Hands-on Learning to Make Theory Reality - Experiential Learning for Aerospace Engineering

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What was your favorite thing you made during your studies?

What did you learn?
Common experiences with experiential learning

**Positives**
- Improved learning retention
- Good educational experiences
- Increased technical learning (‘hard’ skills)
- Teamwork / connecting to others (‘soft’ skills)

**Challenges**
- Lack of scaffolding / guidance
- Support for equitable teamwork

Skilling Laboratory @ Aeronautics & Astronautics

**Makerspace / Laboratory**
- Prototyping
- Laser cutting & 3D printing
- Soldering/electronics
- Flight simulators

**Teaching space**
- Supporting Aero/Astro classes & events
AA100: Introduction to Aeronautics and Astronautics

An entry point into Aero/Astro engineering
AA100: Introduction to Aeronautics and Astronautics

- 3 units
- Offered every Winter
- Undergraduate required Aero/Astro depth course
- Mix of mostly **freshman** (often finding degree path) and **sophomores**
- **Applied physics, hands-on** activities, and **real world** examples.

**Illustrates principles** of fluid flow, flight, and propulsion, lift and drag, aerodynamic performance, orbits, maneuvers, space environment, and propulsion for spacecraft, history and challenges of aeronautics and astronautics.
AA100 at a glance

Gender identify

Academic year

Racial identity

Disability identify
How to engage students in learning?

And make opportunities to apply learning & be creative?

...and maybe even some fun too!
Exploring ways to add experiential learning

Collaborating to design and implement practical activities

Non-experiential
Theoretical focus

Winter 2019 etc

Balsa plane team
challenge

Winter 2021/22

[Remote learning]
Wing simulation

Winter 2020/21

REDESIGN

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Experiential learning: Making a (balsa wood) plane

- **Applying** calculations and theory to create something new
- Rapid **design iterations**
- Testing with practical **experiments**
- **Teamwork** and connection
- Developing **confidence**
- Technical writing
Trying (and failing!) as a team

Forming **communities of practice**

“People who engage in a process of collective learning in a shared domain of endeavor”

Learning by doing

- Teams of **4-5 students** (self-assigned)
- **Issued same materials**
  - balsa wood weights, knife, ruler, glue, plasticine
- Safety materials (cutting mat) & online safety training course (hand tools, sharps)
- Step by step instructions
- **Grading matrix**
- Technical report **templates** with prompts
What theories did students need to know?

- **Aerodynamics**: lift and drag
- **Wing theory**: aspect ratio, angle of attack
- **Flight**: maximum range, lift-to-drag ratio, gliding angle
- **Stability**: center of gravity, pitching moment

https://sites.google.com/site/aerodynamicpropulsion/wings-measurements/wing-calculation
https://www.youtube.com/watch?v=uReN2Nd1yuo
Logistics

- November 2021: Hara and Travaglini initiated the hands-on project idea
- December 2021 (during winter vacation): Hara did his own balsawood design and build. AA departmental approval of the purchase of goods ($700-$1000)
- January 2021: CAs design and test; reordered parts; Travaglini developed design documents and report templates
- February 2021
  - One course: introduction to Skilling Lab and initiate group project
  - Open timeslots: students had access to Skilling Lab
  - One course (a week later): demonstration of the balsawood aircraft (featured by Stanford News and SOE)
  - A week later: students submit final report
Legitimate engineering and communication skills

Applying Learning
Bloom’s Taxonomy
*Using knowledge to create*

Legitimacy
Preparing for professional work
*Emulating industry*

Legitimate engineering and communication skills

- Teams create design proposals
- Set materials
- Test plane
- Final flight test!
- Written report

Novel plane design
Redesign
Test
Design prototype plane
Use equations
Know equations
Applying aeronautical skills through a design loop

Beneficial outcomes

- Positive course feedback
- Community building (especially post remote-learning)
- Encouraging access to engineering identities
- Opportunities for connections outside department
Opportunities for making happy memories!
Where next?

- **Revisit, review, redesign**
  Student feedback, course evaluations, intuitions

- **Tailor to the next class**
  Explore improvements, add teamwork assessment element

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**Fall 2022**
- Review
- Think & talk

**Winter 2023**
- Redesign
- Lab/faculty recruitment

**FLIGHT TEST!**
- Community building event
Try it out in your course!

**Try out some small adds**
- Low resolution prototype (mastery grading; completed/not)
- Pitch ideas as teams (scaled down to design outline only)
- Design iterations (plan, test, redesign)

**Explore pedagogy**
- Redevelop course and/or learning objectives (CTL resources)
- Use Bloom’s Taxonomy to find practical activities (apply/create)
- Contact industry/professional organization and emulate a typical task
Want to know more?

School of Engineering video + more info
THANK YOU!

Experiments in Learning - Experiential Learning for Aeronautical

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