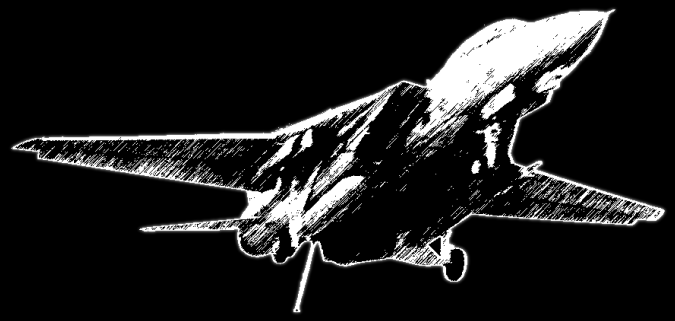
METR4810
MECHATRONICS TEAM PROJECT 2

Paul Pounds

2 March 2015




ROYAL AUSTRALIAN AIR FORCE
AUTONOMOUS NAVAL AVIATION ACADEMY

DON'T MISS THE BOAT

MTR4810

MECHATRONICS TEAM PROJECT II

MMXV

METR4810

- **What**: Mechatronics team project course
- **When**: Starting now, going until week 13
- **Where**: Hawken 50-c404 (mostly)
- **Who**: Cast of thousands
- **How**: Lots of work
- **Why**: Get experience developing complex mechatronic and robotic systems... and

because it's awesome

Specific class objectives

- Explore the trade-offs involved in complex mechatronic/robotic systems
- Gain experience in multi-variable analytical design synthesis
- Exercise practical cyber-electromechanical integration and trouble-shooting techniques
- Build interpersonal skills working in teams

A quick note on objectives

Your objective: 7/7

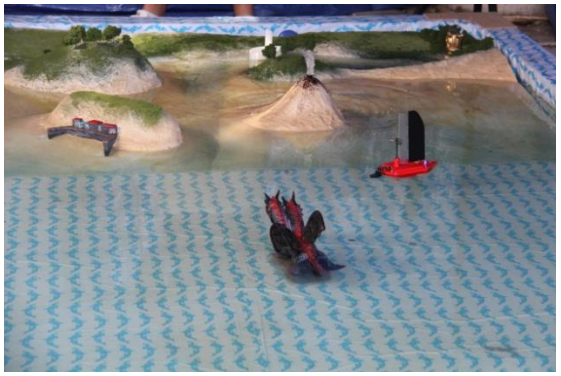
My objective: 5/5

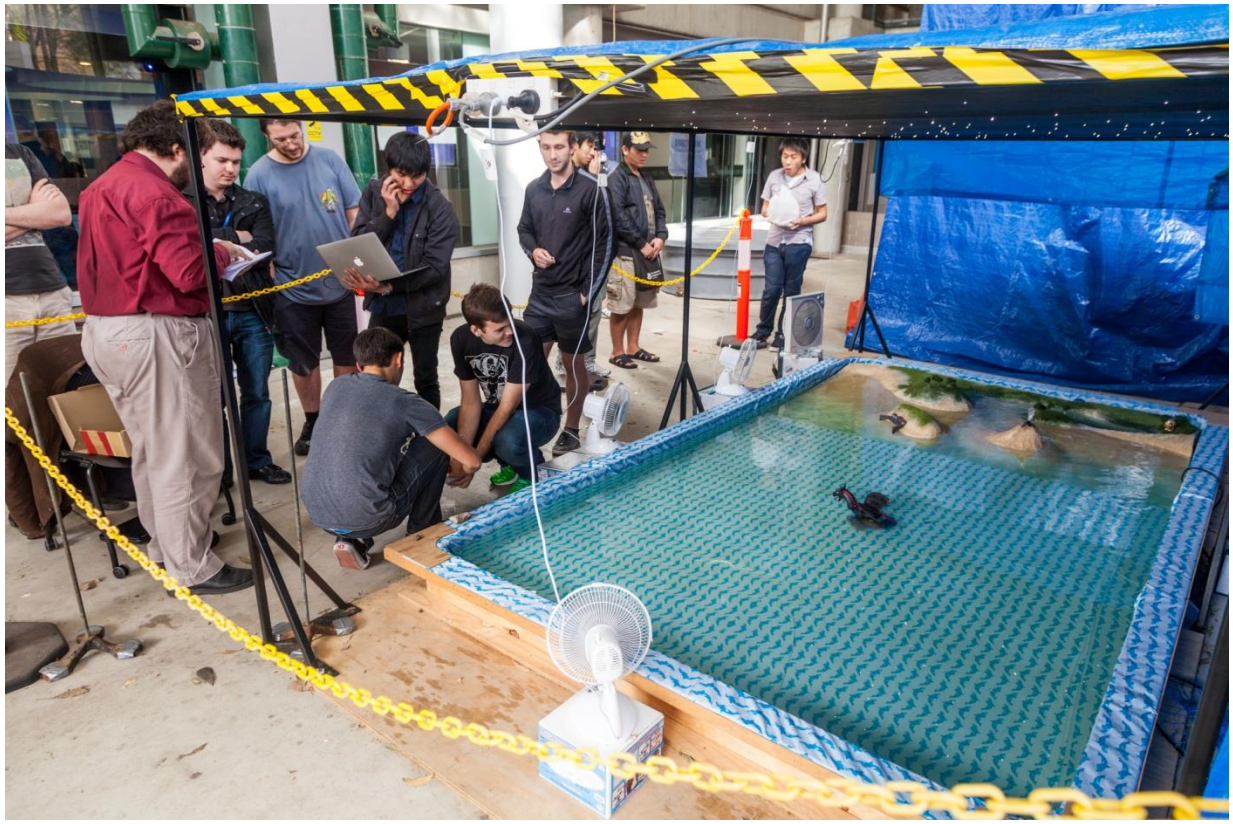
Shared priorities:

- Meet course objectives
- Reduce unnecessary work
- Have fun!

