Rules – General

1. All AIAA Student Members are eligible and encouraged to participate.

Undergraduate students may participate in the undergraduate categories

Graduate students may participate in the graduate categories.

2. The report in Adobe PDF format must be submitted to AIAA online. Total size of the file(s) cannot exceed 20 MB.

A "Signature" page must be included in the report and indicate all participants, including faculty and project advisors, along with students' AIAA member numbers and signatures. Designs that are submitted must be the work of the students, but guidance may come from the Faculty/Project Advisor and should be accurately acknowledged.

Each proposal should be no more than 100 double-spaced pages (including graphs, drawings, photographs, and appendices) if it were to be printed on 8.5" x 11.0" paper, and the font should be no smaller than 10 pt. Times New Roman. Up to five of the 100 pages may be foldouts (11" x 17" max).

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

4. The prizes for 2017 shall be: First place-$500; Second place-$200; Third place-$100 (US dollars). Certificates will be presented to the winning design teams for display at their university and a certificate will also be presented to each team member and the faculty/project advisor. One representative from the first place design team may be expected to present a summary design at an AIAA Forum.

Aircraft Competitions may be invited to SciTech Forum

Engine Competitions may be invited to Propulsion and Energy Forum

Space Competitions may be invited to SPACE Forum

A travel stipend in the amount of $400 will be provided by the AIAA Foundation for the team representative AFTER attendance at the AIAA Forum is confirmed.

5. More than one design may be submitted from students at any one school.

6. If a design group withdraws their project from the competition, the team leader must notify AIAA Headquarters immediately!

7. Team competitions will be groups of not more than ten AIAA Student Members per entry. Individual competitions will consist of only one AIAA Student Member per entry.

Copyright

All submissions to the competition shall be the original work of the team members.

Any submission that does not contain a copyright notice shall become the property of AIAA. A team desiring to maintain copyright ownership may so indicate on the signature page but nevertheless, by submitting a proposal, grants an irrevocable license to AIAA to copy, display, publish, and distribute the work and to use it for all of AIAA's current and future print and electronic uses (e.g. "Copyright © 20__ by _____. Published by the American Institute of Aeronautics and Astronautics, Inc., with permission.).

Any submission purporting to limit or deny AIAA licensure (or copyright) will not be eligible for prizes.

Conflict of Interest

It should be noted that it shall be considered a conflict of interest for a design professor to write or assist in writing RFPs and/or judging proposals submitted if (s)he will have students participating in, or that can be expected to participate in those competitions. A design professor with such a conflict must refrain from participating in the development of such competition RFPs and/or judging any proposals submitted in such competitions.

Schedule and Activity Sequences

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

Letter of Intent — 10 February 2017 12pm (MIDNIGHT) Eastern Time
Proposal submitted to AIAA Headquarters — 10 May 2017 12pm (MIDNIGHT) Eastern Time
Announcement of Winners — 10 June 2017 12pm (MIDNIGHT) Eastern Time

Groups intending to submit a proposal must submit a Letter of Intent via the AIAA.org online submission system.

The Letter of Intent should contain the names of participants, project title, name(s) of faculty/project advisor(s), and contact information for the team leader and project/faculty advisor(s).

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, systems 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 and explained.

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

5. Provide a description of automated design tools used to develop the design.

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)

The design proposal should avoid standard textbook information, and should show the independence of thinking or a fresh approach to the project. Does the method and treatment of the problem show imagination? Does the method show an adaptation or creation of automated design tools?

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.

REQUEST FOR PROPOSAL

Light Business Jet Family Design Challenge

AIAA Graduate & Undergraduate Team Aircraft Student Design Competition

Submitted by the Aircraft Design Technical Committee

Opportunity / Background

The business aviation market was hit hard during the recent economic recession. Demand dropped significantly for business jets and the manufacturers invested in developing new jets and upgrading existing models. In recent years, the economy has struggled as the business jet manufacturers have cautiously launched their new aircraft to meet new demand. Business jets continue to offer great value in business travel with comfort.

The category of light business jets is loosely defined here as aircraft which weigh roughly 13,000-22,000 lb, carry 5-10 passengers, and may have US coast to coast range, depending on payload and winds. This category has several current examples from a variety of manufacturers: The Bombardier-Learjet 40, Cessna Citation CJ3+, the SyberJet SJ30, and Embraer Phenom 300 are a few examples.

New business jet designs typically offer higher cruise speed, larger cabins, and updated technology compatibility. The business passengers continue to expect a comfortable and connected work environment so they can maximize productivity while enroute to their destination. Shorter trip time enables last minute and urgent trips to be completed on short notice to a wide range of destinations. Another key capability is short runway operability, allowing departure locations closer to users' home base and final point of destination which enables even short trip times.

