



Previous Years' Design Case Studies

or

“The definition of madness is doing the same thing over
and over again and expecting a different result”

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9 March 2021

University of Queensland

But first...

A valuable message about safety...

Campus Calamities presents

Deadline

#003



Secondly...

Some house keeping

Submission link woes

- Apologies for the stuff up with the link – change in policy changed the due time, but the go-live time wasn't changed accordingly
 - D'oh!
- To avoid this problem in future, I've simply set *all* the links live, so you can submit whenever you feel like it!
 - Go nuts... but probably no point submitting a report until you've actually built something first?

Problem Analysis

- The METR4810 marking elves (ie. the tutors) worked solidly through the night to get you results for today
 - You're welcome

A few comments...

(Honestly, these comments are the same,
year after year after year...)

Problem Analysis

- When you are writing, think about:
 - Who is the audience?
 - What does the audience know?
 - What do you need to tell them?
 - What *don't* you need to tell them?
- Time spent on talking about obvious things is time taken from talking about things that show you understand the task

Problem Analysis

General writing skills comments

- Pointless introductions that go on and on...
 - You have two pages – use them wisely
 - Don't spend time on ~fancy~ writing
- Lots of misdirected citation
 - References must bring new, useful information
 - Why not *cite* the design spec doc, rather than regurgitating what's in it?

Problem Analysis

- Probably don't need a title page, executive summary or table of contents for a two-page report... just say'n
 - Some crazy people submitted 6+ pages (!?)
- Appendix abuse was rife
 - Appendices are for pictures, plots, tables, *not text*
 - Don't worry: if they were just more text we didn't read them

Problem Analysis

Problem Analysis common threads:

- Lots of simply restating the problem spec
 - Don't regurgitate – tell me something new!
 - What are the implications of the spec?
- What about tacit constraints/requirements?
 - Not everything is listed in the spec.
- Limited translation of spec into challenges
 - Little pre-chewing of the problem

Problem Analysis

Design Analysis common threads:

- Present your analysis before your solution
 - Don't put the cart before the horse!
- Can't fit all the words on the page?
 - Maybe you need fewer words?
 - The answer is never 9 point font and tiny, tiny margins – this obviously isn't acceptable and didn't fly

Problem Analysis

- Oh yeah... and it's not “research” unless you have citations
 - \$DEITY help you if you claim to have done research and don't put in useful, meaningful citations that inform your design decisions.
 - *You've been warned.*

Some useful tips

Meditations on self-review

How to identify good work

- All the necessary parts are present
 - Constraints, requirements, deconstruction, etc.
- Supported thinking – aka justified reasoning
 - “*Because X, thus Y.*”
- Logical flow; links in a chain
 - “X, therefore Y. Y, therefore Z. Z, therefore win.”

How to identify good work

- High level structure
 - You are given enough information to understand each section before you get there
- Intuitive coherence
 - “*Wow, I totally get it!*” – probably good work
 - “*I just don’t understand this!*” – probably not
- Analysis
 - “Given a 15kJ battery, using equation 4 we predict a total operating time of 270 seconds.”

