Table of Contents

1 Introduction(PETER)

This document serves as a style guide for the EGB111 Project Report. The goal is to produce a document of professional standing that presents the critical detail of your project, as indicated below. This guide is to be used in conjunction with the Report Writing and Style Guide available on Blackboard in the Design Report Folder.
Please also refer to Week-10 videos for how to write each section of the report.

2 Structure(PETER)

Generally, documents are broken into “front matter”, “body”, and “back matter”. You may break body sections into subsections as appropriate. The main body of the document, with the section headings as listed below, is recommended. The report should be written concisely, **with all**

calculations to appear as appendices, with the results of these calculations referred to within the report.

Table 1: Document structure

	Section	Notes
Front matter	**Cover Sheet**	Front page
	Statement of Contributions	One page
	Executive Summary	One page
	Table of Contents	One page
Body (approximately 10-20 pages)	**Introduction**	One to two paragraphs
	Conceptual Design	Two to four pages including diagrams and figures
	Detailed Design	Five to ten pages including diagrams and figures
	The Final Design	Two to four pages including diagrams and figures
	Design Performance and Evaluation	About half of one page
	Recommendations and Conclusions	About half of one page
	References	
Back matter	**Appendices**	Extra and generally more detailed diagrams, figures, photos, calculations and results.

2.1 Cover Sheet (front page)(JAMES-DONE)

Use a front cover style of your choosing. Your cover sheet is to include your document title, your team ID, your design studio/workshop session numbers and/or time, author list of your team member names, author signatures, student number, identification of the Team Leader, and the following author declaration statement.

2.2 Author Declaration:(JAMES)

“In signing this cover sheet, each author attests that they have made a fair contribution to the conduct of the design project and the generation of this document. Each signed author also attests that they acknowledge the fair contribution of all other listed authors, and that if a team member is not included in the signed authorship list, the team has discussed this with the unit coordinator and this course of action is supported by the unit coordinator.”

This infers that if there is a team member who is not making a fair contribution, they should not be listed in the team list and they should not be signing against the declaration. Should this be the case, you must reflect the matter in the peer review process and consult with the unit coordinator prior to submission so that the correct and appropriate action can be made. Ultimately, any team members omitted from the declaration, due to a team consensus of them not making a fair contribution, has the right of reply.

2.3 Statement of Contributions (one page)(JAMES)

A statement of contributions must be included as part of the report. This needs to indicate what section of the report each team member wrote. It also needs to indicate what technical component(s) of the report each group member worked on. Technical components are: Structural Design, Mechanical Design and Circuit Design. If the group believes that one or more members have made insufficient contributions to the project, then a percentage contribution should be provided for each team member. Group marks can be modified for individuals with insufficient contributions given that evidence is provided (documentation and meetings with project managers and tutors).

***The percentage contributions should total to 100%**

Team Member	**Report Sections Written**	**Technical Contributions**	**Percentage Contribution**
Team Member A			
Team Member B			
Team Member C			
Team Member D			
Team Member E			
Team Member F			

2.4 Executive Summary (one page)(LACHLAN)

Project EGB 111 involved the design and the construction of a device that had the capacity to move an object from point A to point B. The Aim of our group throughout the design was to develop such a device that had the function of utilizing both a lifting and a rotating system, this was achieved through the presence of electrical and a mechanical system, electro-mechanical.

At first, components of the design, the truss, the mechanical system, and the electrical system, were developed and designed individually. Whilst each component was addressed at every meeting, the group placed precedence and priority on a single design before moving onto the next. This allowed every member of the group to have input into the project at every phase hence leading to a more effective design. Members of the group achieved this during group discussion and in personal time, where each member would 'brainstorm' and assimilate their ideas and present them.

After the development of our design and feedback from our supervisors from milestone 1, components were created and tested both individually and eventually in combination with other components. Prototypes of certain components were crucial in order to verify that key requirements of our criteria were met. For example, the structure of the design, the truss, was built and rebuilt with modifications to its members and joints in the form of 'gusset plates' to ensure it could hold 0.5kg.

