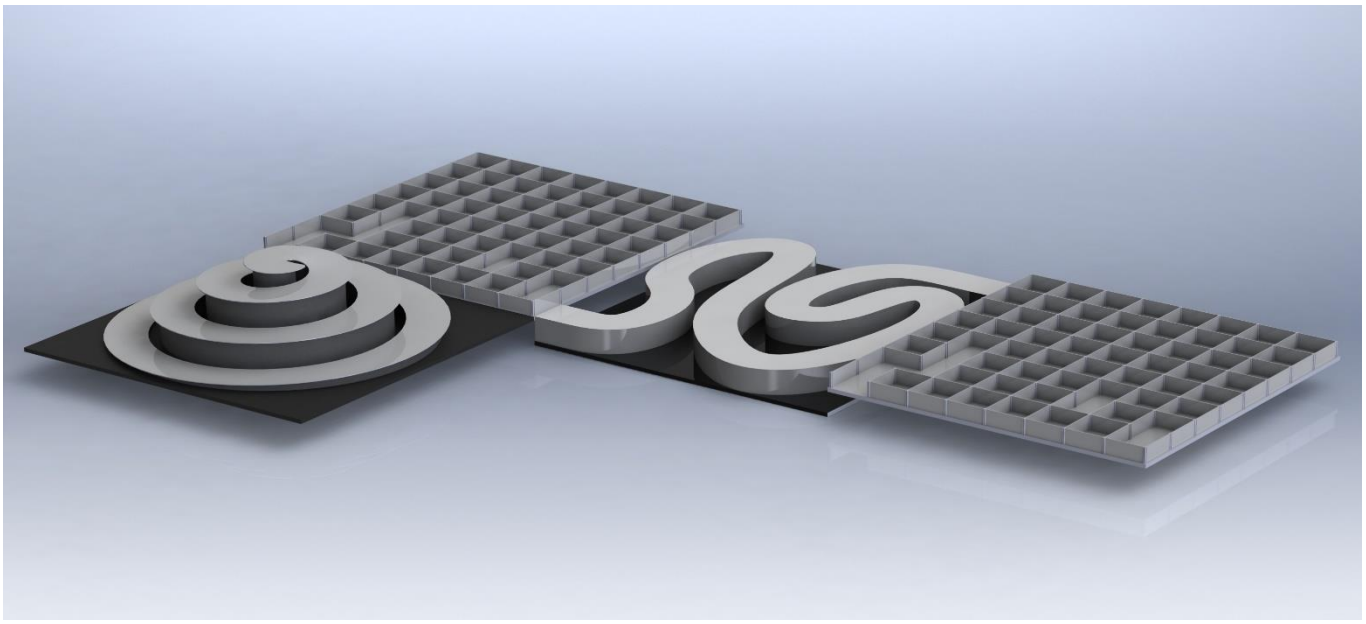


# SER300 Project Brief 2024

MARCH 29

**SER300**
**Dr Andrew Price**
**Rev 1.2**

# Project Brief: Overview

SER 300 is a unit unlike any other for Mechatronics students. Just as Level 3, or third year, is a *significant* step up from what you have experienced to this point in your degree.
The training wheels are off. You're in it now.

SER300 has several key objectives, but the one you may not yet have thought about is the timing of this project and this unit.
This unit is designed to let you experience a project build where you must manage your time, your resources and the knowledge you need to complete the job. Why is that important? Well, these are the attributes that employers desire. As it happens, most graduate positions are advertised for completing students early in their final year. Interviews are often held May through July. Enough time for employers to have a good look at candidates and for students to plan their lives. So, what are you going to talk about at your job interview?
Employers frequently start with marks, attitude and enthusiasm or willingness to play a role. You're almost destined to get the question "So what projects have you worked on"? If you say "Oh everything went just as I planned" they are not likely to believe you. On the other hand, if you say "Here is a project I worked on, here are the problems I had along the way, and here is how I overcame them" you will more than likely get their attention, or at least the next round of the interview process.
The trouble is, you won't have finished your degree, or more importantly, your final year project by the time many interviews roll around. So what you complete at level 3 is what you will have to talk about at your job interviews.
Enter SER300 Mechatronic Design.
In this unit you have a choice of three designated projects. We have designed the projects to reflect the skills expected of any student completing a degree such as this, as well as the need to give you the best story to tell when it comes to your job interview. This is your chance to shine. It will be a long and intense time and you will use every hour this unit calls for, and probably then some. You will get frustrated, annoyed, tired, sad, nervous, and hopefully finish elated with something to show and a memory you won't soon forget. That's how I felt 30 years ago when I sat where you sit now.

