LOGISTICS TYCOON

CRANES, TRAINS AND SUPPLY CHAINS

METR 4810

Prof P. Pounds

The University Of Queensland
AUSTRALIA

Logistics Tycoon

or

"Cranes, Trains and Supply Chains!"

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25 February 2020

University of Queensland

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 grade

My objective: 5/5 SECaT

Shared priorities:

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

What this class is

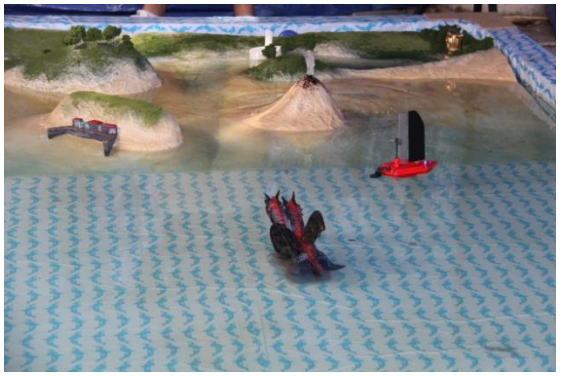
- Taking the safeties off
  - Real challenge, no hand-holding
- Unconstrained design, broad horizons
  - Very few limitations or constraints
- Focus on communication, design process, teamwork

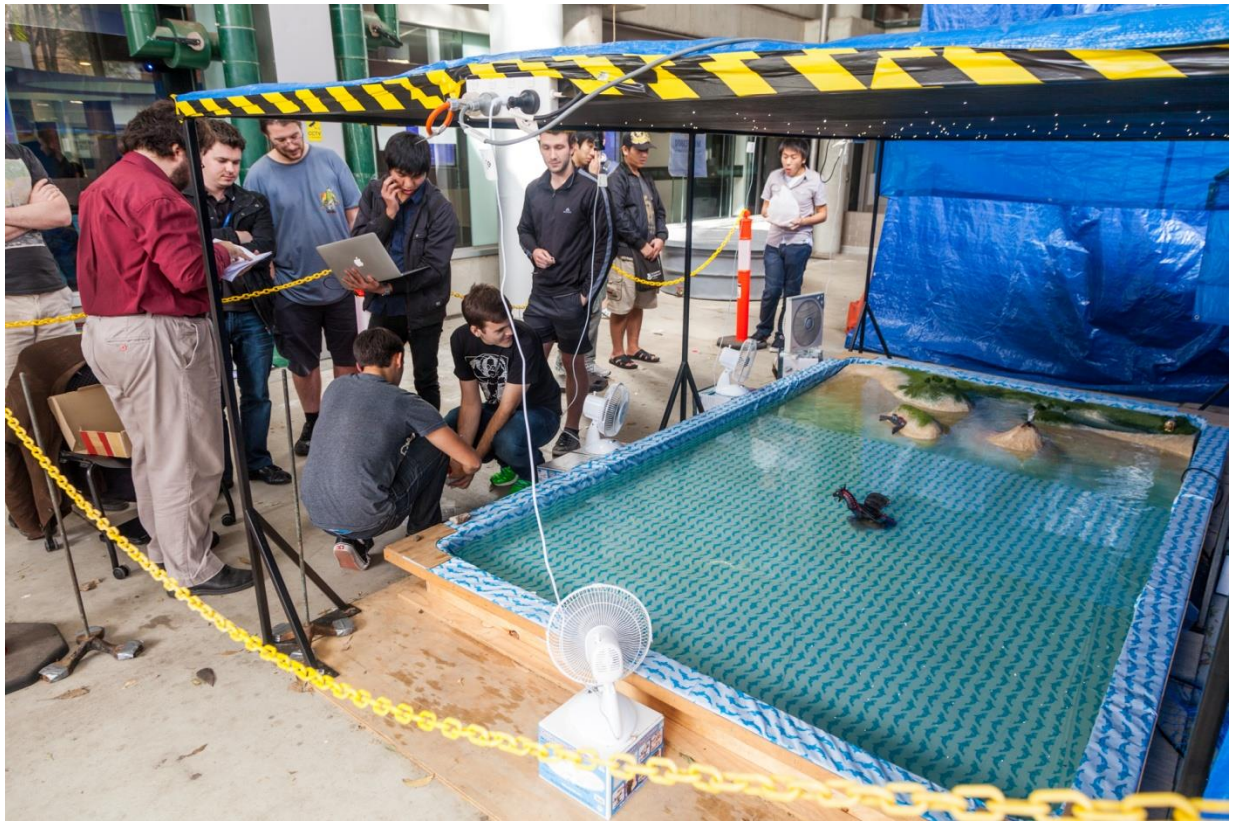
What this class is not

- Not about the project (not really)
  - It's about how you go about solving it
- Not teaching you technical engineering
  - You already know how to do math, etc.
- Not giving you one single, clear path
  - It's scary out there, and much is unknown

