The Final Lecture

or

"Light at the end of the borehole"

Paul Pounds

31 May 2016

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	7/3 – 11/3	Principles of Mechatronic Systems design			Problem analysis
3	14/3 – 18/3	Professional Engineering Topics			
4	22/3 – 25/3	Your soldering is (probably) terrible	Progress review 1		
Break	28/3 – 1/4				
5	4/4 – 8/4	Introduction to Teleoperation			
6	11/4 – 15/4	Q&A 1			
7	18/4 – 22/4	PCB Hints	Progress seminar	25% demo	
8	25/4 – 29/4	Q&A2			
9	2/5 – 6/5	WTF??		50% demo	
10	9/5 – 13/5	Q&A3	Progress review		
11	16/5 – 20/5	Q&A4		75% demo	Preliminary report
12	23/5 – 27/5	Q&A5			
13	30/5 – 3/6	Closing lecture		Final testing	Final report and reflection

You are here

Near the surface!

Lab matters

- Almost at the end!
  - Projects submitted!
  - Toolboxes handed in!
  - Lab cleaned up!

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

- Tuesday 31st
  - 15:30-16:00 Setup
  - 16:00-16:25 Team 3
  - 16:25-16:50 Team 9
  - 16:50-17:15 Team 4
  - 17:15-17:40 Team 2
  - 17:40-18:00 Team 1

Thursday 2nd

- 11:30-12:00 Setup
- 12:00-12:25 Team 5
- 12:25-12:50 Team 10
- 12:50-13:15 Team 6
- 13:15-13:40 Team 8
- 13:40-14:00 Team 7

Marking schema

- Product demo is 60 per cent of class grade
- This is subdivided into:
  - Build quality – 10 marks
  - Basic functionality – 25 marks
  - Locating miners – 30 marks
  - Rescuing miners – 35 marks
  - Mine status report – 10 marks

Totally possible to get 110 marks out of 100.

Functionality and scoring

Basic Functionality	**25/25 Points**
Rescue system enters the mine	10
Images of mine interior returned to surface	5
Rescue system reaches second level	10

Protip: Passing the class pretty much requires up to here

Locating miners	**30/30 Points**
Miner visually identified	2
Miner's sector location noted	1
Miner's health status reported	2
All miners located	5

Miner rescue	**35/35 Points**
Healthy miner rescued	5
Injured miner rescued	6
Deceased miner recovered	4
All miners returned to surface	10

Bonus Functionality	**10/10 Points**
Each sector stability status reported	2

Structure of the final demo

1. Meet tutor at c404 10 mins before slot time
2. Setup and config during 5 min changeover
3. Commence 20 minutes of ~~terror~~ testing
4. Build quality assessment during changeover
5. Fill out PAF and return to tutor
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 after your demo
  - Try to keep your hardware in one piece

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 rescue at least one miner, 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...

The METR4810 Trophy

Teams that successfully retrieve all miners during the 100% or exhibition demos will receive the coveted METR4810 trophy

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 would probably be 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**.

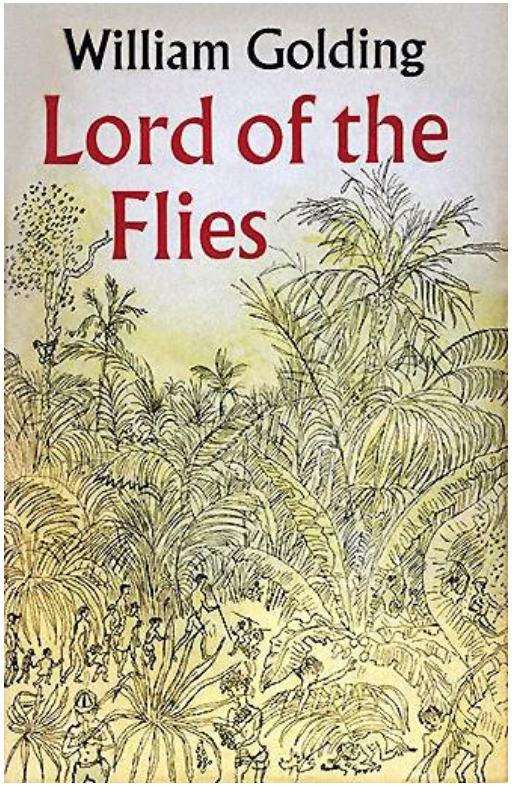
Why is this hard?

