The Final Lecture

or

"Hit the deck!"

Paul Pounds

1 June 2015

University of Queensland

But first…

Some house keeping

Calendar at a glance

Week	Dates	Lecture	Reviews	Demos	Assessment submissions
1	2/3 – 6/3	Introduction			
2	9/3 – 13/3	Principles of Mechatronic Systems design			Problem analysis
3	16/3 – 20/3	Professional Engineering Topics			Analysis peer review
4	23/3 – 27/3	Your soldering is (probably) terrible			
5	30/3 – 3/4	Q&A	Progress review 1		
Break	6/4 – 10/4	Q&A			
6	13/4 – 17/4	Radio module selection			
7	20/4 – 24/4	Aircraft flight	Progress seminar	25% demo	
8	27/4 – 2/5	Q&A			
9	4/5 – 8/5	NO LECTURE IN WEEK 9		50% demo	
10	11/5 – 15/5	Projective geometry	Progress review 2		
11	18/5 – 22/5	Q&A		75% demo	Preliminary report
12	25/5 – 29/5	Q&A		50% demo	
13	1/6 – 5/6	Closing lecture		Final testing	Final report and reflection

You are here

Wheels down!

Lab matters

- Almost at the end!
  - Project submission tomorrow!
  - Toolbox hand-in tomorrow!
  - Lab cleanup tomorrow!

Hopefully, everyone has survived the ordeal.

FAQ Roundup

- **How is the final demo different from the incremental demos?**
  - Aside from the mark cap? No different - just the same.

- **Will it ever end?**
  - Yes, on Friday. Then you are free.

Final report

- Due on Friday
  - *Really, really soon now!*
- Your report must have:
  - Max 5 + 1 pages of explanation/writing
  - Bibliography/math/sims/figures/budgets/etc. in the appendices
  - Analytics
  - Incorporate comments from preliminary report

Final report

- Do not exceed 6 pages of written content
  - Go nuts with the appendices for bibliography/math/sims/figures/budgets etc.
  - There is no such thing as too many pictures
  - Don't try to sneak written content into the appendices – *seriously?* I won't read them.

Exception: you may include a short personal reflection in the appendices, if you wish.

Final report

Remember:

- The preliminary report comments are a guide only, and **NOT** a foolproof sure-fire guaranteed way to get 100% on the final.
- You are expected to make changes and improvements that reflect continued development and changes made since wk11

Final report

- Hand in via the assignment slot, in hard copy by 23:59 pm Friday.

- I’m still happy to sit down with you and go through your preliminary report comments!
  - This is a free, complimentary service, and all part of our value-added customer commitment!

Final demo schedule

- Wednesday 3rd
  - 14:30-15:00 Setup
  - 15:00-15:30 Team 3
  - 15:30-16:00 Team 2
  - 16:00-16:30 Team 4
  - 16:30-17:00 Team 1

Thursday 4th

- 15:30-16:00 Setup
- 16:00-16:30 Team 7
- 16:30-17:00 Team 8
- 17:00-17:30 Team 5
- 17:30-18:00 Team 6

Marking schema

- Product demo is 60 per cent of class grade
- This is subdivided into:
  - Build quality – 10 marks
  - Launching – 40 marks
  - Landing – 30 marks
  - Circuit – 20 marks
  - Dummy drop – 10 marks

  Possible to get 110 marks out of 100.

Functionality and scoring

Launch Functionality	**40/40 Points**
Aircraft leaves the deck	15
Aircraft clears the high bar	25

Protip: Passing the class pretty much requires a successful launch

Landing Functionality	**30/30 Points**
Aircraft touches the landing deck	10
Aircraft at rest on deck	5
Aircraft at rest on deck ‘stable wheels down’	5
Aircraft does not exceed 16 G	1
Aircraft does not exceed 8 G	2
Aircraft does not exceed 4 G	3
Aircraft does not exceed 2 G	4

Circuit Functionality	**20/20 Points**
Aircraft touches the stern deck	5
Aircraft at rest on the stern deck	5
Aircraft at rest on deck ‘stable wheels down’	5
Aircraft does not exceed 8 G	2
Aircraft does not exceed 4 G	3

