Aircraft Design 1

Assignment 1: Analysis of requirements, airworthiness, and fuselage design.

Grading scale:

|  |  |  |
| --- | --- | --- |
| **Grade** | **Evaluation** | **Equivalent grade/10** |
| 1 | Excellent | 10 |
| 2 | Good | 9 |
| 3 | Satisfactory | 8 |
| 4 | Insufficient | No grade |

Your overall grade is calculated by averaging the components in each numbered item. If your overall report was an insufficient, a resubmission is necessary to correct the shortcomings and obtain a grade. If individual items are a 4, it is highly recommended to update them or review them as needed with the provided feedback in your assignment file.

|  |  |  |
| --- | --- | --- |
|  | Group |  |
|  | **Overall assignment grade** |  |
|  | **Submissions** |  |
|  |  |  |
| **1** | Mission definition and Analysis of requirements |  |
|  | Mission Definition, Mission Example, Description of segments | M |
|  | Requirements analysis & completion, Certification requirements, assumptions | Cj |
|  | Identification of Driving requirements for the design, | Cj |
| **2** | Reference aircraft data collection |  |
| **3** | Concept generation and selection |  |
|  | 3 Different aircraft configurations, sketches, and description | Cj |
|  | Selected concept with explanation of selection process | Cj |
| **4** | Study and generation of the complete fuselage layout |  |
|  | Inside-out approach for payload and crew, calculations, and dimensions | CJ |
|  | Visibility analysis, slenderness values… | M |
|  | Demonstration of the flexibility of the design (classes/arrangements OR usage) | M |
| **5** | Generation of technical drawings |  |
|  | Annotated all the estimated fuselage sizes relative to the cabin, nose, and tail cone sections (lengths, heights, rotation and visibility angles, ground clearance with engines and propellers, etc.) | M |
|  | Indicated the estimated size and location of eventual wing/canard/tail crossing areas or engine(s)/landing gears/fuel tank installations | M |
|  | Indicated the estimated length and position of the landing gears | M |
|  | Indicated the estimated size of floor(s) and cabin walls. | M |
|  | Indicated size and position of all access and emergency doors for passengers and cargo (refer to appropriate airworthiness regulations and account for the proper clearance space). In case of UAV, show the access possibilities to (load and unload) the systems. | M |
|  | Indicated size and pitch of passenger’s seats, aisle(s) width, shoulder height, cabin height | X |
|  | Indicated size and position of the seats/accommodations for pilots, crew, flight attendants, operators, etc. | X |
|  | Indicated size and position of cargo holds and overhead luggage bins. Indicated size and position of loading units (account for appropriate clearance distances) | M |
|  | Showed size and positioning of service and rest areas for passengers/crew | X |
|  | **For UAV aircraft**, showed estimated size and positioning of cameras, sensors, antennas, etc. (for simplicity, you can represent these components as simple “boxes” of adequate dimension). | M |
|  | **For Reconnaissance/surveillance aircraft**, indicate estimated size and positioning of operator’s stations (consoles), radar systems/antennas, expendable ordnance, crew rest areas, etc. | X |
|  | **For military trainers and general aviation aircraft**, paid attention to the design of the cockpit (relative positioning of pilots, (ejection)seats dimensions, visual and seating angles, doors, etc.) and the possible integration of engine and air intake(s). Did not design only the cockpit, but the complete fuselage including tail and nose sections | X |
|  | **In case of fuselage mounted engines**, accounted for the room required to accommodate the propulsion system | M |
|  | Considered the space required to accommodate landing gears, radar, and other relevant systems. | M |
|  | Overall top view drawing quality | M |
|  | Overall side view drawing quality | M |
|  | Overall front view drawing quality | M |
|  | Overall long. cross section drawing quality | M |
|  | Overall lat. cross section drawing quality | M |
| **6** | General Report Quality |  |
|  | ABS - Specificity of the report to the design |  |
|  | Template/layout |  |
|  | AAppropriate level of detail |  |
|  | Indication and use of units |  |
| **7** | **Submission Penalty (-0.5pts each)** |  |
|  | Submitted late (number of days late) |  |
|  | Incorrect filename |  |
|  | Incorrect file format (PDF only) |  |

