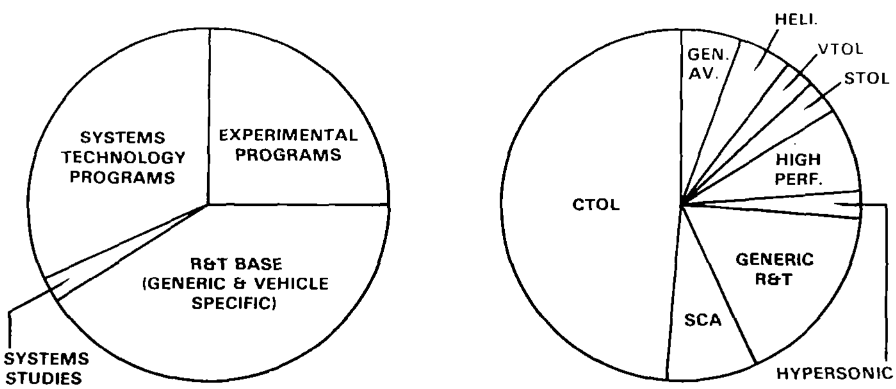

Figure 2.- Aeronautics R&T — 1978. Total R&T: $228 million.

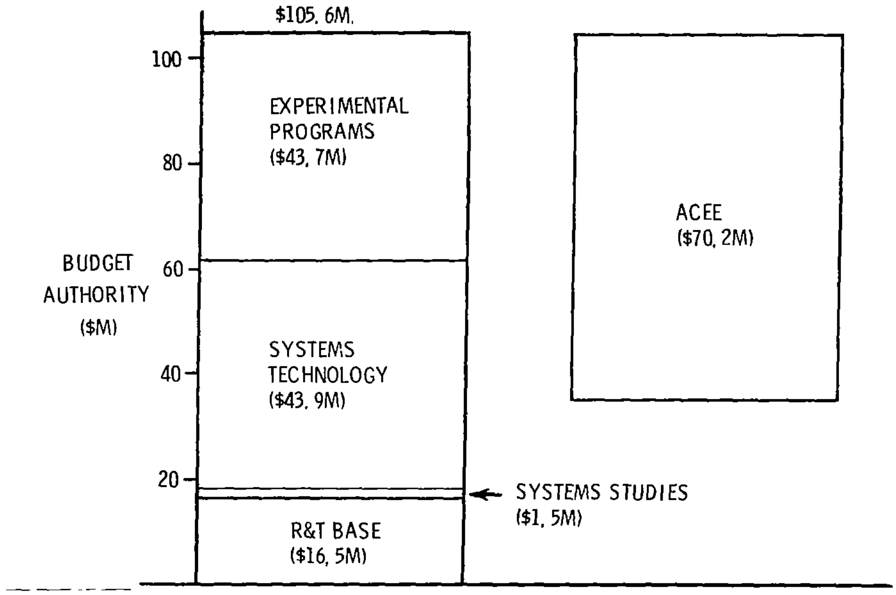

Figure 3.- CTOL budget — FY 1978.

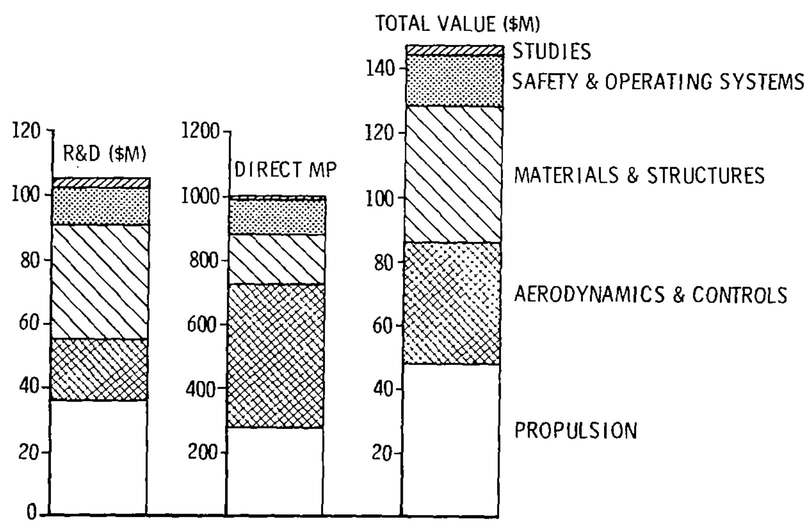

Figure 4.- FY 78 CTOL program by discipline.