You can choose any one of the three projects we have on offer. Keep in mind your circumstances, resources, location, and the nature of international shipping to really stuff things up when you make your choice.
You can change your mind until close of business Week 2 (that means Friday 5pm week 2) You choose the project from the designated projects. You do the work. You reap the rewards.
The unit guide specifies all the boiler plate information you need to understand in terms of your contribution of time and effort, so I will always refer to that document. But what I will say is this. Those that choose to put in the necessary time and effort are likely to succeed. Those that don't attend labs or studios or have somewhere else to be will most likely not succeed. That is the pattern from previous years and it is well documented.

You have some work to do to figure out your best option. Two of the three projects can be easily replicated off campus, the third is somewhat more structured so keep in mind your ability to access the Waurn Ponds campus as part of your decision-making process.

The projects have their complexity managed and are tried and tested (in fact you will be going head to head with history as all these projects have been done by students at your level before).
Like many students the pandemic has messed with your access to labs. Therefore, we have work to do together to fill in the knowledge that third year students should have. Employers will always take the best they can get, regardless of outside factors.

At this point I will be available in the lab during the semester on Wednesdays from 9am to 4pm (Nominal). I will also be floating in and out of the lab on other days covid notwithstanding.

So, you probably would like to hear about the projects…

# Project One: The Domino Effect

## A robot challenge

Stacking Dominos and watching them fall is a past time/hobby or game for many people. This project is designed to explore the Domino Effect in an environment that can be easily replicated by both on campus and off campus students.

## Tasks

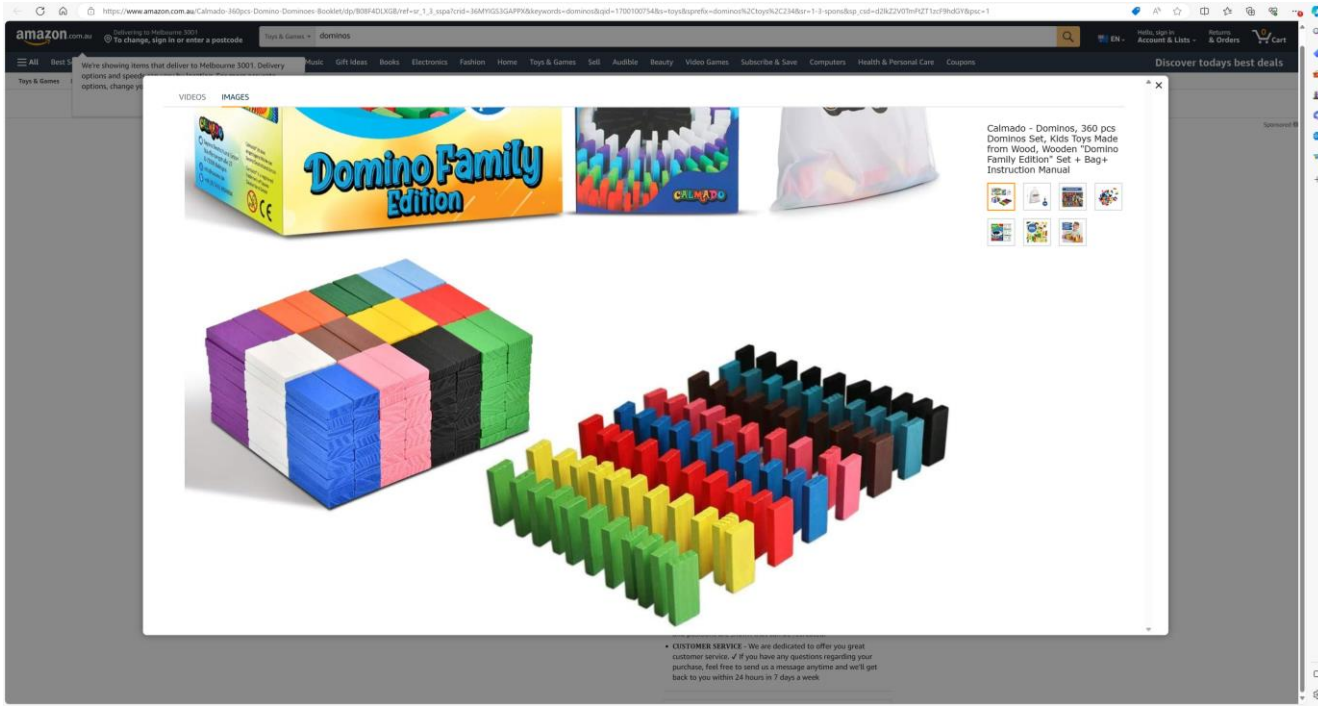
Your task is to design a vehicle that is capable of:

1. Standing Domino tiles on their end in such a manner as to cause the Domino Effect when one falls the rest fall in succession.
2. Stand as many tiles as possible within a 4 minute window without knocking them over.
3. Automatically start and stop via contactless user control
4. On Contactless User Command trigger the fall of all dominos from the last domino standing (backwards or last to first)

Scoring will be based on how many tiles are standing at the end of the 4 minute period and how many of those tiles fall when commanded according to the following equation:

Score Per Round = (Number Tiles Standing/Number of Tiles Placed) X Number of Tiles Intentionally Toppled

Everyone is required to use the same tiles. Below is a link and a description of the tiles we will be using in this trimester:




https://www.amazon.com.au/sspa/click?ie=UTF8&spc=MTo4NDE2OTQzNzMxODg2ODQ6MTcwMDEwMDc1NDpzcF9hdGY6MTA2NjM3MTM1NTAzOjowOjo&url=%2FCalmado-360pcs-Domino-Dominoes-Booklet%2Fdp%2FB08F4DLXGB%2Fref%3Dsr_1_3_sspa%3Fcrid%3D36MYIGS3GAPPX%26keywords%3Ddominos%26qid%3D1700100754%26s%3Dtoys%26sprefix%3Ddominos%252Ctoys%252C234%26sr%3D1-3-spons%26sp_csd%3Dd2lkZ2V0TmFtZT1zcF9hdGY%26psc%3D1

**The tiles are readily available via Amazon internationally.**
**The playing field is a rectangular flat surface approximately 2400mm x 1200mm and covered in white melamine (typical sheet from Bunnings or similar.**
**There will be a strip of black tape (electrical tape or similar) along each edge (approximately 20mm wide) to delineate the edge of the playing area.**

Playing conditions:
(note that these are subject to change until after the intensive week (week 6)

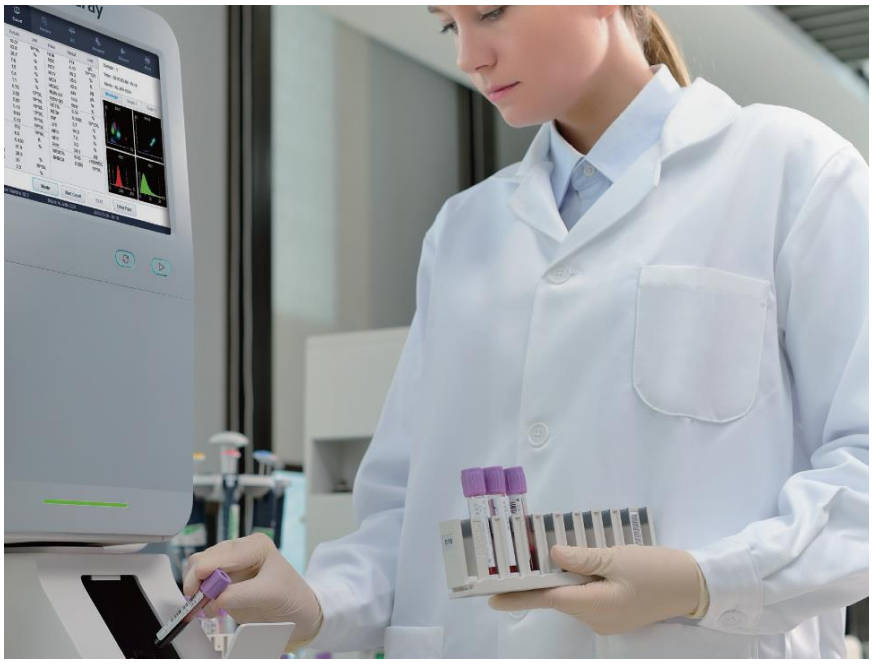
1. The referee's decisions are final
2. There are no exceptions to rule number 1
3. The maximum run time is 4 minutes.
4. Your machine must start and stop using contactless commands (eg Bluetooth). It must also trigger the domino topple by contactless command.
5. Your robot must not damage the track in any way.
6. Touching the robot will incur a penalty of 2 dominos subtracted from the total number standing per touch determined by the referee.
7. Your robot must be fully autonomous.
8. Your machine shall carry and hold the Domino Tiles to be placed.
9. Your machine shall be able to hold a minimum of 50 tiles.
10. If necessary, the robot can be stopped and reloaded with dominos without time penalty. The robot may not be removed from the table, modified or repaired during the time. Reloading ONLY. The time clock will be paused during the reloading and restarted after. Reloading is permitted at the discretion of the referee.
11. A maximum of 1 minute may be taken to reload your machine.
12. The robot must fit into a box 250mm(W) x 250mm(D) x 250mm (H). The H dimension is vertical off the deck.
13. The maximum weight of the robot excluding tiles is 1000g.
14. Commercial sensors which interface via I2C, SPI, RS232 or other recognized industry protocol may be used.
15. You must use the Nucleo G432KC board for this project. No other boards are permitted. A link to the manufacturer's website is available below: **https://www.st.com/en/evaluation-tools/nucleo-l432kc.html**
16. Each tile must be separated by a nominal minimum distance equal to the width of a tile (approximately 20mm+/-1mm) Allowances will be made for bends, turns and other configurations. The intent is to follow traditional domino constructions.