Structure of the final demo

1. Meet at the room at designated time
2. Build quality assessment
3. Setup and config
4. Testing
5. Marking and PAF
6. Commiserate/celebrate at Red Room

Build quality

- Marks are given for the quality of fabrication
  - Neat and tidy assembly
  - Smooth operation of moving parts
  - Clean design and professional finish
- Worth 10 per cent of project mark
  - **Print outs**: budget, code, drawings, etc
- This will be assessed prior to your demo
  - Detailed best-practice guidelines and marking rubric available on Blackboard

Build quality

Grade Band	Electrical (35)		Mechanical (35)		Software (20)		Finish(10)	
Excellent (85-100%)	Clearly designed and well thought-out optimised construction, high-quality of manufacture and defect-free. Professional-quality work	35	Clearly designed and well thought-out optimised construction, high-quality of manufacture and defect-free. Professional-quality work	35	Tight well-structured code, useful comments, easy to read and understand without explanation	20	Beautiful construction, intuitive and pleasurable to use	10
		33		33		18		9
Very Good (75-85%)	Neatly laid out and ordered, orderly sensible circuit routing and layout, high-quality assembly with few defects	29	Solid construction with no excess or deficit of material, tightly-toleranced components, rock-solid assembly, good materials selection	29		16		8
Good (65-75%)	Solid design and construction, few soldering or assembly defects, indications of methodical layout design	25	Clear indication of design and care in construction, well-fitting parts, and robust assembly, few design or fabrication problems	25	Comprehendible, organised and methodical, easy to follow with minimal effort, could be maintained without help	14	Straightforward to use, sensible interface, clean and appealing, everything in its place	7
Satisfactory (50-65%)	Obtuse layout, some suboptimal design elements, construction problems or defects but serviceable	21	Chunky or weak in parts, but not fragile or bloated, inappropriate materials, rough fits, unrefined but serviceable	21	Structured and understandable with effort, unhelpful variable names or functions, difficult to make sense of without explanation	12	Unhelpful markings, unintuitive interface, poor attention to detail, unattractive	6
		17		17		10		5
Poor (25-50%)	Shoddy design/construction, low-quality soldering with a high rate of defects, unlikely to be reliable	13	Rickety, rough and cobbled together; poorly fitting and shoddily assembled, unlikely to be reliable	13	Chaotic and incomprehensible, impossible to modify or maintain, even if it works	8	Frustrating, ugly and unusable	4
		9		9		6		3
		5		5		5		
Very Poor (0-25%)	No attempt made	0	No attempt made	0	No attempt made	0	No attempt made	0

Exhibition demo

- Groups that demonstrate a complete circuit during testing, may be invited to present their work at an exhibition on Friday

- The exhibition is for glory, not marks
  - No points will be awarded, no matter how good or badly you do

But also...

Aviator wings

Teams that complete a wheels-down circuit under 8-gs during the 100% or exhibition demos will receive the coveted METR4810 Autonomous Aviator Wings

And now…

The tables are turned

SECaTs

- SECats opened last week and will be open until the end of semester
  - You should have gotten an email about it
  - Why not take this opportunity to use your laptop/mobile device to complete it *now*?

But while you're doing that…

SECaTs

- In this class, I have been evaluating you.
  - Now is your chance to evaluate me.
- I have been asking you to show me methodical engineering design.

You should expect no less of me!

SECaTs

So, in fairness, I would like to present…

METR4810

An (Abridged) Design Case-Study

The full version was 60+ slides long for parts 1 and 2 out of 7

… and probably boring.

The process

1. Specification
2. Research
3. Analysis
4. Implementation
5. Validation

Specification

What is it I’m supposed to be doing, anyway?

Design Specification

Codified in the “learning objectives”:

1. TEAMWORK

1.1 Be an effective team player.

1.2 Understand your responsibilities in a team situation.

2. DESIGN

2.2 Design an electromechanical and software based product.

2.3 Identify and break down personal and technical problems in product design.

2.4 Implement a complete design cycle.

2.6 Choose appropriate design strategies.

3. PROJECT

3.2 Apply project management skills.

3.4 Produce, implement and devise product plans.

3.5 Deliver a product on-budget and on-time.

4. COMMUNICATION

4.2 Use ICTs for information retrieval and dissemination.

4.4 Write formal reports

4.6 Chair and attend formal meetings.

4.7 Verbally present your design ideas

The underlying goals

Read between the lines:

Get students to experience doing a real **engineering design** project…

… on a **challenging problem**…

… that requires **teamwork** to be successful…

… leading to real world **social dynamics**.