How to identify bad work

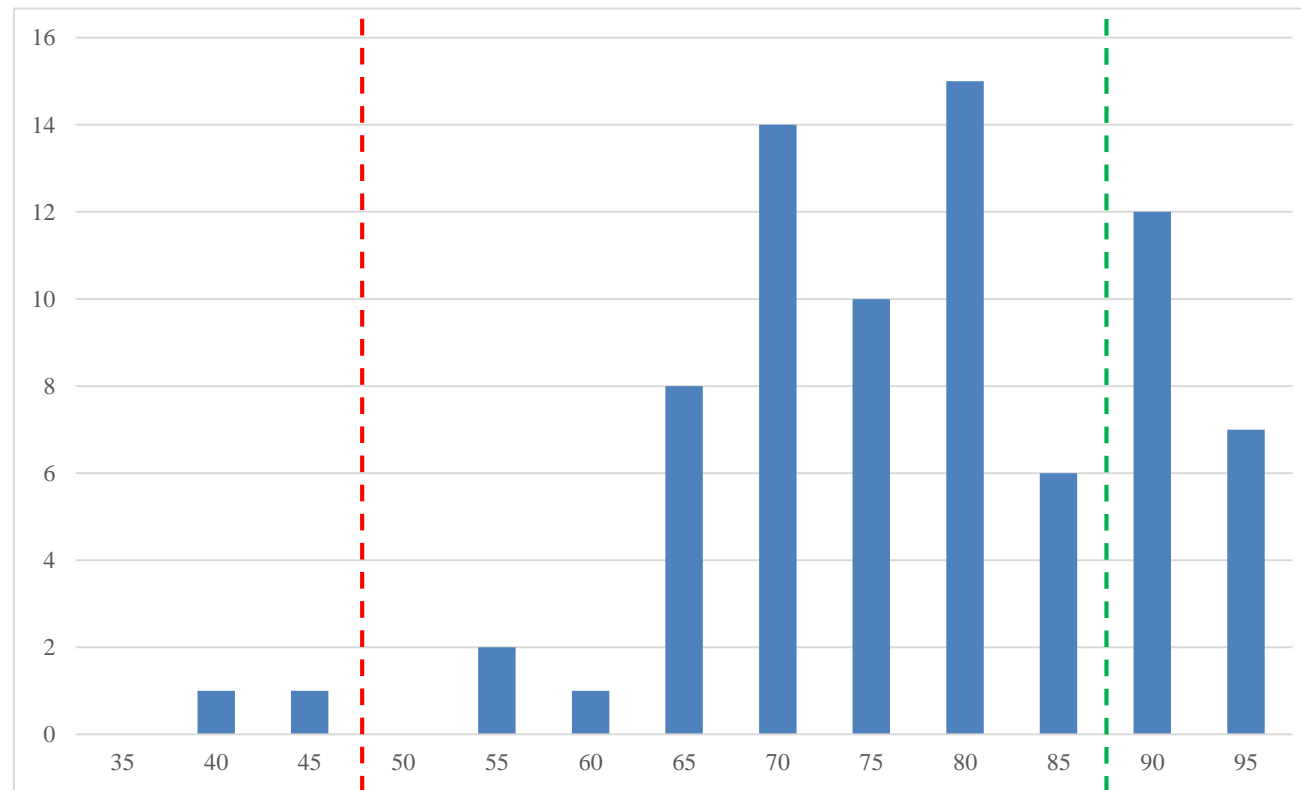
- Key parts are missing
 - Cursory, curt, and often rudely short, eg. 3 paragraphs in a two page assignment
- Lack of due care
 - Spelling, grammar, formatting errors; laziness
- Misdirected register
 - “We’re gonna do engineer haha lol”

How to identify bad work

- Unsupported statements
 - “Geared motors are the best solution.” *Why?*
 - “Research found that AVR’s are effective.” *What?*
- Logical incoherence
 - “Lipo batteries are the most efficient.” *Snuh?*
- Obvious hogwash
 - “The whole system will weigh 50 g and be completed in 3 weeks.” *Wtf?*

Problem Analysis

Results available via Blackboard after lecture



Assignment return

- Pick yours up! (or I'll scan it for external students)
- ~~Available after the lecture!~~ At the prac sessions
- Notes!
- Comments!
- Suggestions!
- WTF!

