

1989/1990  
AIAA/UNITED TECHNOLOGIES/PRATT & WHITNEY  
INDIVIDUAL STUDENT AIRCRAFT DESIGN COMPETITION

**I. PURPOSE**

The purpose of this competition is to stimulate interest in the conceptual phase of aircraft design and provide the individual student an opportunity for a design competition.

**II. ELIGIBILITY**

All student members of the American Institute of Aeronautics and Astronautics who are full-time undergraduate students are eligible to participate in this competition.

**III. PRIZES**

The prizes shall be: *First place-\$1,000; Second place-\$500; Third place-\$250*; with the awards for the students submitting the winning designs. Certificates will be presented to the students and the project advisor.

In addition to the monetary awards, copies of the top three design proposals will be forwarded to the corporate sponsor of the competition.

**IV. SCHEDULE**

Significant activities, dates and addresses for submission of proposal and related materials are as follows:

- A. Letter of Intent -- *March 15, 1990*
- B. Receipt of Proposal -- *June 8, 1990*
- C. Announcement of Winners -- *September 4, 1990*

Students intending to submit a proposal, must submit a letter of intent (Item A), with a maximum length of one page to be received with the attached form on or before the date specified above, at the following address:

Norman Ng  
AIAA Student Programs  
370 L'Enfant Promenade S.W.  
Washington, D.C. 20024-2518

The finished proposal must be submitted (postmarked) to the same address, on or before the date specified for the Receipt of Proposal (Item B).

## V. DATA TO BE SUBMITTED

1. Five copies of the design proposal must be submitted. Each copy of the proposal must be accompanied by a letter of transmittal signed by the individual and endorsed by a faculty advisor. The endorsement must attest to the eligibility of the student for the competition.

2. Design proposals that are used as part of organized classroom requirement are eligible and encouraged for competition.

3. Projects should be no more than 100 double-spaced typewritten pages (including graphs, drawings, photographs, and appendix) on 8.5" x 11.0" paper. Up to five of the 100 pages may be foldouts (11" x 22" max.).

4. A student may only submit one design proposal each year and that proposal must be an individual effort. Faculty guidance, through the classroom or individual instruction, is encouraged and must be carefully referenced or documented within the design proposal.

5. A conceptual design proposal, for the purpose of this competition, will be defined by the following requirements. These requirements are the *minimum* necessary and are not meant to restrict the innovative analyses and presentations. Emphasis should be placed upon a narrative justification of all methods and results.

- A. A final aircraft configuration must be presented. This configuration will include:
  - (1) Three-view drawings of the aircraft.
  - (2) Location of major equipment items (fuel cells, engines, landing gears, avionics bays, etc.)
  - (3) Airfoil nomenclature for lifting surfaces.
- B. A weight statement which includes the weight and c.g. location of each major component must be included.
- C. An aircraft lift and drag analysis will be required. The results will be presented graphically as total drag coefficient versus the aircraft lift coefficient.
- D. The propulsion system's fuel consumption and thrust data for important mission conditions in the flight regime must be presented. Propulsion installation losses should be discussed.
- E. A structural analysis of the wing spar/spars is required.
- F. The results of the three axes static stability and control analysis and a performance analysis is required.

- G. Parametric trade studies which analyze the significant design parameters, excluding cost, are necessary requirements to support the final selection of the design configuration.

#### IV. BASIS FOR JUDGING

1. *Technical Content (35 points)*

This concerns the correctness of theory, validity of reasoning used, apparent understanding and grasp of the subject, etc. Are all major factors considered and a reasonably accurate evaluation of these factors presented?

2. *Organization and Presentation (20 points)*

The description of the design as an instrument of communication is a strong factor on judging. Organization of written design, clarity, and inclusion of pertinent information are major factors.

3. *Originality (20 points)*

If possible, the design proposal should avoid standard textbook information, and possibly should show the independence of thinking or a fresh approach to the project. Does the method and treatment of the problem show imagination?

4. *Practical Application and Feasibility (25 points)*

The proposal should present conclusions or recommendations that are feasible and practical, and not merely lead the evaluators into further difficult or insolvable problems. Is the project realistic from a cost standpoint? Does the presentation include environmental impact studies (where applicable), and analysis of the function of the design in or for society?

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#### DESIGN OBJECTIVES AND REQUIREMENTS

##### REQUEST FOR PROPOSAL: AN ADANCED PACKAGE TRANSPORT

#### I. OPPORTUNITY DESCRIPTION

In spite of the rapid growth of facimile machine communications, the air package transport industry is continuing to grow. Some carriers saw the number of packages shipped per day increase by 25% to 30% in 1988, although growth of this industry is expected to slow to 10-12% per year between now and 1992. Expansion of the package transport industry (both within the US and in international markets), couples with replacement of the existing fleet, is creating the demand for an **Advanced Package Transport** aircraft.

The new aircraft must be compatible with existing and planned sorting hub locations, truck delivery systems and markets for overnight delivery within the U.S. In addition, there is a nearterm requirement to provide 2-day delivery service across a

network of worldwide locations. Next-day service to Tokyo and Hong Kong metropolitan areas is highly desirable.

## II. PROJECT OBJECTIVES

Aircraft design proposals for such an aircraft are sought. It would be an advantage to have an airplane or family of airplanes which would be capable of filling several different mission requirements. This would allow operator greater flexibility in handling the variability in peak delivery volume, and would help to hold indirect operating costs to a minimum.