# Mission definition and Analysis of requirements

* Define the typical mission for the aircraft you were assigned. Generate a simple but exhaustive illustration of the mission, and describe briefly all its segments (N.B. consider that for certain types of aircraft, e.g., UAVs, the mission you are going to define will determine the specific payload/systems to be carried on board)
* Perform a critical analysis of the requirements for your aircraft design case. Check whether the given requirements are appropriate and sufficient to start designing: think of possible propulsion system, certification issues, operational altitude, loiter and diversion manoeuvres, etc. In case, make assumptions and estimations for the missing requirements. Briefly justify your assumptions.
* Indicate what are, in your opinion and also on the base of the reference aircraft data you collected (see point 2), the driving or most critical requirement(s) for your design case. Briefly discuss the foreseen impact of such requirements on the design of your aircraft.

# Reference aircraft data collection

* Collect and organize in a table the reference data of a number of existing aircraft similar to yours (aim for circa 20 reference aircraft, when possible).
* **Note**: You will need reference data throughout the entire set of assignments, so do this research extensively and accurately. Data that are not relevant to this assignment might be important for the next ones! (See advice on the document template)

# Concept generation and selection

* Propose at least 3 different aircraft configurations, which you consider suitable to fulfil your mission and comply with the given requirements. Generate simple sketches of the proposed configurations and briefly describe their characteristics (think of their strong and weak points **relatively to your mission** and requirements).
* Indicate the concept you consider the best to proceed with the design process. Give a brief explanation of your selection process (i.e., indicate your selection criteria and explain why the selected concept resulted superior to the others)

# Study and generation of the complete fuselage layout

* By using the inside-out approach, perform a brief study of possible fuselage layouts to accommodate the required payload (and crew). Discuss the fuselage configuration you consider the most convenient and justify your choice: show the calculations and/or the considerations you used to derive the fuselage shape and dimensions (i.e., type of cross section, diameters, angles, seats size, etc.). Include, when possible, aerodynamic (slenderness values, tail angles, etc.) and visibility considerations (over-nose and sideview angles etc.).
* Once you have determined the best fuselage configuration, make sketches of different possible payload configurations to demonstrate the flexibility of your design. I.e., show how your fuselage is capable to accommodate passengers in different class arrangements, and/or different loading units, and/or different sort of systems and type of payload, etc. **In case of limited possibility** to play with different payload configurations (e.g., general aviation aircraft), discuss different types of mission/usage for your proposed aircraft.

# Generation of technical drawings

Illustrate the results of the fuselage design/sizing process of point 4, by means of adequate technical drawings (**not just freehand sketches!**): provide the **3 views (top, side, front) and some relevant cross** and **longitudinal sections.** Drawings must be properly **annotated and to scale (indicate the scale)**