Calendar at a glance

You are
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				
9	27/4 – 1/5			50% demo	
10	4/5* – 8/5		Progress review		
11	11/5 – 15/5			75% demo	Preliminary report
12	18/5 – 22/5				
13	25/5 – 29/5	Closing lecture		Final testing	Final report and reflection

Progress reviews

- Progress reviews are next week!
 - 15 minute slot per group
 - Each group member presents in turn
 - Should only take 3-4 mins each

- Sign up for session slots via Doodle poll

https://doodle.com/poll/bzvugrvmkemhgmr?utm_source=poll&utm_medium=link

Progress reviews

- How to sign up:
 - Have **one and only one** member of your team nominate a time for your team on the poll
 - When they sign up, they must include their **team number and full name**. If they don't put both, the slot will be cleared.
- If you absolutely can't get a slot that works for all of your group, email me ASAP
 - *But this should never happen*

Progress reviews

- Flexible students should attend the rooms per the scheduled contact sessions
- External students should join via zoom link:

<https://uqz.zoom.us/j/81705489650>

(Yes, Zoom says it goes from 11 to 6, that's just when the link is active to cover the span of all the sessions being run across the three days)

Progress reviews

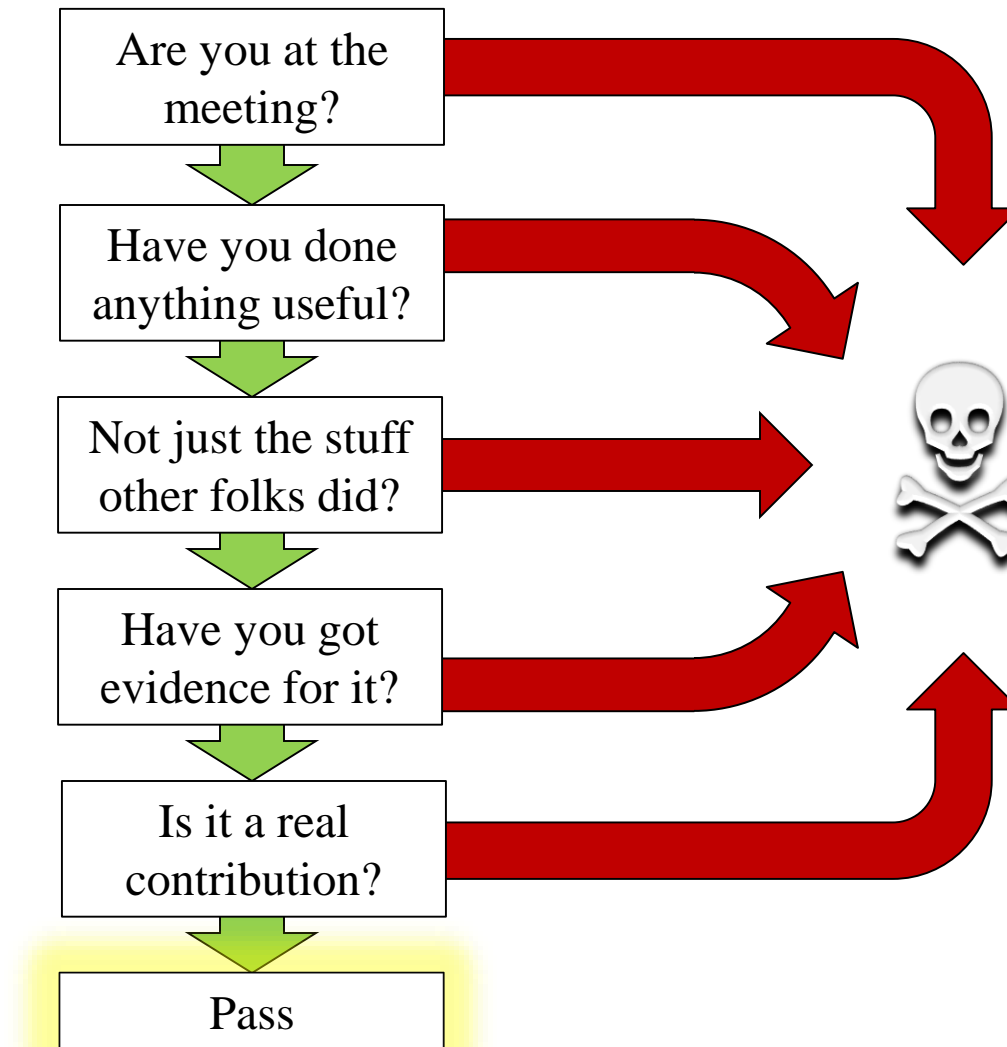
What is expected for the progress review?