The Ghost of Projects Past

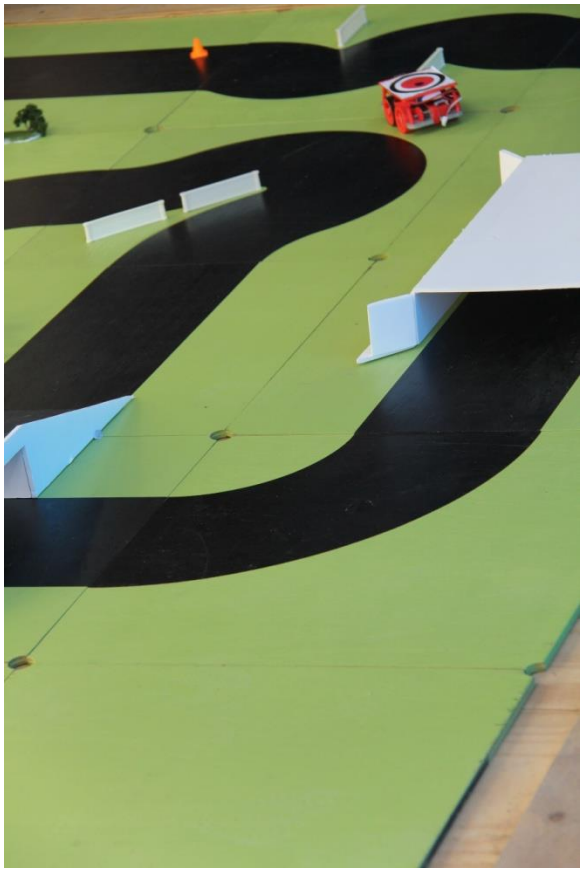
2013: Autonomous sailing and navigation





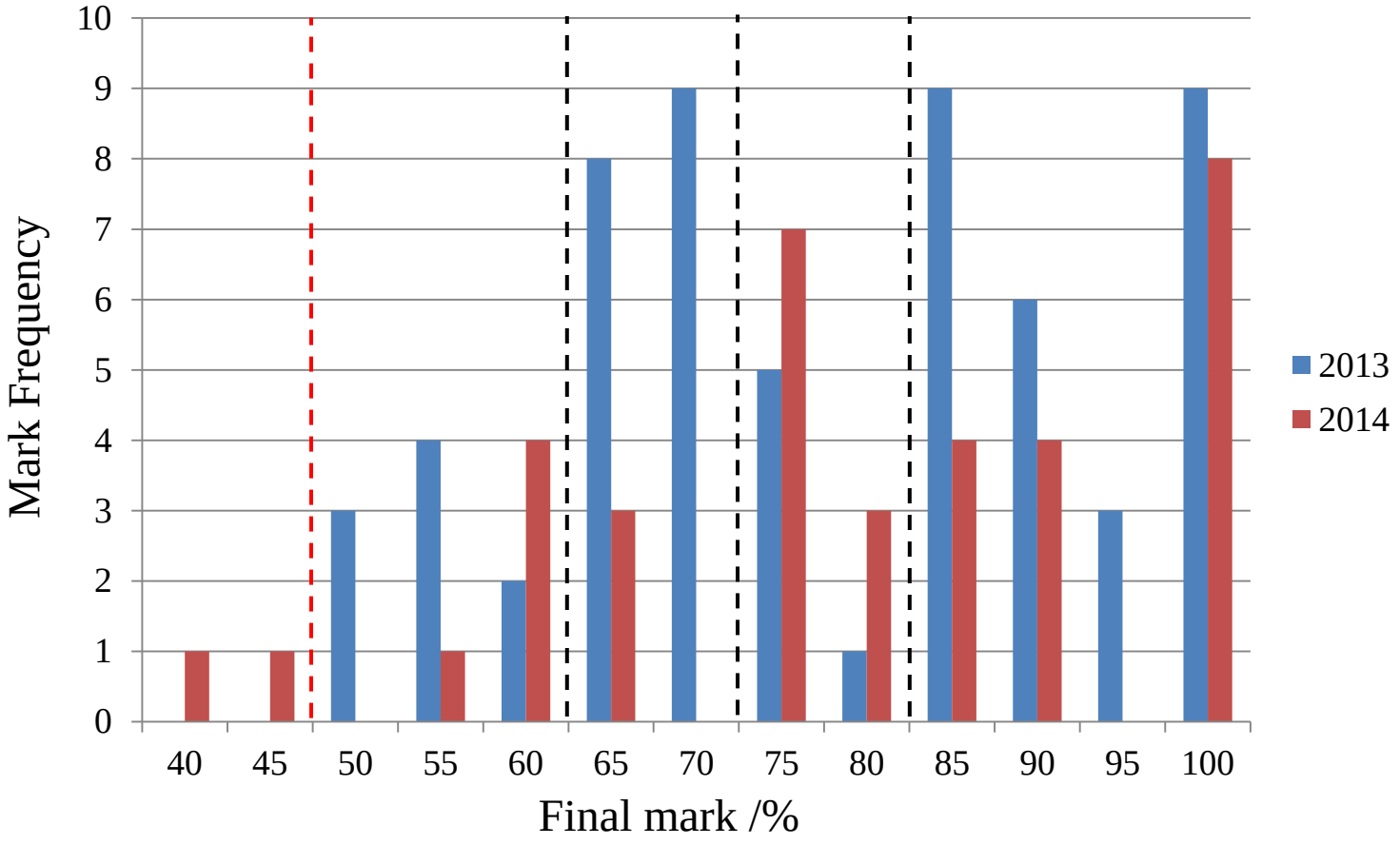
The Ghost of Projects Past

2014: Autonomous race car challenge



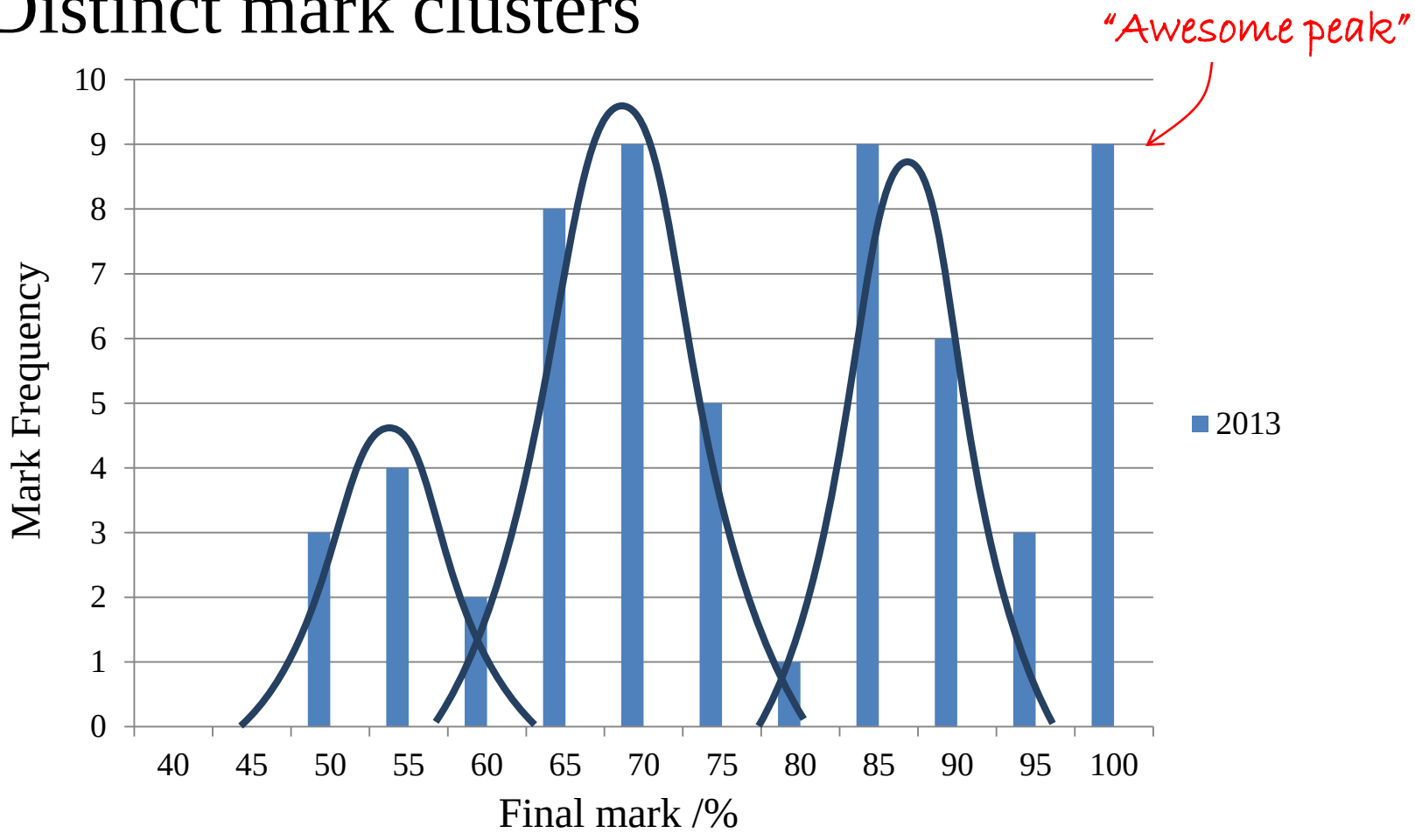
Assessment results

- Atypical mark spread



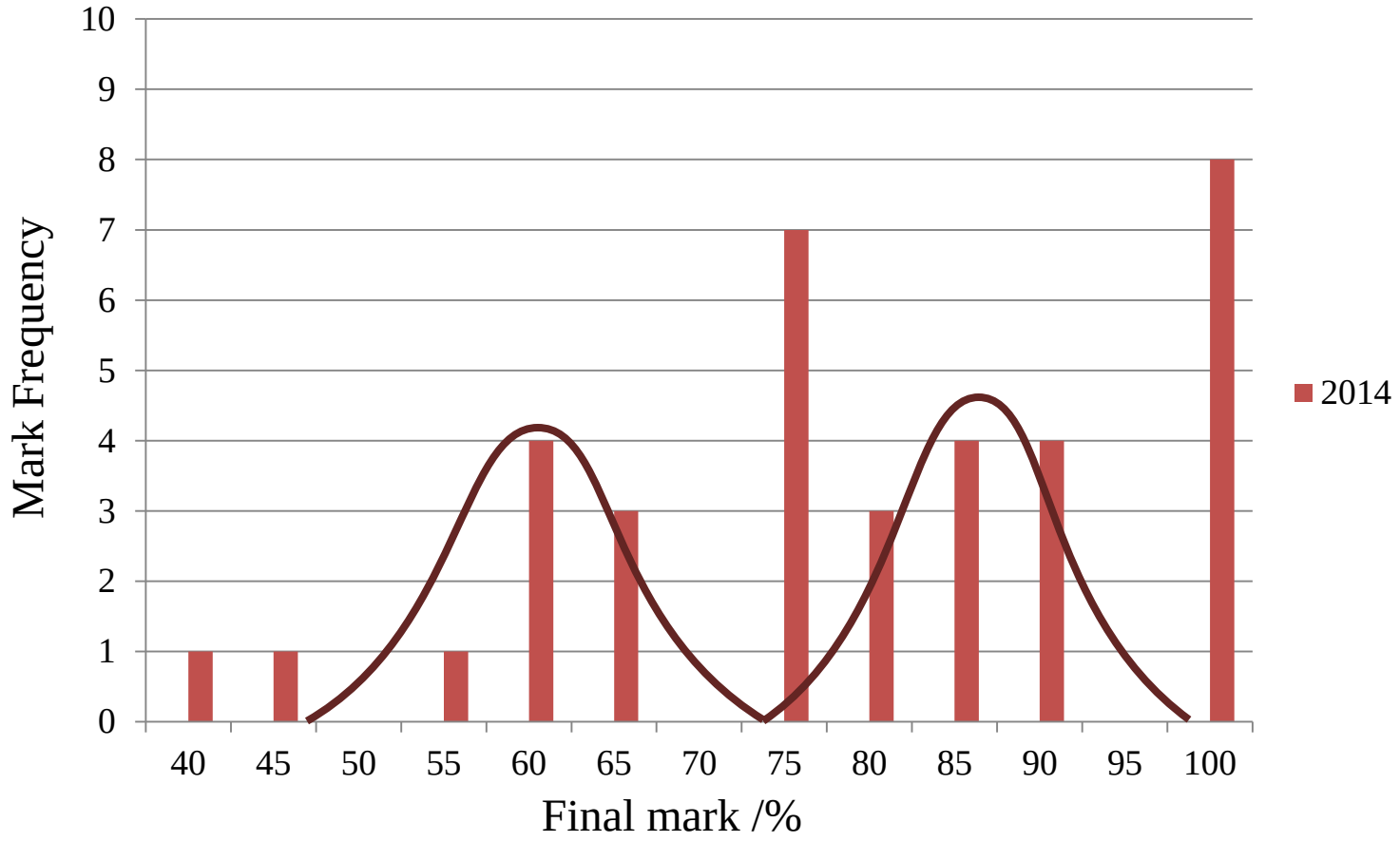
Assessment results

- Distinct mark clusters



Assessment results

- Mark clusters move over time:



Assessment results

- Or, put another way:

	Percentage of class				
	≤3	**4**	**5**	**6**	**7**
2011	0	19	26	22	33
2013	0	25	24	19	32
2014	**6**	14	8	**28**	**44**

Typical student outcomes

Student tend to fall into two broad groups:

The **Get-its** and the **Don’t Get-its**

- The Get-its work as a team, deconstruct the task rationally, try to understand the real problem, and implement a solution well
- The Don’t Get-its don’t

How to pass this course

- Work as a team
- Deconstruct the task rationally
- Understand the problem
- Implement a solution well