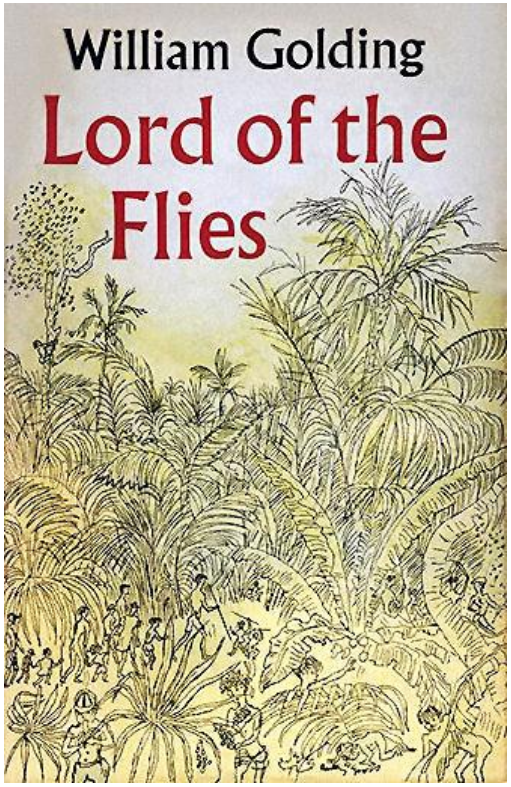
Why is this hard?

Challenging problems?

Social dynamics?

Team work??

<u>This is a recipe for disaster!</u>



And that's before I actually try to teach design!

Research and analysis

Lessons and insights from previous classes

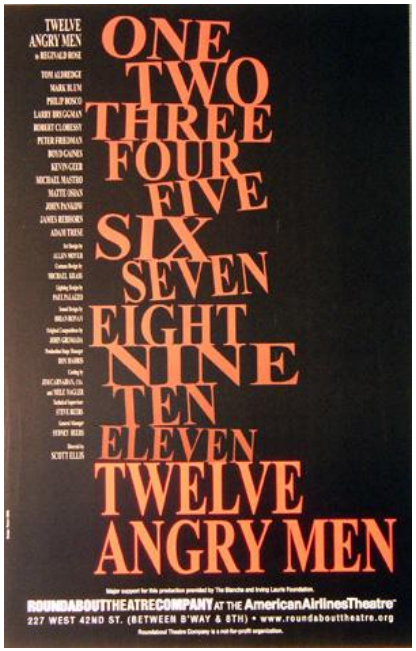
Prior experience

Lessons from METR team projects past:

1. Students are overly familiar with classic projects – Robocup, Micromouse, etc…

2. Friend-based teams can go *catastrophically* wrong ☹

3. PAFs can be unfair and brutal
   – "12 Angry Men syndrome"



Prior experience

5. Product-based courses exhibit boolean failure modes
   – Small errors on the last day are lethal
6. Students rigidly follow design methods and suggested schedules to their detriment
7. Students *never* get started early enough
   – Even when you tell them to!

Translate into design constraints

- Project must be awesome
  - Easy to be motivated by intrinsic drivers
  - ie. for the joy of engineering, not just marks!
- The project must be properly scaled
  - Suitable to teams of four students with mechatronics backgrounds
  - Tough task, but not impossible (with teamwork!)
- The class structure must reward hard work
  - Don’t reward slackers; identify problems early

The idea

- Drones! TOPGUN! TOPGUN DRONES!
  - Better believe I love the ‘80s and aircraft!
  - Also, the X-47B has been doing amazing things

Tom Cruise has a need for speed…

The idea

Big focus on practical elements

- Testing and demo logistics
  - Where can we avoid the effects of wind?
  - What space is big enough to fly in?