The Ghost of Projects Past

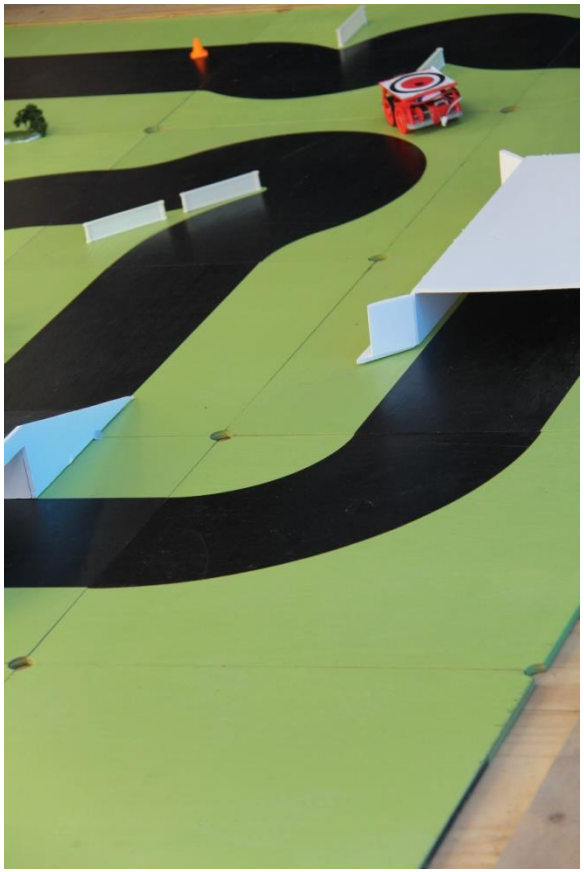
2013: Autonomous sailing and navigation





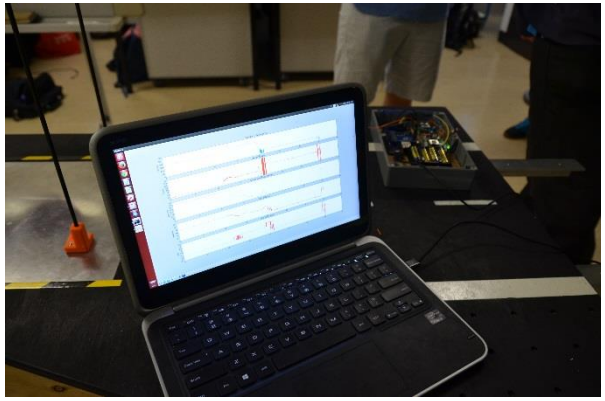
The Ghost of Projects Past

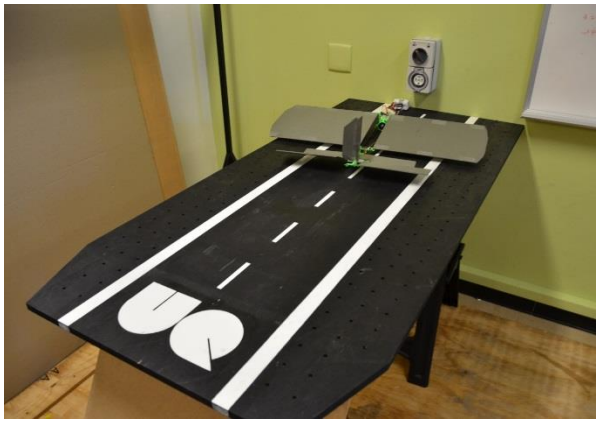
2014: Autonomous race car challenge



The Ghost of Projects Past

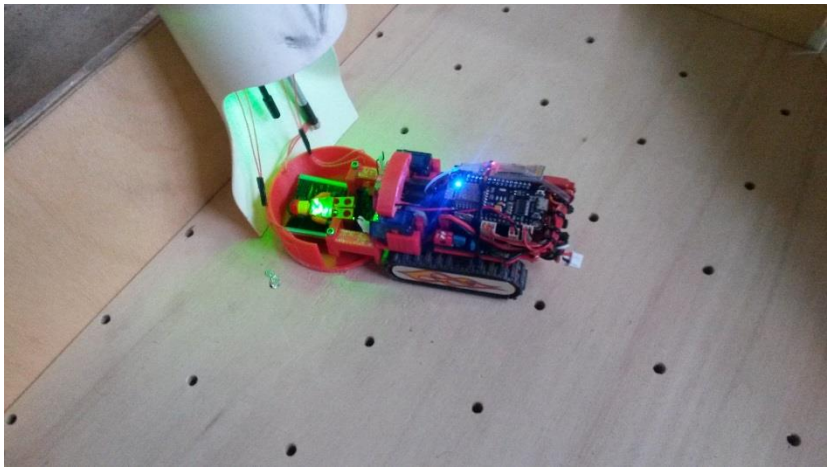
2015: Autonomous Carrier Operations

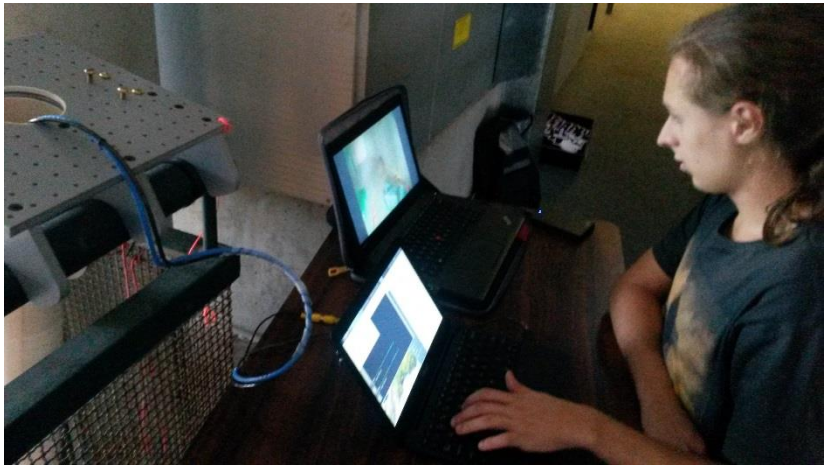




The Ghost of Projects Past