Enough about them…

Now it’s your turn

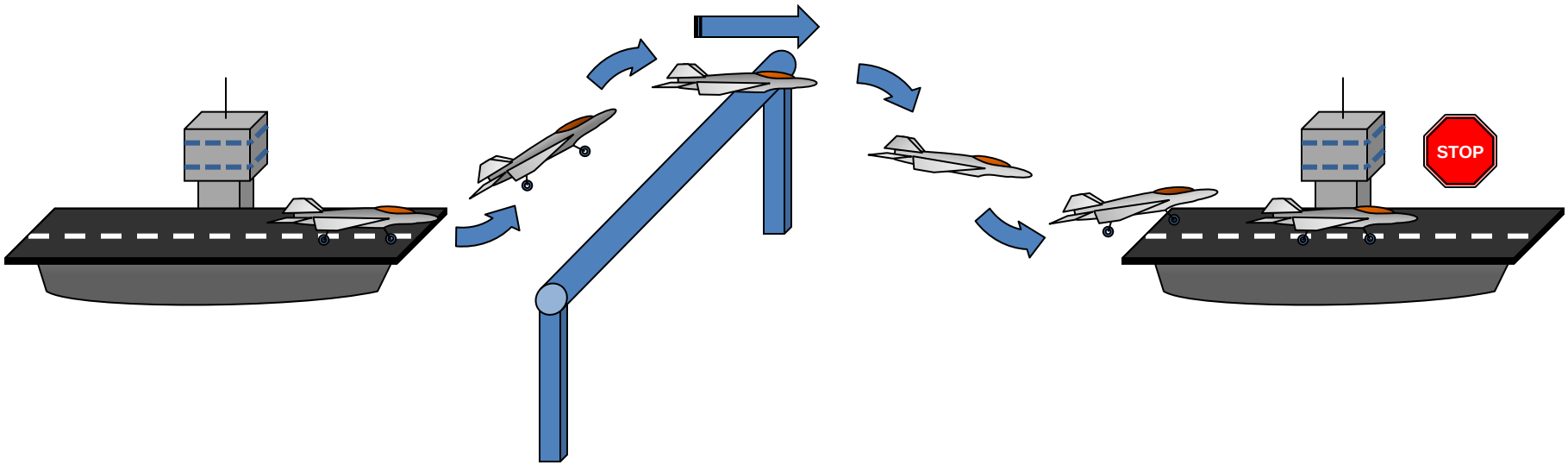
PART 1

The Project

The task

Build a system for launching and landing tiny drone aircraft from a miniature carrier deck

entirely autonomously



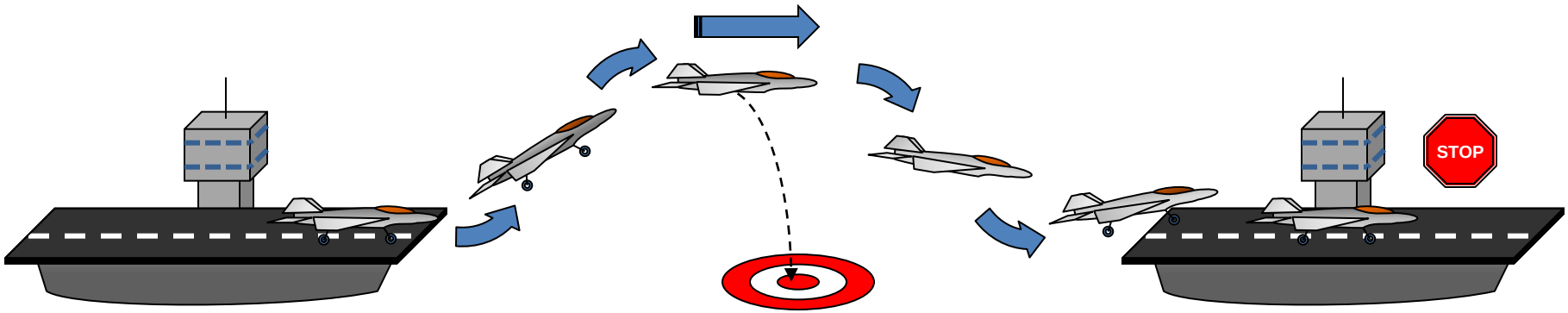
The task

- You will carry a “blackbox” sensor package to measure acceleration on launch/landing
  - You will get more points for completing the mission with lower Gs
- Staged testing
  - First launch, then landing, then a whole ‘circuit’

And if you can do all that…

Bonus task

Drop a ‘dummy’ payload over a fixed target



Key points

- You must build an aircraft, plus whatever it needs to take off and land on the deck again
  - If you can do it without a catapult or arrest system, or whatever, *that's ok*.
- The aircraft is the *least important* part
  - No marks awarded for the aircraft on its own
  - Marks only awarded for the system as a whole

