1986
AIAA/GENERAL DYNAMICS CORPORATION
Team Aircraft Design Competition

I. RULES

1. All groups of three to ten *undergraduate AIAA* branch or at-large Student Members are eligible, and encouraged, to participate.

2. *Five copies* of the design will be submitted; each must bear the signatures, names, and student numbers of the project leader and the AIAA Student Members who are participating. Designs that are submitted must be the work of the students, but guidance may come from the Faculty Advisor and should be accurately referenced and acknowledged.

3. *Design projects that are used as part of an organized classroom requirement* are eligible and encouraged for competition.

4. The prizes shall be: First place—$1000; Second place—$500; Third place——$250; with the awards going directly to the students submitting the winning designs. Certificates will be presented to the winning design team for display at their university and a ceritificate will also be presented to each team member and the faculty project advisor.

5. More than one design may be submitted from student groups at any one school. Projects should be *no more than 100 double-spaced typewritten pages* (including graphs, drawings, photographs, and appendix).

6. If a design group withdraws their project from the competition, the team chairman must notify the AIAA National Office immediately!

II. SCHEDULES AND ACTIVITY SEQUENCES

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

A. Request for Proposal (RFP) release date—15 August 1985
B. Letter of Intent due date—14 March 1986
C. Receipt of Proposal—13 June 1986
D. Announcement of Award Winners—1 September 1986

Groups intending to submit proposals, must submit a Letter of Intent (Item B), 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:

Alina Z. MacNichol
Director of Student Programs
AIAA Headquarters
1633 Broadway
New York, NY 10019

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

III. PROPOSAL REQUIREMENTS

The technical proposal is the most important factor in the award of a contract. It should be specific and complete. While it is realized that all of the technical factors cannot be included in advance, the following should be included and keyed accordingly:

1. Demonstrate a thorough understanding of the Request for Proposal (RFP) requirements.

2. Describe the proposed technical approaches to comply with each of the requirements specified in the RFP, including phasing of tasks. Legibility, clarity, and completeness of the technical approach are primary factors in evaluation of the proposals.

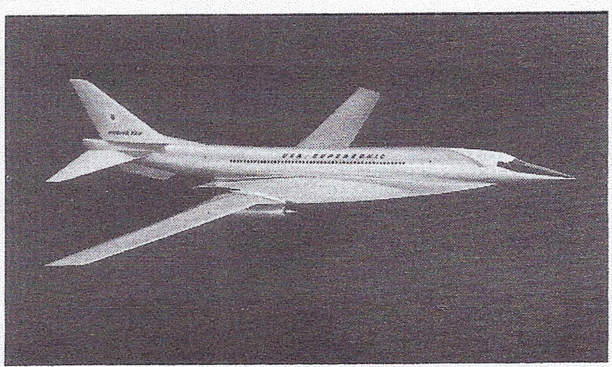
3. Particular emphasis should be directed at identification of critical, technical problem areas. Descriptions, sketches, drawings, system analysis, method of attack, and discussions of new techniques should be presented in sufficient detail to permit engineering evaluation of the proposal. Exceptions to proposed technical requirements should be identified or explained.

4. Define the proposed management organization, and provide a brief biography of proposed management staff. Describe methods and techniques that will be used to assure schedules, costs and product quality.

5. Demonstrate an awareness of manufacturing capability and include a description of facilities required.

6. Include tradeoff studies performed to arrive at the final design.

7. Provide an implementation plan (how the final product will be produced).



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 effectiveness of the design as an instrument of communication is a strong factor in judging. Organization of the 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 should show 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 group 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?

Design Objectives and Requirements

Request for Proposal for a Supersonic Cruise Business Jet

I. OPPORTUNITY DESCRIPTION

Expanding international markets for corporations and diplomatic missions for government executives could create a demand for the time-saving and rapid response that a long-range supersonic cruise business jet would provide. Typical transatlantic flight times could be reduced from a current seven hours to as little as two and a half hours with such an aircraft; transpacific flight times could also be dramatically reduced.

II. PROJECT OBJECTIVE

The objective of this competition is to provide a business jet design with a service entry date of the late 1990s that would provide transatlantic range at supersonic speeds and transcontinental range at high subsonic/transonic speeds. To meet the objective, the use of advanced technologies and innovation will be required.

III. REQUIREMENTS AND CONSTRAINTS

The aircraft shall be capable of transporting ten people (two pilots and eight passengers) on each of the following missions. A weight allowance of 225 pounds is required for each person (including baggage).

Missions

1) *Supersonic Transatlantic Mission:* The aircraft shall have a range of 3200 nautical miles and a total flight time of less than four hours. A tradeoff study, based upon the engine selected, should be conducted to determine cruise Mach number and the results of this study should be presented. The balanced takeoff field and the landing field lengths must not exceed 8500 feet. At takeoff, the one-engine-out climb gradient shall meet FAR Part 36 Regulations. The mission performance should include fuel for: a) taxi-out and takeoff allowance; b) FAA climb ($V \leq 250$ KCAS up to 10,000 feet); c) optimum climb path and acceleration to cruise Mach number; d) cruise climb at cruise Mach number; e) descent to destination; and f) reserves.