# Project Two:

# Automated Fluid Analysis Machine

## Imagine a situation where you need to test fluids for certain markers or conditions on masse…

Many graduates of a course like Mechatronics find themselves working or looking for work in the electronic product development or biotech fields. As it happens there is a large industry in product development in Victoria. Design firms are on the look out for talented engineers with an affinity to product design and the ability to synthesize solutions to develop new products and new ideas. That is to say engineers who understand that its more than just circuit boards and programming. This project is all about sensor interfacing, mechanics and data representation. As well as designing a suitable, aesthetically pleasing, functional enclosure.



Your client is seeking a new product, an automated Fluid analysis machine. It must be a product complete with sensors, internal power supply and robust enclosure as well as

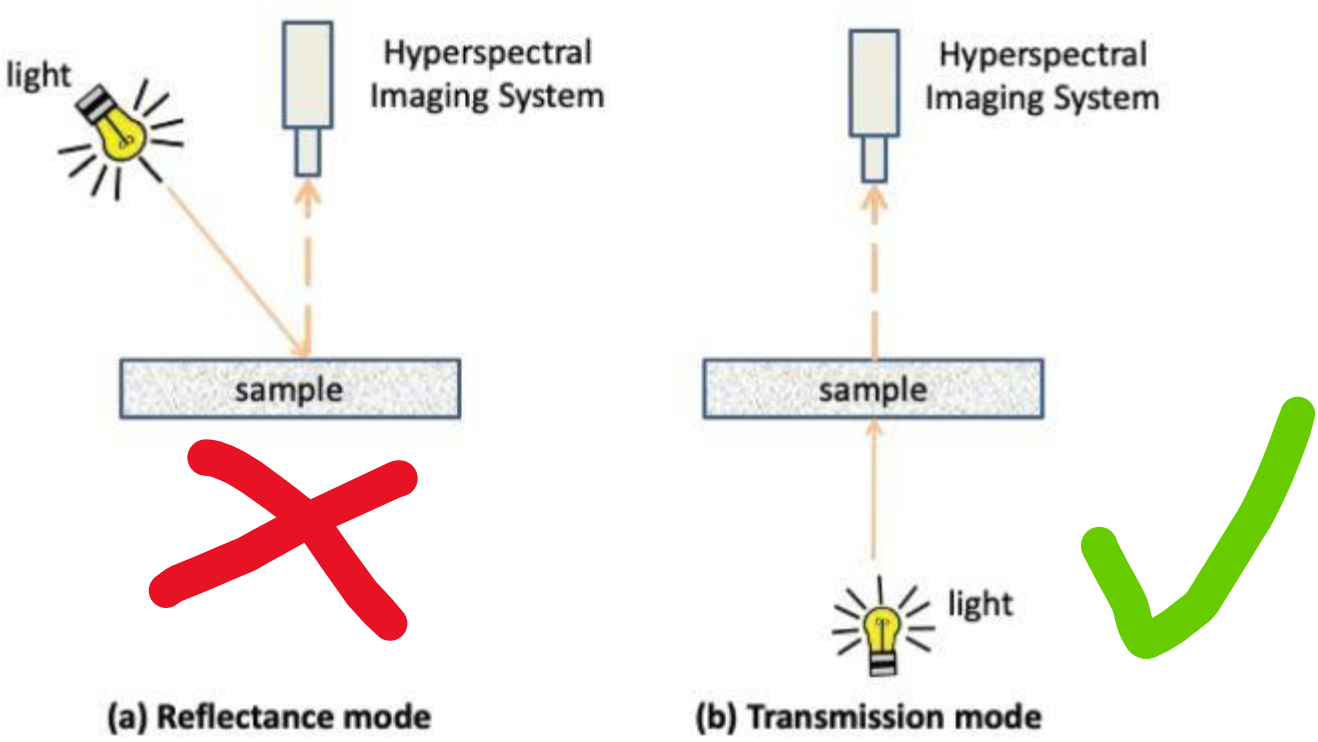
a mechanism for loading, unloading and storing up to 10 sample tubes of the following type:

https://www.amazon.com.au/POPETPOP-Laboratory-Scientific-Experiments-Containers/dp/B094R7HFP3/ref=d_pd_vtp_sccl_3_2/357-3482260-6868420?pd_rd_w=XjWqb&content-id=amzn1.sym.6c5371fd-e430-44b8-a1bd-99d66b7c7085&pf_rd_p=6c5371fd-e430-44b8-a1bd-99d66b7c7085&pf_rd_r=5AS1AEAN3SA5CKS59QF8&pd_rd_wg=VpkNr&pd_rd_r=5ca18dd0-1433-41a6-896a-fb1f0bdd67fb&pd_rd_i=B094R7HFP3&psc=1

Note other options may be available depending on your location. You will need to discuss any change to the specification with your project supervisor (Unit Chair). You are advised that the tube must be clear. Clarity of the material will be a factor in the quality of the analysis you are able to perform. The two bottles described are deemed suitable for the purpose. Substitutes may not work due to the clarity of the material.

Your Fluid Analysis Machine must be able to sense both the color of the sample and its concentration, based on the intensity of received light. You will need to use a light source and suitable detector to determine the best transmittance for each possible sample.
Samples may be red, green, yellow, blue, and possibly Vulcan, an unknown color…

Your machine must use a Transmissive method to sense your sample.




Reflectance mode will not work with translucent samples and is not permitted by your client.

Your product must be self-contained and have a battery life of at least 2 hours. It must be reliable and repeatable.

Your system must be able to store up to and including 10 sample tubes before and after analysis.

Your system must feed each sample individually to the measurement instrument to determine its concentration and color.

Colors and concentrations may be simulated using food coloring available from most supermarkets.

(Hint put a drop of dishwashing liquid in the water to minimize chances of your test samples becoming biological samples by themselves 😉 )

**You will need to record the concentration and the color of each sample and display the sample number (1-10) and the appropriate information on a screen as well as the time and date of the sample on a suitable screen.**

**You will also be required to upload your sample data via Bluetooth to a tablet in real time.**

WARNING

Im saying this straight up. Your samples will be liquid. There will be NO spills left in the lab. All sample containers must have lids and must be sealed prior to working in the lab. You are considered senior engineering students and that is how you will be assessed.

Spills of any kind must be completely and totally cleaned. This is not negotiable. Failure in any regard will result in you being ejected from the lab with a please explain notice.

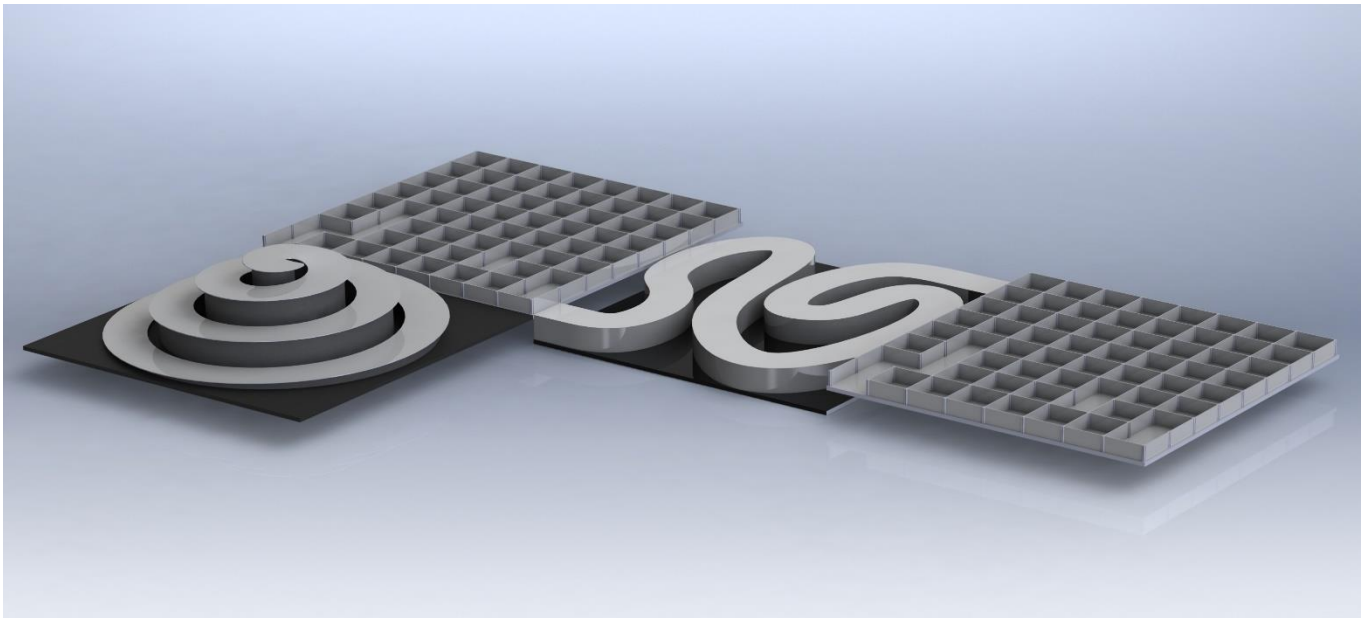
Playing conditions:

(Note that these are subject to change until after the intensive week (week 6)

1. The referee's decisions are final
2. There are no exceptions to rule number 1
3. Success shall be demonstrated by testing and comparing your product with known standards for colors and concentrations
4. Your product must be robust and properly contained in a suitable enclosure
5. Demonstration time (excluding sample setup) shall be limited and timed to 4 minutes maximum (ie show us what your product can do in 4 minutes)
6. Commercial sensors which interface via I2C, SPI, RS232 or other recognized industry protocol may be used.
7. The maximum weight including enclosure is 1.5kg.
8. Your design must be handheld and fit into an enclosure with a maximum horizontal footprint of 28000mm$^2$. There is no limitation on height however commonsense and aesthetics should play a big part in your design.
9. You must use the Nucleo G432KC board for this project. No other boards are permitted. A link to the manufacturer's website is available below: **https://www.st.com/en/evaluation-tools/nucleo-l432kc.html**

# Project Three: The Maze of Doom

Mouse maze with a twist (well a spiral actually).



This is a favorite of mine, and a challenge to successfully complete. The fastest time ever recorded from start to finish is 64 seconds (yep seconds!). A mouse maze is a very traditional project for third year engineering students and one which will test your skills at mechanics, sensor systems, programming, strategy, battery management, testing, fault finding, planning and reliability. The challenge is there, like the four minute mile… Can you break 1 minute???

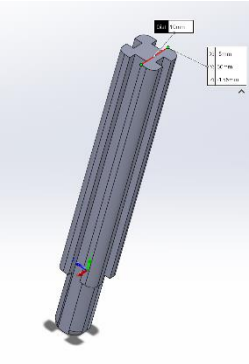
## Tasks

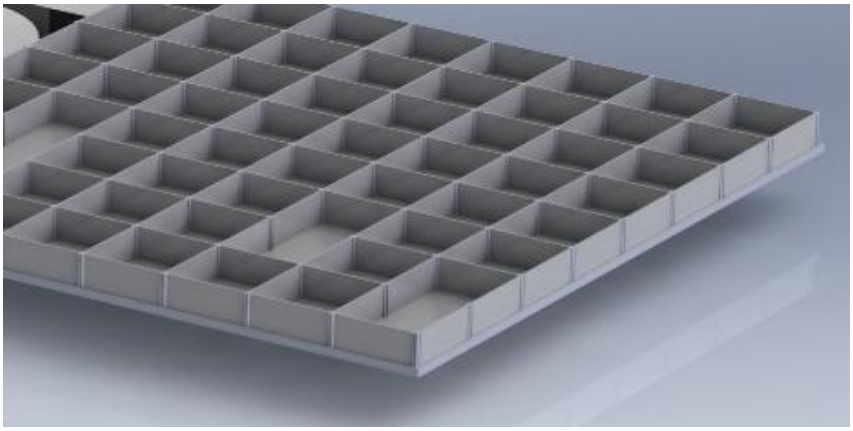
Your task is to design an autonomous vehicle that is capable of:

1. Traversing through the Maze of Doom without falling off, stopping or losing its way
2. Avoiding damage to all surfaces (no dents, scrapes, gouges, or damage of any kind!)
3. Navigate the walled sections of the mouse maze

4. Navigate the Causeway of Doom without falling off
5. Climb the Tower of Doom and finish.

The walled sections of the maze are reconfigurable (and subject to change during the semester 😊 ) The walls are 60mm high and approximately 147mm apart. At each corner is a pillar which holds the wall segments vertical.

