

AOE 4065/4066 Airplane Design W.H. Mason

Office: 224-13 Randolph

Office Hours: 11-12 Mon, 10-11 Tues, 2-3 Wed, 1-2 Thurs
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Class web page:

http://www.aoe.vt.edu/~mason/Mason_f/SD1.html

What We're Trying To Do:

from former Engineering Dean and President,
Paul Torgersen:

“In teaching engineering design, we require students, either individually or in small groups, *do engineering.*”

What the heck is this?



Objectives:

Our objectives for this class:

- The design *process*
- Engineering methods in real life
 - this is not the same thing as calculations
 - iterations/revisions required!
- Engineering *teamwork* and projects
 - trick: individual responsibility in a group
- Effective *communication*
 - within the team
 - external Design Reviews and Reports
- ***Airplane design*** (what we really signed up to do)

Each actually deserves its own class

Today

- The Projects and the Selection Process
- How the class is going to work
- “Max” Moga and the F-22
 - if we get the video to work
- A simple homework, due Friday
- What’s next for the next 3 classes

Projects for 2009/2010

- AIAA Team Undergraduate Design Competition:
 - Alternative Fuels and Environmentally Friendly Aircraft System (8 students/team)
- A Human Powered Airplane (HPA) (8 students?)
- Piezoelectric controlled UAV (design/build/fly)
 - 4 students with 4 from ME
- Boeing DARPA ESM Project? (4 students)
- DBF support project (4 students)?
- NASA Competition?

Review: Our Objectives (ABET)

1. Design an aerospace vehicle system using the *design process*.
2. Compile data, compare and assess current aircraft capabilities against a specific design requirement (*the mission statement*).
3. Use design requirements and observation from Objective 2 to define specific aircraft configuration features - *generation of aircraft concepts*
4. Estimate aircraft size, weight and thrust required by the concepts to satisfy mission requirements.
5. Do an engineering analysis to assess an aircraft design's potential to meet given design requirements.
6. Make pro/con charts comparing design concepts against the desired design metrics - *select a "preferred" concept*
7. Do parametric analysis to select design variable values (span, *t/c*, etc.).
8. Work on a multidisciplinary design team.
9. Make informal design review and formal design presentations.
10. Write an engineering design report.

A Key Thought on Design

You may never design an airplane, *but*:

- “shaping up” the problem, figuring out the right questions
- collecting the key information
- making quantitative/qualitative trade studies
 - pro/con tables with quantitative ranking
 - carpet plots/parametric analysis
- using engineering-based analysis to make decisions
- recognizing social, legal and financial considerations
- selecting and refining the preferred concept

These are universally valuable, *this is* engineering

Typically taught only in design?

Typically how the class works:

- Several individual assignments, laying the groundwork
- Some current events presentations by 2-person groups
- Initially, some lectures common to all teams
- Then by teams:

1st semester: Conceptual Design

- establish several concepts that satisfy the RFP
- downselect to two concepts at the mid-term review
- pick a preferred concept in the final presentation

Use the laws of nature to justify your selection

2nd semester: Preliminary Design

- using the preferred concept, do the preliminary design
 - > refine and lots more detail/analysis
- document with final report and presentation

Textbooks (?)

Textbooks are for reference, specific information - peruse them, we don't specifically lecture from them.

- pdf files of class presentations are on the class web site
- Kirschbaum's Design Layout Guide
- Information Sources Guide: through Mason's homepage, or:
 - <http://www.aoe.vt.edu/~mason/Mason/ACinfoTOC.html>
 - The AOE home page is: <http://www.aoe.vt.edu/>
- Software and manuals - web page, linked from the class page
- "Course Text": Raymer
- ordered several sets of Roskam's 8 Vol *Airplane Design*
- ordered several copies:
 - Niu's book, *Airframe Structural Design*
- also good: Moir/Seabridge, *Aircraft Systems: Mechanical, electrical, and Avionics Subsystem Intergration*

Grades

1st semester: 40% individual, 60% team

- individual/team assignments
- mid-term and final design review presentations
- final report

2nd semester: 20% individual, 80% a team grade

- individual design and report chapter contributions
- mid-term and final design review presentations
- final report

Each Semester:

- Peer reviews by team members and instructor assessments also used to adjust grades

Honor Code

- *All material from other sources must be cited, including drawings, plots, pictures - immediately where they are used*
- *Permission must be obtained to put copyrighted material on the web*
- *All members of the team are equally responsible for the contents of design reports.*

Infractions are honor court violations

Other Housekeeping

- Class Web Page
- Schedule
 - gets confusing - pay attention
- Syllabus

Another odd concept



Stay up to date

- *Aviation Week*
- *Aerospace America (AIAA)*
 - *the Daily Launch email newsletter*
- *Flight International*
- the Web:
 - The Google Institute of Technology

What is this?