- Need to show that you've made a decent start to the project:
tangible evidence
 - Desired: rigorous analysis, detailed simulations working compiled code, breadboarded electronics, mockups of mechanical design
 - Inadmissible: scrawled pictures, isolated printouts of code, lousy rushed CAD or circuit diagrams, datasheets of that one part you found

Progress reviews

- Don't panic: we are reasonable
 - The progress review is entirely to motivate you to get started early, and check your progress
- We can tell very easily if you've actually made an effort – if you have, you'll be fine!

Progress Review flow chart



And also...

- You will be doing PAFs for each of your team members
- The PAF will contribute towards the final scaling of your final product score
 - This really counts!
- Please return your completed PAF to the tutor *before* you leave, or else email them to the course coordinator (ie. me).

And also also...

- You must submit (as a team) a signed (by every member of your team) document stating what the roles of each person (in the team) are
- We will refer back to this document in subsequent reviews
- It's not an immutable contract, but it is expected to be broadly adhered to

Team updates

- The group allocations have been updated to correct a copy-paste error
 - Deduplicated a student who appeared twice, corrected a student's name, other sundry fixes.
 - Many apologies for any distress caused.
- If you are concerned a duplicate of you may still be at large, please let me know immediately
 - If you spot your doppelganger in the lab, *do not engage* – call security on 53333 and wait for backup.

Make-up induction session

- If you missed Wednesday's induction session, you can sign-up for the make-up sessions!
 - Two sessions: 9:00 and 13:00 on Thursday 11th (I didn't choose these times!)
 - Same link as before:
<https://student.eait.uq.edu.au/urite/index.wphp?act=show&schedule=264>
 - Sign up before the morning-of!

On campus lectures

- Lectures will be held on campus from next week – woot!
 - Room location TBA, will notify via Blackboard announcement
 - Echo360 will be enabled.
- I will try to arrange Zoom simulcast for External students
 - Hopefully everyone will win! Yay!

Group budgets

- Richard Newport is organising budgets
 - Should be done by the time you're reading this.
- Really, though, now is the time to be thinking, not buying
 - How do you know what to buy unless you've thought about it?
 - While you're thinking, why not do some analysis?
 - Sure would suck to end up buying the wrong thing, amirite?

A few notes on ordering

Richard Newport reminds us:

- You cannot order anything from ebay
 - Hint: most ebay stores have websites where you can order the exact same thing at the same price
- You cannot order from anything China
 - Credit card trouble, apparently?
 - Hint: most stuff on Alibaba can be bought from Australian retailers at similar prices

FAQ Roundup

- **When can we get STL files?**
 - Right now! On Blackboard!
- **Do we have to use Altium? Can we use KiCAD/Eagle/etc?**
 - Use whatever you like – I’m not the boss of you. I use Eagle at home, and don’t really like Altium, but I can help you out whatever you use.
- **No seriously, do we have to go to all the lectures/contacts/pracs?**
 - Only if you really want to – the pracs are there for the tutors to help you, and the contact sessions are times for your team to meet. Use those times to best effect, per your judgement. I really do recommend coming to the lectures and pracs, though!
- **When do we get our budgets?**
 - As noted previously – should be available now, or very soon.

FAQ Roundup

- **Can we use a RasPi?**
 - Sure
- **Can we leave something attached to the service module adaptor?**
 - Sure
- **Can we use parts from a hacked hobby drone?**
 - Sure

That is which not specifically prohibited is permitted.

Back to the deconstruction...

Design Case Studies?

Lolwut?

The process

1. Identify the requirements (design brief)
2. Create specification
3. Deconstruct the problem
 - Functional decomposition
 - Causal dependency tree
 - Parameter space, performance space, metric
4. Synthesize a solution

Let's do it!