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

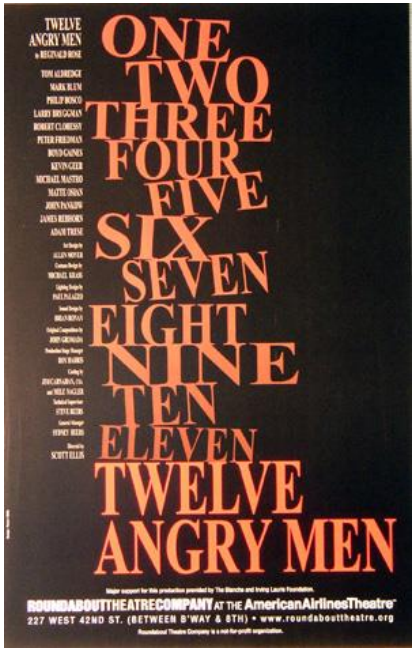
Prior experience

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

- Inspired by the 2010 Chilean mine disaster

The idea

Big focus on practical elements

- Borehole and mine – strict size constraints
- Long cable lengths – comms challenges
- Obstacles and debris – mobility challenge
- Grasping objects – manipulation challenge

Lots of good disparate problems to tackle!

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… mine rescue!

Meeting the spec’

Why mine rescue?

- No reuse of previous project work
- Four clear, independent mechatronics tasks
  - Control, rescue vehicle, recovery stage, comms
- Naturally motivated analysis and integration
- More focus on design, less on fabrication
  - Less to build, but plenty to analyse
  - Lower time burden and better learning value

Implementation

Key design subsystems:

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

Sensible assessment

Assessments 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>,
didn’t win – we are not surprised!

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 – huge variety!
- Difficult but obviously achievable
  - Not futile; tangible reward for time put in
  - Early pay-off for effort (eg. get to second level)

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

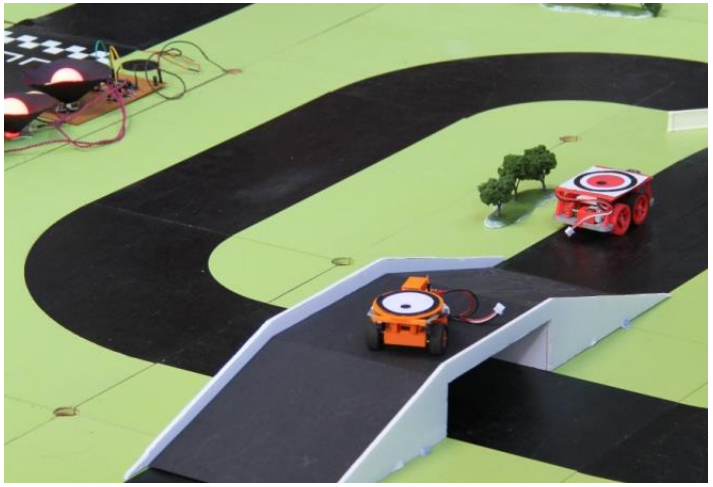
Previous years' feedback

Main strong points:

- Intellectually stimulating
- Learned a lot in the course
- Incremental PAFs = *good*

Main weak points:

- Teams released too late
- Availability of apparatus



This year

Several experimental changes:

- Teleoperation rather than autonomous ✓
- Individual problem analysis ~~peer review~~ ✓
- Multiple testing apparatus installations ✓
- Post-Q&A coffee sessions ✗
- Very high analysis standards ?

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!
- Let you get on with your work
  - Mine apparatus ready ahead of time (mostly)
  - Multiple sets of testing equipment

"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 ☹
- Had to be a disciplinarian

Things I *can* change:

- Clearer instruction on problem analysis
- Better management of machined parts fab

What you liked

- Incremental demos – well used!
- Apparatus ready to go early
  - Borehole notwithstanding
- Multimodal lectures (optional attendance)
- Sense of humour (?)

What you didn't like

- People left hanging by Doug taking leave right when machined parts were being done
- Standards were high and feedback frank
  - Maybe too harsh?
- Too much nagging about shit from Paul

Outcome

- This year has run pretty smoothly, all things considered... with only a few small bumps
- Everyone seems pretty on the ball
  - 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 2016

Theme

This year's theme was suggested by my father

In 2014 he was diagnosed with terminal liver cancer, and given two months to live

