The Final Lecture

or

"All good things"

Paul Pounds

28 May 2013

University of Queensland

But first…

Some house keeping

Calendar at a glance

Week	Dates	Lecture	Reviews	Demos	Assessment submissions
1	25/2 – 1/3	Introduction			
2	4/3 – 8/3	Principles of Mechatronic Systems design			
3	11/3 – 15/3	Principles of Sailing			Design brief
4	18/3 – 22/3	Sensor Fusion and Filtering	Progress review 1		
5	25/3 -29/3	Your Soldering is Terrible			
Break	1/4 – 5/4				
6	8/4 – 12/4	3D printing	Progress seminar		
7	15/4 – 19/4	Image Processing on Microcontrollers		25% demo	
8	22/4 – 26/4	Fluid Mechanics			
9	29/4 – 3/5	Q&A	Progress review	50% demo	
10	6/5 – 10/5				
11	13/5 – 17/5	Q&A		75% demo	Preliminary report
12	20/5 – 24/5	Q&A		50% demo	
13	27/5 – 31/5	Closing lecture		Final testing	Final report and addendum

You are here →

← Abandon ship!

Lab matters

- This is the last week of lab use
  - Last big push
  - Keep it tidy for one more week!
- **Toolbox hand-in:** c404, 2 pm, Thursday 30th
  - Return complete toolkits in good condition
  - Your desk must be cleared/clean, locker empty
  - Don’t panic if you’re testing 2-3 pm… just show up to the lab when your testing slot is done

Lab matters

- The room will be cleaned prior to sign-off
  - Floor swept out
  - Rubbish to go in Hawken skips
  - Soldering area tidied up
- It’s a really terrific idea to clean the lab early if you can!

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

- Also, just 2 pages and a picture won't cut it
  - 2 pages *without* a picture won't cut it either!

~You know who you are~

Final demo

- Wednesday and Thursday this week!
  - Held at the METR3800 testing tank (duh)
  - Where most of the marks are!
  - Your chance to win the treasure of Axolotlzuma!
- Also looking for volunteer groups for a special exhibition session at 11 am on Friday 31st
  - Interested? Email me!

Final demo schedule

- Wednesday 29th
  - 9:00-9:30 Setup
  - 9:30-10:00 Team 15
  - 10:00-10:30 Team 13
  - 10:30-11:00 Team 3
  - 1:00-1:30 Team 2
  - 1:30-2:00 Team 12
  - 2:00-2:30 Team 1
  - 2:30-3:00 Team 8
- Thursday 30th
  - 9:00-9:30 Team 7
  - 9:30-10:00 Team 9
  - 10:00-10:30 Team 6
  - 10:30-11:00 Team 11
  - 1:00-1:30 Team 5
  - 1:30-2:00 Team 10
  - 2:00-2:30 Team 4
  - 2:30-3:00 Team 14

Marking schema

- Product demo is 60 per cent of class grade
- This is subdivided into:
  - Build quality – 10 per cent
  - Basic functionality – 20 per cent
  - Voyage result – 30 per cent
- All three parts will be assessed during the final demo sessions

Structure of the final demo

1. Meet at the tank at designated time
2. Hand over box with design notes + boat
3. Build quality assessment
4. Basic capabilities demonstration
5. Seaworthiness certificate
6. Three voyage attempts
7. Go to c404 to clean out lockers and gear
8. 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 course grade
  - **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 33	Clearly designed and well thought-out optimised construction, high-quality of manufacture and defect-free. Professional-quality work	35 33	Tight well-structured code, useful comments, easy to read and understand without explanation	20 18	Beautiful construction, intuitive and pleasurable to use	10 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 17	Chunky or weak in parts, but not fragile or bloated, inappropriate materials, rough fits, unrefined but serviceable	21 17	Structured and understandable with effort, unhelpful variable names or functions, difficult to make sense of without explanation	12 10	Unhelpful markings, unintuitive interface, poor attention to detail, unattractive	6 5
Poor (25-50%)	Shoddy design/construction, low-quality soldering with a high rate of defects, unlikely to be reliable	13 9 5	Rickety, rough and cobbled together; poorly fitting and shoddily assembled, unlikely to be reliable	13 9 5	Chaotic and incomprehensible, impossible to modify or maintain, even if it works	8 6 5	Frustrating, ugly and unusable	4 3
Very Poor (0-25%)	No attempt made	0	No attempt made	0	No attempt made	0	No attempt made	0

Basic functionality

Not the same as the seaworthiness certificate

- Worth 20 per cent of course grade

5 marks each to be awarded for demonstrating:

1. Floats in water – i.e. doesn't sink
2. Wind propulsion – i.e. not just drifting
3. Sensing – extracts environment information
4. Intentionality – aims for specific direction

Seaworthiness certificate

Only required for bonus achievement points

- Place your boat on one side of the tank
  - Any position or orientation you like
  - Fans will blow from the opposite side
- Successful if the boat reaches the other side
  - Success may be granted if the boat makes substantial progress within tank size limitation.