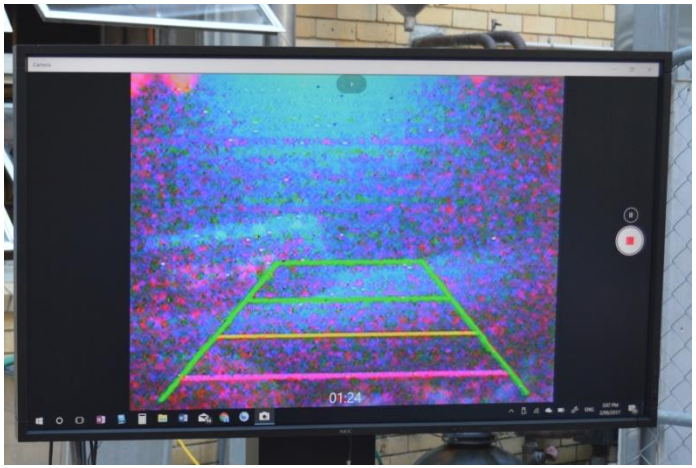
2016: Subterranean Mine Rescue

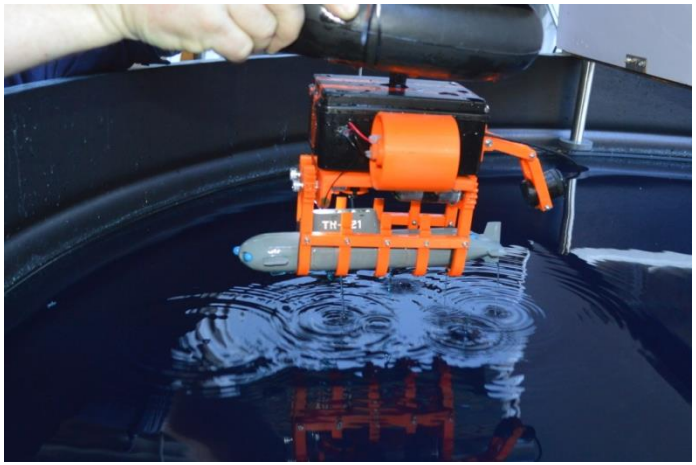




The Ghost of Projects Past

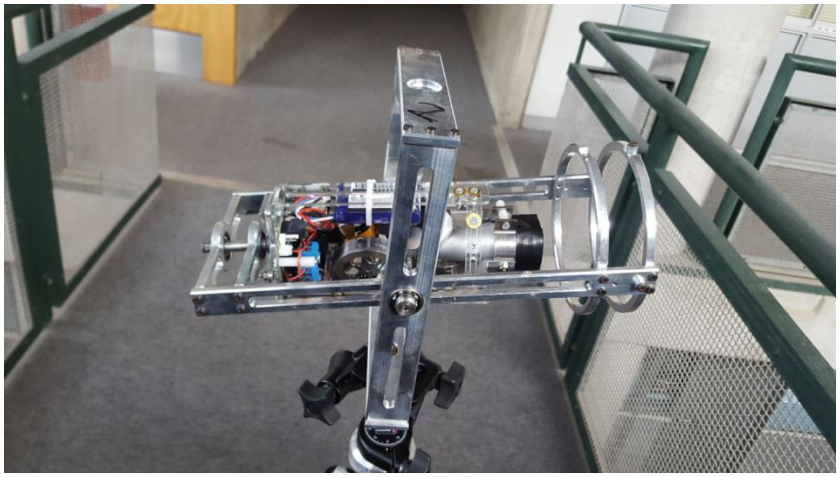
2017: Sunken Submarine Recovery

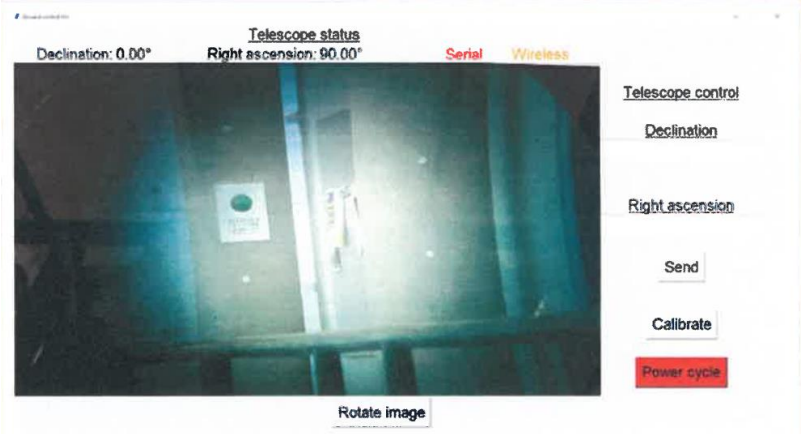




The Ghost of Projects Past

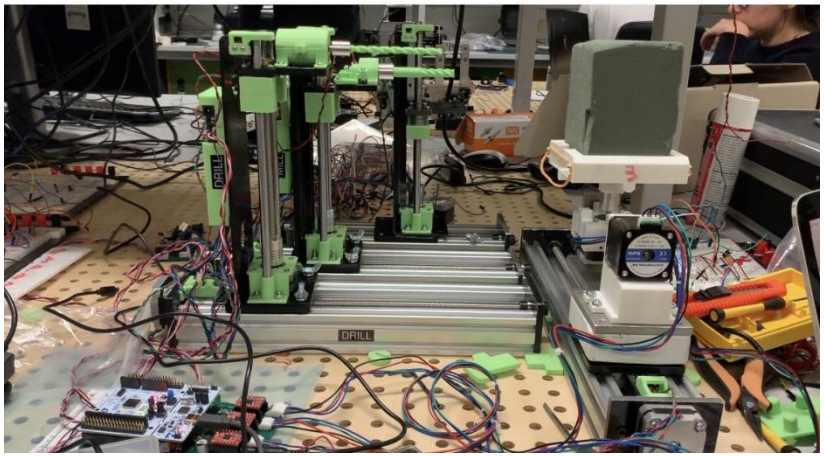
2018: Exoplanet Space Telescopes

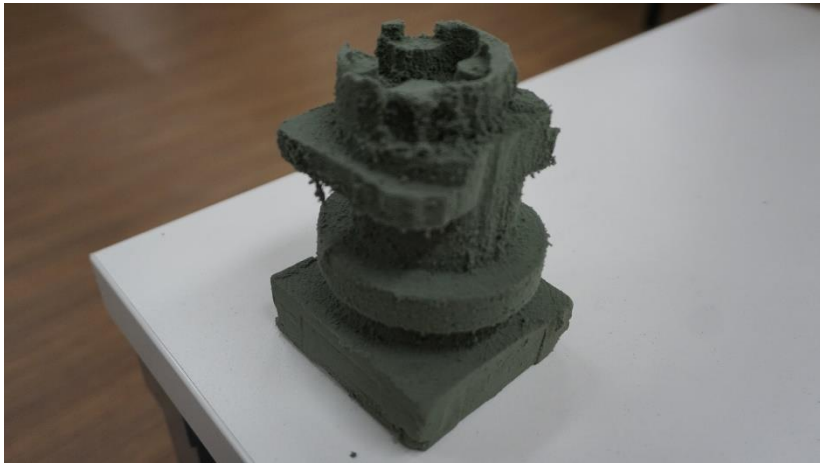