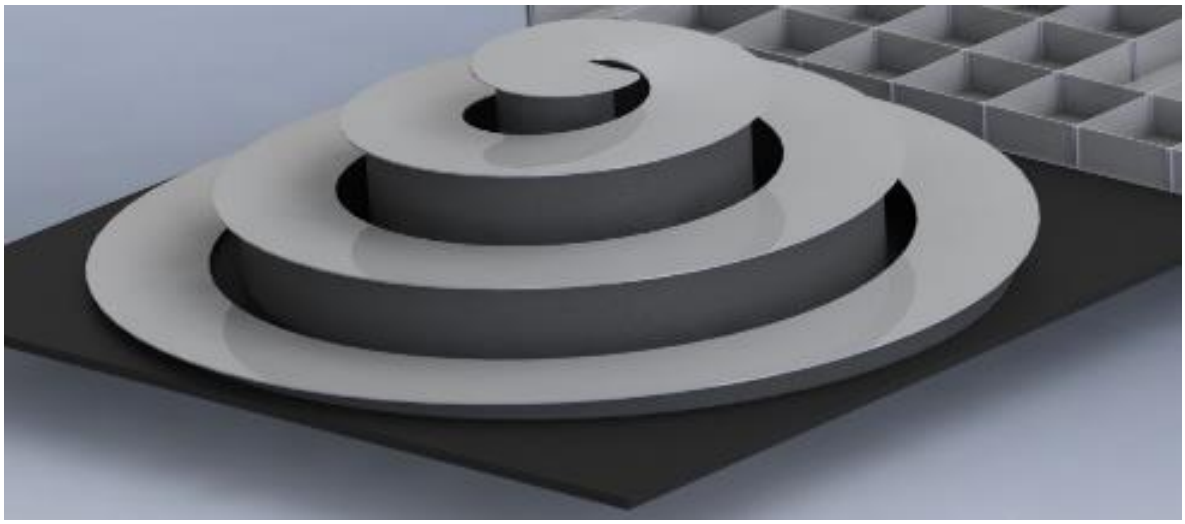




The pillars are 10mm x 10mm (important since they constrict the width of the passage just a little bit, but don't forget to take this into account (that's such a big hint, Im getting generous in my old age…) ) The pillars are red and the wall segments white. The base of the walled section is white. There will be a designated starting point and only one exit to the next section. The walled sections can and will be reconfigured throughout the semester (cause its fun 😊).

The causeway (of doom) has no walls and provides a different sensing challenge. The surface of the causeway track shall be semi-gloss white. The surrounding horizontal surface shall be semi-gloss black. The vertical surface shall be gunmetal grey.

The width of the track is nominally 147mm but varies slightly.



To make it to the top of the spiral (of doom 😊) is to conquer this challenge! The spiral surface is semigloss white, while the surrounding areas are semigloss black. The total height of the spiral is approximately 300mm. The width of the spiral track is nominally 147mm but varies slightly. The big hint here is measure it for yourself.

Playing conditions:
(note that these are subject to change until after the intensive week (week 6)

1. The referee's decisions are final
2. There are no exceptions to rule number 1
3. The maximum run time is 4 minutes. Finishing positions will be used to determine completeness of task. Fastest time and or distance will be used to determine the champion.
4. Your robot must not damage the track in any way.
5. All robots will be impounded prior to the track being released for the showcase. This means that you will not be able to view the track and preprogram your robot. Preprogramming the course is not permitted.
6. A touch will incur a penalty of 5 seconds added to your time.
7. Your mouse must be fully autonomous.
8. Your mouse must display to a tablet or similar its current estimated location (eg start of first maze, end of causeway, start of spiral etc) via Bluetooth.
9. Commercial sensors which interface via I2C, SPI, RS232 or other recognized industry protocol may be used.

10. Your mouse must fit into a volume 150mm(W) x 150mm (D) x 150mm (H) (Though commonsense should play a big part in your design).

10. Bump switches (limit switches) are not permitted as range or contact sensors (you must use a more sophisticated solution such as IR or Time of flight sensors)
11. 40KHz ultrasonic sensors are not permitted as range or contact sensors as they wont work. I'm saving you the time of finding this one out for yourselves.
12. You must use the Nucleo G432KC board for this project. No other boards are permitted. A link to the manufacturer's website is available below: **https://www.st.com/en/evaluation-tools/nucleo-l432kc.html**
13. **Each robot will be permitted one run to scan the maze (maximum time 4 min) and one run to complete the fastest time. The runs will be consecutive without a gap between.**

**You may be tempted to use VLXXX Time of flight sensors for your navigation because a friend did once or you heard they were the easiest. I would advise against them because they are more expensive the Infrared sensors and harder to interface. Have a look at 38KHz infrared distance sensors and black stripe sensors at places like Pololu.com for a cheaper more reliable alternative.**

**General Playing Conditions**

**If you ask any student that has completed a unit like this in the past they will tell you one thing. Don't underestimate the amount of testing and refinement necessary.**

**All products using batteries of any kind must have a suitably related fuse in the positive lead closest to the battery. Failure to comply will result in disqualification (just look up Lithium Polymer Battery fires on Youtube to understand why this is so important) Remember that the fuse is to protect the battery from your circuit, not the other way round!**

