

Timeline Aircraft Design Laboratory AE 417

(conducted first 2016-17, sem 1, primary instructor GR Shevare)

Week 0 :

call for self nomination of group coordinators

Week 1 : Introduction

- introductory lecture, rules,
- group formation
- presentation for next week (in gray)

team members, dream projects (= # of team members),
2 shortlisted projects after brainstorming along with (rough) mission statement, critical technologies, task sharing etc.

Week 2: Rough mission statement

- cross evaluation by groups
- group-wise presentation & feedback by instructors, TA
- presentation for for next week:

slide 1 : The group no, table of names of the group members

slide 2 : The preferred project, the likely customer

slide 3 : The Mission Statement to satisfy the customer

slide 4 : Critical technology without which project can be realised

slide 5 : Objective function(s) for optimizing the design

slide 6 : Generic design variables - such as size, weight, fuel/energy, materials, etc. and constraints on them, if any

slide 8 : Parameters (things you will not vary/change, bought out items)

Week 3: Freezing mission statement, discuss concepts

Customer (very specific)

Mission Statement (owned by group, catering to customer, scientifically plausible, doable using combined expertise)

Two Concepts to satisfy mission requirements, sketch 3D using VSP

Compare concepts qualitatively, further single concept to further

Week 4:

- Exhaustive feedback given by instructors
1. Consolidate the slides produced so far taking into account comments given on various occasions
 2. Write a [report](#) (doc or pdf file) based on the discussions and the consolidated slides
 3. The [report](#) must be as per the format available on the web-page of the department (<http://www.aero.iitb.ac.in/aero/academics/Seminar/report.pdf>)
 4. The [report](#) in addition to what is given in the above link must have following sections
 - 4.1) Group, the strength /weakness of its members, roles and responsibilities of individuals(one page)
 - 4.2) Dream product development projects (equal to no of members in the group) along with the motivation (two pages)
 - 4.3) Two selected products discussed in the group along with the justification for selecting them (one page)
 - 4.4) One product ultimately chosen for development along with reasons (one page)
 - 5) Identifying customer and Arriving at Mission statement. These two must lead to specification of the user specifications requirement (two pages)
 - 6) Possible concepts, they must be completely different from each other. They should be qualitatively compared so that one of them is chosen for further development

Week 5:

(present 15 min. including Q & A)

- Present two concepts to suit mission requirements.
 - Discuss pros & cons
 - Freeze one to carry forward
1. The concepts must be in the form of sketches.
 2. Guess values for generic design variables such as (a) shape/size, material, power/energy requirements, etc. must be given.
 3. Report the design methodology that you intent to use. It must be iterative so that design variables are changed to optimise objective function.

Week 6:

No CLASS (midsem).

(10 min. presentations)

(required after midsem break)

1. You cannot change the mission statement now onwards
2. Give reasons for choosing the concept from the two concepts based on qualitative arguments in the form of a table.
3. Give a suitable name for your product. You justify the chosen name (but the justification need not be reported)
4. The [frozen conceptual design](#) (call it a system) must be reported in terms of the following:
 - (4.a) 3 view drawing + 1 isometric view drawings (line drawings using a professional CAD software). At least 20 dimensions must be shown on the drawing. The drawings must show volumes and locations for payloads, fuel/batteries, equipment, instruments, operator (if any). The sizes and volumes for these items must be justified.
 - (4.b) Identify a performance (objective function) to be optimised, design variables available, constraints to be satisfied. These must be mathematical relations with SI units. For some projects, identifying a flight plan will help.
 - (4.c) Give a list of sub-systems. Make separate tables for (i) sub-systems to be designed and (ii) sub-systems to be bought out, (iii) Write down operating conditions/flight plan
 - (4.d) Come up with flow chart for iterations for [conceptual design](#) based on analytical expressions based on classical non-numerical methods or empirical data. The examples for analytical expressions are (I) drag of a wing based Prandtl lifting line theory, stresses based on Euler-Bernoulli bending theory, torsion of closed/open thin walled boxes, zeroth dimensional (thermodynamic) analysis of jet engines, etc. The analysis must be carried out at-least once. The change in the [conceptual design](#) must be shown in 3 view drawings + 1 isometric view

Week 7

10 min. presentation on the status so far at *half-way-mark*.

Expected:

- Frozen conceptual design.
- CAD drawings with numbers.
- Design loop & objective function
- Some analysis.

Week 8

Fix up a name for your product- the name must be such that intended use of the product is easily understood by intended user

We have reached a stage where any decision must be through calculations.

It is essential that you are able to show two flow charts: (a) data flow chart - which calculation requires which other calculations? (b) the sequence of calculations

Most groups have not fixed objective function properly. There should be only one objective function. If you are confused about more than objective functions, choose the one which is the more important objective function and fix the desired value for the other objective functions.

Most groups have not chosen design variables properly. The criteria for choosing design variables are: (a) Design variable should not depend on any other design variable. (b) Do not choose a variable which you can not change, (c) The design variable should affect the objective function considerably

Meet instructor(s) for extra input

Week 9

Evaluation Activity

To Do list is given below.

1) Produce and submit CONSOLIDATED [report](#) of design activity carried out so far before ***. mid-night

1.1) The [report](#) must be as per format given on the web-page of the department

1.2) The [report](#) should include three view drawings (CAD). CAD drawings to highlight (a) subsystems to be bought, (b) subsystems to be designed, (c) subsystems to be designed and areal very critical.