But he's a brave fighter and I'm glad he's lived to see it come to fruition

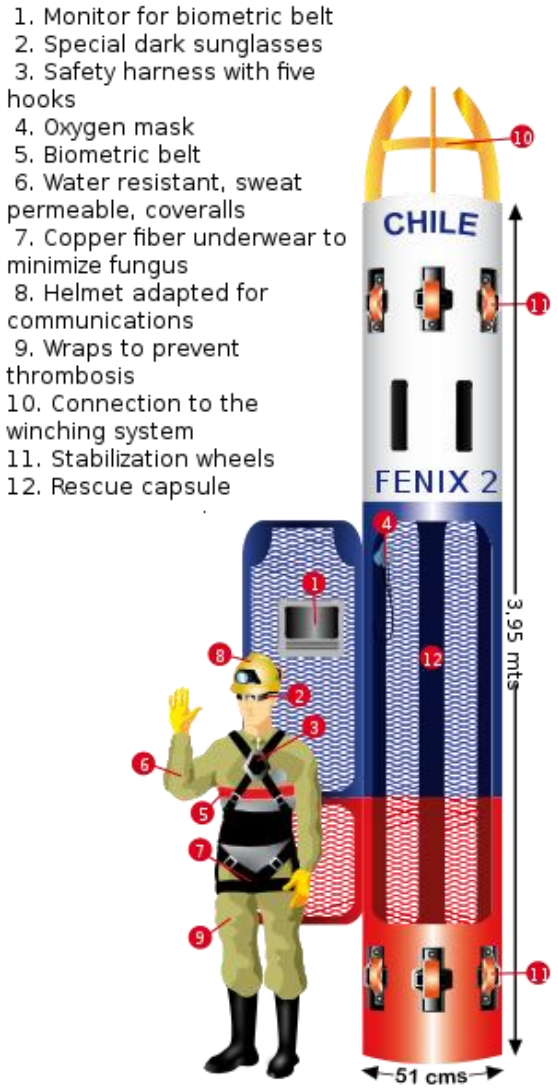
☺

Theme

- 2010 Chilean Mine collapse
  - Simple, with good technical tie-ins
  - Interesting “closed box” problem
  - Nice link to Australian mining: an Oz mining team drilled the rescue borehole!
- Obvious Minecraft link and LEGO is a good source of scale workers
  - Awkward hybrid LEGO/Minecraft theme it is!

Chilean rescue vehicle

- Designed by the Chilean navy
  - With help from NASA
- Only 54cm diameter!
- Many features!
  - Wheels with damping system
  - Onboard oxygen supply
  - Communications system
- There's a replica at the ANU
  - A gift from Chile to Australia!



Theatrical introduction

- A splashy introduction gets students engaged
  - My way of saying “This is gonna be awesome!”

2013 : Showed up in my full academic regalia
  - Very popular, great result!

2014 : 3 minute Power Point animated intro
  - Surprisingly negative feedback (?)

2015: Aviator glasses and flight jacket, address to recruits
  - No one under 30 remembers TOPGUN

This year, I was limited by overseas travel ☹

Theatrical introduction

- The animated introduction was Plan B
  - I had intended to show up with mining hardhat, and equipment as if I'd just come from the mine site… but killed by travel
- Even then, I aimed to give the lecture live via Skype, but my all-investors company board meeting went 3 hours overtime... sigh

Theatrical introduction

- Planning ahead, before I went to the US, I'd pre-recorded and time-synched the entire lecture Just. In. Case.
  - The whole presentation was one seamless Power Point file.
  - Turns out it was very much worthwhile!

Good thing for Plan C, right? :/

Website theme

- Each year, I hire an artist to help give the class a sexy, slick theme
  - This year included an overhaul of the website code, which hadn't been updated since 2013
- One neat idea was a pit that descended as you scrolled down
  - And got deeper as the semester progressed…
  - A metaphor for METR4810?

