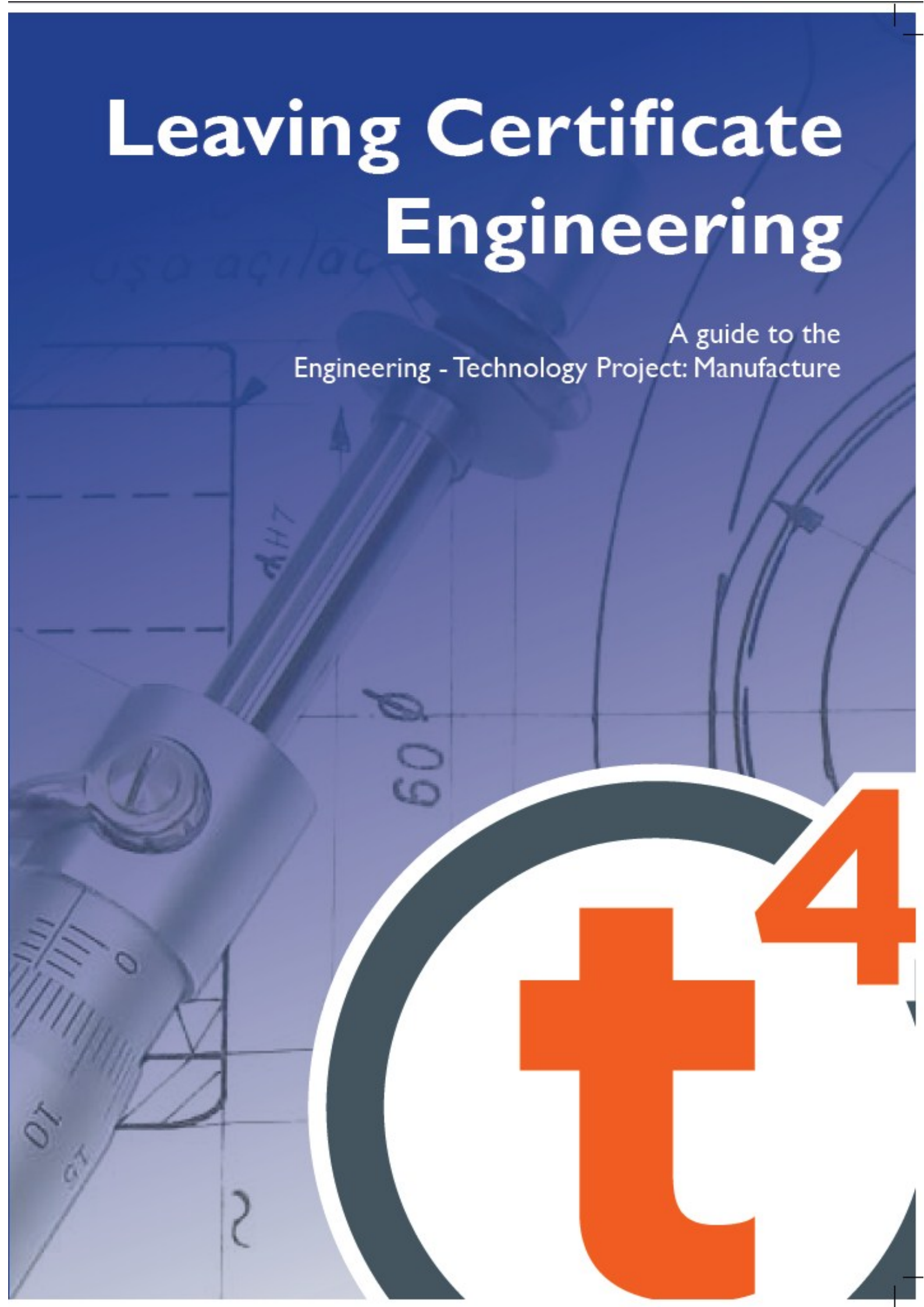
Leaving Certificate Engineering

A guide to the
Engineering - Technology Project: Manufacture



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Foreword

Leaving Certificate Engineering aims to develop skills of creativity, problem solving, innovation, research, enterprise, design, manufacture and reflection. Information Technology is an important part of learning in Engineering. The student project gives an opportunity to display the skills they have developed. 30% (150 marks) of the total marks in Engineering, at this level, are allocated to the completion of the student project.