The Voyage

- Worth 30 per cent of course grade!
- Three attempts
  - Start at centre of eastern edge, facing due West
  - 5 minutes for each attempt
  - Randomly placed dragon
  - As many fans as I can scrape together

Highest score of the three is the one counted

Voyage marks

"But… how are marks going to be calculated from our point score??"

Voyage marks

Non-trivial, non-linear function:

Voyage mark = min(total points*5, 35)

Landfall location	**Points**
Lost at sea	NA
Island	2
Desert	3
Forests	4
River	5

Achievement	**Points**
Winter attempt*	+1
Reached the Temple of Axolotlzuma	+2
All ships reach river delta	+1
No off-board computation	+1
$20 under budget	+1
Snagged ship freed by judge	-1

Maximum demo score

- Maximum of 35 out of 30? Lolwut?
- Sharp-eyed readers of the ECP will notice that that demo is listed as scored out of 65%
- Teams may score up to 5 extra marks
  - Up to 65 marks for a “perfect” score

But also…

You were promised treasure!

The Treasure of Axolotlzuma

The Treasure of Axolotlzuma

If a team's boat successfully reaches the temple during the three final demo attempts, each member of that team will receive an Axolotlzuma trophy

The Treasure of Axolotlzuma

If a team's boat successfully reaches the temple during the Friday exhibition session, each team member present will receive an Axolotlzuma trophy

The exhibition session

- Just like the final demo, but not for marks
  - Will not be considered for marks, no matter how well or poorly you do
- But! A second chance to get the trophy
  - No limit on number of attempts (or boats in the water concurrently)
- Please email me if you would like to enter your boat in the session

And now…

The tables are turned

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…

METR3800

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?

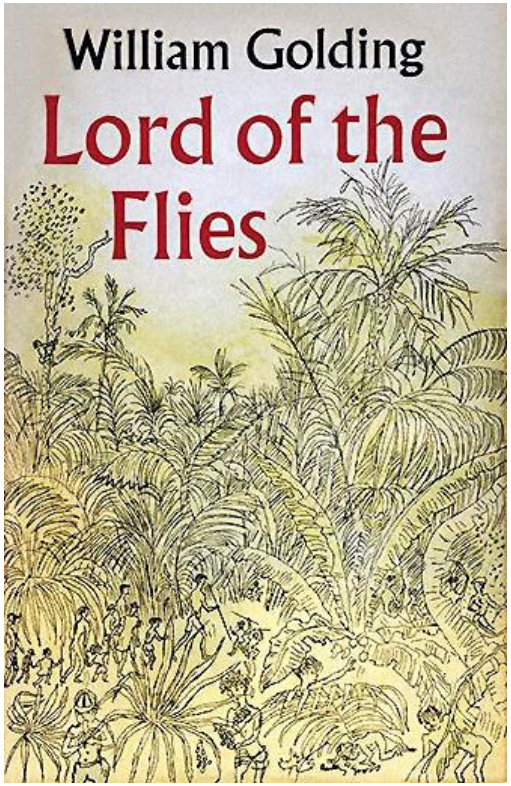
Challenging problem?

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

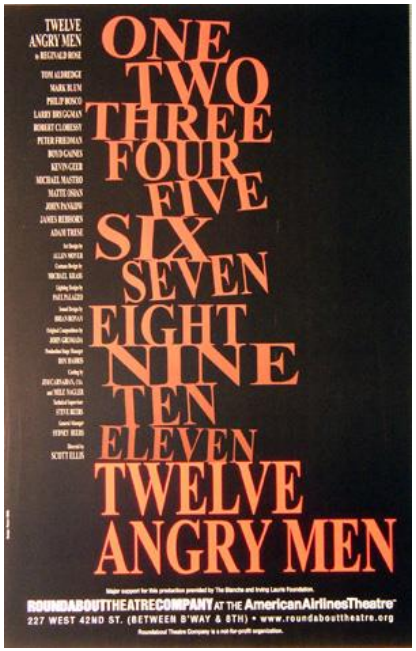
Prior experience

Lessons from METR team projects past:

1. Students overly familiar with old projects
   – Everyone knows Micromouse and Robocup

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

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



Prior experience

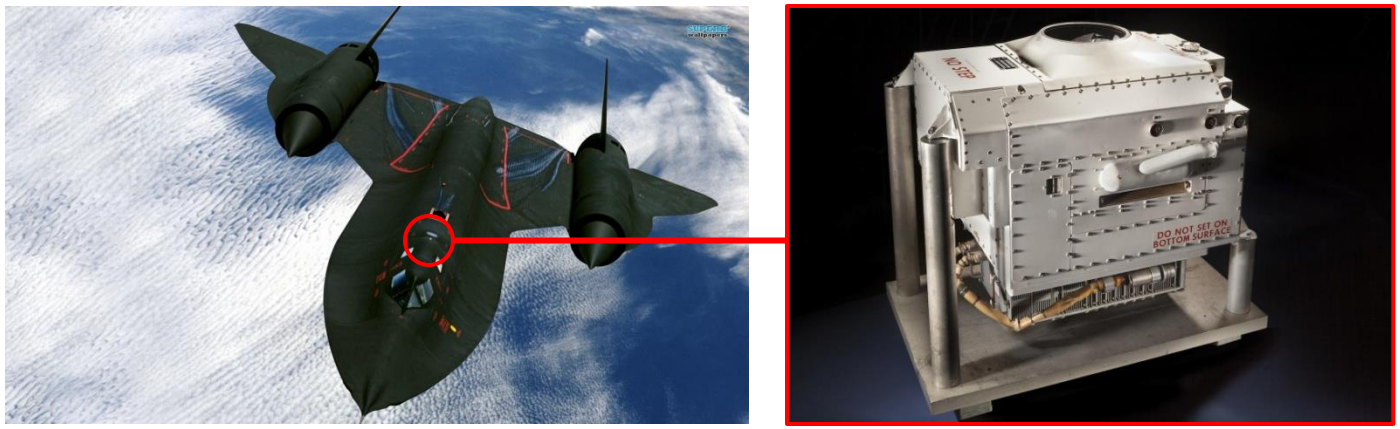
4. Supervised team meetings don't work
   – Results in "Potempkin Meetings"
5. Product-based courses exhibit boolean failure modes
   – Small errors on last day are lethal
6. Students *never* get started early enough
   – Even when you tell them to!

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

- Had the itch for an “astral navigation” project that used LED ‘stars’ for guidance



Nortronics NAS-14V2 Astroinertial Navigation System

As seen on the Lockheed SR-71. Inertial-aided ANS could track up to 56 stars in the daytime – through a circular window in the upper fuselage – and use them to estimate both position and altitude.

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… Autonomous sail boats!

Meeting the spec’

Why autonomous sailing?

- No reuse of previous project work
- Four clear, independent mechatronics tasks
  - Wind, hull, vision/planning, electronics/sensors
- Naturally motivated obstacles/disturbances
- More focus on design, less on fabrication
  - Lower time burden and better learning value

Implementation

Key design subsystems:

- Sensible assessment
- Making it challenging
- Making it fun

Sensible assessment

- Assignments as a *de facto* project plan
  - Design brief to get you thinking early
  - Regular freeform milestones every 3 weeks
  - Big milestone in the middle
  - Early submission to get you working on report
- Reports differentiate students, give chances
  - Allows good students to survive bad groups
  - No single assessment is ‘sudden death’
  - Safety net options – designed to reduce angst

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 hazards to test specific design skills
  - Volcano for disturbance rejection, dragon for obstacle avoidance, narrows for navigation

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>, won this year!

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
- Difficult but obviously achievable
  - Not futile; tangible reward for time put in
  - Early pay-off for effort (eg. a hull that floats)

Results

How it went down

My philosophy

- Engineering is the highest, purest and most noble pursuit of the human experience
- 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

What I think I did well

- Kept it real
  - Treated you like Men (or 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

- Focussed on success and learning
  - Toy problem, real analysis; no busywork
  - Second chances – no ‘cliff’ assessment
- Made time for students
  - Made myself available in the lab
  - Lots of one-on-one feedback on assessment
- Put a *crazy-astronomical* amount of effort into goshdarned near everything

What I think can be improved

Things I *can't* change:

- Political bun-fight over tank location
- Needs more lab space and 3D printers
- Miserable clash with METR4900

Things I *can* change:

- More upfront material about report writing
- More fans! (ie. more testing of apparatus)
- More (longer) lecture content?

What you liked

- You learned lots
- Project was challenging and interesting
  - Hard, but rewarding!
- Lots of feedback on reports
- Sense of humour (?)
- Free coffee after Tuesdays Q&A!