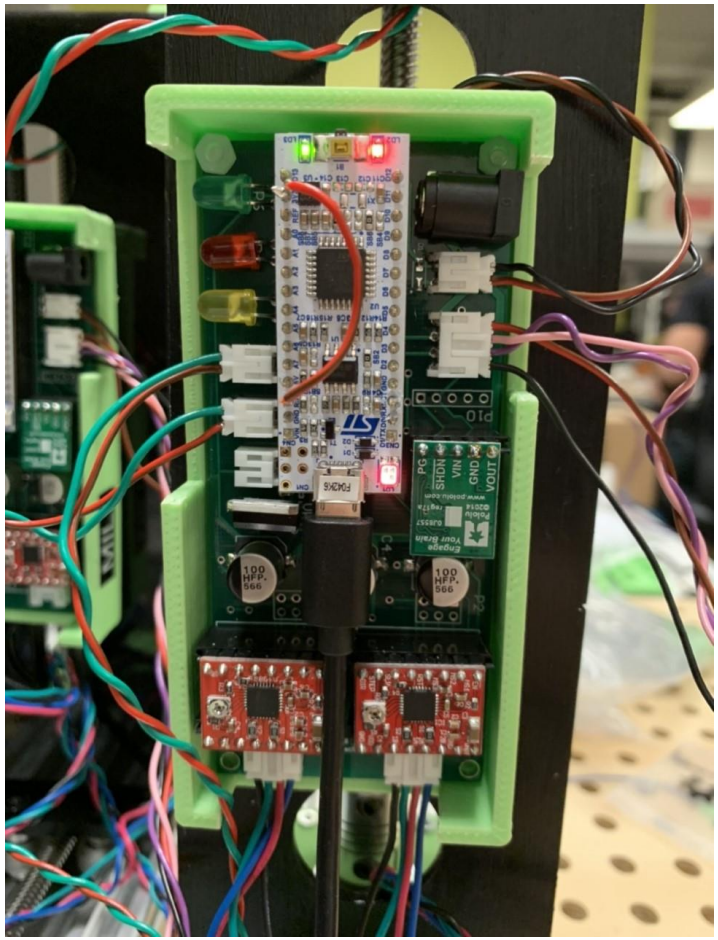


The Ghost of Projects Past

- 2019: Automatic Machining

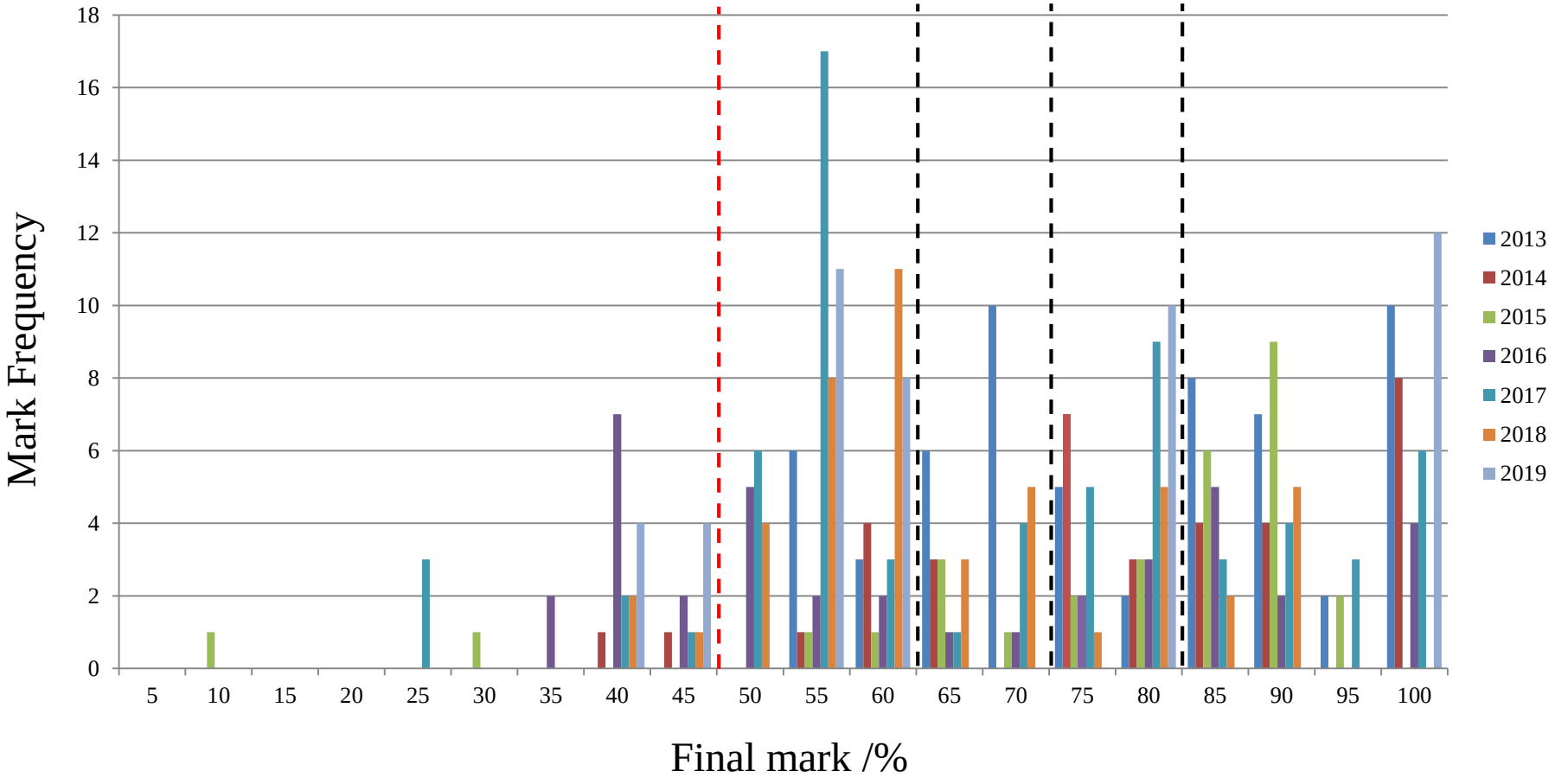






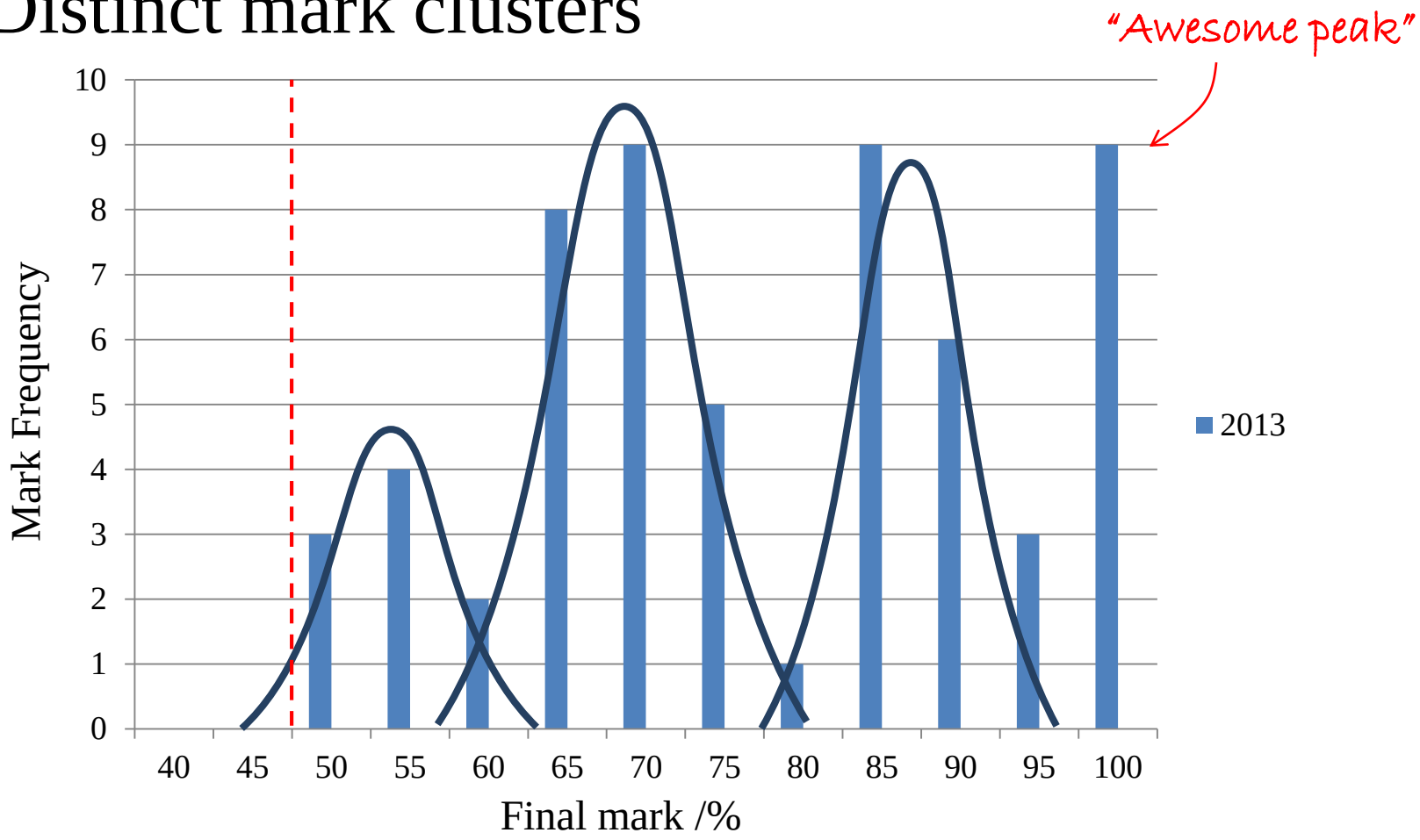
Assessment results

- Atypical mark spread: not a real bell curve



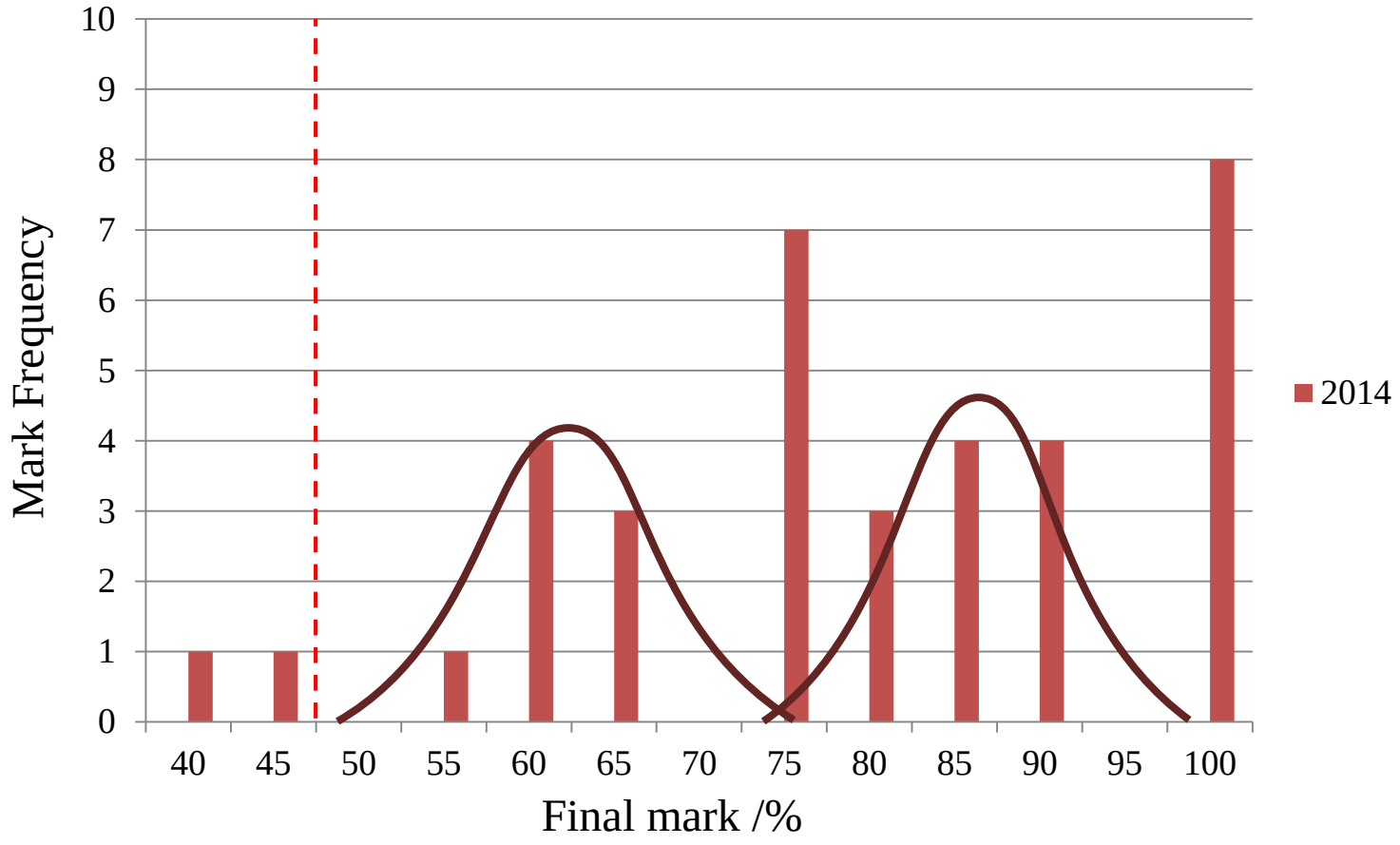
Assessment results

- Distinct mark clusters



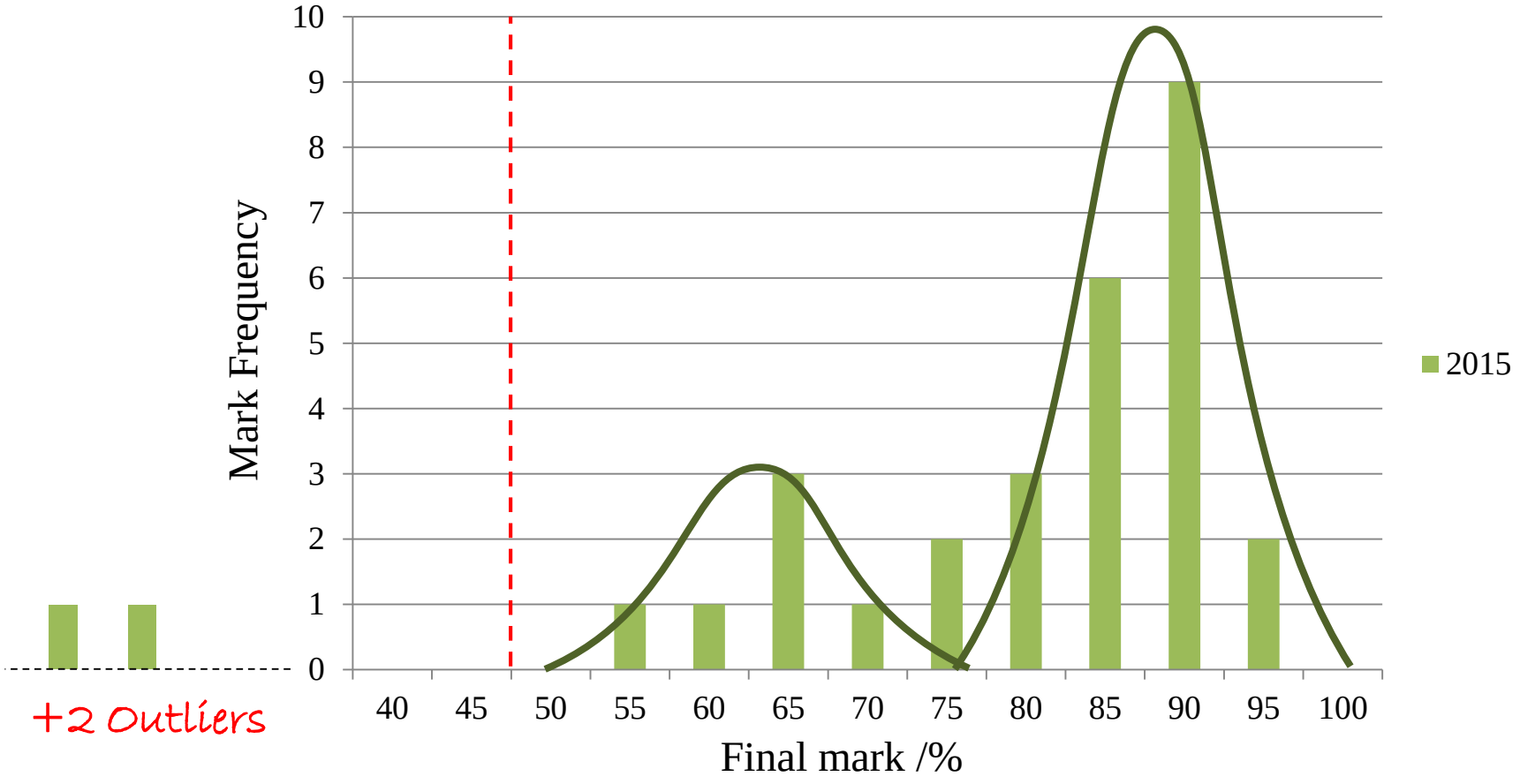
Assessment results

- Mark clusters move over time:



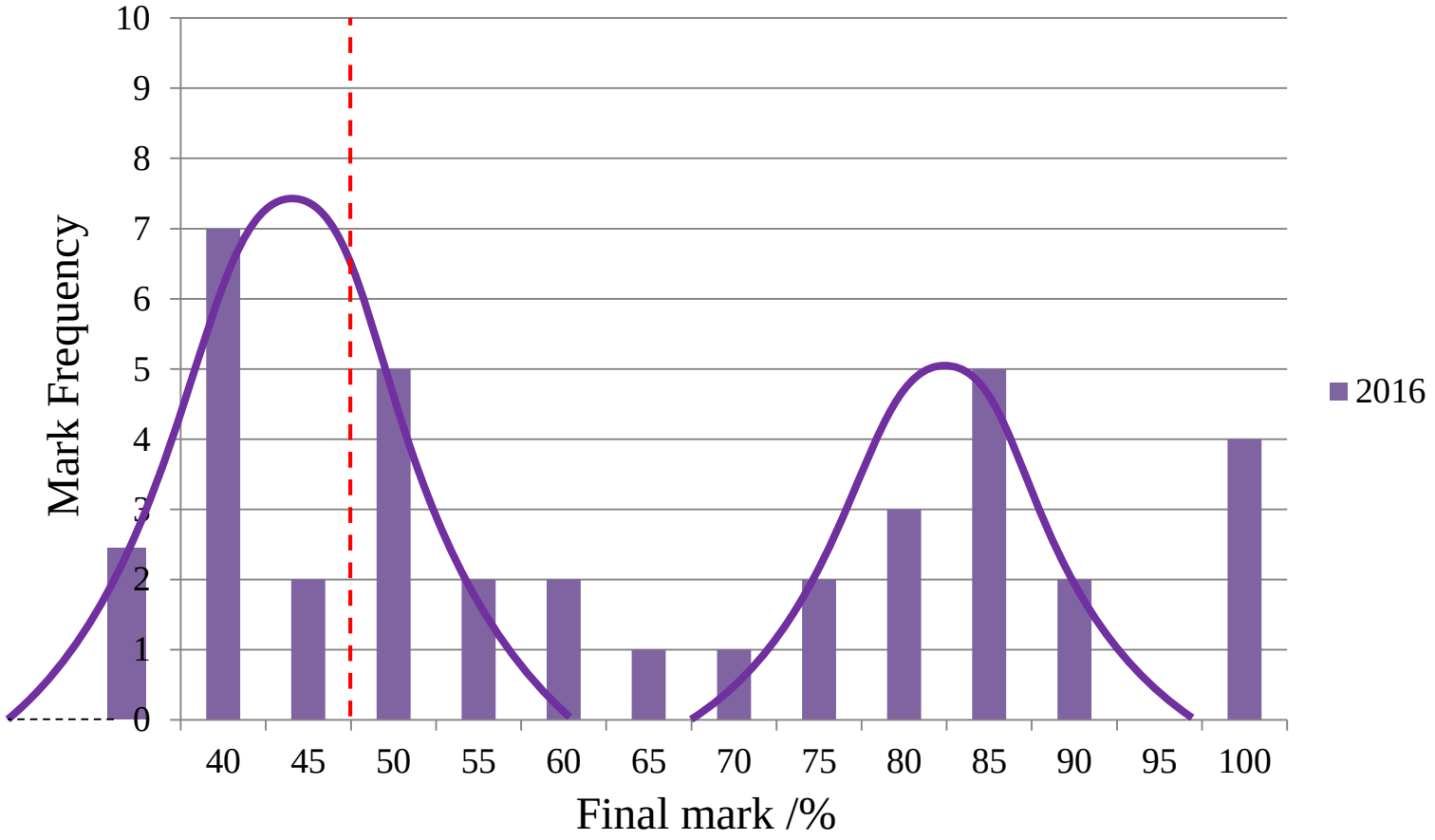
Assessment results

- Increasing performance, but more failures



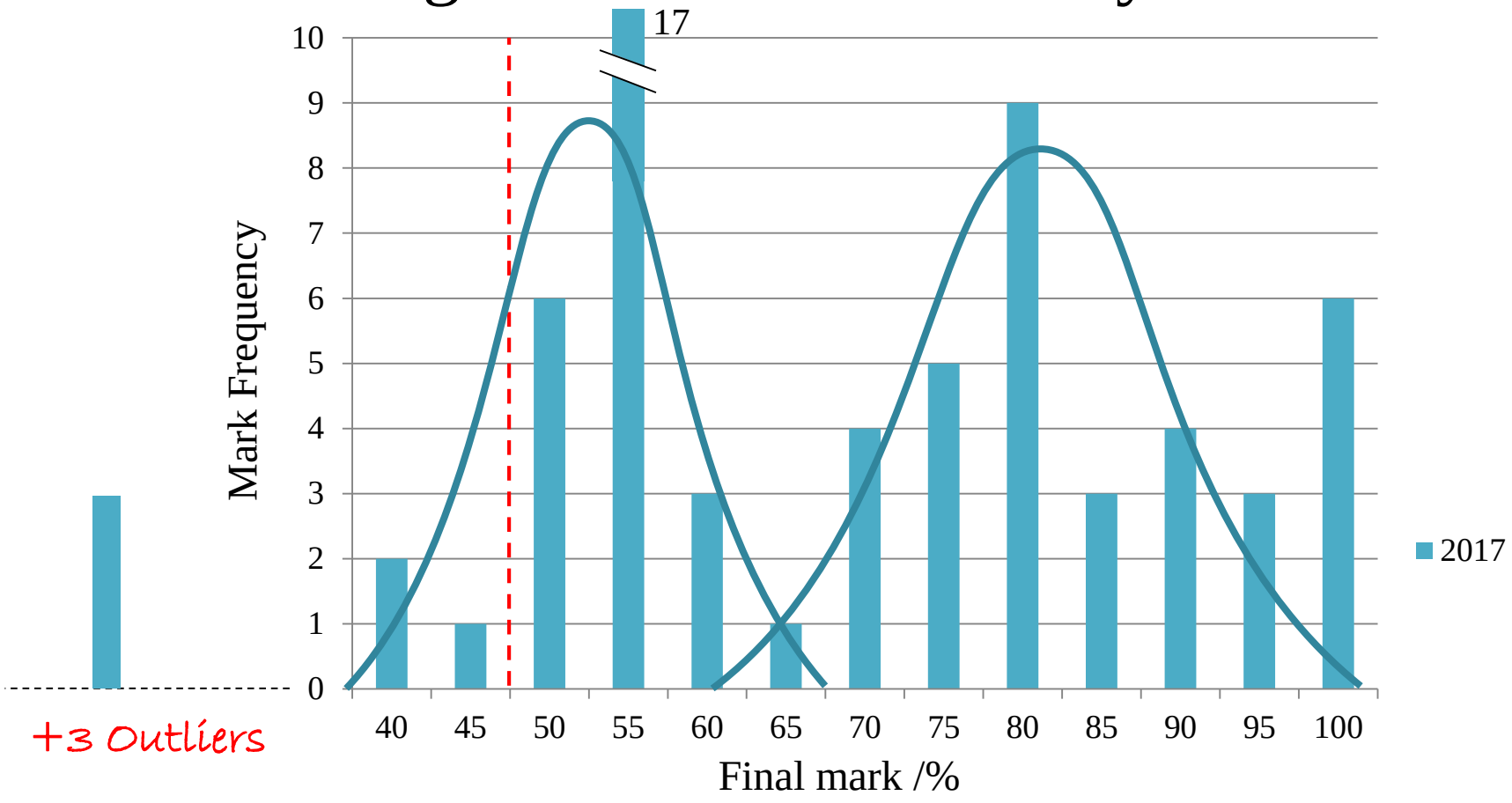
Assessment results

- Strong successes but higher failure rate, still



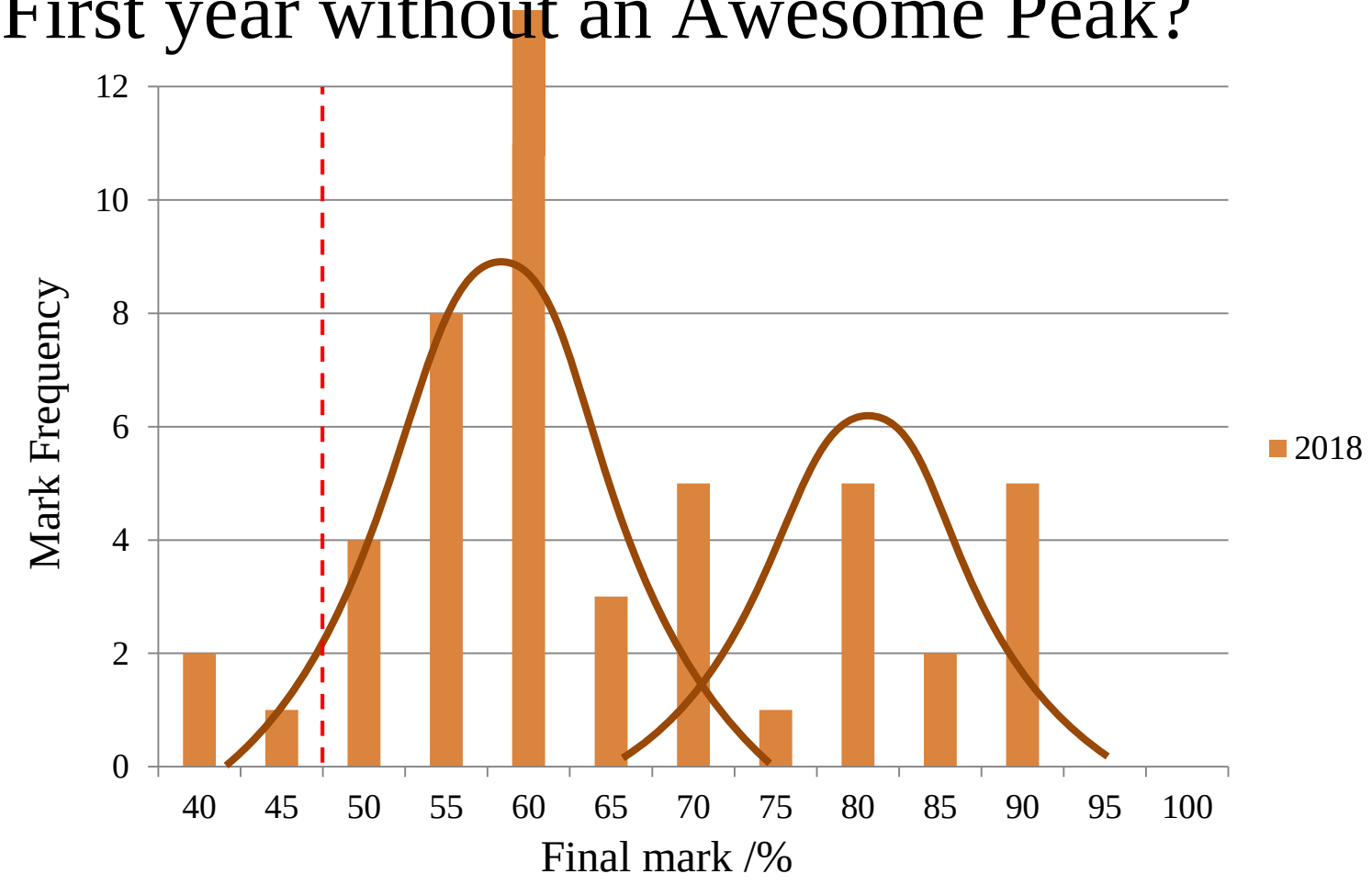
Assessment results

- Marking criteria saved so many butts!



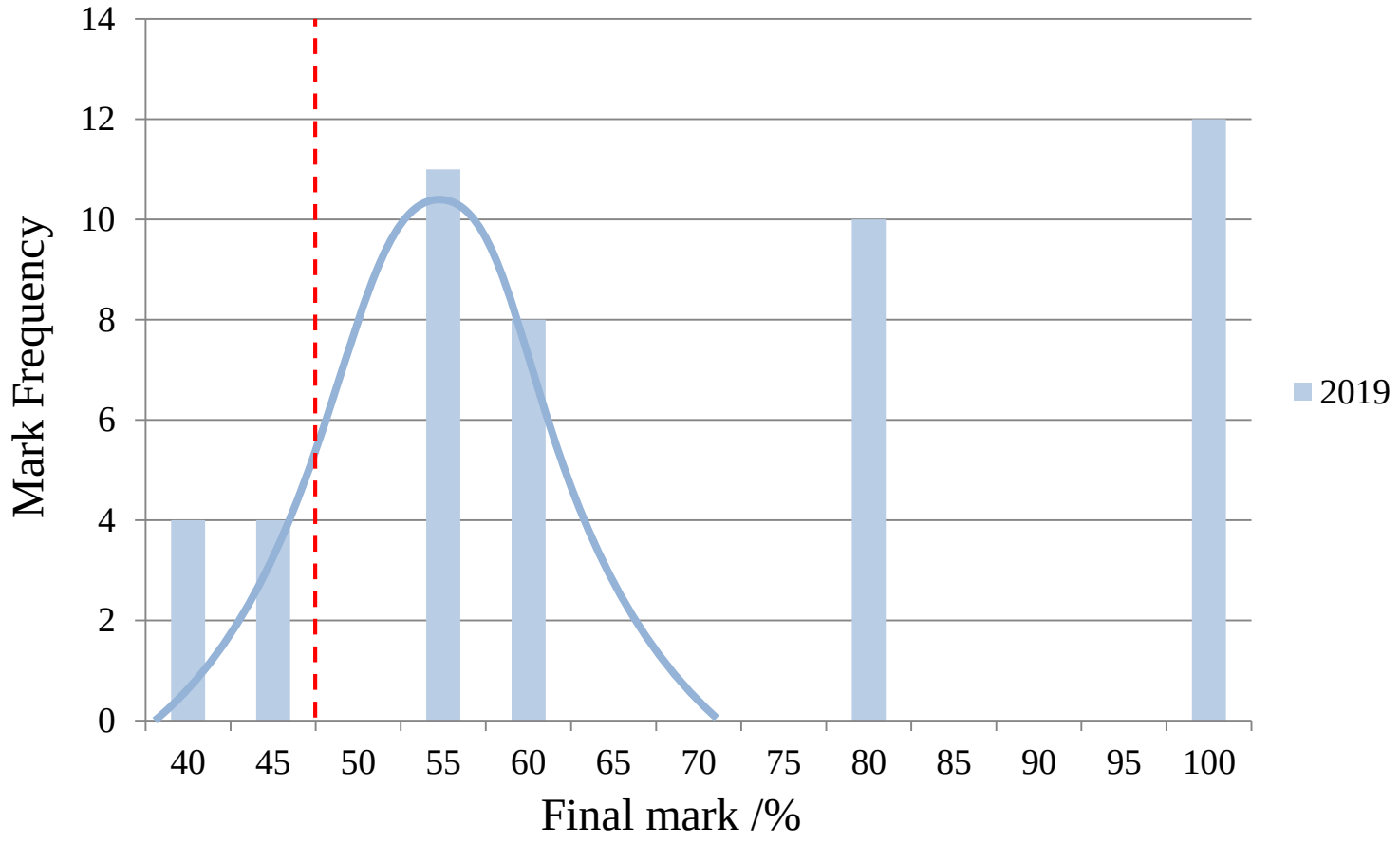
Assessment results

- First year without an Awesome Peak?



Assessment results

- Qualitative assessment; mixed results?



Assessment results

- Or, put another way:

	Percentage of class					
	≤3	**4**	**5**	**6**	**7**	**Avg**
2013	**0**	25	24	**19**	**32**	5.58
2014	**6**	14	8	**28**	**44**	5.90
2015	**7**	16	10	**30**	**37**	5.66
2016	**29**	24	5	**21**	**21**	4.52