As part of the Engineering – Technology Project: Manufacture the student must produce a model as a solution to a given brief along with a folio which will clearly show the students thought process as they work through the development of their solution; *"the folio provides a record of the work of the candidate and should contain all the details of the project work from the initial ideas to the final evaluation". (Chief Examiners Report: State Examination Commission, 2011).* For this reason, it is important that the folio is produced as the work is being completed. Each stage of the process drives the next and the folio serves as a means of recording this information. The breakdown of marks for each part of the project is detailed below;

Model	-	110 Marks
Folio	-	40 Marks

While there are 40 marks (8%) available for the production of the folio, it must be appreciated that the quality of the planning, which is recorded in the folio, will have a large impact on the quality of the model, for which there are 110 marks (22%) awarded.

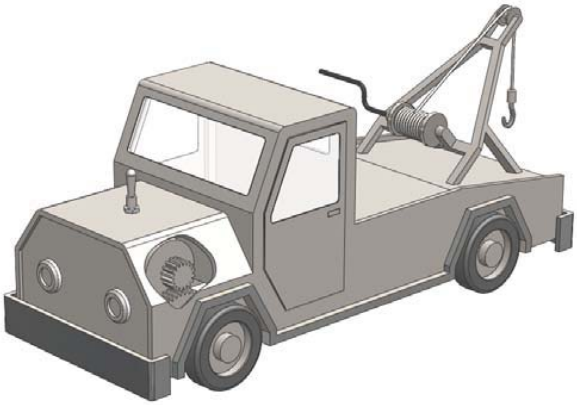
The ability on the part of the student to tell their story throughout the making of the project is very important. It is essential that this thought process is recognised by any person that reads, or indeed assesses, the folio. Text, sketches, questions and conclusions on each section of the project will allow the student to display their thoughts to the reader. Therefore, it is important that the process of looking back at the days work becomes an everyday activity in the Engineering classroom.

The project brief issues from the State Examinations Commission in October, of year two, of the Leaving Certificate Course. A specified deadline for completion is indicated in the instructions to candidates. The purpose of this document is to offer guidance to both teachers and students on possible approaches to successfully completing the Engineering – Technology Project: Manufacture.

Project Brief

The Engineering project brief, at this level, outlines a problem and a presents an image of a possible solution. An example of the 2011 Engineering – Technology Project: Manufacture is given below.

*Make a **Model Recovery Truck** according to the example shown or according to an alternative design.*



A student may base their design on the presented solution or an alternative design. The solution to this problem results in the production of a model. The steps taken from start to finish are recorded in a written folio. The folio must include the following;

(a) **Planning Details** required before undertaking the task or alternative design details;
(b) **Parts List** and **Working Drawings**;
(c) Organisational Plan, indicating the **manufacturing process**, **materials and finishing treatments** to be used;
(d) **Testing and Evaluation** of the finished model including special instructions, if necessary, regarding the testing of the model by an examiner.

Marks are awarded for the folio as follows:

	Marks Awarded
• Planning/Alternative design details	*5*
• Parts List/Working Drawings	*10*
• Work Plan/Manufacturing Processes	*10*
• Materials & Finishes	*5*
• Testing and Evaluation	*5*
• Presentation of folio	*5*

The project brief will also place some requirements and restrictions on the completed design. These elements are included under the **'Project Manufacture'** heading of the Project Brief. The Project Manufacture element of the 2012 Project Brief is outlined below.

Project Manufacture (110 Marks)

Special Note: Toys or modified toys are not acceptable

(a) Using appropriate materials make the model according to your plans which should include:
   (i) An electrical drive for the model operated by an ON/OFF Switch
   (ii) **One** decorative feature to enhance the presentation of the model.