- Carrier top is small, compact, easy to store
  - 2014 race track tiles take up too much space
  - 2013 miniature coastline had to be tossed

Comparative analysis

There are many other candidate projects, but I won't discuss them here, as they will likely be used for future years and are **TOP SECRET**

So… yeah… carrier drones!

Meeting the spec’

Why autonomous carrier landing?

- No reuse of previous project work
- Four clear, independent mechatronics tasks
  - Mechanics, aerodynamics, sensing and control
- Naturally motivated analysis and integration
- More focus on design, less on fabrication
  - Lower time burden and better learning value

Implementation

Key design subsystems:

1. Sensible assessment
2. Making it challenging
3. Making it fun

Sensible assessment

Assignments as a *de facto* project plan

- Design analysis to get you thinking early
- Regular freeform milestones every 3 weeks
- Big milestone in the middle
- Early preliminary report submission to get you working on report *before* crisis point

Sensible assessment

- Reports differentiate students
  - Allows good students to survive bad groups
  - Safety net options – designed to reduce angst
- Multiple chances for most assessments
  - No single assessment is ‘sudden death’
  - Recover marks from bad luck failings

Making it challenging

- Multiple competing objectives
  - Must use the synthesis step to find a solution
  - Duct-tape approach will not succeed
- Obvious approaches inferior to carefully reasoned approaches – rewards thinking
- Add challenges to test specific design skills
  - Good landing control vs simple robustness
  - Light-weight solution vs sophistication

Making it fun

- Just what makes something ‘fun’ is ineffable
  - But years of game design experience help!
- Sense of humour and consistent style
  - Little bit quirky, little bit silly, very polished
  - A little bit of theatre!
  - ‘Look and feel’ modelled on MIT Mystery Hunt

My team, <Entire Text of Atlas Shrugged>,
wrote last year’s hunt – great success!

Making it fun

Several key design features that elicit ‘fun’

- Well-defined objectives
  - You know what to do; clear project spec’
  - Collaborative puzzle-solving
- Multiple possible solutions – plane or vtol?
- Difficult but obviously achievable
  - Not futile; tangible reward for time put in
  - Early pay-off for effort (eg. get over the bar)

Results

How it went down

My philosophy

- Engineering is the highest, purest and most noble pursuit of the human experience
  - All else is artifice or drudgery
- You are training to be engineers, and this is a chance to actually practice engineering
- You are not your grade*
- There will be second chances

* They make me assign you a grade

The good, the bad, and fun details

I did some things well,

other things not so well

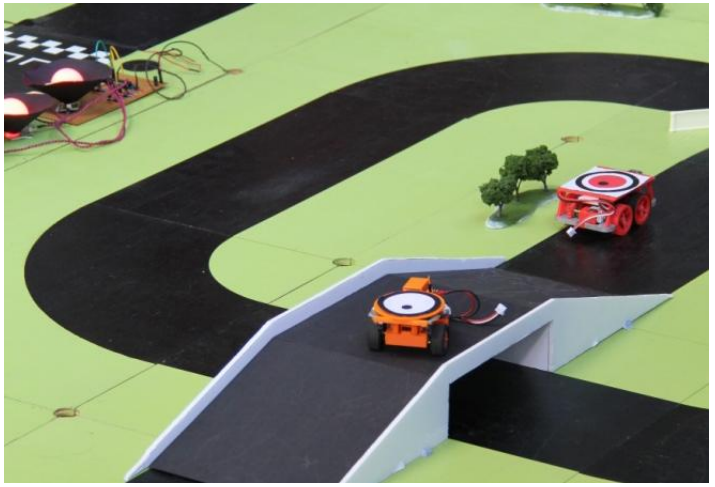
Previous years' feedback

Main strong points:

- Intellectually stimulating
- Learned a lot in the course

Main weak points:

- Class organisation/structure
- Availability of apparatus



This year

Several experimental changes:

- Incremental PAFs – spread over 13 weeks ✓
- ~~Teams not released until week 3~~ ✗
- ~~Advanced task spec not given until basic functionality is demonstrated~~ ✗
- Design analysis via Platypus instead of design brief

What I think I did well

- Kept it real
  - Treated you like Men and Women
- Cared about the stuff that matters
  - No stupid nit-picking about stuff
  - Told you what to really expect from industry!
- Used assessments wisely
  - Encourages thinking and keeps you on track
  - Rewards hard work and discourages freeloaders

