# Introduction

## Background

RoboCup Rescue is an international competition to foster research into intelligent rescue robots. UNSW teams have won the award for best autonomous robot three times. Until now, most of these robots have been very big but a new part of the competition is aimed at developing small robots that can get into confined spaces.

As inspiration you may consider a scenario where one of these small rescue robots is used to explore a disaster site that is inaccessible to other rescuers by using ultrasonics to map out the space and identify victims.

## Challenge

Your team is tasked with designing a small rescue robot, building a prototype and testing it.

You are required to design a simple rescue robot that can perform the basic functions detailed in this document. You are also responsible for the build, delivery, and testing processes.

You must deliver your robots design, prototype, and software to the test client's testing facility and perform the tests set out in the performance and testing protocols[1]. The client will be evaluating your design on the whole design, not just the final products. Special attention will be given to innovative designs[2].

## Assessment

The team will be assessed using 5 group submissions:

- Conceptual design presentation
- Design proposal document
- Compliance Testing
- Design poster and interview
- Prototype robot performance

Individual assessments are outlines in the Project Outline document.

[1] The performance and testing protocols will be released after the Design Proposal is received so that students focus on their design work and not just passing the test. There will be ample time to build a prototype capable of passing every test.

[2] In this context, "innovation" means something that is unique and does not appear in any other teams' designs.

# Prototype Robot

In this challenge there will be four basic steps to the design process:

1. Conceptual Designs – where teams present broad-brush ideas covering the basic features of the final prototype robot.
2. Design Proposal – where teams document their chosen design in detail.
3. Build – where teams build the robot detailed in their Design Proposal, with small modifications that result from lessons learned during preliminary testing. This phase includes Compliance Testing to be certain teams will finish on time.
4. Final Testing – each prototype robot will be put through a series of tests and evaluated for performance and innovation.

## Constraints

### Size and Weight

The prototype robot must be able to fit inside a cylinder 250mm in diameter and 250mm high when the robot is in the "fully extended" position.

The prototype robot must weigh less than 1000 gm including its batteries.

### Operating System

The robot operating systems is to be developed on an Arduino Uno microcontroller mounted on the robot. The microcontroller will receive operating instructions via a USB cable[3] and will control the functioning of the robot.

The robot controller will enter instructions via a laptop keyboard and receive feedback from the robot without being able to see the robot and its surrounds[4]. For ease of testing, a long USB cable may be required.

### Construction

Any materials may be considered for use. However, no toxic, radioactive, or dangerous materials will be allowed.

The cost of producing your robot must be less than $120. Note that this is not the cost your team would incur in building the robot, but the cost the client would need to spend to build the robot from scratch, purchasing all required materials from regular channels. Regardless of where you obtained materials for your robot, in your design report you must justify that your robot could be constructed for less than $120. This cost includes the cost of the Arduino Uno board.

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[3] A USB cable is being used in place of the wireless connection that would be used in a real-life scenario. Teams may use a Bluetooth connection instead if they wish.

[4] In the RoboCup competition, operators are placed in a booth and can only receive feedback from their robot.

## Functionality

The rescue robot prototype must be capable of performing the following functions:

- Manoeuvre through a maze while under operator control,
- Manoeuvre over rough terrain[5],
- Detect objects in its path (walls, etc.) and report the distance and location of the object through the operating system, and
- Identify and rescue a victim.

## The Maze

A maze will be constructed with the following characteristics:

- Walls will be made from boards 300mm high and 420mm long,
- Cells will be 420mm square,
- Walls will not resist pushing and robots will be penalised for knocking down walls,

The robot is required to find its way into the maze turn around and return to the starting position.

## Rough Terrain

A step field will be constructed for the robot to traverse. The robot must demonstrate that it can ascend and descend rough terrain by climbing and descending the stairs. The steps will vary from 6mm to 36mm.

## Rescuing The Victim

The robot is required to find and rescue a victim. It will be placed in a maze facing away from a victim (tennis ball) in the next cell of the maze. The robot must scan and find the victim, report the "find" to the operator, move towards the victim (tennis ball), and transport it back to the starting location and lower it to the ground. The tennis ball is an analogue for a human victim and must be treated with care.