The reserve fuel is the sum of: a) 7% of trip fuel (items a-e above); b) missed approach; c) climb and subsonic cruise at optimum altitude for 250 nautical miles; d) descent to an alternate airport; and e) 30 minute hold at optimum altitude.

2) *Transcontinental Mission:* The aircraft must have a range of at least 2130 nautical miles. The cruise Mach number should be as high as possible, but cause no sonic boom on the ground. The mission performance and reserves requirements are the same as those for the Transatlantic Mission.

3) *Emergency Mission:* To insure the safety of the overwater flight, a mission calculation should be made for the case where one engine becomes inoperative at the halfway point in the supersonic Transatlantic Mission flight (i.e., after 1600 nautical miles). The remainder of the flight should occur at the most efficient flight conditions. The total usable fuel on board must be sufficient to complete the flight without depleting the reserves.

Design Criteria

1) *Accommodations:* The pressurized cabin must be capable of containing the flight crew, passengers, baggage area, and lavatory. The cabin shall be pressurized to provide a cabin altitude equivalent to 8000 feet at an aircraft altitude of 60,000 feet.

2) *Propulsion System:* Typical propulsion data will be provided for those students who indicate an intent to respond to this RFP. The propulsion package will contain the following items for engines designed for Mach numbers of 1.5, 2.3, and 2.7:
a) Fact sheet on engine to serve as an introduction to size, weight, and performance.
b) Profile drawing.
c) Curves of specific fuel consumption for standard day conditions as a function of thrust, Mach number, altitude, and power setting. These curves include typical installation losses for inlet and exhaust effects, bleed air, and power extraction.
d) Guidelines for scaling to match aircraft size requirements.

3) *Structures:* An analysis of temperatures for cruise conditions on the external structure is required. Materials for the structure should be suitable for the temperature environment the aircraft will encounter.

4) *Aerodynamics:* Consideration might be given to the effects on the configuration of obtaining supersonic laminar flow. If this is done, the method and probability of obtaining laminar flow should be described.

5) *Stability and Control:* An analysis of the stability and control of the design is required for supersonic and subsonic cruise, and low-speed operation (i.e., takeoff and landing). The configuration should either be statically stable or should include the design of a flight control system with fail-safe redundancy provisions.

6) *Sonic Boom:* Sonic boom plays a significant role in the design of this type of configuration. Flights that cause sonic booms over land are prohibited; therefore, the Transcontinental Cruise Mission must not cause a sonic boom over land. The Transatlantic Mission is assumed to be completely over water. Ground-track overpressures may be estimated using the method in Ref. 1.

7) *Noise:* Noise is a major factor in the design of a configuration such as this. In actual practice, the design would be affected by source noise, operating procedures, community planning, and economics. These areas are beyond the scope of this preliminary design. However, for this RFP, estimates (optional) are requested of the jet noise for standard day conditions at the takeoff, approach, and sideline points as defined in FAR Part 36. The methods in Ref. 2 predict jet noise and the methods in Ref. 3 estimate atmospheric attenuation.

8) *Costs*: Cost is a major factor in aircraft design and is influenced by government policies, world economics, and numerous other factors. For this proposal very simplified cost estimates (optional) are requested.

Configuration Selection Criterion

The final configuration proposed shall be selected on the basis of the lowest maximum TOGW to satisfy all of the requirements and constraints stated herein.

References

[1]Carlson, H. W., "Simplified Sonic Boom Prediction," NASA TP-1122, 1978.

[2]"Gas Turbine Jet Exhaust Noise Prediction," ARP 876, *Society of Automotive Engineers,* March 1978.

[3]"Standard Values of Atmospheric Absorption as a Function of Temperature and Humidity for Use in Evaluating Aircraft Flyover Noise," ARP 866A, *Society of Automotive Engineers,* Aug. 1964.

IV. DATA REQUIREMENTS

The following data are required for the final configuration:

Design Data

1) Cruise Mach number for each mission.
2) Aircraft external dimensions and areas.
3) Aircraft 3-view drawing.
4) Interior cabin layout drawing.
5) Location and volume of fuel tanks.
6) Drawing showing retracted landing gear position.
7) Aircraft weight statement.
8) Aircraft center-of-gravity envelope.
9) Aircraft wing data (aspect ratio, taper ratio, thickness, etc., and high-lift devices).
10) Aircraft drag polars for subsonic and supersonic cruises, takeoff, and landing configurations.
11) Materials used in the aircraft structure and their expected temperature environment.

Performance Data

1) Trade study results to determine the Transatlantic Mission cruise Mach number.
2) Segment-by-segment characteristics of the Transatlantic Mission profile (aircraft weight, fuel weight used, percent total fuel, time, distance, altitude, and velocity).
3) Transcontinental Mission cruise Mach number.
4) Segment-by-segment characteristics of the Transcontinental Mission profile.
5) Optimum Mach number/altitude combination for the one-engine-out condition.
6) Fuel required for the emergency mission.
7) Balanced takeoff and landing field length versus TOGW for sea level, standard day conditions.
8) Summary of handling qualities.
9) Summary of engine noise and sonic boom overpressures for the Transatlantic Mission (optional).
10) Cost estimates of development and operations (optional).