As testing of the beta design ceased, the final design was modified a fair amount in order to improve the time taken and functionality for rotation of the device, stability and structural capability of the device, and the circuit of the device. The 3V motor for the lifting system which was theoretically able to meet the time requirement of the criteria, had to be replaced by a 12V motor, as in practice, it was unable to lift the required mass within a suitable time frame. The thickness of the balsa wood for the truss was also reduced as it was discovered that during testing, the 5x5mm wasn't at 1.5kg, an optimal requirement for our project. Finally, the circuit was altered in order to incorporate the 12V motor and as such, a reimagining on how the electrical system was going to fail during the 1kg safety factor test, had to occur.

During the final construction of the device, additions to the device were made as a result of the location of motors and to improve the reliability of the joints. A platform on the rear of the truss was created to house the end of the pulley system and also the accompanying motor, through the use of two wooden platforms on either side of the truss. Finally, the addition of 'gusset plates' was implemented in order to ensure that the failure of the design occurred only in the members and not the joints.

The summary will be completed after the final results.

2.5 Table of Contents(PETER)

The table of contents should be automatically generated so that it remains synchronised as you make changes. You may choose your own layout style for the table of contents. Ensure that the table of contents is updated for your submission. The table of contents has its own page.

2.6 Introduction (one to two paragraphs)(PETER)

A brief description of the design task, the purpose of this document and what is presented in this document. It should also indicate the project objectives (what are you aiming to achieve from the project?). Eg. Weigh under 2kg, project cost under $100, etc.

The aim of this project is to investigate the procedures and testing required for the design of a truss structure and accompanying electrical components in order to lift and carry a mass in a way similar to a crane. The purpose to such a report being made is to instruct and teach others of how such a project came together so that anyone could easily remake this mechanism. This design was made to specifications outlined in the design brief. Covered in the subsequent pages is the processes made toward selecting a material for the truss and base, the calculations made for the whole design, including truss, motor and electrical. Preliminary designs have been constructed as well as finalised designs for the purposes of this report.

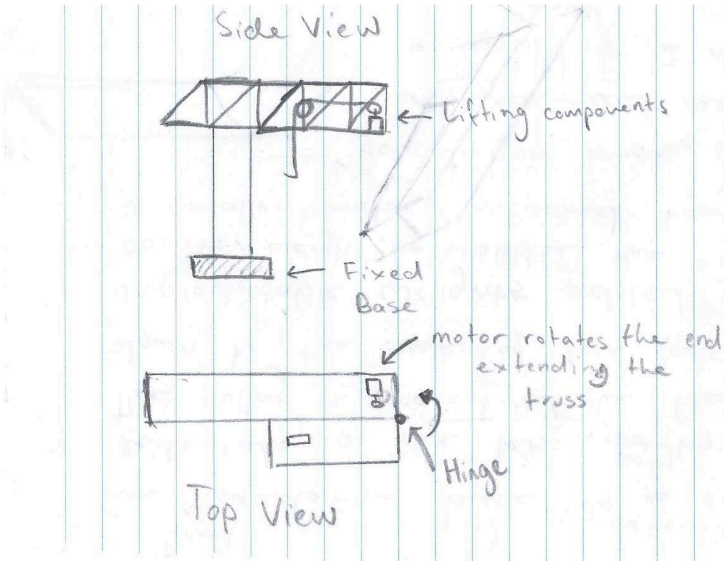
The project was a challenge issued to lift a half kilogram mass from a pedestal 50 millimetres across a one metre square board and deposit the mass on a 100-millimetre-tall pedestal opposite the origin pedestal. There were two options for the truss with the first being a fixed structure whereupon it is placed on one edge of the board closer to the 50-millimetre pedestal or the other option being a non-fixed object that can only move in two of three grass areas the metre squared board.

The group worked as a whole on this project after a team charter was made for all members to do an equal part in the whole project. Everyone contributed toward the construction of this device.