To the visualiser, Batman!

Two examples

- 2016 “Mineshaft” borehole rescue robots
- 2017 “Hunt for Sir Nils Olav” sunken submarine recovery robots

Example 1

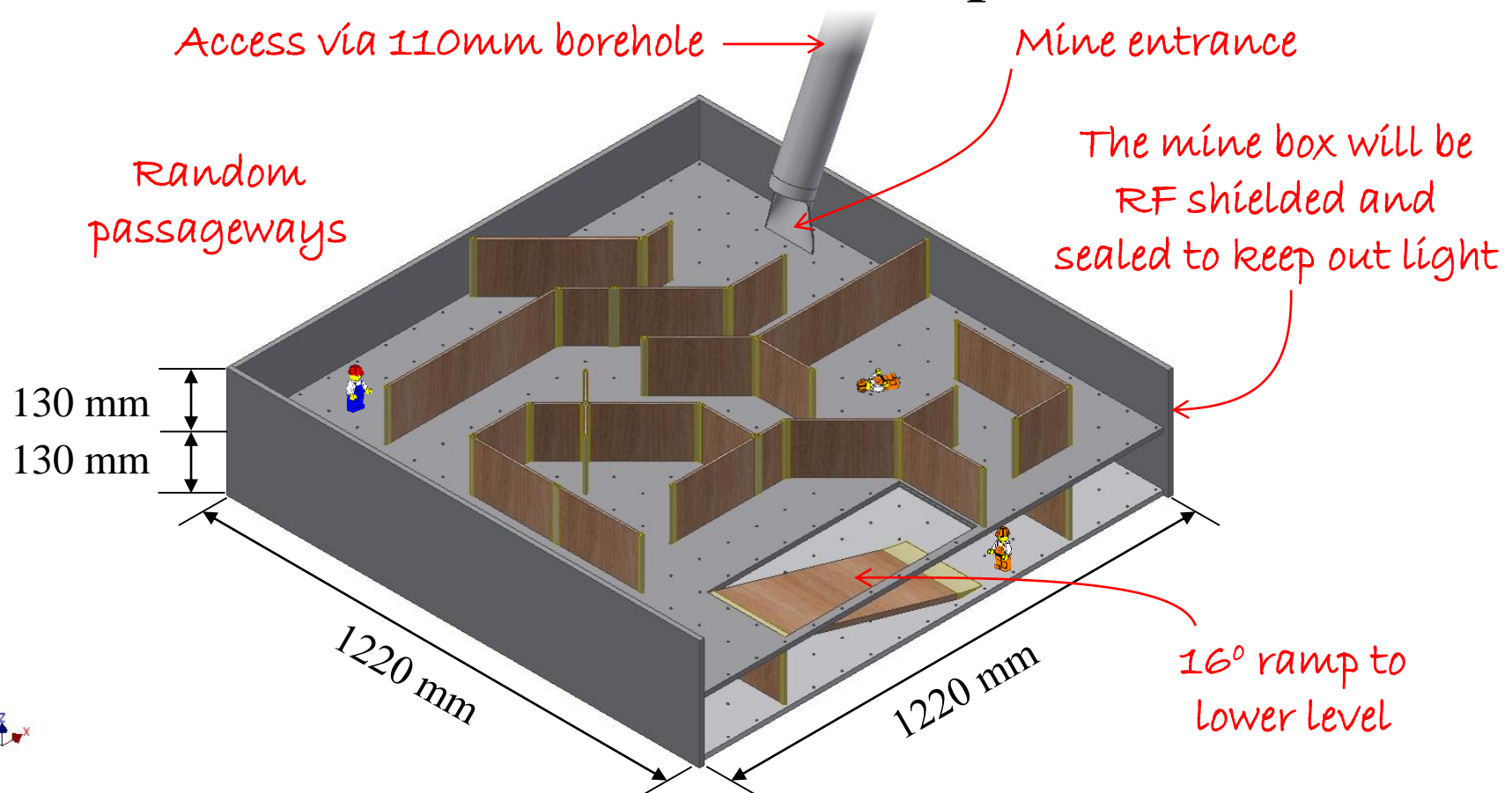
The 2016 Project

The task

Build a system for entering a miniature subterranean mine via a narrow borehole to locate and rescue trapped miners