(b) **The use of bought-in electronic solutions will result in lost marks.**

(c) All main operating features of the completed model to be **clearly visible without dismantling.**

(d) The longest dimension should not exceed **250mm**

(e) Electric power should not exceed **9 volts.**

It is not appropriate for a student to take an existing toy or model and use it in their presented solution. This will be viewed as unnecessary recycling and will result in the student losing marks.

The project brief states that the model must be driven by an electrical drive. This identifies a need for a mechanism which would convert rotary motion of the motor to rotary motion of the wheels. This demands that the student investigate a number of possible mechanisms which would solve this problem. A useful resource for Structures and Mechanisms, as well as others, is available through the T4 website at the following link: http://www.t4.ie/Technology_Resources_Core_Structures.html

Consideration must be given to a decorative feature which must be included in the students design. This may take the form of contrasting paint colours, shape of particular parts or the inclusion of other parts to make the model look more pleasing. This is something that the student will have to put some thought into when planning their design.

Other considerations include the visibility of individually parts, the size of electric power used and the longest dimension of the completed model.

Each of the process headings will be dealt with individually, in turn, through this document. Presentation is central to all elements of the folio and hence will be addressed first.

Presentation of the completed folio

The folio details the work of the student from the start to finish. It must be neat and well presented. It should include photographs, sketches and text. Handwritten notes and explanations can be included where necessary.

Consider the following points;

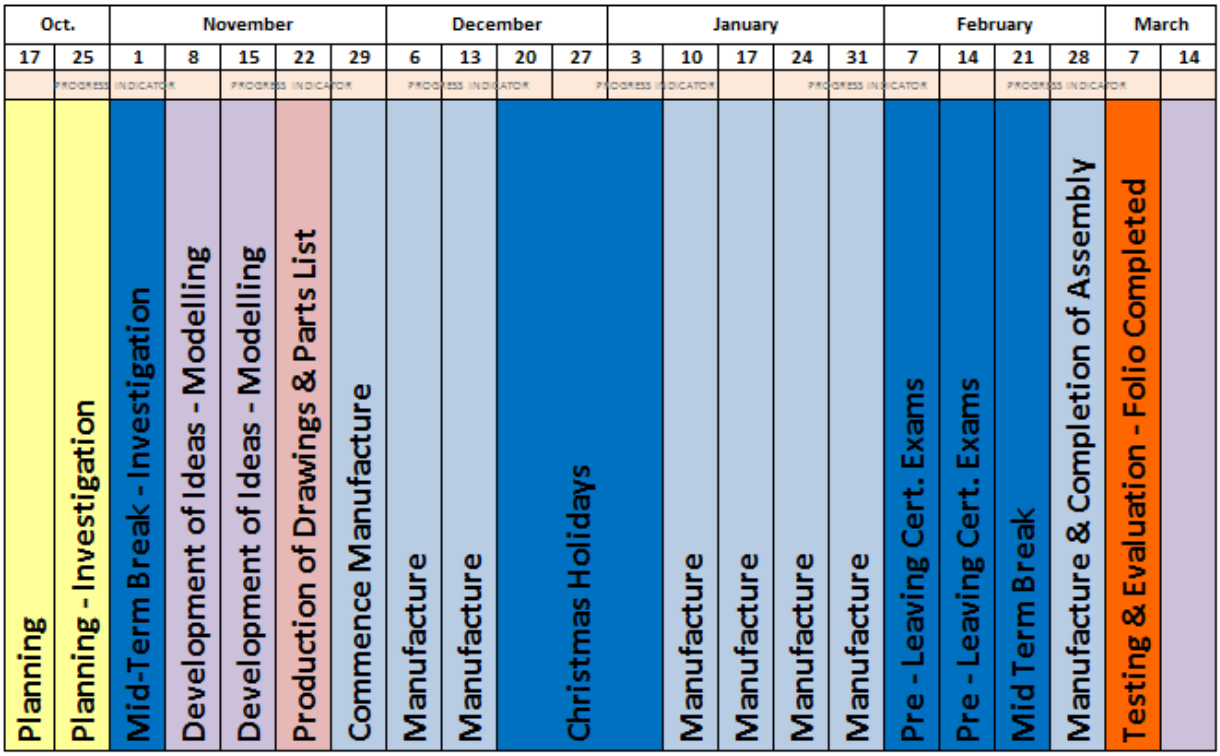
- The presentation, in whatever format is chosen, A3 or A4, must be clear. Written notes, Sketches, photos, images from magazines, books, newspapers and the internet may be used.
- Students should try to make the folio as interesting as possible.
- Computer skills can be used to improve the presentation of the folio.
- Layout should be kept very clear. It should be easy to follow. It should record the research completed.
- The folio should have a well-designed front page stating the student's examination number and include pictures relevant to the material inside.
- The completed folio should be suitably presented for the reader. A suitable method of binding the folio should be used as part of the presentation.