Project Objective

This RFP asks for a two-member aircraft family of fixed wing, light business jets designed to carry up to 6 and 8 passengers. The entry into service (EIS) is 2020 for the first model and 2022 for the second model. This aircraft family is envisioned to have a high level of part commonality between family members to minimize the development and production costs. A 2,500 nmi design range will allow for operational flexibility and a maximum cruise Mach number of 0.85 will shorten trip time. The short takeoff and landing field length will add to the operational flexibility.

Most successful general aviation manufacturers create a range of products to cover as wide as possible of a product with a minimum of development and non-recurring development costs. The re-use of major airframe components (wings, empennage, landing gear, cowlings, engines etc.) is common (e.g., Piper Cherokee and its derivative designs, Beech Bonanza and its derivatives). For this study, the commonality between the single and two seat variants in this LSA family is a key requirement.

The design objective is to minimize the acquisition and operating cost. Advanced technologies should be used only where justified based on performance and cost (note entry into service date) and within acceptable cost and schedule risk.

General Design Requirements

- Maximum Cruise Speed of Mach 0.85 at 35,000 ft
- Rate of Climb of 3,500 fpm (flaps up, gear up, sea level, ISA, max takeoff power)
- Service Ceiling of 45,000 ft
- Maximum Sea Level Takeoff Balanced Field Length of 4,000 ft at Maximum Gross Weight with dry pavement, ISA
- Maximum Landing Field Length of 3600 ft at Typical Landing Weight

Six seat family member minimum requirements

- Must meet FAA Federal Aviation Regulations Part 23 Airworthiness Standards for certification - see Federal Aviation Regulations (FARs) and Advisory Circulars (ACs) for full description
- Minimum range of 2500 nmi at Long Range Cruise (LRC) assuming NBAA IFR Range with 100 nm Alternate (1 pilot + 2 passengers; passenger/pilot at 200 lbs each)
- Baggage capacity of 500 pounds/30 cubic feet
- 1 or 2 flight crew
- 6 passengers, including 1 in the cockpit if there is no copilot

Eight seat family member minimum requirements

- Must meet FAA Federal Aviation Regulations Part 25 Airworthiness Standards for certification - see Federal Aviation Regulations (FARs) and Advisory Circulars (ACs) for full description
- Minimum range of 2500 nmi at Long Range Cruise (LRC) assuming NBAA IFR Range with 100 nm Alternate (4 passengers; passenger/pilot at 200 lbs each)
- Baggage capacity of 1,000 pounds/60 cubic feet
- 8 passengers

Other Considerations

- Consider what features will be basic and which will be optional to a customer
- Consider how the performance and unique features of the aircraft will be used in marketing over other similar aircraft

Design Objectives

- The re-use of at least 70% of the airframe structure and systems by weight for both the 6 and 8 seat variants is a design objective. This includes everything in the empty weight of the airplane with the exception of the engine.
- Minimize production cost by choosing materials and manufacturing methods appropriate for the production rate that is supported.
- Make the aircraft visually appealing so it will be marketable and identify what features are important to the pilot, passengers, and owners.
- Make the aircraft maintainable and reliability at least as good as comparable aircraft.

Notes and Assumptions

- Assume an EIS of 2020 for the first model and a 2022 EIS for the second model when making technology and concept assumptions
- All performance to be computed for International Standard Atmosphere

Proposal and Design Data Requirements

The technical proposal shall present the design of this aircraft family clearly and concisely; the proposal shall cover all relevant aspects, features, and disciplines. Pertinent analyses and studies supporting design choices shall appear in sufficient detail.

Full descriptions of the aircraft are expected along with performance capabilities and operational limits. These include, at a minimum:

1. A description of the design missions defined for the proposed concepts for use in calculations of mission performance as per design objectives. This includes the selection of cruise altitude(s) and cruise speeds supported by pertinent trade analyses and discussion.
2. Aircraft performance summaries shall be documented and the aircraft flight envelope shall be shown graphically.
3. Payload range chart(s)
4. A V-n diagram for the aircraft with identification of necessary aircraft velocities and design load factors.
    a. Required gust loads are specified in Federal Aviation Regulations (FAR) 23.333 (c) and 25.341 and the load factors may be computed using the formulas in FAR 23.341 or FAR 25.341.
5. Materials selection for main structural groups and general structural design, including layout of primary airframe structure as well as the strength capability of the structure and how that

compares to what is required at the ultimate load limits of the aircraft. The maximum dive speed of the airframe shall be specified.