Here are some numbers

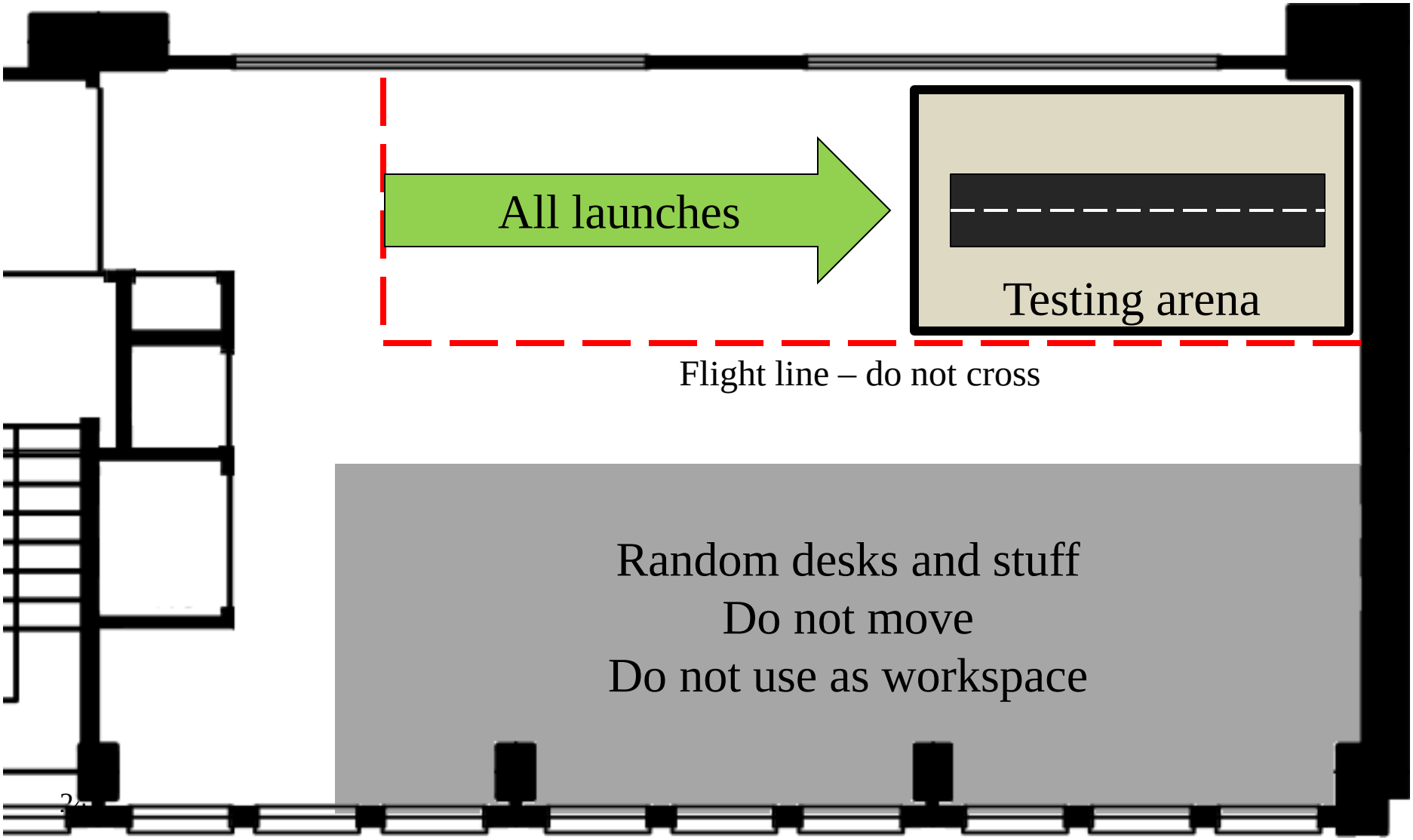
There are a few sensible limitations:

- Aircraft weight: <150 g
- Aircraft footprint: <750 mm diameter
- Catapult energy: <15 kJ
- Blackbox: 16mm x 16mm x 3mm, <10 g
- Height of high bar: 0.75 m < h < 1.5 m

Full details on restrictions and constraints are in the task specification document

Testing arena

MS-207 floor plan



Scoring

- Performance will be measured with a points system for demonstrated functionality
- Points to be awarded during scheduled demonstration sessions in week 13
  - Multiple attempts ok
  - 30 minute total time for set up and test

See rules and description document for details

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

PART 2

Assessment

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

What to expect

- Expect to learn new things on your own
  - You need will need to know *more* than just what you've been taught at university thus far
- Expect to apply real effort
  - This course **actively** punishes freeloaders
- Expect to be involved
  - Lots of peer assessment; PAFs can be ~***vicious***~
- Expect change
  - The specifications will change (intentionally)

A common theme

- Present analysis to justify design decisions
  - Motor torque/power calculations
  - Chassis structural loads
  - Clearance and tolerance of components
  - Microcontroller control cycle overhead
  - ... and such!

If you can’t back up it up with numbers, you‘re really just **guessing**

Deliverables

- Paper analysis and peer review – 10%
- Progress Review 1 – pass/fail†
- Progress Seminar* – 10%
- Progress Review 2 – pass/fail†
- Preliminary Report – pass/fail†
- Final Product Demo* – 60%
- Final Project Report – 20%

* Team assessment with peer and tutor weightings

† More on this later

Paper analysis – Part I

Due March 13th – 5% (2 pages max)

- Break down the design problem, determine its scope, requirements and constraints.
- Describe the key underlying engineering design challenges.
- Present a candidate solution, and explain how your approach will overcome them.
  - Analysis is golden.

Paper analysis – Part II

Due March 20 – 5%

- Assess other students' analysis
- Rate them from 1 to 5 for
  - Deconstruction and understanding of the problem
  - Quality and depth of analysis
  - Feasibility – i.e. would it actually work?

Parts I and II to be submitted and peer assessed in Platypus

Progress Reviews 1 and 2

Due 30 March – 3 April and 11 May – 15 May

- Tutor-mediated meetings
- Demonstrate your progress in the preceding period with tangible **evidence** of your contributions – eg. prototypes, code, etc
- Pass/fail mark based on quality of work and relative progress towards the goal

EXPECT NO MERCY.