1.3) Specification of all the sub-systems which are to be bought

1.3) Systematic analysis methodology / procedures identified for subsystems to be analyzed and

designed including critical sub-systems

1.4) The sequence in which the analysis methodologies / procedures are to be carried out for subsystems to be analyzed and designed including critical sub-systems

1.5) Results of from the analysis methodologies / procedures for subsystems

1.6) Identify (a) the objective function you wish to optimise, and (b) design variables you have identified to change the designed

(1.7) Produce a table showing design variables used in analysis carried out in (1.4) and the increments / decrements you are proposing with arguments.

(1.8) CAD drawings to highlight showing changes to subsystems subsystems to be bought and subsystems to be designed

2) Produce and submit CONSOLIDATED ppt of design activity carried out so far before *** 1400 Hrs.

How to make slides: (a) The fonts used must be such that text is readable by all participants, (b) Avoid using elaborate sentences instead use bullets, (c) Any procedure, analysis methodology must be in the form of flow chart in the standard / accepted format

- The first slide must include the group no, group members, name of the product and the mission statement
- The second slide must show 3 view drawing of the CAD, as it is on the day of the presentation
- The third slide to show design methodology in the form flow chart
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The fourth slide slide onwards to show : (a) Individual subsystem highlighted in CAD along with the name of group member responsible for design, (b) the detailed specification of the subsystem as of date, (c) detailed methodology used in the section or designing individual sub-system in the form of flowchart, (d) results obtained, (e) plan of action to improve the subsystem / system

Week 10

Present two iterations of conceptual design obtained through an optimization process.

The following FOUR submissions are required before 00 hours on Monday (next class)..

1) A presentation with the following slides

slide 1 : Description of 2nd version of conceptual design

slide 2 : CAD of 2nd version of conceptual design

slide 3 : analysis carried out using discipline # 1 and conclusion reached

slide 4 : analysis carried out using discipline # 2 and conclusion reached

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second last slide : Description of 3rd version of conceptual design due to analysis shown in slides above

last slide : CAD of 3rd version of conceptual design

2) A a soft copy of the report incorporating how conceptual design is evolving as explained in an

iteration as shown in (1) above. Improvements indicated during last presentation must be incorporated

3) A1 sized multi-coloured poster for the user. It should be such that the intended user is able to identify the use of the product

4) A1 sized single coloured poster for examiners. This should indicate how the product has been designed in the form of flow chart.

Week 11

1. Discuss the 2 iterations, methodology, reason for design change.
2. Prepare for final presentations..

Each group hands over the following material on *****, before **** Hrs to Aero. Dept. Office.

(a) Three hard copies of your CONSOLIDATED [Report](#) : The [report](#) must be as per the format available on the department web-page. The body of the [report](#) must start with the mission statement leading to conceptual designs and then to a suitable [conceptual design](#) through iterations as given in Appendix A

(b) Two hard copies of A1 sized posters : One of the posters should be for a layman, explaining the features of your product. This can be a coloured poster. The other poster should explain the CONSOLIDATED methodology (flow chart) you have followed while designing the product and very brief specification of the product. This poster should be of only in one colour

(c) A soft copy of the CONSOLIDATED presentation which one of your representative will give on Thursday, 3rd Nov. afternoon: This presentation is expected to be of last 45 minutes (including Q&A session). It should not be more than 20 slides. There should be at least one slide for each of the item given in Appendix A

Appendix A : The essential items required in the design [report](#) and presentation

- (i) mission statement, its importance
- (ii) at least two conceptual designs and their qualitative/quantitative comparison
- (iii) objective function (performance) of the product being optimized, design variables, constraints, conflicts
- (iv) design methodology as flow charts
- (v) series of conceptual designs (there must be at least three of them) arrived at
- (vi) analysis carried out and results obtained including the discussions. The relevant (applicable) details such as meshes / elements, type of simulations, boundary conditions, initial conditions, gains fixed, parameters used are required to be reported.
- (vii) status of the current [conceptual design](#)
- (viii) front view, top view and side of the product from CAD with as many details as possible

- (ix) advantages and limitations of current design
 - (x) future developments suggested
 - (xi) conclusion
 - (xii) list of references, data sheets, papers, books, simulation tools you used
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Week 12

Final evaluation (50% weightage). Based on

1. Posters (peer evaluated)
2. Presentation (2 examiners unconnected with the course)

Example evaluation

Mission Statement: Human powered aircraft for a wealthy enthusiast (Group # 1)

Criteria	Marks out 10
The "Mission Statement" is clear and meaningful	
Conceptual designs (there must be at least two of them) seem meaningful. They are not contrary to the laws of physics, and capable of satisfying the mission statement	
The parameters (variables which cannot be changed by designer), design variables (the variables which can be changed by the designer) and the cost/objective function (for optimizing the design) with the constraints on them are clearly stated	
The preliminary design chosen is based on one of the conceptual design with qualitative or quantitative arguments	
The final conceptual design has evolved after at least three iterations through quantitative (but not necessarily high fidelity) analysis	
The design team has shown willingness to explore new subjects/topics necessary for the design project	
The design is not lopsided (i.e. some aspects are given more weightage while others are neglected or side lined)	

The team has used supporting arguments, information which is technically sound	
The text, figures, tables, in the report readable and clear	
The activity is worth at least “15 hours x no of team members” worth of effort?	
TOTAL	Out of 100

Projects (2016-17)

1. Human powered aircraft for a wealthy enthusiast
2. Modular spacecraft deorbiting mechanism
3. Aerial fire extinguisher in urban environment
4. Bullet taking a curved trajectory in horizontal plane
5. Recoil-less quad-rotor for firing bullets
6. Small drone for indoor surveillance
7. Intelligent self-aligning umbrella
8. Tiny drone for reconnaissance of in-house targets
9. Flying taxi as a vehicle for urban transport
10. An aircraft model for demonstrating Phugoid mode