* Annotate **all** the estimated fuselage sizes relative to the cabin, nose, and tail cone sections (lengths, heights, rotation and visibility angles, ground clearance with engines and propellers, etc.)
* Indicate the estimated size and location of eventual wing/canard/tail[[1]](#footnote-1) crossing areas or engine(s)/landing gears/fuel tank installations.
* Indicate the estimated length and position of the landing gears.
* Indicate the estimated size of floor(s) and cabin walls.
* Indicate size and position of all access and emergency doors for passengers and cargo (refer to appropriate airworthiness regulations and account for the proper clearance space). In case of UAV, show the access possibilities to (load and unload) the systems.
* Indicate size and pitch of passenger’s seats, aisle(s) width, shoulder height, cabin height.
* Indicate size and position of the seats/accommodations for pilots, crew, flight attendants, operators, etc.
* Indicate size and position of cargo holds and overhead luggage bins. Indicate size and position of loading units (account for appropriate clearance distances)
* Show **size and positioning of service and rest areas for passengers/crew.**
* **For UAV aircraft,** show estimated size and positioning of cameras, sensors, antennas, etc. (for simplicity, you can represent these components as simple “boxes” of adequate dimension).
* **For Reconnaissance/surveillance aircraft, indicate estimated size and positioning of operator’s stations (consoles), radar systems/antennas, expendable ordnance, crew rest areas, etc.**
* **For military trainers and general aviation aircraft**, pay particular attention to the design of the cockpit (relative positioning of pilots, (ejection)seats dimensions, visual and seating angles, doors, etc.) and the possible integration of engine and air intake(s). Do not design only the cockpit, but the complete fuselage (you can estimate the size of the fuselage tail and nose sections by means of typical slenderness values and making assumptions on the required space to install engine(s) and eventual air intakes)
* In case of fuselage mounted engines, account for the room required to accommodate the propulsion system.
* Consider the space required to accommodate landing gears, radar, and other relevant systems.

**Maximum size: 20 pages in total (font 12 pt), excluding references and appendices.**

# General Notes for Engineering Reporting

* **ABS (Always Be Specific)**: Focus the discussion on your specific aircraft and design, do not discuss aircraft/spacecraft projects in general, but it is ok to refer to typical designs for comparison.
* **ABC (Always Be Concise)**: Be concise. Always justify & discuss your statements in a clear but concise way. Describe figures, tables, graphs and trendlines and refer to them in the text (no floating figures). Introduction, abstract, acknowledgement sections, etc., are not required.
* **Properly reference** your sources; use IEEE or AIAA engineering reference styles. Ensure all figures/tables/graphs/diagrams have descriptive captions and labels/numbers that are referred to in the body of the text. Make appropriate use of literature data. When using work from others, always include detailed references. Plagiarism and straight copying of work is a USC honour code violation and will be reported!
* Treat this as a full engineering report: there must be a narrative explaining the report and systems, not simply a compilation of images. You are welcome to include some history of the system you discuss as well, as long as it is properly referenced, which includes IEEE or AIAA type-referencing.
* **RTFM** (**Read the assignment twice**): Make use of the document template provided on blackboard. You are allowed to use your own template as long as it contains the same elements as the provided template. Add relevant oversized additional information (technical drawings, flow charts) in appendices. Do not forget the required Appendixes! Appendices do not count towards the page limit.
* When using drawings, schematics and images, make sure they are **clearly readable**. Produce good quality drawings **(annotated and to scale**). Hand drawings are acceptable for concept sketches, but only **CAD drawings** are acceptable for the final concept!
* Remember: the required level of detail is that of conceptual design (check the number of decimals in your drawings annotations!)
* Remove any unneeded white space in all images.
* Make appropriate use of literature data and airworthiness regulations to refer to any standards or justifications behind your system’s operation.
* Make smart use of tables, equations and graphs to present the system and narrate your work, and use appropriate captions.
* Make proper use of version control and submit using the requested filename convention.
* Use a spelling/grammar checker to verify your work!
* For military or UAV aircraft refer, when possible, to the civil airworthiness regulations that matches your type of aircraft the best (unless you can find appropriate information in literature).
* **Pay attention to units**! DON’T mix different units and/or different unit systems (or include both).
* Assignment examples provided (if any) are examples of work that was graded “good” or “excellent”, and may contain errors. Use/reference at your own risk.
* **Remember to indicate the approximate time you spent working on the assignment (do not include the time spent learning Word, Excel, LaTeX, CAD systems, etc.)**

1. **Of course, the accuracy of the wing and tail designs will not be judged, because they are out of the scope of this assignment. Thereby you do not need to annotate them in the drawings.** [↑](#footnote-ref-1)