What you didn't like

- Project was really hard!
  - Maybe too hard?
- Collision with other classes assessments led to numerous sleepless nights
- Still nobody can tell you what "scope" is

Fun details

- The constellations are all based around Internet memes
  - Did you work them all out?
- Inscriptions are actual Latin (via Google)
  - Most are silly; some are hints about the project!
  - Markings and guides on the maps are accurate
- I blew $1500+ of my own money on this
  - If it's worth doing, it's worth making awesome!

Cutting-room floor

A few cool things didn’t make the cut…

Discarded challenges

Extra hazards to keep things scary:

- Some sort of kraken that would attack ships
- Whirlpool that would spin ships around
  - These were all too complex to implement and it was felt that randomness was unfair to students

Another discarded early idea:

To get the trophy, you would have to make the return journey with an added 50g cargo

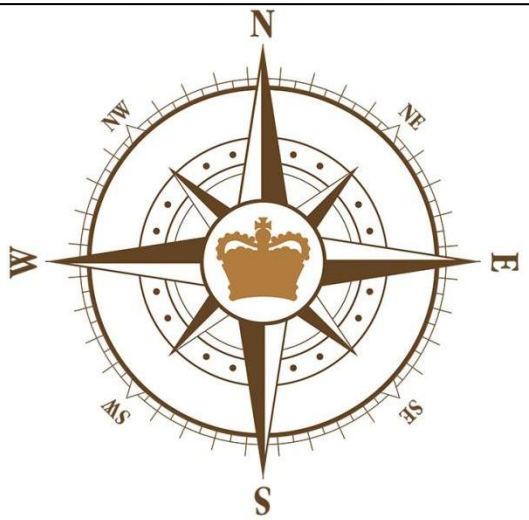
Rejects and concept art

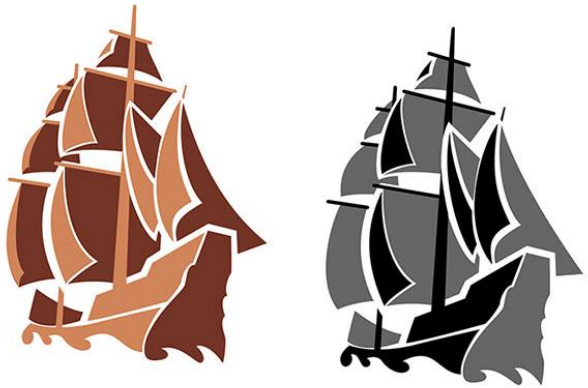
The art team came up with some awesome stuff, but not all of it was included

Some of it was also terrible

“Corsair” art style

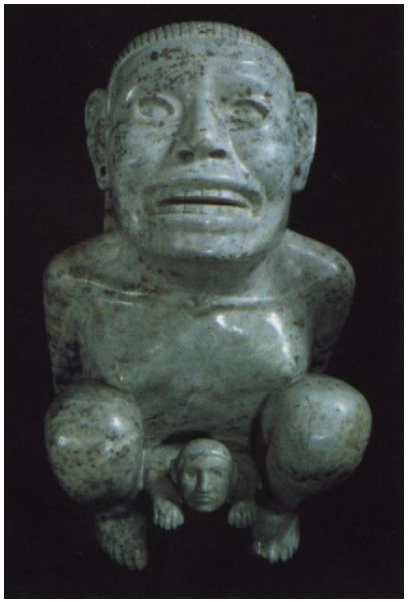
Too web 3.0?





