Project Brief

Autonomous Delivery System

INTRODUCTION

Moving objects from one location to another accurately, carefully and rapidly is a common engineering activity in day to day life and an important function in many industries including construction, mining, medical, military, manufacturing and more. Developing methods to automatically move objects and materials has fascinated inventors and engineers throughout history. Today there are so many different types of systems available for such a wide variety of automatic movement functions that it would be impractical to list them all, but as inspiration, here is one recent example: http://www.kivasystems.com/resources/demo.

PROBLEM DESCRIPTION

The problem to be solved is that of autonomously moving fragile cargo (an egg) from a pre-determined start position to one of two or more fixed, higher locations, as quickly as possible without damaging the cargo. The destination location will be wirelessly communicated to the delivery system by a control module after the system has started moving. Each group will be issued with a control module at the Thursday lecture in week 2, the operation of which will become clearer at the lecture.

DETAILS OF TEST CONDITIONS

The autonomous delivery system (ADS) must satisfy the following constraints:

- As a team you are restricted to spending no more than $80 on materials for the final design.
- It must be a single system, i.e. the entire solution should be connected and move as one object.
- It must start behind the start line, as shown in Fig 1.
  - The ADS must be wholly within the start line
  - Prior to starting, manual adjustment/intervention/operation is allowed
- The system must not have a height greater than 400 mm before it crosses the starting line.
- There must be a “go” button or switch, which initiates the operation of the system.
- The system must operate autonomously (automatically), i.e. without any manual intervention: once the “go” button has been pressed, no manual adjustment/intervention/operation is allowed.
- The exact length of the test area (i.e. from the start line to the destination) will
be advised
- The destination locations D0 – D3 will comprise openings that are 100 mm wide and 100 mm high; the surrounding area will be a hard surface (i.e. square holes in a wall). The destination locations will have a basket attached to the rear of the surface so that the cargo will not easily roll out.

Figure 1. Testing area (top view). Note that the control module will be standing up on its long edge, i.e. with the speaker pointing parallel to the desk top, facing towards the path of the ADS/cargo, with the switches at the top

Figure 2. Testing area (side view). D0 – D3 are the ‘addresses’ of the destination locations. The vertical measurements are from the table top to the bottom of the location opening
**RULES**

No modification of the control modules is permitted. Any materials may be considered for use. No toxic or dangerous materials however will be allowed. If your system looks like it cost more than $80 to build, you will be asked to produce receipts\(^1\). Use of remote controls is not permitted.

**EVALUATION OF FINAL SOLUTIONS**

Multiple criteria will be employed in scoring the final solutions, roughly in priority order of weight:

**Performance**

Performance will be measured in terms of:

1. The speed of the delivery. This will be the most heavily weighted criterion.
2. Whether the cargo is delivered correctly, or how close to correct delivery the system achieves.
3. Whether the cargo is delivered safely (no breakages!).
4. How robustly the system can detect the control module.
5. Whether correct delivery can be demonstrated multiple times.

Bonus marks will be awarded for:

- Correct delivery to four locations (specified by *two* control modules positioned sequentially following the starting line)
- Delivery using the spoon provided – the egg must be placed in the spoon at the start and delivered only using the spoon, and the spoon must be attached to the system only by the handle (with no “guides” near or around the spoon itself)

During final testing, two attempts may be made.

**Robustness**

This will be subjectively determined based on criteria such as: how the system would function if someone shook it slightly or dropped or bumped it and how much background noise the system’s sensor can tolerate.

**Innovation**

This will be subjectively determined by the panel of judges based on the uniqueness of your design in comparison to the other entries. In general this is related to the way in which you utilise technology to perform the primary functions of the design and the degree of difference between your solution and the other competitors, but is also related to the simplicity and elegance of your solution (simpler systems are cheaper to manufacture).

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\(^1\) The use of recycled (second-hand) materials is encouraged, and may be a way to save costs, however items that have a high purchase value may also attract a high valuation price. All valuations will be at the discretion of the lecturer.
Aesthetic Appeal
This will be subjectively determined by the panel of judges based on the visual attractiveness, use of a theme or visual novelty.

THE CONTROL MODULE
The control module acts as a relay, which is activated using an infrared light and produces an auditory signal (one of two, depending on the destination). The control module has three switches (looking at the front of the board):

- Leftmost: This is the on/off switch, for conserving battery life
- Middle: This sliding switch has three positions: “normal” (right), “test” (middle) and “fail/retransmit” (left – this is not used). Except in the “test” position, the control module produces a sound only when activated by infrared light directed to the phototransistor.
- Rightmost: This switch changes the state, denoting the destination location, between a ‘D0’ and ‘D1’. You will notice that in the ‘D1’ state, the red LED is illuminated (unless the battery is flat!).