2.7 Conceptual Design (two to three pages including diagrams and figures)(JACOB)

The group approached the design in response to the project task and the device's criteria which established the group's objectives and constraints. The project task was to assemble a semi-autonomous model lifting device which carefully moves a 500-gram object from the lower pedestal A, located in one corner of the course to the opposite corner pedestal B. Subsequently, the group established design requirements in response to the device criteria. Firstly, the device's mechanical sub-system must be designed with a safety factor between 1 to 2. Thus, the device must function with the 500g load, however, seize with any load 1kg or heavier for hypothetical safety reasons. Secondly, the device's structural subsystem must be design with a safety factor between 2 to 3. Thus, the design must support loads less than 1.5kg, and break at the tested 1.5kg. Thirdly, the device must complete the task within 45 seconds and weigh under 1.5kg. Finally, the device must consume no more than 10 watts of power, and 24 volts and 3 amps of input. Furthermore, the group set out specific design constraints which include simplicity and time, as well as cost. Overall, this led the group to suggest 3 unique concepts, ultimately leading to the final concept and its design.

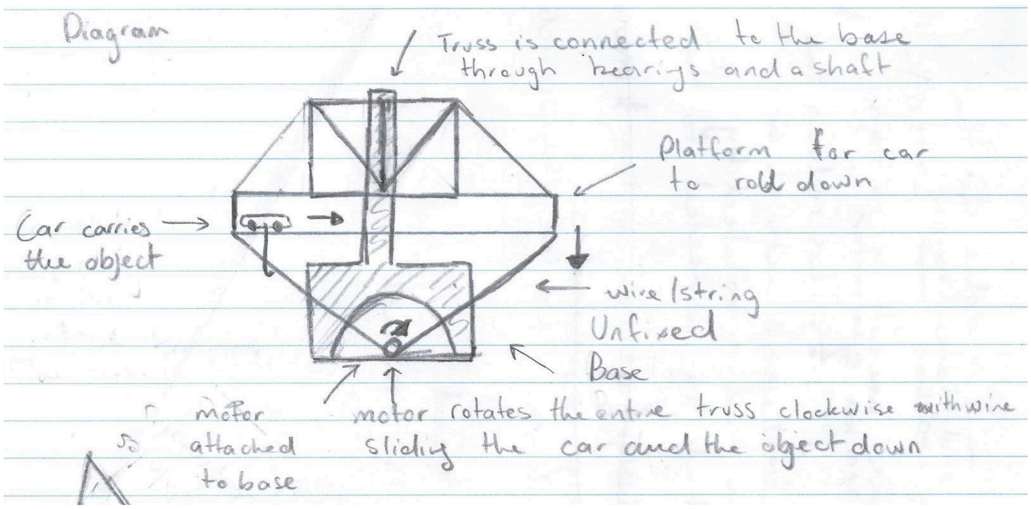
Initially the group agreed to create a fixed device. The device would be fixed unevenly between the two pedestals; thus, concepts were generated to overcome the offset. The first concept proposed was to lengthen the truss upon drop off. The concept consisted of two different sized trusses connected by a hinge which was rotated by a motor extending its length, as indicated in figure ?. The concept required a straight foundational base structure and the lifting components to be placed inside the smaller truss which would lift the object.



1st Concept
Figure ?

The design was evaluated to be too difficult and unreasonable to meet the established design objectives and align with the group’s constraints. The concept required three separate motors along with gears for the three separate movements, which included rotating the entire truss, rotating the smaller truss about the hinge, and lifting the object. This most importantly impedes on the design performance requirement of completing the task within 45 seconds, as there is a slow additional movement to avoid breaking the entire truss. In addition, the group would have to spend more money and time to source a motor and buy or make the gears, ignoring the group’s constraints. Furthermore, the concept made the device’s structural subsystem hard and unreasonable to analyse, inhibiting the structural design requirement of a safety factor of 2 to 3. As all of the weight is placed on the hinge, translating all the force onto that side. Conventional assumptions couldn't be made and the load would create a lot of torsion, twisting the truss because of the uneven load. The joint member analysis did not incorporate torsion, so it could not be predicted. Furthermore, the smaller truss is disconnected from the main truss, thus all of the lifting components would have to be located at the front of the smaller truss creating unknown additional loads, especially when extended. The moment arm when fully extended doubles the equivalent load, thus the unknown loads become more significant and it leaves little room for breakage. Overall, the concept was deemed to be unreasonable and new ideas were formulated in response to its problems.