2017	**18**	31	13	**18**	**19**	4.94
2018	**4**	57	13	**15**	**11**	4.72
2019	**16**	23	16	**20**	**25**	5.06

Typical student outcomes

Student tend to fall into two broad groups:

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

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

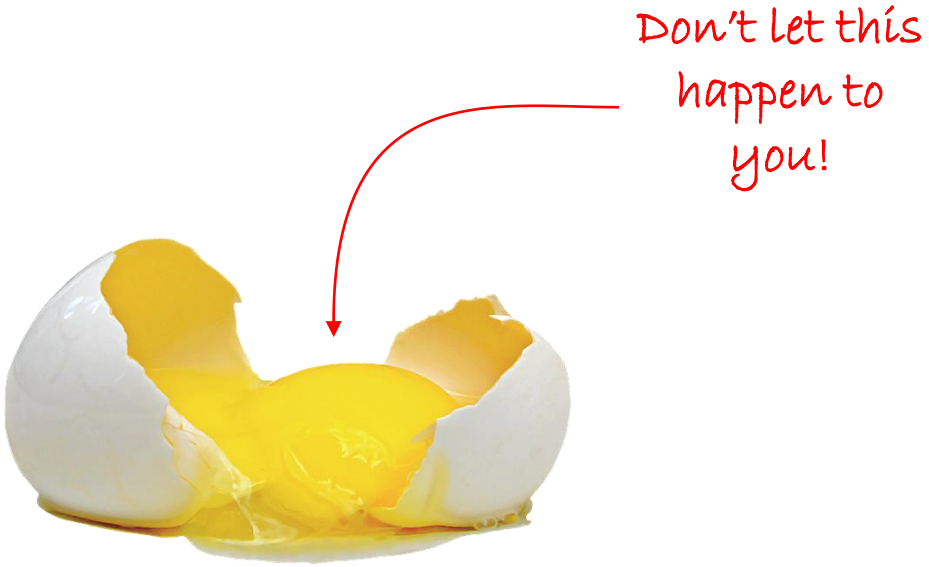
Sins of the forbearers

- 2013: Mortal ability, immortal ambition.
- 2014: You cannot 3D print a passing grade
- 2015: Balsa, electrical tape, hot glue and paperclips – *zero engineering analysis*.
- 2016: “Testing? What testing?”
- 2017: Assumed maximum hand-in volume limitation wouldn’t be enforced – it was.
- 2018: “But, but… I did *my* bit!!”
- 2019: “Nothing matters but precision!!!1!”