The nearest edge of the control module will be located exactly 150 mm from the start line. Your system can be aligned as needed at the starting position.

ELIGIBILITY
The prototype system must be designed and built by engineering students registered in ENGG1000, without the help of either design or construction from anyone not registered in the course. Staff, students or university technicians may be used as consultants for specific information.

TESTING PROCEDURE
The testing of the systems will be conducted in a competition on Monday 28th May from 2:00-5:00 pm during Week 13. The tentative location of the competition is room EE319.

You will be given two attempts to demonstrate your system. You will be given no more than two minutes to set up and three minutes to complete each attempt. It is strongly advised that teams do not plan to make modifications between attempts. No equipment will be provided to do so. You may wish to bring any tools and materials to make running repairs if necessary.

ACCEPTANCE TESTING
The acceptance testing, held in week 9, requires the successful demonstration of the following. Note that these individual demonstrations do not need to be integrated as one system yet.

1. Getting the control module to produce its audio signal
2. System movement that demonstrates some degree of control (groups will need to be prepared to explain what their control strategy is based on)
3. Evidence of detection of an audio signal from the control module
4. Evidence of the correct detection of both audio signals; i.e. differentiation between the two
5. A structure that can raise the cargo to the correct heights for destinations D0 and D1 without full automation, and can be expected to deliver the cargo correctly when fully integrated

Bonus marks may be obtained for demonstrating further integration and/or additional functionality towards the final testing (i.e. typical of being ahead of schedule).

**New in 2012: 20% of the total acceptance testing mark** will be allocated to the extent to which all five requirements have been equally met, even if not all are successful. In this component a mark of zero may be attained if *any one* requirement is completely inadequate (requirement not met and clearly no effort or forethought has been applied by that part of the team); full marks may be obtained e.g. if reasonable progress has been made on *all* requirements and all team members are able to speak convincingly on the part of the system they worked on, during the testing. Acceptance testing is a checkpoint not just for the system but for the effectiveness of the team itself.

**GROUP ORGANISATION**

The group of 8 must be sub-divided into two or three sub-groups of 2-3. Your group must elect a leader and at least one note-taker\(^2\) by the start of the second mentor meeting in Week 3. The members and purpose of each sub-group will be decided (by the team) by the end of the third mentor meeting in Week 4. A suggested approach for determining the purpose of each sub-group is to come up with a conceptual design that breaks the overall problem into two or more sub-problems, which are then allocated to the sub-groups.

**MATERIALS AND SUPPLIERS**

Mitre 10 is located at Matraville and is a short bus trip from UNSW. For a larger and more extensive range Bunnings Warehouse is located at Mascot and can be accessed via public transport.

An electronics starter kit of components will be supplied to each group at the Week 3 lab. A limited range of electronic components (e.g. integrated circuits, transistors, diodes, LEDs, but not motors and not unusual or very specific components) will be available from the EE&T Electronics Workshop (EEG15). To request these, you will need to (i) show a sketch of your circuit diagram to a lab demonstrator and (ii) fill out the component request form at [http://engg1000.ee.unsw.edu.au/component-request-form.pdf](http://engg1000.ee.unsw.edu.au/component-request-form.pdf) and have this signed by the demonstrator. If the request is expensive, you may be directed to purchase the component from the workshop instead (so bring money). You are strongly advised to purchase your own prototyping board (or “breadboard”). These can be conveniently purchased from the Electrical Engineering School Office for $15.

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\(^2\) All team members should be taking their own notes anyway. The team note-taker should be certain to record all decisions, tasks, times/dates and other key information.
Teams wishing to purchase other electrical equipment may consider trying Jaycar (Bronte Rd, Bondi Jn; York St, City) as an alternative to Dick Smith (Westfield Bondi Jn; Moore Park Supa Centre; Westfield Eastgardens). Also there is a Hobby Shop on the south side of the Kingsford roundabout which should have plenty of interesting bits and pieces.

This listing is not intended to be exhaustive nor even comprehensive. Rather, it is to provide your team with ideas that they may wish to follow up on. Neither the mentors nor the Course Coordinator can provide any information beyond that contained here.

It is quite likely that not all team members will have contributed equally towards covering expenses. It is therefore up to the team to decide how these costs are covered. It is strongly recommended that each team member makes an equal financial contribution.