Despite the group’s orientation to a fixed design, an unfixed concept was proposed. This concept consisted of platform which housed a car carrying the object which was connected to the bottom of a large truss. One motor would be attached to the unfixed base and would rotate the truss and subsequently the platform clockwise, sliding the car down towards the other end of the truss as seen in figure ?.



2nd Concept
Figure ?

This concept was in direct response to the initial concept problems. It was originally thought to use one of the supplied motors, but required a gearbox like the previous concept, saving the group money and time, and simplifying the construction. In addition, the device had one movement increasing its chance of achieving the time objective even when performed considerably slow to avoid breakage. However, the concept overtime conveyed new problems which made it difficult to meet specific design objectives and group constraints. The concept required a large and sturdy platform and truss to transport the object and an even sturdier base, as it was unfixed. Thus, making the device the required size and strength could potentially impede on the weight objective of 1.5kg. Furthermore, the group anticipated the large amount of torque required by the single motor, due to the device’s size. This deterred the group as the motor and gears would definitely need to be sourced. Also, potentially impeding on the device’s mechanical subsystem, as the group wasn’t sure how reasonable this was and how we would anchor the motor due to the large amounts of torque. Overall, this concept seemingly fixed the initial concept’s problems, however, conveyed new problems which ignored the group’s constraint of simplicity, time and cost potentially inhibiting specific design requirements, thus deterring the group.

Finally this led the group to create the actual concept. The concept utilises an angled fixed foundational structure which extends towards the middle of the two pedestals. The truss simply rotates about rollers from pedestal A to B. A pulley lifts the object up which is connected to a motor and gearbox located at the other end of the truss with counterweights, as seen in figure ?
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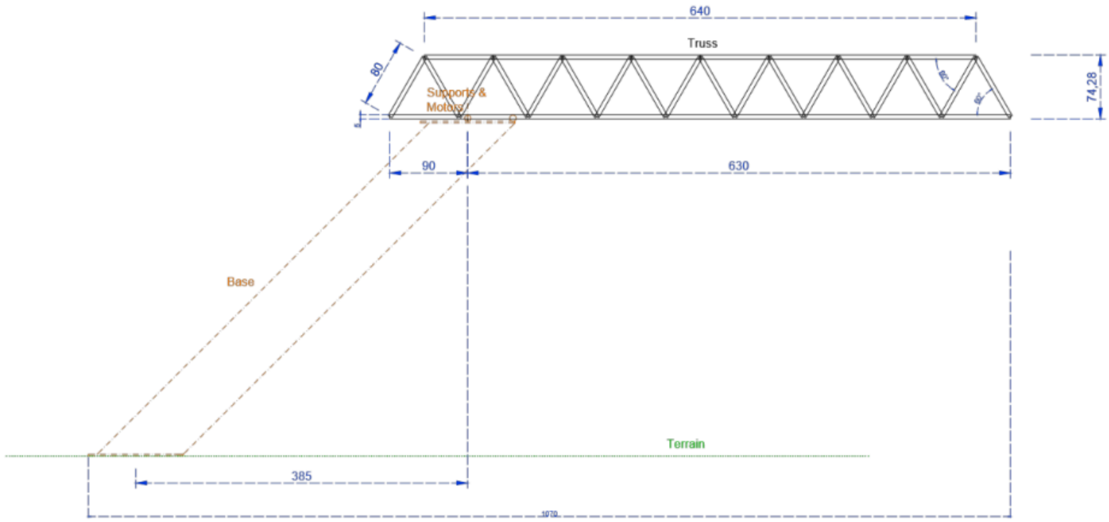


3rd Concept
Figure ?