Welcome back, frequent fliers

This course breaks eggs

- You are probably going to find this course technically or socially challenging (or both!)
  - This is intentional



How to pass this course

- Work as a team
- Get started early
- Deconstruct the task logically
- Understand the *real* problem
- Implement a solution well

How to fail this course

- Don’t contribute to your team
- Do it all at the last minute
- Don’t play nice with others
- Fixate on your pet approach
- Do lazy, effortless hacking

Enough about other people…

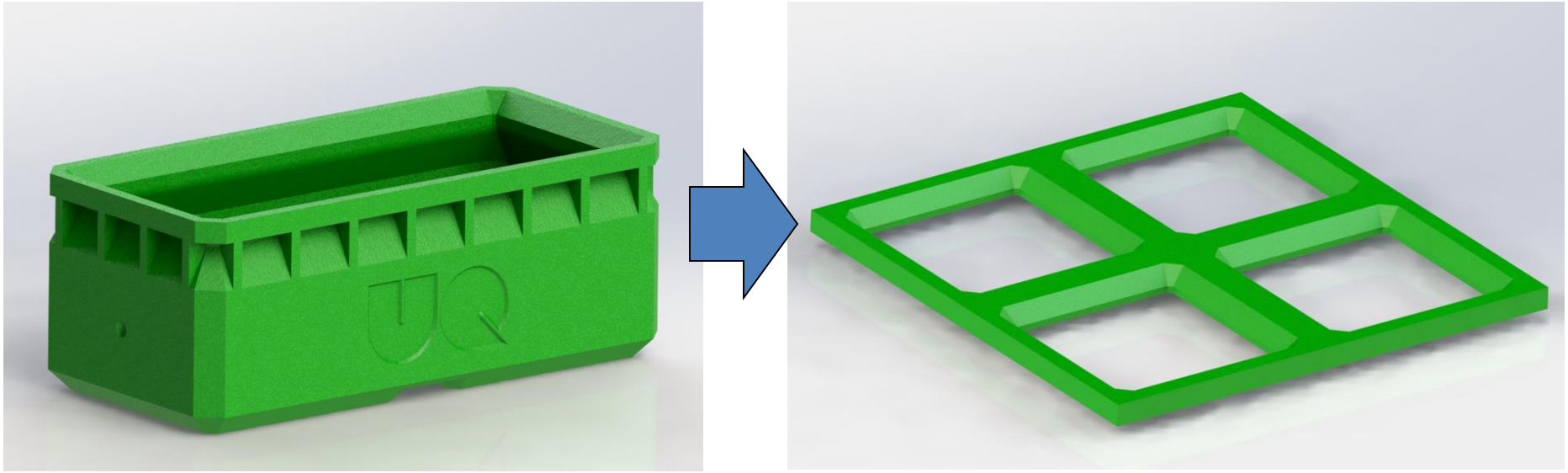
Now it’s your turn

PART 1

The Project

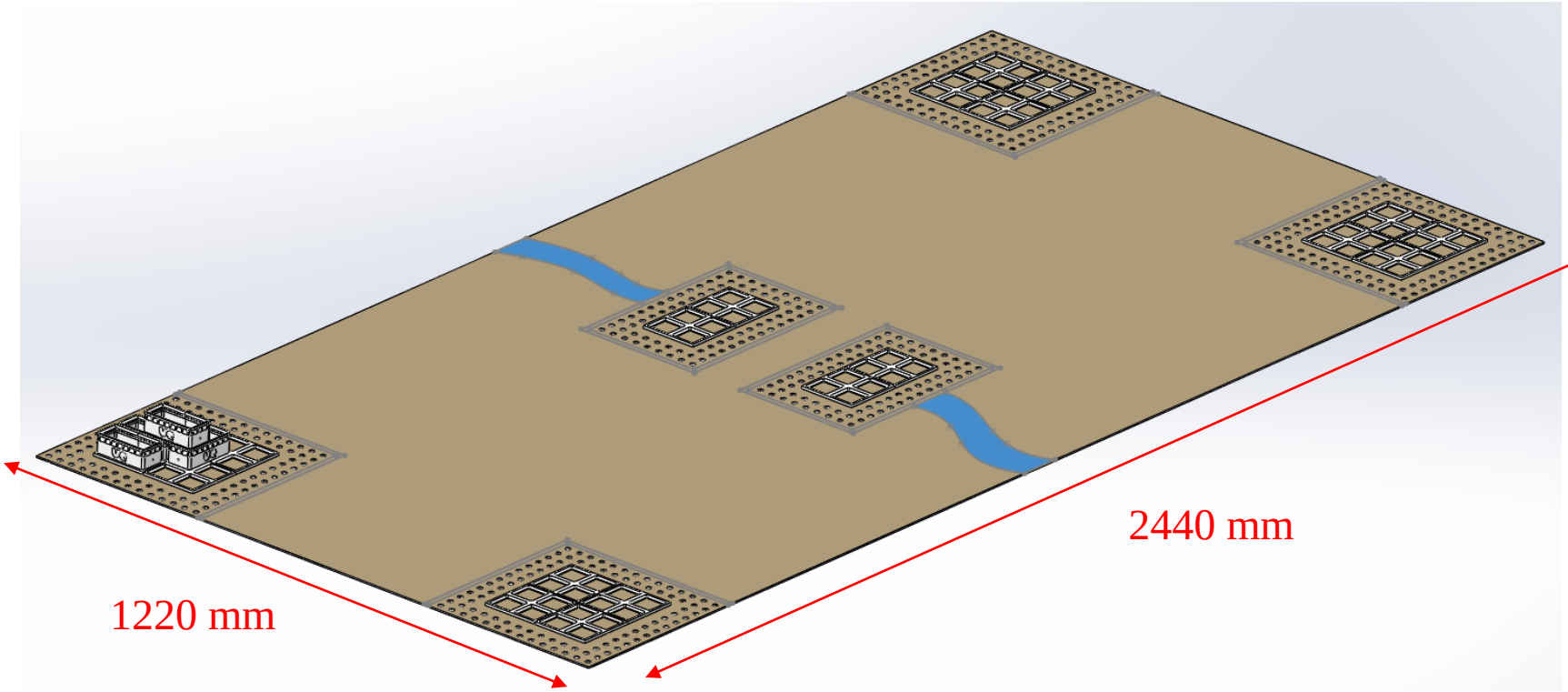
The task

Build a rail network of trains and cargo handlers to deliver 60 coloured cargo containers to the “freight yard” loading pads of the corresponding colour



The task

- Baseboard: four freight yards at the corners, with a neutral interchange at the centre, straddling a river



Rail systems

- Tracks must be Brio, Lillabo or similar compatible 40 mm wood modules.
  - Students may build their own tracks, so long as they are compatible with 40 mm wood systems.

- Teams may build bridges to cross the river, but no off-the-shelf bridges may be used
  - Any bridges must have enough clearance to allow a container to pass under them

The task

Provided apparatus consists of:

- 15 containers of each of four different colours: red, yellow, green and blue
- Various colours of freight yard pads: red, yellow, green, blue and white (neutral)
- Baseboard with routed holes for freight yard pads and mounting handler equipment

The task

- Containers may be stacked – 2 container slots per pad, four pads of each colour… 15 containers of each colour. You do the math.

- You only have to deliver as many colours of containers as you have students, so 3-person teams aren't totally screwed… (it's ok, *relax*)

Other things

- $400 budget, including any tracks you buy
- *Only* STM32 and PIC microprocessors may be used
  - No Atmega microprocessors of any sort
  - Why? Because previous students abused the privilege – *select your processor analytically*.

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

Key points

- Multiple different systems to be developed in parallel – don’t short-change any part
  - Each subsystem is harder than it looks
- This task is intended to be *challenging*
  - Focus on getting readily achievable points first
  - Get a functional cargo delivery pathway early

Submitting parts to the workshop

- You must have at least one machined part per team – ie. milled, lathed, water-jet cut
  - Your job will be costed in magical "workshop bucks" charged at $30 per hour, or quarter-fraction thereof.
- Submit jobs via EAIT Faculty Workshops job request form, as "coursework":

  https://student.eait.uq.edu.au/workshops/jobrequest.wphp
  - Submissions open in week 6, and close end of week 10
  - if your part isn't in by then, you're on your own

Printing parts in the makerspace

- 3D printing is to be done by the makerspace
  - There are no 3D printers in the lab
- You will be given a 500 g quota that will be accounted against for all parts printed.
  - Only parts printed by the makerspace may be submitted for final assessment
  - Home printed parts are ineligible.
- Nominate *one* student to submit print files

Scoring

- Performance will be measured with a point system for demonstrated functionality
- Points will be awarded during scheduled demonstration sessions in week 13
  - 30 minute total time for set up and test
  - Last 5 minutes reserved for pack-down/marking

See rules and description document for full details

Functionality and scoring

Build quality	**10/10 Points**

Basic Functionality	**30/30 Points**
The cargo handler system moves	10
The train system moves	10
The cargo handler system lifts a container	10

Protip: Passing the class pretty much requires you to be able to do this

Intermediate Functionality	**30/30 Points**
Load a container onto a train car.	15
Move a train between two freight yards	10
Unload a container from a train car onto a freight yard pad	5