Managing the time available for completing the project

Good planning will help students to ensure that the project is completed within the available time. Goals must be set for each week of the project and break it down into bite sizes. This will help to ensure that time is used effectively and reduce the need for extra work as the deadline approaches. A copy of the school calendar will identify holidays, school trips, dates for pre-exams etc. which will help to plan available time more effectively and accurately.

An example of good planning of the time available is shown overleaf.

Timeline for completion of LC Engineering Project



Planning/Alternative Design Details

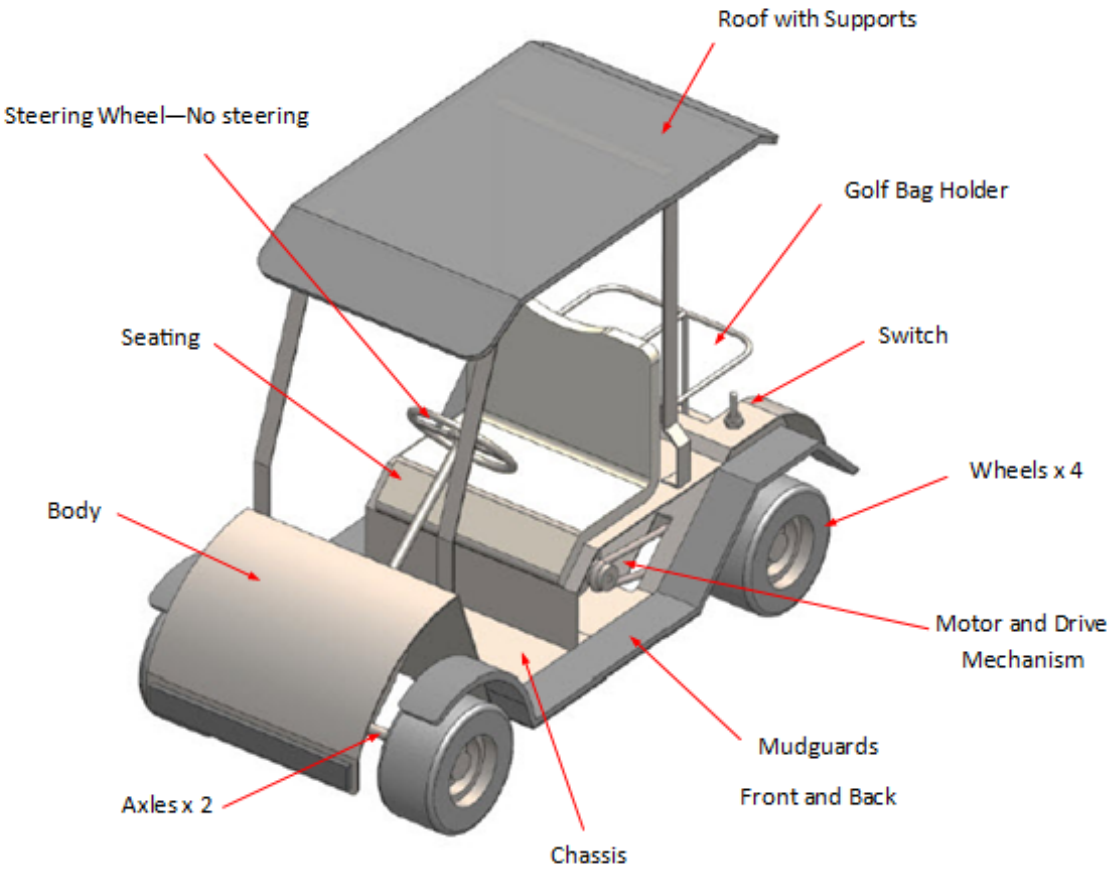
While the written brief states what the student must manufacture, the image presented in the brief contains a lot of information which will help to inform the student of the requirements of the project brief. The presented image should be examined and the various parts should be labelled. This will help the student to identify what is required and avoid unnecessary work. This step should be completed whether the student is using the presented solution or an alternative design.