"Let that which does not matter truly slide" – Tyler Durden

What I think I did well

- Useful experiences, fair grades
  - Toy problem, real analysis; no busywork
  - Focus on professional practice in industry
- Made time for students
  - Made myself available in the lab
  - Lots of one-on-one feedback
- Project well-organised, well-balanced
  - Very achievable task, but plenty of complexity

What I think can be improved

Things I *can't* change:

- Miserable clash with METR4900, CSSE
- Some team members were unreliable ☹

Things I *can* change:

- Tweak the structure of the first two weeks
- Better guidance for PCB batching

What you liked

- Incremental demos – very popular, wow!
- Multimodal lectures (optional attendance)
- Sense of humour (?)
- Coffee after Monday Q&A!

What you didn't like

- Collision with other classes assessments led to unnecessary time-optimisation stress
- Much concern about the "spirit of the rules"
  - Perhaps I should be more specific?
- Standards were high and feedback frank
  - Maybe too harsh?

Outcome

- This year has been slow to start, with low stress followed by high stress
- The launchers turned out to be a bigger challenge than most expected (me included)
- Most teams seem to have pulled it together

High hopes for testing day!

• • •

And now for something completely different

Behind the scenes

The making of METR4810 2015

Theme

- This year's theme was inspired by the 1986 Tom Cruise film TOPGUN
  - Instantly recognisable (to people over 30)
  - Simple, with good technical tie-ins
  - Strong images of cool flying machines and military technology

Theatrical introduction

- A splashy introduction gets students engaged
  - My way of saying “Hey, this isn’t just another class! This is gonna be awesome!”

2013 : Showed up in my full academic regalia

- Very popular, great result!

2014 : 3 minute Powerpoint animated intro

- Surprisingly negative feedback (?)

This year, I went for a much simpler approach

DIY aviator jacket

- Surprisingly easy to do a “fighter jock” jacket
  - Huski flight jacket
  - Aussie flag patch
  - RAF mission patches
  - Adafruit drone badge
  - “Remove before flight” tag

But most importantly…

- The 1980s taught me that aviator shades were a necessary and sufficient condition for being cool…

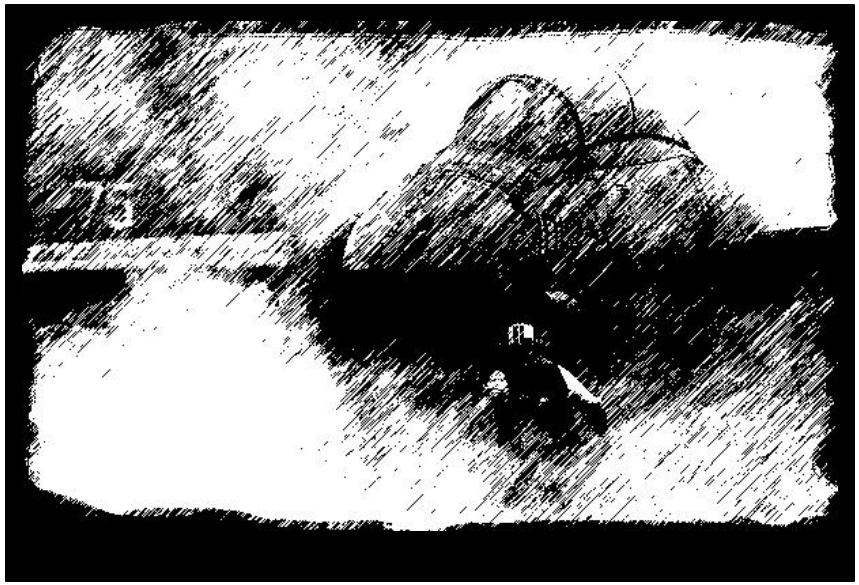
Visual design

- Obviously must riff on the TOPGUN logo for the class – “TOPDRONE” writes itself

- The internet conveniently provides three different TOPGUN fonts… why so many??
  - None of these fonts have numbers - wtf?

Visual design

- Wanted something that evoked an iconic tone, while also being ‘fun’ and easy to do
  - Charcoal sketch filter to the rescue!