6. Complete geometric description, including dimensioned drawings, control surfaces sizes and hinge locations, and internal arrangement of the aircraft illustrating sufficient volume for all necessary components and systems.
    a. Scaled three-views (dimensioned) and 3-D model imagery of appropriate quality are expected. The three-view must include at least:
        i. Fully dimensioned front, left, and top views
        ii. Location of aircraft aerodynamic center (from nose)
        iii. Location of CG location (relative to nose) (maximum takeoff gross weight design condition)
        iv. Tail moment arms
    b. Diagrams and/or estimates showing that internal volume requirements are met, including as a minimum the internal arrangements of the six and eight seat variants.
    c. Diagrams showing the location and functions for all aircraft systems.
7. Important aerodynamic characteristics and aerodynamic performance for key mission segments and requirements (this includes, but is not limited to: L/D, velocity, rate-of-climb, duration, fuel/energy consumption, etc.)
8. Aircraft weight statement, aircraft center-of-gravity envelope reflecting payloads and fuel allocation. Establish a forward and aft center of gravity (CG) limits.
    a. Weight assessment summary shall be shown at least at the following level of detail:
        i. Propulsion (engine/motor, propeller, spinner etc.)
        ii. Airframe Structure
            1. Wing
            2. Empennage
            3. Landing Gear (including wheels tires and brakes)
            4. Fuselage
        iii. Control system (flight controls linkages, bellcranks, engine controls etc.)
        iv. Payloads (seats, seatbelts, cushions and other
        v. Systems
            1. Instruments, wiring, tubing and Avionics
            2. Fuel/oil (battery if electric) Systems
            3. Hydraulic/pneumatic/electrical systems (if chosen)
9. Propulsion system description and characterization including performance, dimensions, and weights. The selection of the propulsion system(s), sizing, and airframe integration must be supported by analysis, trade studies, and discussion
10. Summary of basic stability and control characteristics; this should include, but is not limited to static margin, pitch, roll and yaw derivatives.
11. Assessment of commonality by weight for 6-passenger and 8-passenger variants to show how close the designs are to the objective that 70% of the weight behind the firewall remains common.

12. Summary of cost estimate and a business case analysis. This assessment should identify the cost groups and drivers, assumptions, and design choices aimed at the minimization of production costs.
    a. Estimate the non-recurring development costs of the airplane including engineering, certification, production tooling, facilities and labor
    b. Estimate the fly away cost of each member of the family
    c. Estimate the price that would have to be sold for to generate at least a 10% profit
        i. Show how the airplane could be produced profitably at production rates ranging from 4 to 10 airplanes per month or a rate that is supported by a brief market analysis
    d. Estimate of direct operating cost per airplane flight hour
        i. Fuel, oil, tires, brakes, and other consumable quantities
        ii. Estimate of maintenance cost per flight hour (annual inspection)

The proposal response will include trade documentation on the two major aspects of the design development, a) the concept selection trades, and b), the concept development trade studies.

A) The student(s) is (are) to develop and present the alternative concepts considered leading to the down-select of their preferred concept (two aircraft family). The methods and rationale used for the down-select shall be presented. At a minimum a qualitative assessment of strengths and weaknesses of the alternatives shall be given, discussing merits, leading to a justification as to why the preferred concept was the best proposal response. Quantitative justification of why the selected proposal is the best at meeting the proposal measures of merit(s) will strengthen the proposal.
B) In addition, the submittal shall include the major trade studies conducted justifying the optimization, sizing, architectural arrangement and integration of the specifically selected proposal concept. Quantitative data shall be
    1. presented showing why their concept ‘works’ and is the preferred design compromise that best achieves the RFP

Specific analysis and trade studies of interest sought in proposals include:

13. 1. Mission performance and sizing for the definition of a mission profiles.
14. 2. Overall aircraft concept selection (airframe and propulsion system) vs. design requirements objectives
15. 3. Consideration to conventional or unconventional configurations with regards to design requirements and objectives
16. All concept and technology assumptions must be reasonable and justified for the EIS year.

Procured Data

No data is procured as part of this RFP.

Reference Material

http://www.ecfr.gov/cgi-bin/text-idx?rgn=div5&node=14:1.0.1.3.10
http://www.ecfr.gov/cgi-bin/text-idx?rgn=div5;node=14%3A1.0.1.3.11

Representative Light Bizjet Designs for Reference

http://cessna.txtav.com/citation/cj3 (Citation CJ3+)
http://www.syberjet.com/sj30 (Syberjet SJ30)
http://www.embraerexecutivejets.com/en-us/jets/phenom-300/pages/overview.aspx (Embraer Phenom 300)

Aircraft Design Technical Committee, POC: Doug Wells douglas.p.wells@nasa.gov