This concept is in direct response to the previous two design, meeting the group's established objectives and constraints. The truss would only need two motors, one to lift the object and the other to rotate the truss. Thus, this would save the group time and money, utilising the provided motors. Likewise, there is only two separate movements increasing the likelihood of achieving the performance objective of 45 seconds. In addition, the motors will see insignificant torque compared to the prior design increasing the probability of accomplishing the mechanical subsystem of the design. The standard truss design is likely to be under the weight objective of 1.5kg. In addition, the structure is more easily calculated, reducing trial and error and increasing the likelihood of achieving the structural subsystem required safety factor. Overall, this concept addressed all the design objectives and group constraints initially established, thus becoming the final concept for the project.

The final concept was mostly unchanged, however, some ideas within the concept were changed. The group decided that the original truss support pin and rollers wouldn't rotate the truss and was replaced by a gear which the truss sat on, rotating the entire truss. In addition, counterweights were removed to reduce overall weight and the lifting components were used as counterweight at the rear of the truss. Furthermore, the gearbox idea was replaced with a gearhead motor as it was simpler and more compact.

2.8 Detailed Design (five to ten pages including diagrams and figures)(JACOB)

The content in this section should rely heavily on calculations taught within the subject. Calculations should be presented as appendices, with this section of the report outlining the calculation methodology and results.
Describe, through text, tables, and illustrative diagrams, the detailed design for the project. This should include the following sections:

2.8.1 Structural Design

- Materials testing and selection
- Truss calculations
- Balance/bolt force calculations
- Testing of truss
- Selection of other parts of the structure (may be overdesigned and don't need supporting calculations)

2.8.2 Mechanical Design

- Selection of motors, gearboxes or other mechanical components for the project.
- Calculations for at least 1 electro-mechanical system for the 0.5 kg load. Must show that the system will move the mass for a given input voltage, and predict what speed it will move it at.
- Testing of mechanical systems

2.8.3 Circuit Design

- Circuit design (including calculations of voltage, current and power of all circuit elements for the 0.5 kg load)
- Circuit testing