Visual design

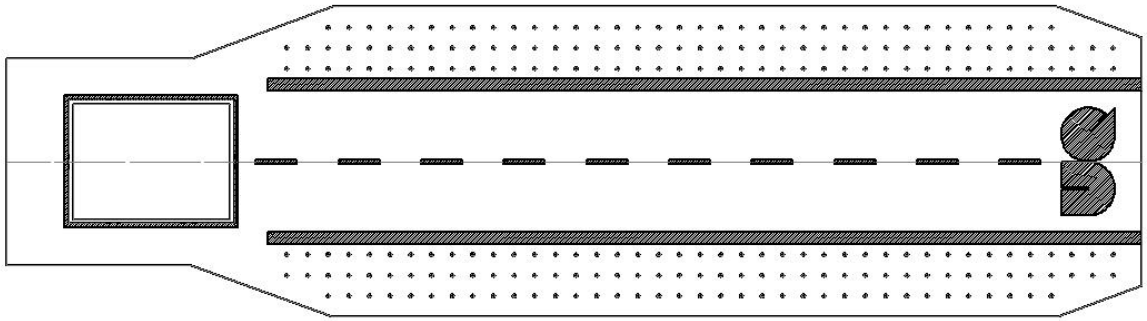
- The Autonomous Naval Aviation Academy patch is based on the real US Navy Fighter Weapons School patch

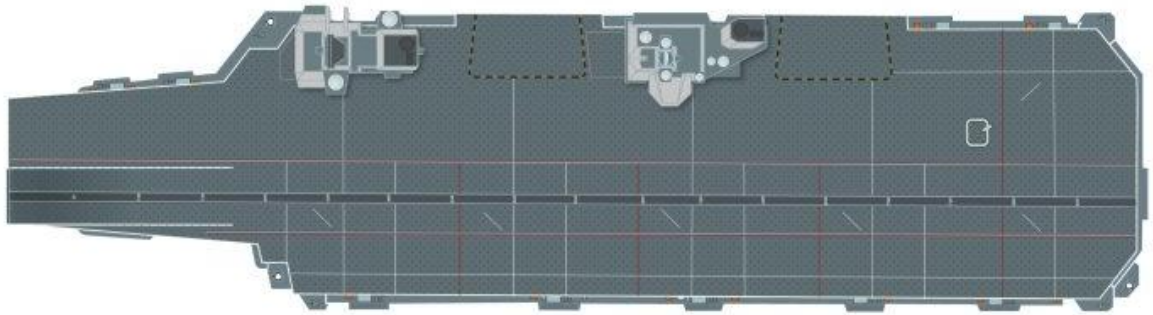
Carrier design

- Australia actually has two aircraft carriers, HMAS Canberra and HMAS Adelaide
  - But I think they look… uninspired