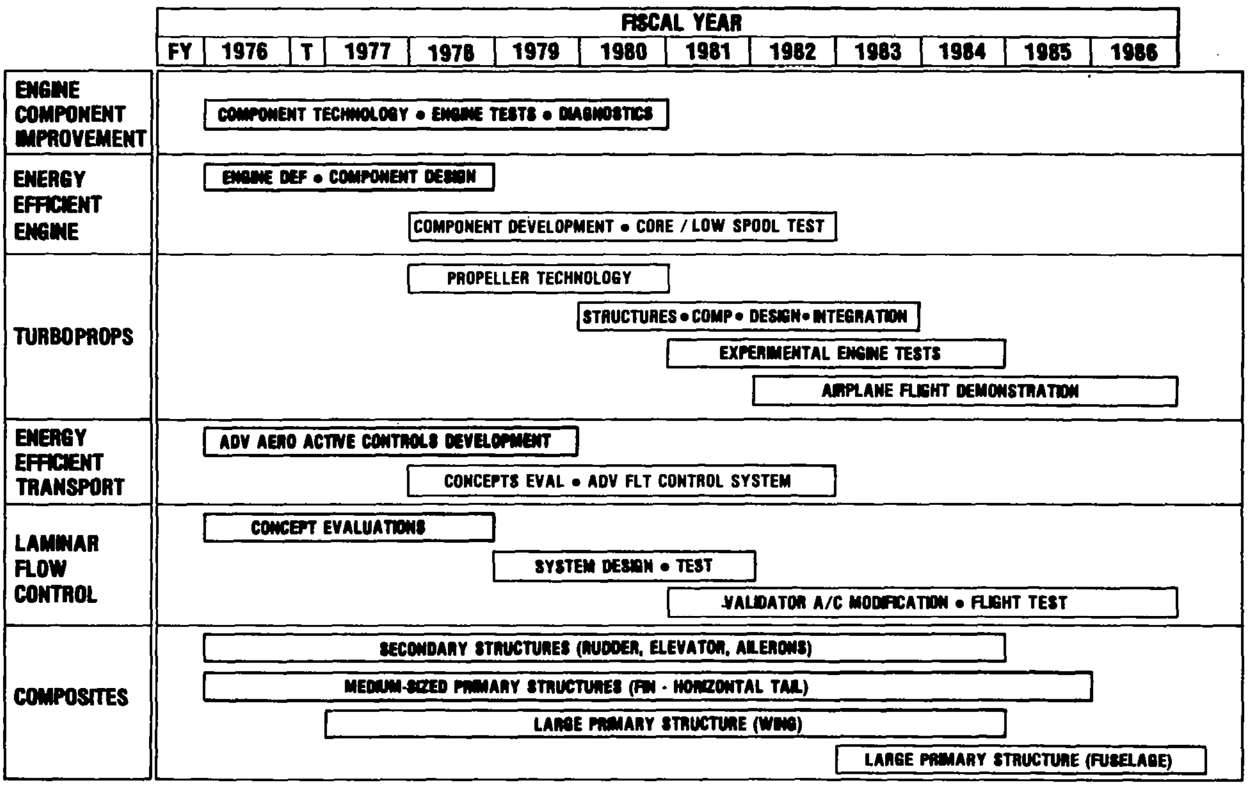

Figure 5.- Aircraft Energy Efficiency program.