Progress Seminar

Due 14 – 18 April (team assessment) – 10%

- Provide a 10 minute seminar outlining progress towards developing a solution to the problem.
  - Focus on the progress, not the approach
  - Each student present for roughly equal time
- Assessed by course coordinator and tutors

Preliminary Report

Due 22 May

- Describes the methodical analytical approach to solving the subtask, how it relates to the other subsystems within the project and the analytical process that was used in developing the solution.
- Show the formal, disciplined, quantitative engineering process followed, demonstrating the feasibility of the approach taken.

Final Product Demo

Due week 13 (team assessment) – 60%

- The Main Event – show your system works!
- Marks awarded for functionality, achievements and build quality.
- Hand in everything needed to make your system work, including documentation and printouts of design schematics.

Above all: Convince me you can *engineer*.

Final Report

Due 5 June – 20 %

- Identical to the preliminary report, but incorporating corrections and reflecting any changes from the last two weeks.
- Preliminary report will be returned with comments so that you have an opportunity to revise your work and improve upon it,

Just like in real life!

Incremental demos

- Spontaneous night-before failure of hardware systems is **brutal** and **unfair***.

  Just like real life!

- If your system is sort-of working early, you can have it tested in an incremental demo.
  - If the final demo mark is less than what was scored in an incremental demo, you will be awarded the incremental demo mark.

Incremental demos

- Scored just like final demo, but final mark is capped according to time left in semester
  - Week 7: 25%
  - Week 9: 50%
  - Week 11: 75%
- Incremental demos are by appointment only*

* Do not attempt a demo with an obviously non-functional system or you may forfeit future incremental demo privileges

Bonus task

- To try the bonus task, you must demonstrate a flight circuit during an incremental demo
  - The idea is to stay ahead of schedule
  - Doing it at the final demo isn't good enough
- Details of the bonus task will be disclosed once you have demonstrated a circuit

Pass/fail penalties

- Subpar (or absent) pass/fail submissions incur a deduction from your final grade
  - Project reviews: 5% each
  - Preliminary report: 10%
- These deductions are *cumulative*
  - If you were to fail all of them, your maximum achievable grade for the course would be 80%

PAF and TAF

- A substantial fraction of assessment is peer-moderated; others are tutor-moderated
  - Regularly adjusts results by up to **2 grades**
- It's vital your team recognise your efforts
  - A bitter or frustrated team means a low PAF!
- Ultimately, peer and tutor weighting is mediated by the course coordinator

Peer assessment

- At progress reviews, progress seminar and final demo, you will fill out PAFs
- Your demo mark will be scaled by all of the PAFs, according to a weighting scheme:
  - Progress review 1: 10%
  - Progress seminar: 20%
  - Progress review 2: 30%
  - Final demo: 40%

Calendar at a glance

You are here

Teams assigned here

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	???	Progress review 1		
Break	6/4 – 10/4				
6	13/4 – 17/4				
7	20/4 – 24/4		Progress seminar	25% demo	
8	27/4 – 2/5	Switch to Q and A sessions			
9	4/5 – 8/5			50% demo	
10	11/5 – 15/5		Progress review		
11	18/5 – 22/5			75% demo	Preliminary report
12	25/5 – 29/5				
13	1/6 – 5/6	Closing lecture		Final testing	Final report and reflection

Paul on travel week 1

Try to work ☺

Madness week

PART 3

Class Organisation

Blackboard and splashy website

- This class has a Blackboard page and a "splashy" outwards-facing website
  - If the two ever differ (which they won't), the Blackboard page is considered authoritative

Blackboard: learn.uq.edu.au/

Splashy: robotics.itee.uq.edu.au/~metr4810/

Platypus: metr4810.uqcloud.net/platypus

(If you've used Platypus before, your log-in should just work)

Weekly schedule

- Lectures – 2 hours once per week
  - Professional topics and Q&A sessions
- Practicals – 2 hours twice per week
  - Tutors available in lab (but 24/7 access)
- "Contact" – 2 hours twice per week
  - Time set aside for meetings, demos, etc.

Altium notes and soldering tutorials will be made available online (details TBA)

Class clashes

I am aware of some clashes with other classes

- Most notably METR4900
  - This will ruin your life – plan accordingly
- Any others I've missed?

All lecture content will be online

Major announcements go out via Blackboard

Lectures

- Boring, useless lectures help *nobody*
- I will endeavour to provide lectures that are educational, useful and (sort of) entertaining
- Lectures will be student-driven: you tell me what you want to learn about and I'll teach it

Lectures

- Lecture 1: Introduction to the project
- Lecture 2: Principles of mechatronics system design
- Lecture 3: Professional engineering topics
- Lecture 4: Your soldering is terrible (probably)
- Lecture 5: ???

Topics may be nominated by emailing me, and then voted for on a doodle poll

Some suggested topics

- Principles of aerodynamics
- Aircraft dynamics
- Projective geometry
- Computer vision
- Sensor-fusion and filtering
- Localisation
- Schopenhauer and philosophical pessimism

Teams

- Teams will each consist of four people
  - Except for when they don't
- Teams will each be assigned a tool kit
  - Complete kit must be returned ***or else***
- Work together! Contact sessions are set aside for team meetings and collaboration

Teams

- You will have to work with people you hate*

  Just like in real life!