Carrier design

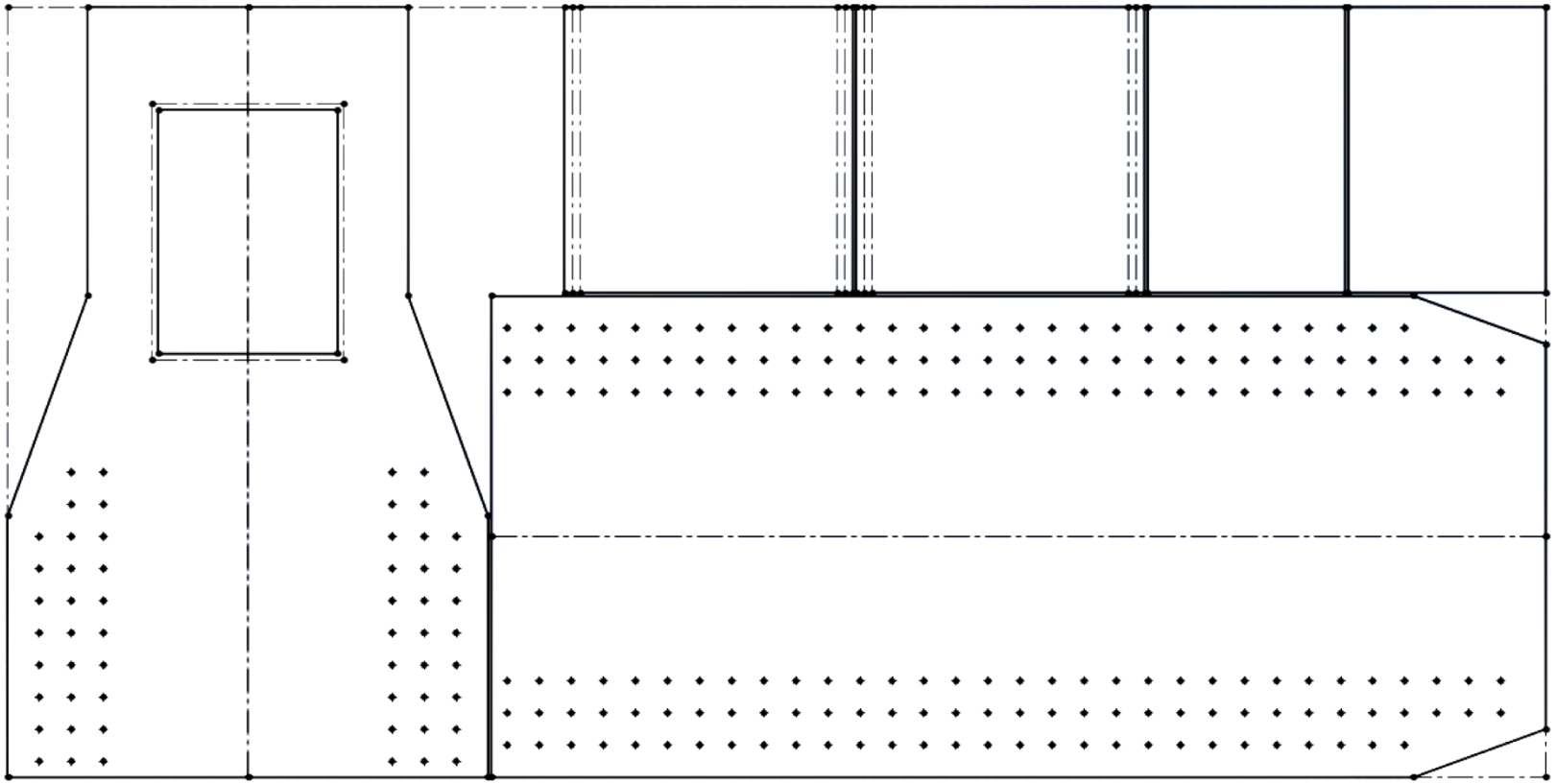
- Instead, HMAS Gatton is roughly styled on the Queen Elizabeth-class supercarriers
  - You get to build the island superstructure!





Carrier design

- The carrier top is cut from a single standard sheet of 12 mm plywood from Bunnings



Autonomous aviator wings

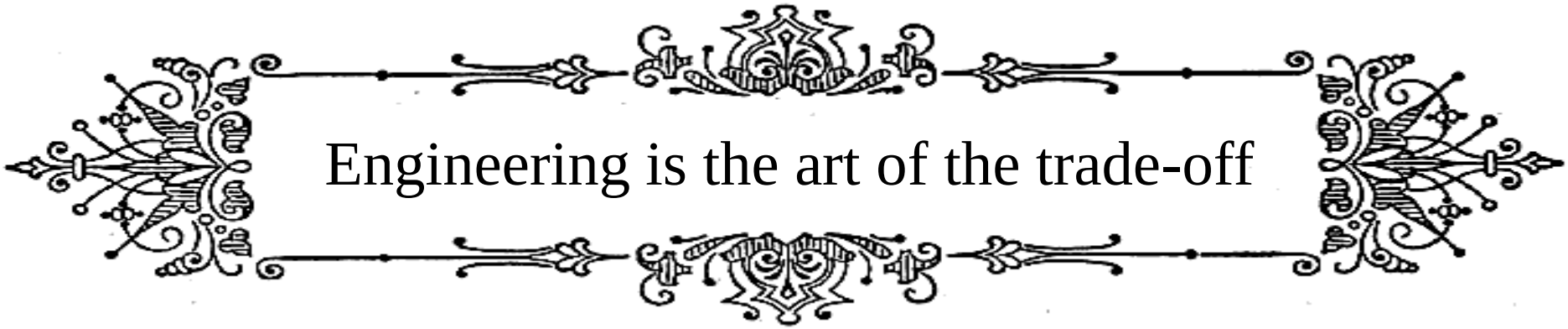
- The aviator wings based on a RAAF wings and FAA astronaut wings
  - Design, CAD and 3D printed all within 5 hours

Final thoughts

This class was never about building drones

This class was about starting along the path from being a *student* to being an ***engineer***.