It is important that a good effort is made at this stage to identify all of the requirements of the presented solution to avoid producing a project which doesn't fully satisfy the project brief.

An example of how this may be completed is shown overleaf.

Planning - What has to be included in my Golf Buggy?

(2012 - Engineering Project: Manufacture)



What has to be included in my Golf Buggy?

- Chassis - part onto which everything else is fixed.
- Two Axles- to support the wheels
- 4 Wheels- to allow the buggy to move
- Motor and Drive Mechanism - Attached to axle to allow the buggy to move forward.
- Body - to make it look like a real golf buggy
- Seating - to allow the driver of the golf buggy to sit down while driving.
- Switch - to control the buggy and turn the motor off and on.
- Steering Wheel - to make it look like a real buggy. Steering mechanism not shown so not required.
- Mud guards - Attached to the chassis covering the front and back wheels.
- Golf Bag Holder - At the back to hold the golfers bags. Holder shown has room for two bags.
- Roof and supports - Supports attached to chassis supporting roof to protect golfers from rain and sun

Investigation of possible solutions

Having identified the various requirements of the project the next step is to perform some investigation. This step must be completed whether the student is using the presented solution or an alternative design.

Investigation:

This may include any or all of the areas listed below.

Field Trip - Shops - Exhibitions

Libraries - Books - Magazines – Catalogues - Websites

Field trips, shops and exhibitions allow first hand access to real life examples. This allows the student unlimited access to take plenty of photographs, measurements and establish sizes and proportions. A collage of photographs, taken by a student, is shown below. *Note the use of the measuring tape to measure both the overall sizes and the sizes of component parts.* These measurements are recorded and can be scaled to establish the overall proportions & sizes of the subsequent model, based on the size restrictions of the brief.