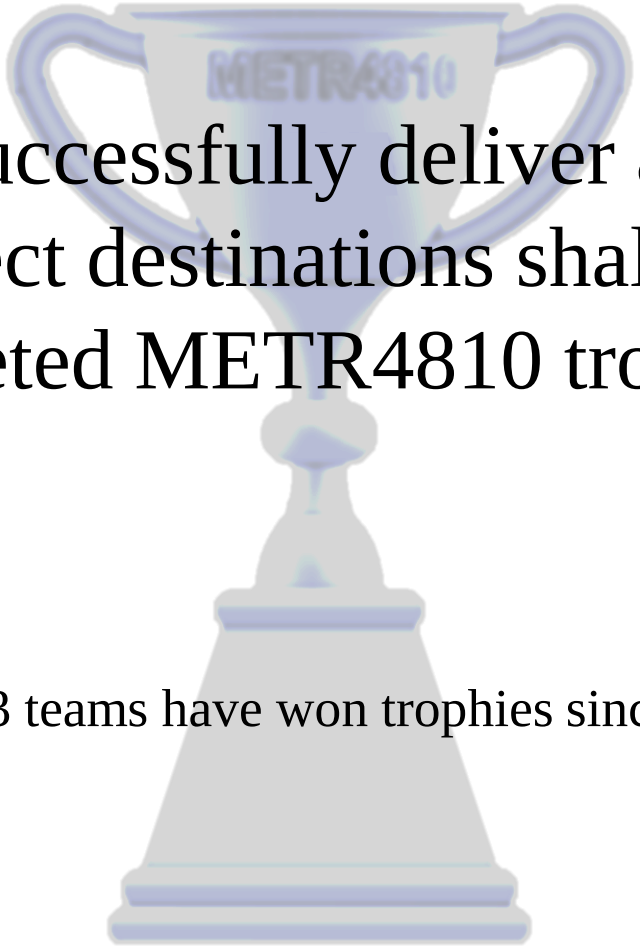
Advanced Functionality	**30/30 Points**
Deliver a container to its correct destination freight yard pad	0.5/container

Bonus Functionality	**10/10 Points**
Load a container autonomously	4
Move a train between two freight yards autonomously	3
Deliver a container to the correct destination freight yard pad autonomously	3

The low energy solution

- There is often a simple, elegant low-energy solution to an engineering challenge
  - There is no ‘right’ way to solve any problem
  - Some people spend much energy on a complex solution, only to get frustrated when someone else finds a much simpler way
  - The simpler way is **more correct**; if you are struggling with your approach, maybe you need to rethink your assumptions?

The trophy



Teams that successfully deliver all containers to their correct destinations shall receive the coveted METR4810 trophy

Only 13 teams have won trophies since 2013

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

On qualitative assessment

- Last year I used qualitative assessment
  - IE. I set grades based on holistic observation of your demonstrated achievement
- Grade results were on par with previous results, but student engagement was noticeably reduced
  - The first and only year that no team completed 100% of the task and no trophies were awarded

On qualitative assessment

- Question: do students need fine-grained numerical feedback to stay motivated, or was the cohort quality different?

- This year, I have reverted to numerical assessment to A/B test this approach.
  - I will be very interested to see how student engagement varies from last year

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 load simulations
  - Clearance and tolerance of components
  - Microcontroller control cycle overhead
  - Decision matrices... and such!

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

Deliverables

- Problem analysis – 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

Problem analysis

Due 6th March– 10% (2 pages max)

- Break down the design problem, determine its scope, requirements and constraints.
- Describe the key underlying engineering design challenges – what makes this hard?
- Present a candidate solution, and explain how your approach addresses the problem.
  - Analysis is golden.

Progress Reviews 1 and 2

Due 16th – 20th March and 5th – 8th 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.

Statement of roles

- At Progress Review 1, your team will be required to present a statement of lead developer roles signed by the whole team.
- You will be expected to account for your responsibilities at subsequent reviews
- *Remember:* You shouldn't/don't have to be the only monkey working on that system, and you should help others!

Progress Seminar

Due 6th – 9th 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 presents for roughly equal time
- Assessed by course coordinator and tutors

Preliminary Report

Due 15th May – pass/fail

- Describes the methodical analytical approach to solving your 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 25th – 29th May (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 29st May – 20 %

- Identical to the preliminary report, but incorporating corrections and reflecting any changes from the final 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 the final demo, but the marks are 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

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 recognises 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 weighted by all of the PAFs through the semester:
  - Progress review 1: 10%
  - Progress seminar: 20%
  - Progress review 2: 30%
  - Final demo: 40%

Tutor assessment

- TAFs work just like PAFs, except the score is provided by the tutors
- Tutors pay attention to who is working and usefully contributing throughout the year
  - Being present and effective in the lab is a great way of convincing them you're a contributor
  - This is evidence based: we take notes.

The TAF also works as a sort of safety valve for hard-luck students

Calendar at a glance

You are here

Teams assigned here

Week	Dates	Lecture	Reviews	Demos	Assessment submissions
1	24/2 – 28/2	Introduction			
2	2/3 – 6/3	Principles of Mechatronic Systems design			Problem analysis
3	9/3 – 13/3	Previous years deconstruction case studies			
4	16/3 – 20/3	Professional Engineering Topics	Progress review 1		
5	23/3 – 27/3	PCB design tips			
6	30/3 – 3/4	Your soldering is (probably) terrible			
7	6/4 – 10/4*	Introduction to firmware design	Progress seminar	25% demo	
Break	13/4* – 17/4				
8	20/4 – 24/4	Q and A sessions			
9	27/4 – 1/5	Q and A sessions		50% demo	
10	4/5* – 8/5	Q and A sessions	Progress review		
11	11/5 – 15/5	Q and A sessions		75% demo	Preliminary report
12	18/5 – 22/5	Monday lecture!!			
13	25/5 – 29/5	Closing lecture		Final testing	Final report and reflection

Break! 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/

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 thrice per week
  - Time set aside for meetings, demos, etc.

Your team should meet and interact continuously outside of class – *at least* once per week

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

… but you'll hear it first in class, by design

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: Previous years' deconstruction case study
- Lecture 4: Professional engineering topics
- Lecture 5: PCB design tips
- Lecture 6: Your soldering is terrible (probably)
- Lecture 7: Introduction to firmware design

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

Lectures

- No, you don't *have* to attend lectures, but if you don't you're really missing out
  - Protip: Students who attend lectures historically do better than those who don't!
- Lectures are the first and most immediate way of hearing about what's happening and getting your questions answered
  - Note: recordings aren't interactive

Some suggested topics

- Digital control
- Electromechanical devices
- Radio communications
- Principles of rail dynamic stability
- Sensor-fusion and filtering
- 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
  - Exclusion requests must be in by Friday
- Otherwise, teams will be allocated by *magic*
  - Teams will be assigned in week 2

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

Laboratory space

- A fair number of students this year
  - Not terrible, but some possible crowding
  - 17 teams, 12 workstations…
- Consequence: share and keep it tidy
  - New (smaller) lockers for project work
  - Shared 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/grindr/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

- Every year, I go out of my way to find ~~people~~ violators to make an example of
  - Don't let this happen to you!

Proposed lab management policy

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

And now a word from our sponsor…

A valuable message about safety…


Campus Calamities presents
Burning Ambition
#001

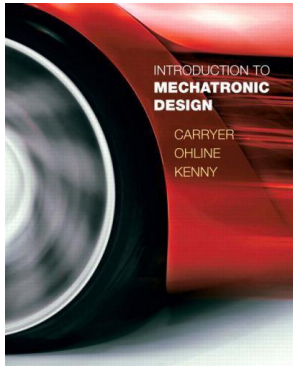
And now a word from our sponsor…

Thank you for your attention

(We're trying these out, tells us what you think!)

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)
- Textbook
  - "Introduction to Mechatronic Design" by Carryer, Ohline and Kenny



(recommended but not required)

Knowledgeable people

- Course Coordinator and Professtrix:
  - Pauline Pounds
- Technical Staff
  - Peter Bleakley
  - Jason Herriot
- Tutors:
  - Will Deer
  - Madison Beare
  - The enigmatic ‘Kalt’
- Emergency Auxiliary Temporary Back-Up Replacement Stand-in Teaching Faculty
  - Dr. Phil Terrill
  - Dr. Tyson Phillips

Contact info

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

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

➢ Serious? Email first to arrange a meeting

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

On that topic…

- I often get comments in the SECaTs about things that *could* have been addressed during the semester if I'd been told about it earlier
- Don't wait until you're angry in week 13
  - Tell me about it as soon as it comes up so I can explain it/solve it/fix it/find it/sort it right away
- I'm always happy to help! ☺

Contact info

Who: Me!

Why: Questions, issues, concerns, ennui!

Where: GPS 78-529 or Wordsmiths

When: 11ish to 5ish – by appointment (or drop in)

What: Coffee or coke (either kind)

How: pauline.pounds@uq.edu.au

What happens next?

- Send me group exclusion requests
  - Email me ASAP!
  - Groups will be posted next week
- Attend the afternoon practical session in Hawken c404 Wednesday 4th March
  - 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: Stephenson's *Rocket* still exists and you can go see it at the National Railway Museum, UK.

Questions?

?