The mine

Two levels of random passageways,
connected via a ramp

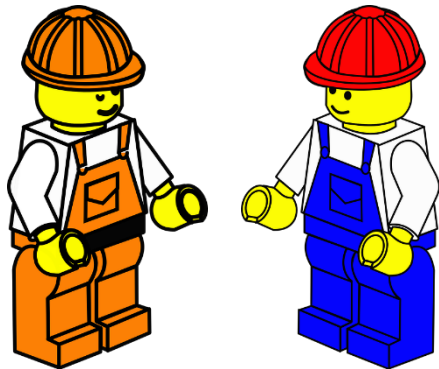


Hazards

- With the mine damaged by an earthquake, expect obstructions and debris:
 - Rock falls, with boulders up to 100 μ Tons
 - Rubble piles and gravel
 - Toppled mining equipment

The miners

- The miners are represented by LEGO™ minifigures scattered through the mine*
 - You must locate the miners, report their health status, and return them to the surface



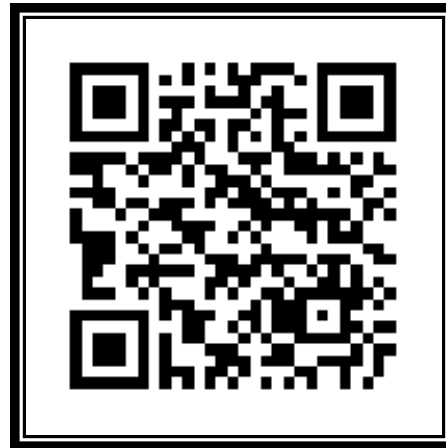
Worker appearance
may vary

Miner health status appearance guide

Standing	Green label	Healthy
Sitting	Yellow label	Injured
Lying down	Red label	Dead

Seismograph readings

- Seismograph monitors are scattered throughout the mine
 - Scan the readouts (in the form of QR codes) to assess mine safety condition



Here are some numbers

There are a few parameters:

- Rescue time available: 25 minutes
- Borehole diameter: 100 – 150 mm
- Onboard lipo battery energy: <15 kJ
- Lego minifigure weight: <10 g

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

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
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

Deconstruction

- What's required?
- What are the constraints?
- What's the scope?
- How can we decompose the problem?
- What are the hard parts of these tasks?
 - Why?
 - How can we address them?
- Example solutions