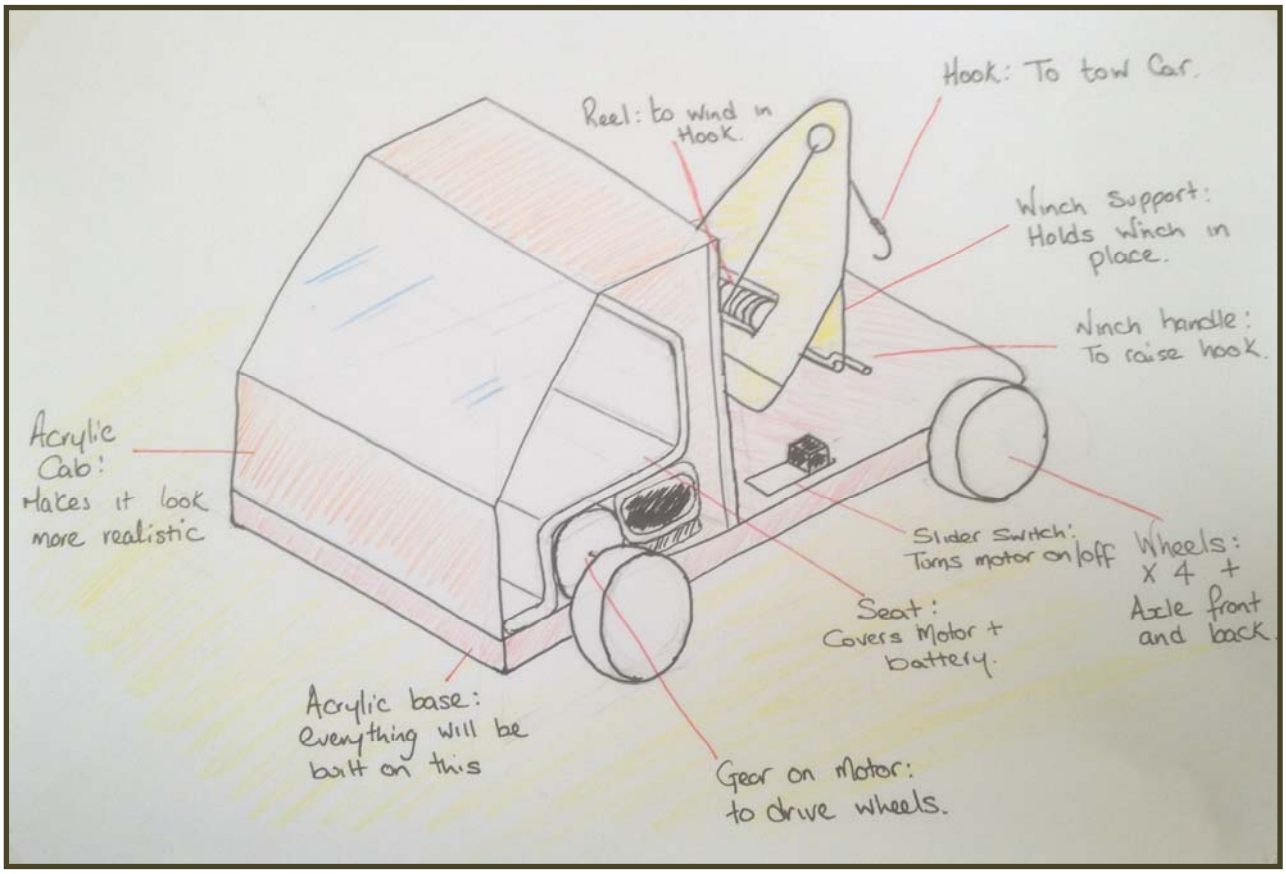
Whilst every effort should be made to access real-life examples it may not always be possible. In these instances the same procedure can be applied to images of objects.

Libraries, books, magazines and catalogues are useful sources of information. A variety of different designs can be viewed as well as solutions for different parts of the designs. Internet research is probably the easiest method but it must be clearly stressed it is not the only one. ***Printed material taken directly from the internet/magazines should not be included***. ***Students must show how they used the information they gathered rather than just reproducing it.*** All this information should be stored and used to present the planning details of the folio.

Alternative Design Details

Having completed the planning and investigation it is now necessary to present a proposed solution. This proposed solution will be in the form of a sketch or sketches. This solution must include all of the requirements as identified in the examination of the image of the given solution. It is important that the solution is accompanied with text which indicates the finer detail of the design solution. Other sketches may be also included to show this detail.

An example of a students presented solution of the Model Recovery Truck (Engineering – Technology Project: Manufacture, 2011) is shown below.



Creating a prototype of the chosen solution.