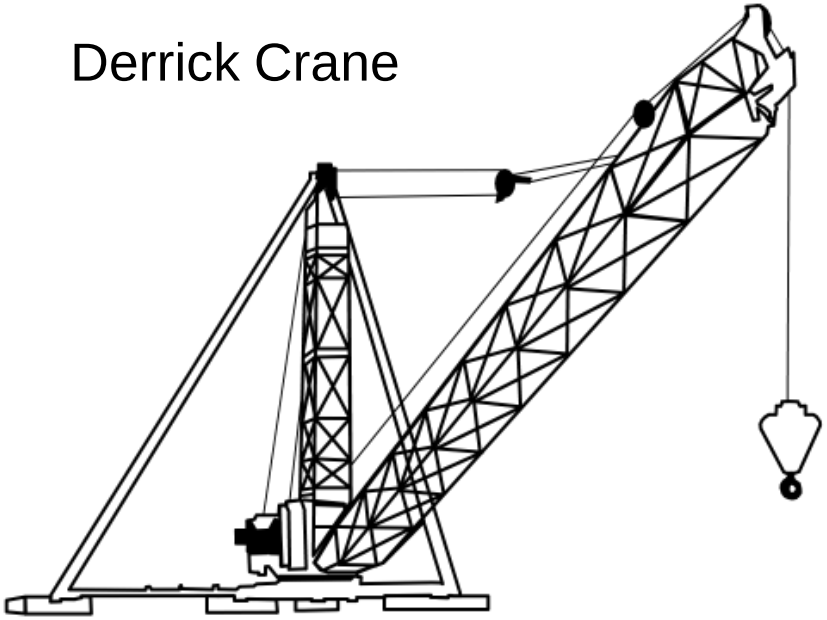
Website theme

- Initial art concept was pretty close to final
  - A few different graphics

Website theme

- The artist had a very different crane in mind
  - I had to explain what a derrick crane was…

Derrick Crane



Not a Derrick Crane

Website theme

- A few cutesy ideas for the theme:

- I vetoed the terrible pun. You're welcome

Other efforts

- We tried making graphics from photos of the LEGO miners… they were *awful*

Cutting room floor

Considered much more brutal challenges:

- Collapsible ceiling with knock-out supports
- Partial walls and collapsed wall sections that couldn't be driven through
- Flickering interior lights to mess with vision
- CRUSH TEST: put 5kg weight on rover

These were all discarded because they were of only questionable educational value

Cutting room floor

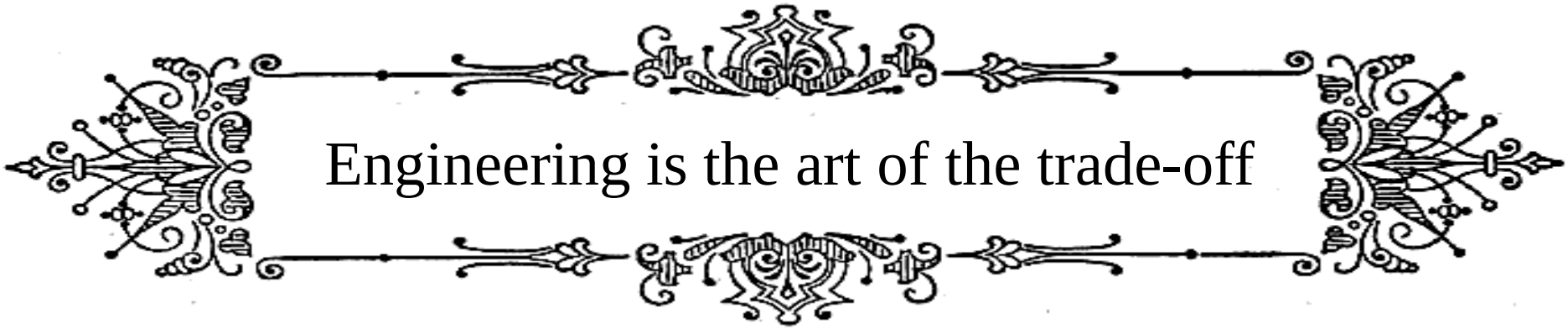
- Toyed with the idea of "achievements" and a score tracker…
  - Too hard to implement in time available
  - Not entirely sure what sensible achievements would have been anyway

Final thoughts

This class was never about rescuing miners

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 2016

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

Paul Pounds as Mine Superintendant
Alex Macintosh as Foreman
William Deer as Shift Boss
Christopher “Kit” Ham as Kooky Seismologist
Prof. Steve Wilson as Acting Course Coordinator
Dr. Michael Kearny as Backup Lecturer
Peter Bleakley as Lab Director 1
Doug Malcolm as Lab Director 2
Dr. Surya Singh as Mine canary

Produced by Paul Pounds

Original score by Paul Pounds

Camera and Cinematography

Camera 1	Dr. Surya Singh
Camera 2	Michael Eastwood
Key grip	Alex Macintosh
Gaffer	William Deer
Best Boy	Christopher “Kit” Ham

Editing by Paul Pounds

Casting
Paul Pounds
Prof. Peter Sutton

Production Design
Paul Pounds

Art Direction
Paul Pounds

Set Decoration
Paul Pounds
Keith Lane
Ian Daniels
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
Michael Eastwood

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

Visual Effects
Paul Pounds

Audio Effects
freeSFX.co.uk

Stunts

Stunt Coordinator	Paul Pounds
Stunts performed by	Paul Pounds
Safety Manager	Jeanelle Scown
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
Casey Fung

Web Design
Hotpot Creative
Chris McKenna
Paul Pounds

Web Administration
Dr. Hanna Kurniawatti

Transportation
Dr. Surya Singh

Special thanks to
Keith Lane
Doug Malcolm
Michael Eastwood

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

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