The Design Lab

After hours access by Hokie Passport

- computers
- drawing tables
- conference/work tables
- file cabinets
- mailboxes (in student lounge)

You have priority - others use as available

Lab Computers:

- Many CPUs in the design lab: Need account/password
- *fill out account forms*
- Networked to laser and color inkjet printers ??
- “Standard” software available
- Some restricted software may be put on these computers
- A plotter (up to D size) and a scanner

Electronic Design

- Final reports/presentations will also be electronic
 - see class web page for previous design report
- CDs will be turned by each team at the end of the year



A Homework Problem: Due Friday

What's Next (3 classes)?

- Talk about the Design Process in General
- Airplane Design in Particular
- Review? Why Airplanes Look Like They Do

Lets not have
Hokies involved
in anything like
this



F-22 demo Video?



YF-22 first flight



For current info:

Check the class web page

Schedule Available on the web page as a **pdf** file
calendar (frequently revised/updated)



Our Expectations?

Conduct yourself as an engineer:

- good communication/attitude/team member
- turn work in you can be proud of
- be reliable: do what you say you'll do
- demonstrate engineering profession honesty

Suggested Reading:

- “The Unwritten Rules of Engineering,” by W.J. King

Note: from the “Rules of Engineering”

1. Engineering is done with numbers. Analysis without numbers is, at best, only an opinion.

Let's fill out some questionnaires and take the admissions exam



- Read the rest of the charts by downloading them from the class website

The “Design Problem”

Aerospace is International

- Airbus is competing head-on with Boeing
- Japan is entering the aerospace business
- almost all commuter aircraft made outside the US

International Competition is Fierce

- Designing for Competitive Advantage
is the new watchword

Global Teaming is Now Standard

The View on Current Crop of New Engineers

Industry:

- don't have the mind set of "engineers"
- Boeing: We are no longer satisfied customers

This is not specifically Virginia Tech,

- *this a general assessment*

John McMasters, Boeing:

- New hires must serve excessively long apprenticeships before they become fully productive (*i.e.*, we must fill significant gaps in their education as well as providing job-specific training).
- We see too many new graduates with an inadequate grasp of what *engineering* (as contrasted with *engineering science*) is and how one practices it, particularly in the currently evolving industry environment.
- There seems to be a dislocation in “value systems” between academia and industry. Academic success (as measured by test scores and grade point average) shows no discernable correlation with subsequent performance on the job (as measured by salary growth and perceived value of an employee to a company)



National Research Council:

- Formal Educational System: “does not prepare students to keep current with engineering advances throughout their professional practice—few engineers have been taught to expect *continued learning* to be part of their careers. Many have never read a current engineering paper or made an in-depth library search, do not read their journals.”



So What's a Good Designer?

- #0: Always asking questions, curiosity about everything
- #1: Great associative power: lets them recognize and draw upon parallels in other fields for ideas (implies that designers have eclectic interests and often roam far afield in science and engineering - said to be “interested in everything.”)
- #2: Presented with a problem, always seem to respond with a flood of ideas, then look to interactions with associates to sort out the good from the bad
- #3: Strong inner directed personalities: are sure of themselves, able to accept with equanimity the guffaws at the poor solutions they propose along with the kudos for success

from NRC publication,

“Improving Engineering Design, Designing for Competitive Advantage”

The Current Approach

- Some purely AE teams
- Often a team is joint with another school or department
- Design Projects:
 - Some teams do the AIAA design competition project
 - Often teams do other “special” projects
- We will have Freshmen join the teams in the Spring Semester

from Benjamin Cosgrove, Boeing Commercial Airplanes Head Engineer:

“New engineers today have an overdependence on computers. They have a tendency to believe everything the computers tell them. You throw in a bunch of numbers and out comes the answer, and therefore it must be right. Just because it comes out on a computer printout doesn’t make it right.

I should be able to go to a wing designer and say to him or her, “We need to change the gross weight by 5%. How does that change the bending moment of the new wing?” If that person runs a calculation on the back of the envelope and says it’ll do this, that’s fine with me. But when someone says I’ll give you the answer in three days when it comes out of the computer, that’s an overdependence. You’ve got to have practical thinking people who know what they’re doing.”