## Eligibility

The robot must be designed and developed by engineering students registered in DESN1000, without help from anyone not registered in the course. Faculty members, graduate students or university technicians may be used as consultants for specific information. All external references must be acknowledged – failure to do so constitutes an act of student misconduct.

Pre-built robotic kits, such as the 'Lego Mindstorm' are not permitted and will receive zero marks.

[5] A step field will be used to test the robot's ability to manoeuvre over rough terrain. Steps will vary in height from 6mm to 30mm.

# Team Submissions

Each team will make 4 submissions as a group comprising 65% of the final grade. The remaining 35% of the final grade will come from individual submissions.

Team submissions will be evaluated using a Teamwork Assessment and individual marks will be adjusted up or down according to the team's evaluation of the individual's contribution. Students who fail to contribute to team submissions risk losing all the associated marks.

## Engineering Design Process (EDP) Concept Generation Presentation

The details of this submission will be posted separately in Moodle.

Summarising:

- Week 4
- 20% of the final grade
- Oral presentation submitted via video
- Subject to teamwork evaluation

## Design Proposal

The details of this submission will be posted separately in Moodle.

Summarising:

- Week 7
- 15% of the final grade
- Written report
- Subject to teamwork evaluation

## Poster and Interview

The details of this submission will be posted separately in Moodle.

Summarising:

- Week 10
- 10% of the final grade
- Design poster and interview
- Subject to teamwork evaluation

## Prototype Robot and Software

The details of this submission will be posted separately in Moodle.

Summarising:

- Week 8 & 10
- 20% of the final grade
- Compliance Testing (5%) and Final Testing (15%)
- Subject to teamwork evaluation

## Prototype Robot Evaluation

Final Testing will consist of simulations in a laboratory environment to evaluate the prototype robot, its design, and its ability to rescue a victim.

There will be four tests performed and each robot will be scored according to its performance:

- Manoeuvring in tight places by negotiating a small maze
- Handle uneven terrain
- Rescuing a victim, with emphasis on the gentle handling of the victim
- Smooth operation of the robot via the user interface

The engineering qualities of the robot will also be evaluated by a panel of judges from a team poster and interview. These qualities will include:

- Engineering quality of the simulated prototype robot
- Robustness of the design
- Aesthetics of the prototype robot
- Innovation of the prototype robot design[6]

Detailed testing protocols will be provided after teams have presented their design concepts.[7]

[6] In this context “innovation” means some beneficial design element that no other team has used.

[7] Testing protocols are withheld so that teams are not focused on the testing and can explore unlimited design options. The protocols are simple and straightforward with no real surprises.

# FAQ

## I'm not a Mechanical, Electrical, or Computer Engineer, I don't know about this stuff

Although the project looks like something a Mechanical, Electrical, or Computer Engineer might be best doing, the focus of this course is not on demonstrating your knowledge of Engineering Science. Relatively few equations will be relevant to achieving the best design. The emphasis for this course is on implementing the Design Process as a Team. Regardless of your background you will find (if you look), a significant role to play which will help your team obtain the best results.

## How do I start?

Innovative Design requires extensive searching to build up your knowledge of existing technologies, indeed some of the success of your project will depend on how effectively you can source information from books, magazines, the Internet etc and distil this into design concepts and ultimately tasks for action by project team members.

## I'm totally lost, what do I do?

Talk to your mentor.

## My mentor doesn't seem to be giving me much help, what should I do?

Consider the sort of questions you are asking. If you are you trying to get them to design the system, they are unlikely to be helpful. The best way to get the answers you are after is to show that you have put time and effort into the process, and you are after information to move to the next stage of the project. Questions such as “I have looked at xyz and I am concerned about abc…” are likely to be viewed more favourably than “I'm confused.”

## I'm having trouble thinking of ideas, what do I do?

Don't feel that the only time you can think of ideas is during formal meetings. There are plenty of objects that should be able to provide inspiration. A long walk can be a good opportunity to ‘clear your mind’ and think of ideas. When in meetings focus the discussion to get the best value out of everyone's input.