Ended up going with a more renaissance look

Axolotlzuma evolution



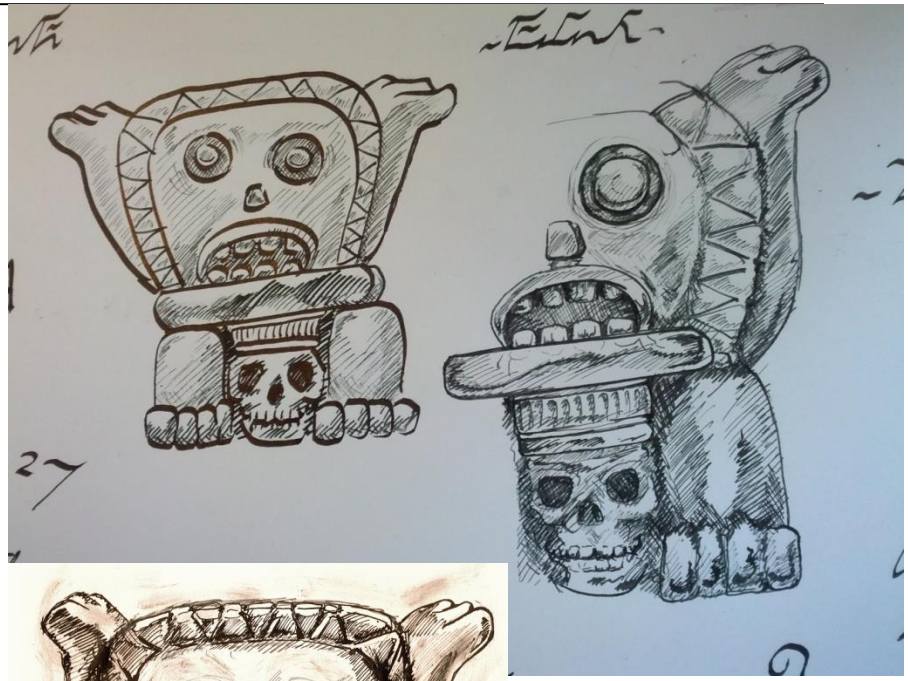
Greenstone idol
Dumbarton Oaks
Collection

'Golden Idol'
Raiders of the
Lost Ark

Tribal head
Axolotlzuma
concept

Final chosen
Axolotlzuma
concept

Axolotlzuma evolution



Splash pic

- Had to give a quick, instantly catchy intro

Fonts and calligraphy

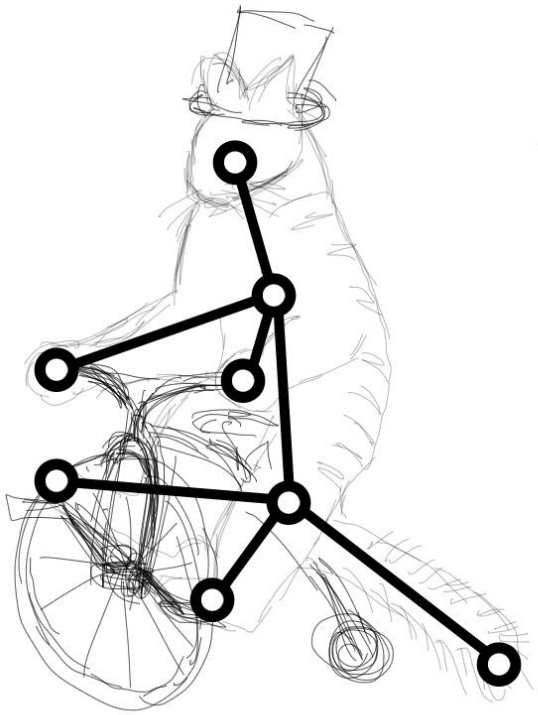
- Gives the website a Ye Olde style
  - Artist learned calligraphy just for this project!

METR3800

Mechatronics Team Project 2

2013

Unused constellations



"The Cyclist"

"The Cat"

These went unused because they're terrible

"The Traitor"

Conclusion

We'll have to wait until Friday! ☺

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

Cast of Thousands

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

The *simply amazing* workshop guys:

Keith Lane, **Grant Tayles** and **Mark James**

The *astonishingly supportive* **Keith Bell**

The *patience-of-saints* **Eddie Platt**

And now…

Vote Paul in 2013

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


Voyage to the New World
~Fin~
Treasure of Axolotlzuma

Starring Paul Pounds as Course Coordinator

Written and directed by Paul Pounds

Supporting Cast
Paul Pounds as Royal Messenger
Chris “Kit” Ham as Tutor 1
Adam Keyes as Tutor 2
Jared Page as Tutor 3
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 Singh the Merciless

Produced by Paul Pounds

Original music by Paul Pounds

Camera and Cinematography

Camera 1	Dr. Surya Singh
Camera 2	Michael Eastwood
Key grip	Jared Page
Gaffer	Adam Keyes
Best Boy	Chris “Kit” Ham

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
Mark James

Costume Design
Blashki & Sons
Country Road
David Jones
Hugo Boss

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
Erika Vasos
Michael Eastwood

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

Technical Support Group Manager
Keith Bell
John Kohlbach (acting)

Workshop Unit 1
Keith Lane
Greg Tayles
Mark James

Workshop Unit 2
Peter Bleakley
Ray White
Dejan Subaric
Doug Malcolm

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

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

Public Relations and Marketing
Izaeel Koh

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
Eddie Platt
Andrew Cameron
Michael Eastwood

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

In memory of Keith Bell

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