2.9 Final Design (two to three pages including diagrams and figures)(JOSH)

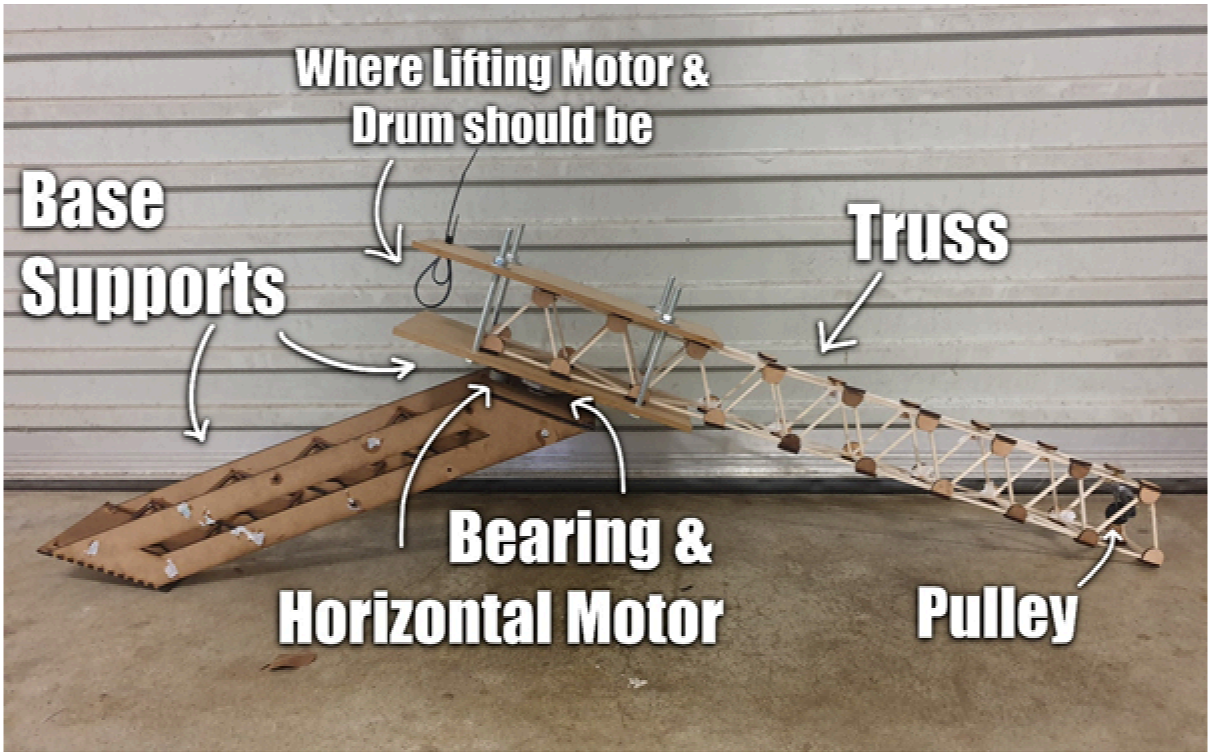


Figure X1

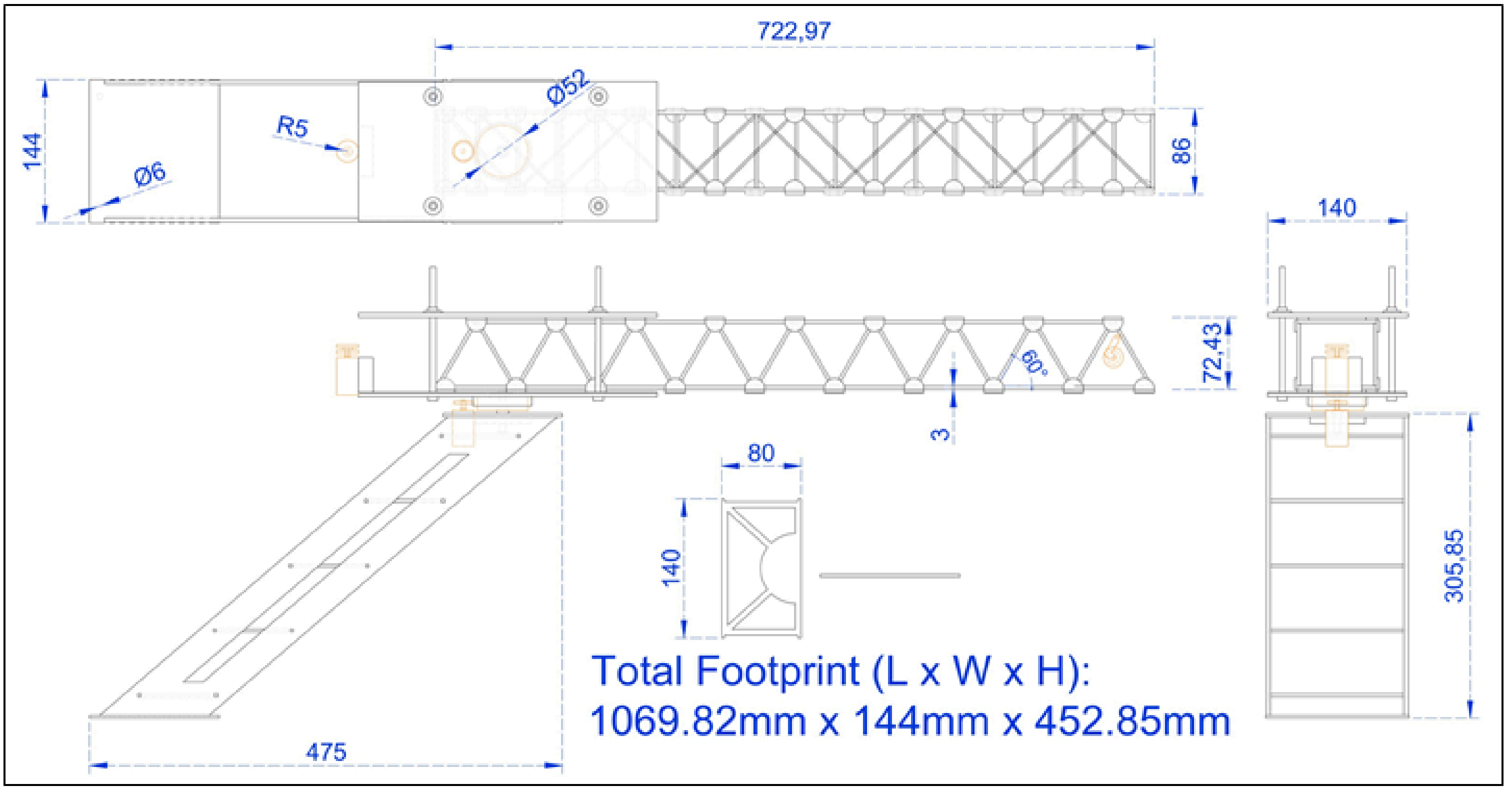
The crane produced for assessable testing is a tower crane with a fixed footing as per project specification. It utilises two motors, a pulley system and a variety of materials across the various sections. The design of the entire structure has been an iterative process, developing and testing each sub-system before incorporating it into the final design. A photo of the built crane with labelled sections is presented in Figure X1. A detailed description of each sub-system, materials and costs involved are displayed in Table T1.