- You may email me and request one person with whom you do not want to work

- Otherwise, teams will be allocated by magic
  - Teams will not be assigned until week 3

*If you don't hate them now, you will by the time you're done

Laboratory space

- Fewer students this year (Why? No idea!)
  - Space not so terrible ... I think
- Consequence: (still) be neighbourly
  - Lockers for project work under desks
  - Share space and resources
  - Get started early; consider how you can work most effectively in the final two crunch weeks

<eyeofsauron>

Laboratory space

- The laboratories are governed by the UQ risk management policy
- To work in the lab:
  - You **MUST** have completed the induction
  - You **MUST** have read the lab risk assessment
  - You **MUST** wear appropriate footwear
  - You **MUST** abide by all safety requirements
- If you do not follow the guidelines you will be barred from the lab

Laboratory space

- Just in case you forgot:
  - No eating/drinking in the lab
  - No sleeping in the lab
  - No non-METR4810 students in the lab
  - The lab is not for facebook/tindr/gaming/ socialising/having a life etc.
  - I am held personally responsible for the safety and condition of the lab and I get ***very*** grumpy.

So don't say you weren't told.

Laboratory space

- Keep the lab clean and orderly
- Cleanliness "warning light" system in effect
  - Status noted on Blackboard/class website

Green: Full speed ahead

Yellow: Clean up needed

Red: *Danger Will Robinson!**

Black: "*Uh oh.*"**

*Lab will go to limited hours until cleaned.

**Lab will be locked until further notice.

</eyeofsauron>

Keeping the lab tidy makes for a nicer place to work and makes it easier to get stuff done

The testing arena

- Politics and geometry have decreed that the testing arena cannot be in c403 or c404
  - Instead, it will be set up in Mansergh Shaw 207

- When people start testing, we will install netting to catch wayward aircraft
  - Let us know when you're ready to fly *before* you start testing

Working with the carrier

- Access to the carrier deck will be during scheduled practical sessions
  - Available other times by request
  - I cannot guarantee you access to MS-207
- Some simple rules:
  - You must wear rubber-soled, closed footwear
  - Do not lean against the supports or rail
  - Be SAFE with launchers and tiny rotors

Your attention, please

On that point…

Your attention, please

Look before you launch

- Use your remaining eye to ensure no one is in the flight line

Your attention, please

High speed blades are serious business

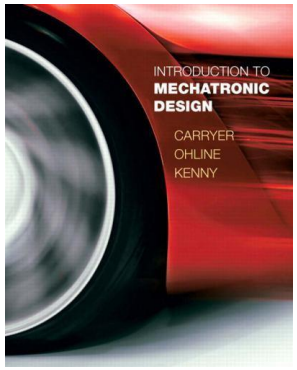
- Don’t connect a propeller/fan/rotor to power outside of a protective duct

Your attention, please

Be smart, be safe.

Resources

- Website
  - Everything will be posted on the Blackboard class website: (learn.uq.edu.au)
  - Better-looking class website will mirror course materials: (robotics.itee.uq.edu.au/metr4810)
  - FAQ document will be updated periodically
- Textbook
  - "Introduction to Mechatronic Design" by Carryer, Ohline and Kenny (recommended but not required)



Micronwings.com

- Southern hemisphere's leading purveyor of fine, hand-crafted miniature aircraft
  - Website full of great tips!

- They are kindly providing a group discount
  - Ask me for details before ordering
  - Orders *must* go through ETSG for the discount

(I am not affilliated with MicronWings in anyway, they're just totes awesome)

Knowledgeable people

- Course Coordinator and Chief Conspirator:
  - Paul Pounds
- Technical Staff
  - Peter Bleakley
  - Ray White
  - Dejan Subaric
  - Keith Lane
  - Doug Malcolm
- Tutors:
  - Reuben Strydom
  - Timothy Filmer
  - Nicholas Hourigan
- Emergency Auxiliary Temporary Back-Up Replacement Stand-in Teaching Faculty
  - Prof. Steve Wilson
  - Dr. Michael Kearny

Contact info

If anything is bothering you, bring it up *early*

- Rules questions
- Technical issues
- Ordering
- Assessments
- Group problems
- Enrolment
- Disenfranchisment with the sociopolitical gestalt

➢ Serious? Email first to arrange a meeting

➢ No? Just stop on by! (but email is good too)

Contact info

Who: Me!

Why: Questions, issues, concerns, ennui!

Where: GPS 78-529 or Wordsmiths

When: 10 to 4 – by appointment (or drop in)

What: Coffee or coke (either kind)

How: paul.pounds@uq.edu.au

What happens next?

- Send me group exclusion requests
  - Email me ASAP!
  - Groups will be posted start of week 3
- Attend the afternoon practical session in Hawken c404 Wednesday 18th March (week 3)
  - Toolbox handouts
  - Room induction, 3D printer induction

And start thinking about solutions!

Tune-in next time for…

Principles of Mechatronic Systems Design

or

"Striking a Balance is Making Everybody Equally Unhappy"

Fun fact: At the United States Navy Strike Fighter Tactics Instructor program, anyone who quotes the TOP GUN film is fined $5.

Questions?

?