Deconstruction

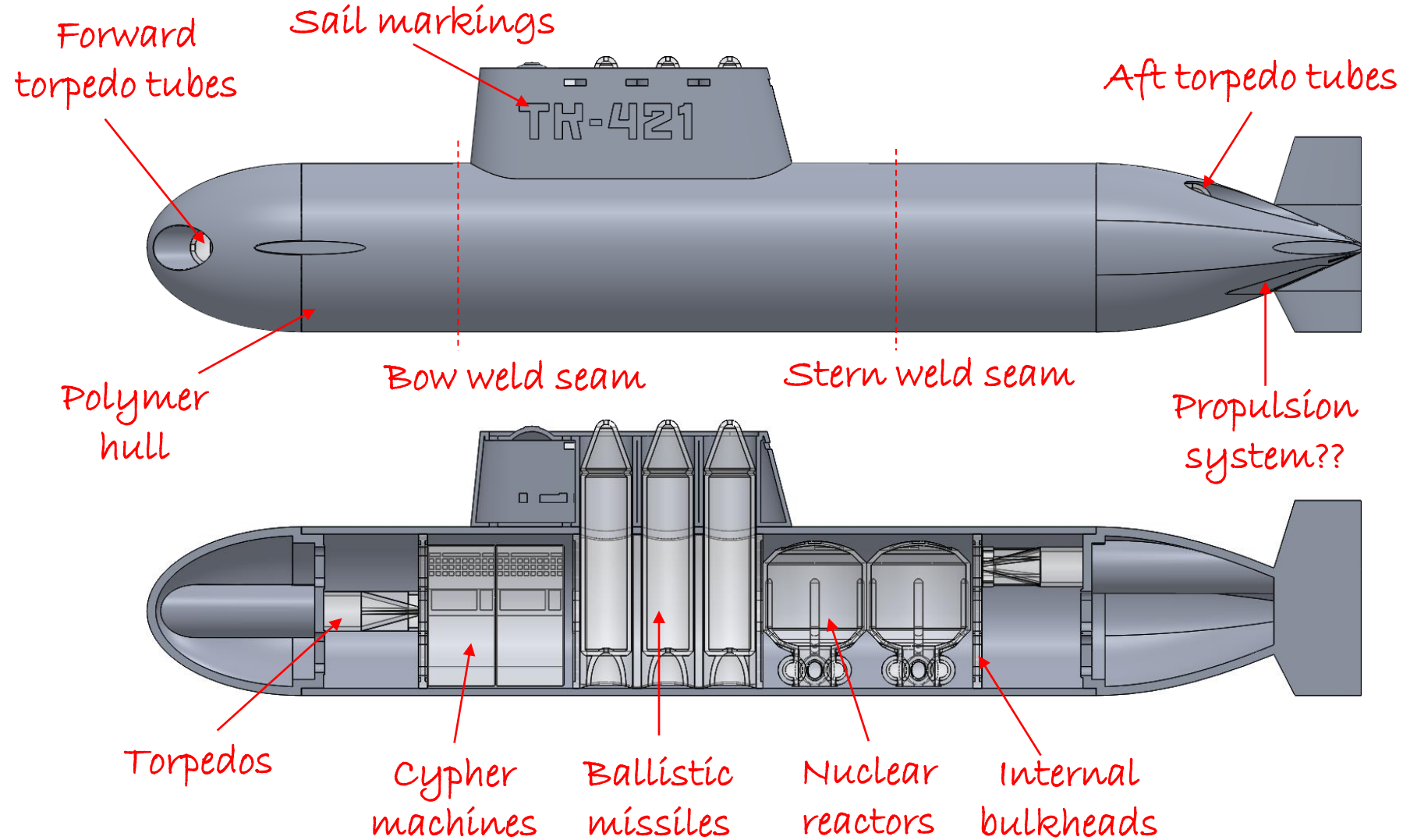
Example 2

The 2017 Project

The task

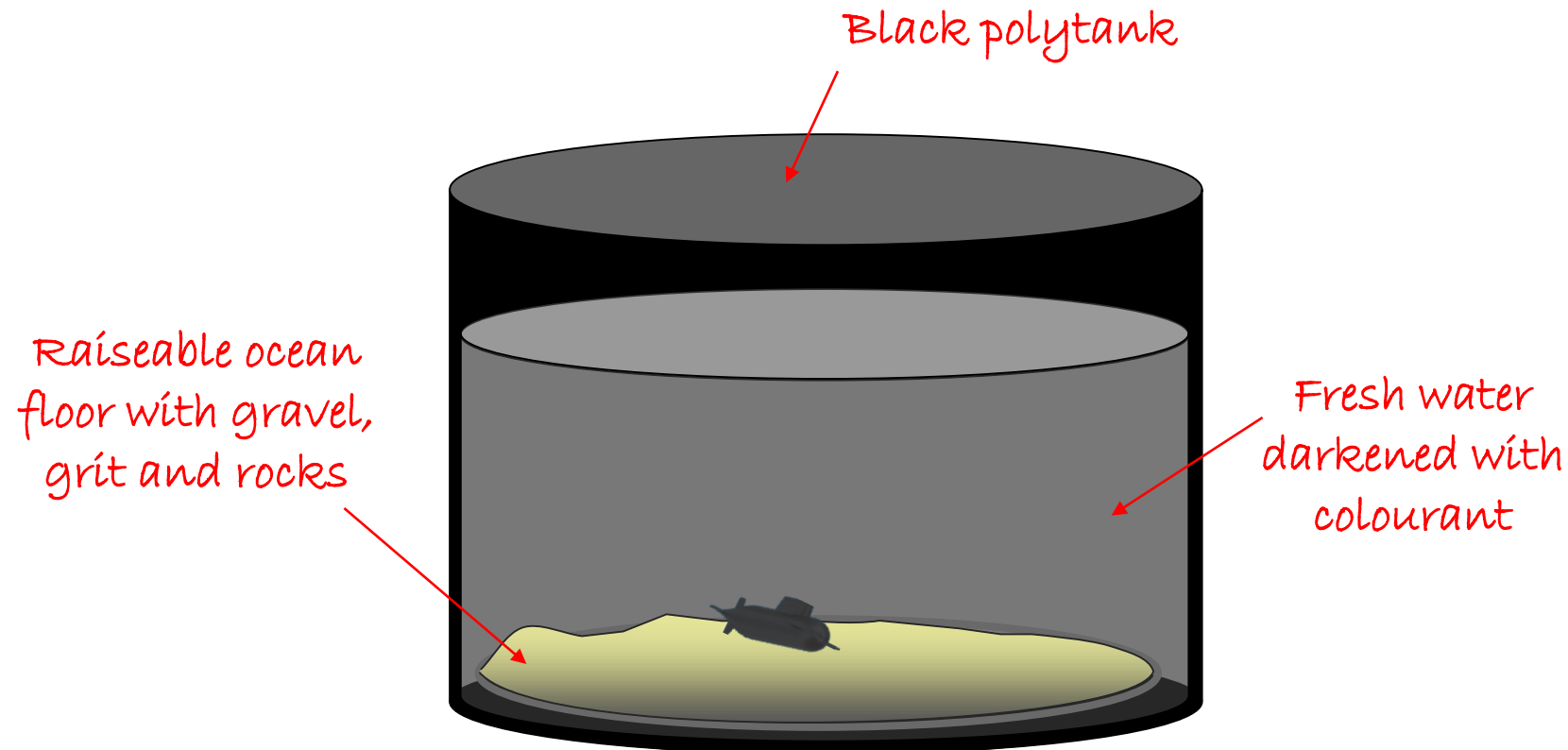
Build a system for recovering a sunken
(miniature) submarine wreck from the
(miniature) ocean floor

Intelligence brief: The *Sir Nils Olav*



Testing tank

- 2m x 2m converted rainwater tank near Hawken building



Here are some numbers

There are a few parameters:

- Recovery time available: 25 minutes
- *Sir Nils Olav* length: 275 mm
- *Sir Nils Olav* weight: 300 – 500 g estimated
- Water depth: 1.5 – 1.75 m

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

Functionality and scoring

Basic Functionality	25/25 Points
Return images of the sea floor to surface	10
Locate the wreck of <i>Sir Nils Olav</i>	10
Return image of sail markings to surface	5

Recovered items	30/30 Points
Torpedo	2 each
ICBM	2 each
Reactor module	4 each
Code cipher machine	2 each

Recovered hull sections	35/35 Points
One separate section	10
Two separate sections	15
Three separate sections	20
Two joined sections	25
Two joined sections, one separate section	30
Entire submarine intact	35

Bonus Functionality	10/10 Points
Find other sunken objects	2.5/object

Deconstruction

- What's required?
- What are the constraints?
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Deconstruction

Questions?

?

Tune-in next time for...

Professional Engineering Topics

or

“Stuff they should have taught you at university, but didn’t”

Fun fact: Just the design specification for the Lockheed Martin F-35 strike fighter was over 600 pages long.