-system	Description	Material	Cost & Tools
	ecisely engineered portion of the . A warren truss design 720mm long bays is featured with all joints ced by gusset plates. Cross members o featured perpendicular and ally along the top and bottom of the prevent torsion. The result is a very ght structure.	ers: 3mmx3mm t Plates: d uper glue	als were provided by nPad. Time spent es many hours of , drawing and analysis l as multiple members tiple LaunchPad ns testing and bling the truss. **ly 20 hours for 3 ers.**

Supports	ase supports provide housing and for the truss as well as position the g point to be in the centre of the board. ase features multiple 'steps' to prevent ı. Two boards clamp the truss securely e, these boards connect the truss to aring.	Base: HDF clamps: MDF, nx6mm bolts uts	naterials were provided LaunchPad. Truss s were purchased for ne was spent designing AD program, testing, utting and gluing. **nly 7 hours.**
g & ntal Motor	ystem enables the head of the crane to freely from the base using electrical A 12V, geared motor is secured in o the base support and has a gear fit shaft. The bearing's internal ring is d to the base with a tightened nut/bolt. earing's outer ring is press fit into three leep acrylic gears that are glued onto se of the MDF truss clamp.	g: 52mm OD x ID ball bearing 12V 70RPM acrylic	g and motor were ased for **$24**. Gear als were provided by hPad. Time was spent ing, prototyping, ng, cutting, building, and testing. **Over 12 .**
& Pulley	ystem enables the load to be lifted and ted by the structure. A 12V, geared is attached to a press-fit drum which the string attached to the load. The at the far end of the truss exists to e the direction of the lifting string as it the rear of the truss clamps.	toy train wheels 12V 36RPM Acrylic Polyester yarn	material sourced from hPad. Motor, and o motor, purchased for ime was spent ing, building, testing, prototyping/laser , shopping. **Over 15 .**
cal	ystem enables the controlled use of cal power to run the horizontal and motors. A circuit was designed using PDT switches to enable a single power to run the two motors at different	s: copper or: 40ohm n film	naterials were supplied t of the EGB111 unit. or connectors, resistors ntainer were ased for $XXXX. Time pent designing, ng and testing. 3

Table T1

Table T1 shows that the final design can be broken down into the various sub-systems which also coincide with stages of development. Each system is designed to meet specifications listed in EGB111 project brief [with only the truss failing to meet optimal requirements by supporting a weight above 1.5kg in testing??]. Precise drawings of the structure with all primary dimensions is presented in Figure X2 . Each section came with its own challenges, often costing significant time to complete. A simple breakdown of cost for each



section is presented in Appendix JOSH1 (That means put in appendix).

Figure X2

Prior to the assessed demonstrations in week 12 and week 13, the crane structure was tested for the various criteria that was specified in the EGB111 project brief. The performance of final design is presented in T3.