**All devices must pass scrutiny prior to being allowed to compete. Details will follow.**

**All products must be the student's own work. I take this very seriously and will be questioning each participant in depth. Please note that code and designs from previous years are on file and all code will be scrutinized for plagiarism. Don't do it.**

**Receipts for all purchases shall be submitted with the final report and produced on request (keep a folder with everything you do in it so you can produce any document we discuss whenever (hint that includes receipts, schematics, drawings, diagrams, scratchings, ideas, flow charts, the lot. ) You might like to call this your Design History File…**

**All program files, projects, charts and graphs shall be submitted for comparison to minimize the risk of cheating. Take this seriously because we do.**

**No extensions are possible in this unit due to the nature of the project assessment task. As such we have extended the delivery time as long as possible already. Keep this in mind and start early! Leaving it to the last few weeks will exponentially increase the work and the stress.**

**Other Playing conditions will be added as we proceed.**

**Through hole components are not permitted. All PCB components shall be surface mount. (switches, fuse holders and plugs are the exceptions. Any other unusual component please seek permission from the unit chair before proceeding with your design.)**
**All projects are permitted up to and including three student designed PCBs. PCBs must be interconnected via ribbon cable.**
**PCBs which are part of a commercial breakout board (for example time of flight sensor or motor driver) are not included as part of the PCB count.**

**Breadboards are permitted only for testing but are not permitted in the final product. Hint, once your design is working, make a copy on breadboard. The biggest cause of stress and failure is usually breadboard and cheap interconnect wires. Do yourself a favor and throw them away!**

**Wires are limited to connections between sensors and main PCB, motors and main PCB and Battery and main PCB. All other signals must be a pcb trace. Rats nest wiring will not be accepted.**

**It is recommended that you use professionally made, plated through hole, silk screen, solder mask pcbs available from various suppliers. They will save you HEAPS of time and worry and make assembly so much easier and more reliable.**

**All designs are permitted a budget of $AU400 maximum(not including freight). Receipts must be provided as part of your final submission.**

**You are not the first. Every Mechatronics or computer systems engineer for the last 40 odd years has done a project not dissimilar to what you are doing now.**

**Conditions for the showcase. (NEW FOR 2024)**

**In order to make it to the showcase round your machine must first demonstrate that it is fit for the purpose for which it was intended. For that reason we will be pre vetting all entries on Wednesday of week 12. Further details will follow however this will be mandatory. Those projects chosen by the Unit assessment panel will then be able to compete in the showcase the following day (Thursday of Week 12) More details on the exact timing will be released during the semester but for now expect to be involved Wednesday of week 12 and Thursday morning of week 12.**

**At the start of the showcase day, prior to commencement, all entries will be Impound and removed only for your run. They will then be returned to the impound. This is to make the competition as fair as possible.**

**The Fluid Analysis Machine showcase will be a runoff with the best entries competing for accuracy and speed in both concentration and color. Each person will be provided with an identical set of calibrated samples prepared by our laboratory staff. This competition will be run in parallel on the day.**

## Components

I'm not going to provide a list of components 'you need to buy'. This is third year (level 3) and you are capable, and required, to make decisions and component choices on your own. Any suggestions I or my team make are like what you get on the front of a Corn Flakes pack. What you see is merely a 'serving suggestion' .


It doesn't mean you have to eat Cornflakes with strawberries and milk…

Having said that, you can discuss with me your thoughts and I will give my opinion because we are pushed for time (it may be, "I don't know you'll have to test it". And yes, I will answer a question with a question especially if I think you can work it out yourselves). Be prepared however to change your mind as your design (and your understanding) evolves. That's engineering design.
Your selection of components, motors, batteries, gearboxes, sensors, screens will be determined by *your* design. Needless to say there will be choices to be made and consideration of the project you choose will help determine those choices (speed, carrying capacity, battery life for example)

You may find the following links useful

digikey.com.au
adafruit.com
sparkfun.com
Element14.com.au
RSComponents.com
Dfrobot.com
Pololu.com
Tamiya.com
Hobbyking.com.au
Pcbway.com
Jlcpcb.com

**I strongly advise you to avoid eBay or similar which have very very (very) long freight times. Especially in the current world climate. Its why I'm taking the extraordinary step of releasing the project selection to you in January well ahead of semester. Failure to plan for delays in component delivery is not regarded as an excuse for failure to complete the task.**

**You can minimize the freight by sharing orders. Organize yourselves and minimize cost and delays wherever possible. This too is engineering.**

**Having said all that, this is your show. It's all about you.**
**Show us all what you can do.**

**Regards**
**Dr Andrew Price**