The most important truth in your degree



Take-home points

- Think about things analytically, first
- It's rarely possible to optimise any one thing without regard for other subsystems
- You need to get along with your fellow engineers if you want to succeed

Conclusion

Have to wait until demo day!

Cast of Thousands

Dozens of people helped make this a success, but a few deserve particular recognition:

The *simply amazing* workshop guys:

Keith Lane and **Grant Tayles**

The *always helpful* **John Kohlbach**

And now…

Vote 1 Paul in 2015

Fun fact: If we don't get higher than 3.5 on Q8, we don't get paid!

METR4810

MECHATRONICS TEAM PROJECT II

MMXV

DON'T MISS THE BOAT

Starring Paul Pounds as Course Coordinator

Written and directed by Paul Pounds

Supporting Cast

Paul “Dangerzone” Pounds as Academy Instructor
Reuben “Birdeye” Styrdom as Air Boss
Timothy “Slick” Filmer as Red Team Flight leader
Nicholas “Takeout” Hourigan as Red Team RIO
Prof. Steve Wilson as Acting Course Coordinator
Dr. Michael Kearny as Backup Lecturer
Dr. Surya Singh as Trap Monkey
Peter Bleakley as Lab Director 1
Doug Malcolm as Lab Director 2

Produced by Paul Pounds

Original music by Paul Pounds

Camera and Cinematography

Camera 1	Dr. Surya Singh
Camera 2	Michael Eastwood
Key grip	Timothy Filmer
Gaffer	Nicholas Hourigan
Best Boy	Reuben Styrdom

Editing by Paul Pounds

Casting
Paul Pounds
Dr. Peter Sutton

Production Design
Paul Pounds

Art Direction
Paul Pounds

Set Decoration
Paul Pounds
Keith Lane
Greg Tayles

Costume Design
Country Road
David Jones
John Hanna

Makeup and Hair

Styling and grooming	Paul Pounds
Cosmetics	Paul Pounds
Assistant to Dr. Pounds	Dr. Surya Singh

Production Management
Prof. Paul Strooper
Dr. Peter Sutton
Prof. Steve Wilson
Dr. Surya Singh

Assistant Director
Prof. Steve Wilson

CGI and Artwork
Paul Pounds
Chris McKenna

Props and Practical Effects
Paul Pounds
Peter Bleakley
Dejan Subaric
Michael Eastwood

Visual Effects
Paul Pounds

Stunts

Stunt Coordinator	Paul Pounds
Stunts performed by	Paul Pounds
Safety Manager	Eddie Platt
Safety Supervisor	Harry Penkeyman
Electrical Safety	Dennis Bill
Site Officer	Martin Bull

Animal Wrangler
Dr. Surya Singh

Technical Support Group Manager
John Kohlbach

Workshop Unit 1
Keith Lane
Greg Tayles

Workshop Unit 2
Peter Bleakley
Ray White
Dejan Subaric
Doug Malcolm

Finance and Administration Unit
Prof. Peter Sutton
Dr. Surya Singh

Location and Facilities
Ian Mclough
Michael Shiel
Martin Bull
Ross Meakin
Liam Bull

Public Relations and Marketing
Izaeel Koh
Madelene Flanagan

Web Design
Hotpot Creative
Chris McKenna
Paul Pounds

Web Administration
Dr. Hanna Kurniawatti

Transportation
Dr. Surya Singh

No students were harmed in the teaching of this class

Special thanks to
Keith Lane
Doug Malcolm
Michael Eastwood

And all the students who made this class fun and enjoyable!

HOTPOT CREATIVE

The robotics design lab

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AUSTRALIA