Testing was conducted on the crane throughout the development process with each sub-system integrated and tested iteratively. The testing and results in Table T3 are only related to the final design. In this table, 'Test Method' provides the process used to record the observed result seen in the 'Result' column. Tests were either conducted with the crane bolted to the supplied testing mat or secured by weights/hand if appropriate for the test. Testing the final truss design to breaking point was only conducted once prior to demonstrations. Multiples attempts to induce electromechanical failure for a weight of 1 kg were made. The current draw for the lifting motor between 0.5kg and 1kg was slight (0.6A – 0.7A). The small difference in current meant any resistor that would cause the motor to cease functioning at 1kg may be too slow to complete the lift in less than 45 seconds.

As many of the tests on the final design emulate the demonstration assessment, the results are assumed to be a strong indicator of actual performance. Unfortunately, breaks were not reliable when testing this truss prior to the final design so it may be the case that failure does not occur in assessment. The electrical circuit has a method of failure that is not precise and therefore may also not reliably fail. The assessment also requires all criteria to be met in succession, something not fulfilled in testing (e.g. breaking of the truss was done on a different day to electronic failure).

2.10 Design Performance Evaluation (About Half One Page)(PETER)

This section should critically evaluate the performance/expected performance of your design at completing the set task. It should clearly state whether or not you meet your objectives (as previously listed in the report)

***Note: That by the end of Week 12 it is expected that you have completed pretesting of your design on the testing board. This means you should have some performance data to enable you to write this section**

The design has exceeded expectations in regards to the specifications it had to meet. After a pre-test the lifting motor had to be replaced as it did not lift at the desired speed. During this same pre-test the rotation of the device was just fine. A small adjustment also had to be made after weighing the device which showed that it was just over the 1.5 kilogram limit. As such, a small amount of the truss' support had to be removed. It is possible that this slight alteration will assist in the structural failure when supporting a 1.5 kilogram weight meeting another design specification that is an unknown at the present.

During pre-testing phases, the device met three of the four requirements. This device was under 1.5 kilograms and completed the 0.5 kilogram lift and rotation in under 45 seconds. The electromechanical system also failed trying to lift the 1 kilogram mass. These were the three requirements that were met with the structural failure at 1.5 kilograms requirement not being met. Although the device completed the required lift on its first attempt it was not perfect despite the planning that went into the design.

Overall, the design is good but not perfect. This project is exemplary in its performance but is too structurally strong to meet all of the design requirements. Alterations will likely be made to address these issues while still allowing a complete maneuver.

2.11 Recommendations and Conclusions (about Half One Page)(JAMES)

It gives a brief summary of the key findings or information in your report and highlights the major outcomes of your investigation and their significance. Do not conclude anything that has not been discussed earlier in the report – this section should not introduce any new content.
Make some recommendations regarding what steps should be undertaken to advance the project further based on the outcome of the testing. Think of this as a to-do list based on the findings from this report.

2.12 References(EVERYONE)

You must correctly and appropriately reference your sources using and appropriate style such as QUT Harvard (author, date) or IEEE (numbered). Ensure you apply correct in-text referencing and bibliographic formatting and structure as defined by the style.

2.13 Appendices(EVERYONE)

Your appendices contain extra and generally more detailed diagrams, figures, photos, calculations and results. Generally speaking, only data and diagrams and figures are placed in the main body of the document if there is immediate and relevant discussion around them. If they do not form an intricate part of the discussion of the main document, they should go into the appendices.

3 Formatting

This document uses a default Microsoft Word style plus recommended improvements described herein. You may alter the styles/formatting in a bid to improve on the presentation of your document. **Refer to report Writing and Style Guide available on Blackboard in the Design Report Folder for a detailed report writing template.**

Other suggestions for improving the formatting beyond that of the default are:

- Page number in the bottom-center of each non-title page.
- Header with the session and team identifier, right justified.

The default font formatting styles for Microsoft Word are as follows:

- Body "Normal" 12pt Calibri
- Heading "Heading 1" Calibri Bold
- Sub-heading "Heading 2" Calibri 13

You may use any of the following fonts in this report. Your body text must be no smaller than 11pt for ease of reading/

- Times New Roman
- Ariel
- Calibri

***Note some breaks (page and section) and other formatting tools have been used in this style guide. Use to show/hide formatting marks button to see these in the document, see Figure 1 below.**

Figure 1: Show/Hide Formatting Marks Button Location