## III. REQUIREMENTS AND CONSTRAINTS

The design of the aircraft should be based on a productivity analysis using the following missions:

*Mission 1:* An aircraft or fleet of aircraft which is capable of transporting 1.4 million cubic feet of cargo from Memphis to Los Angeles (1,400 n.mi.) per night.

*Mission 2:* An aircraft or fleet of aircraft which is capable of transporting 100,000 cubic feet of cargo from New York to Los Angeles (2,145 n.mi.) per night.

*Mission 3:* An aircraft or fleet of aircraft which is capable of transporting 35,000 cubic feet of cargo per night from Paris, R.F. to New York (3,150n.mi.).

A fleet of aircraft is referenced to allow flexibility in aircraft take-off gross weight in determining productivity trade studies.

All missions assume Boeing 85% Annual Winds and FAR Part 121 fuel reserves.

Airport field length shall be no greater than 7,000 ft. at max. take-off weight, pressure altitude 5,000 ft., ISA + 10°C.

Proposals should specifically address the following areas:

### 1. *Quite and safe operation:*

The aircraft must be certifiable to U.S. FAR Part 25, Airworthiness Standards; Part 36, Noise Standards (Stage III), and Parts 91 and 121, Operational Criteria as a minimum. Design analysis demonstrating that the aircraft can be certified under the BCAR's is desirable. Quantitative analysis of noise footprints for the proposal aircraft is not required. However, features of the aircraft design that are effective in reducing noise levels should be highlighted and discussed.

## 2. *Productivity:*

A quantitative measure of aircraft productivity shall be established and justified in the proposal. This productivity measure shall be used as the basis for design trade studies. Productivity should consider (at least ) payload revenue, direct operating costs, and indirect operating costs.

## 3. *Cargo*

Cargo volume should be matched to cargo weight capability at 10 lb./cu.ft. Ability to use existing ground equipment (loaders, nose docks, etc.) is desirable, but not mandatory. Aircraft tip-over analysis must address fully loaded containers in the most aft loading position.

An analysis of loading/unloading and ground servicing operations shall be included in the proposal. Both maximum payload and maximum fuel load cases shall be considered. Fuel and cargo loading can be performed simultaneously if the configuration allows this to be accomplished with safety. Flexibility to handle a wide range of standard cargo box sizes (refer to NAS 3610) is desirable. The aircraft must be compatible with the LD-11 cargo container.

Capability for safe handling of hazardous materials must also be shown.

## 4. *Crew and passenger services:*

Provisions should be made for automated galley to prepare catered food. Four or more jump seats are to be provided for non-paying passengers (e.g., airline employees). Easily accessible lavatory for crew and passengers is required. Provision must be made for storage of crew baggage.

## 5. *Mechanical dispatch reliability:*

The production aircraft should achieve mechanical dispatch reliability of 99.8% in operation. Numerical estimates of mechanical dispatch reliability will not be considered in evaluating the design proposals. However, design features that enhance reliability should be highlighted and discussed.

## 6. *Maintenance costs:*

Design features that make the aircraft simpler to maintain and/or reduce the time required for maintenance should also be highlighted and discussed. Features that will reduce cost of aircraft or engine spares should also be emphasized.

## 7. *Engines:*

Proven engines and spares commonality with aircraft already in the fleet are highly desirable. An engine deck will be provided.

**8. Weights:**

Container weights are significant and are to be specifically accounted for in the weight and balance analysis. Weight allowances for cargo handling systems such as floor rollers, container floor locks, and cargo doors are to be included in the aircraft empty weight accounting.

**9. Communication and navigation equipment:**

All-weather (CAT III-b ILS) capability is required. The proposal will identify a preferred conceptual design. Preliminary and/or detailed results are required to substantiate innovative and/or high-risk features of the design. Proposed applications of new materials and structural concepts, in particular, should address the issue of testing to ensure a long useful life.

**IV. DATA REQUIREMENTS**

The final proposal shall include sections and/or data on the following:

1. Discussion of the design approach, including trade-offs and criteria used, as well as justification for the chosen design.
2. Include a three-view drawing and inboard profile of the final proposal. Include general dimensions.
3. Provide weight and balance data, including permissible center-of-gravity travel.
4. Performance analysis, including aerodynamic and range performance, stability and control, and field performance discussions. Discuss the techniques used to determine the performance characteristics.
5. Include discussion of the structural arrangement and primary load paths.

**V. ENGINE DATA**

The proposed set of "rubber" engine data will be sent upon request by contacting:

Norman Ng  
AIAA Student Programs  
370 L'Enfant Promenade, SW  
Washington, DC 20024-2518

ENTRY APPLICATION FORM

1989/1990  
AIAA/UNITED TECHNOLOGIES/PRATT & WHITNEY  
INDIVIDUAL STUDENT AIRCRAFT DESIGN COMPETITION

Title of Design Proposal: \_\_\_\_\_

Name of School: \_\_\_\_\_

Designer's Name: \_\_\_\_\_

AIAA Member Number: \_\_\_\_\_

Graduation Date: \_\_\_\_\_

Degree: \_\_\_\_\_

In order to be eligible for the 1989/1990 AIAA/United Technologies/ Pratt & Whitney Individual Student Aircraft Design Competition, you must complete this form and return it to the Director of Student Programs before **March 16, 1990**, at AIAA Headquarters, along with a one-page "Letter of Intent" as noted in Section IV, "Schedules."

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Faculty Advisor Signature

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Project Advisor Signature