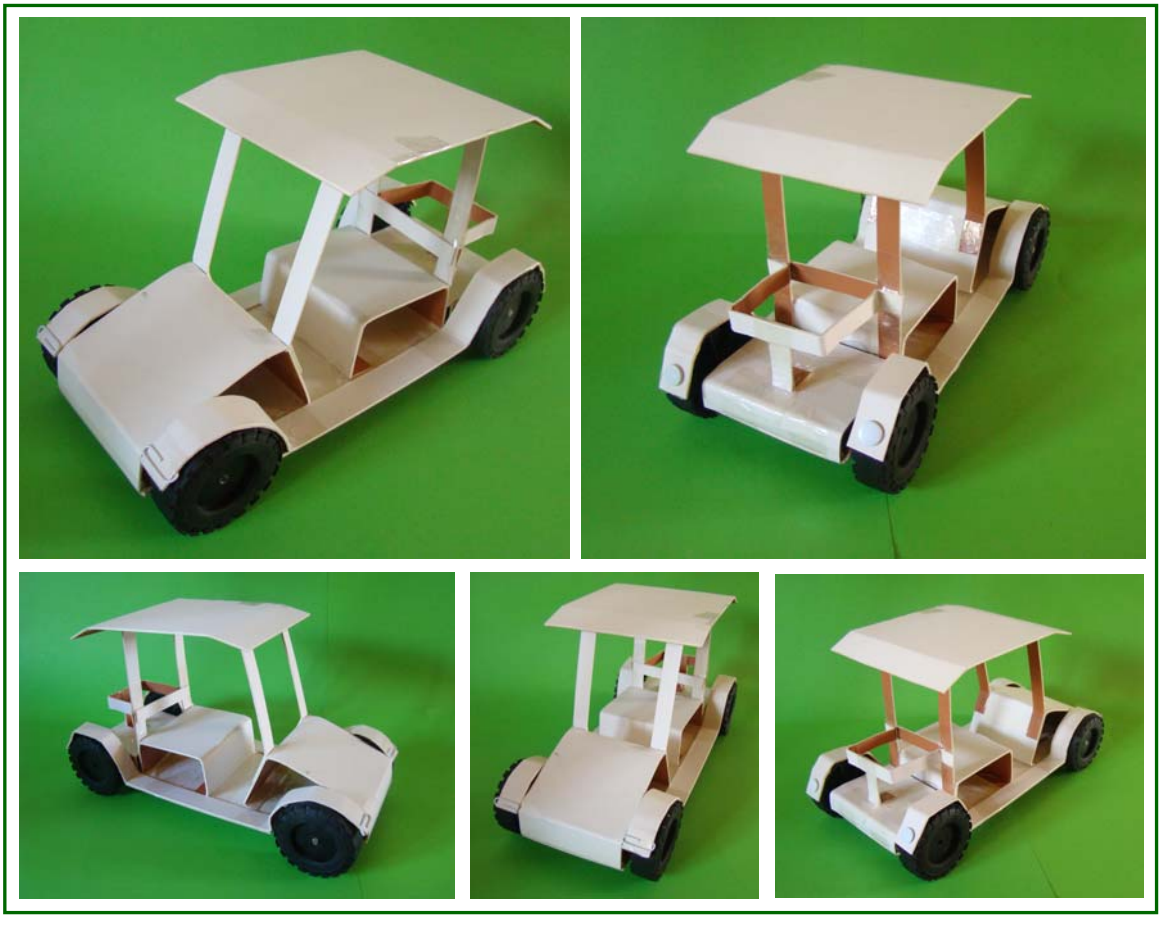
Having sketched a solution for the project brief, students should create a prototype at this stage. The prototype bridges the gap between the sketch and the working drawings.

The process of producing a prototype model;

- Gives a better understanding of shape, size and proportions.
- Students learn from mistakes made at this stage, which cost less time and money.
- Aids the process of generating 2D drawings as measurements may be taken from the prototype model. Parts of the model may be flattened out to help in creating working drawings.
- Helps students to plan the marking out and manufacture of the individual parts and may identify problems that have not been foreseen.
- Gives the student something real to refer back to as the project is being manufactured.

This model should be presented along with the completed solution, for examination, to show the level of planning that had been completed prior to manufacture. An image of a student's prototype of the Model Golf Buggy (Engineering – Technology Project: Manufacture, 2012) is shown below.

This model was made from modelling card, wire from a clothes hanger for the axles, paperclips, thumbtacks, pritstick and sellotape.



Parts List/Working Drawings

Working Drawings

A good prototype will be very useful when making drawings of the parts of the chosen design. These drawings will guide the student through the manufacturing process and will help to reduce the time taken to make the model. Completion of the working drawings using the prototype model will help to avoid mistakes and the need to make parts over and over again. Working drawings will help with the assembly of the finished project. These working drawings may be completed by hand or using SolidWorks.

What should be included in the working drawings?

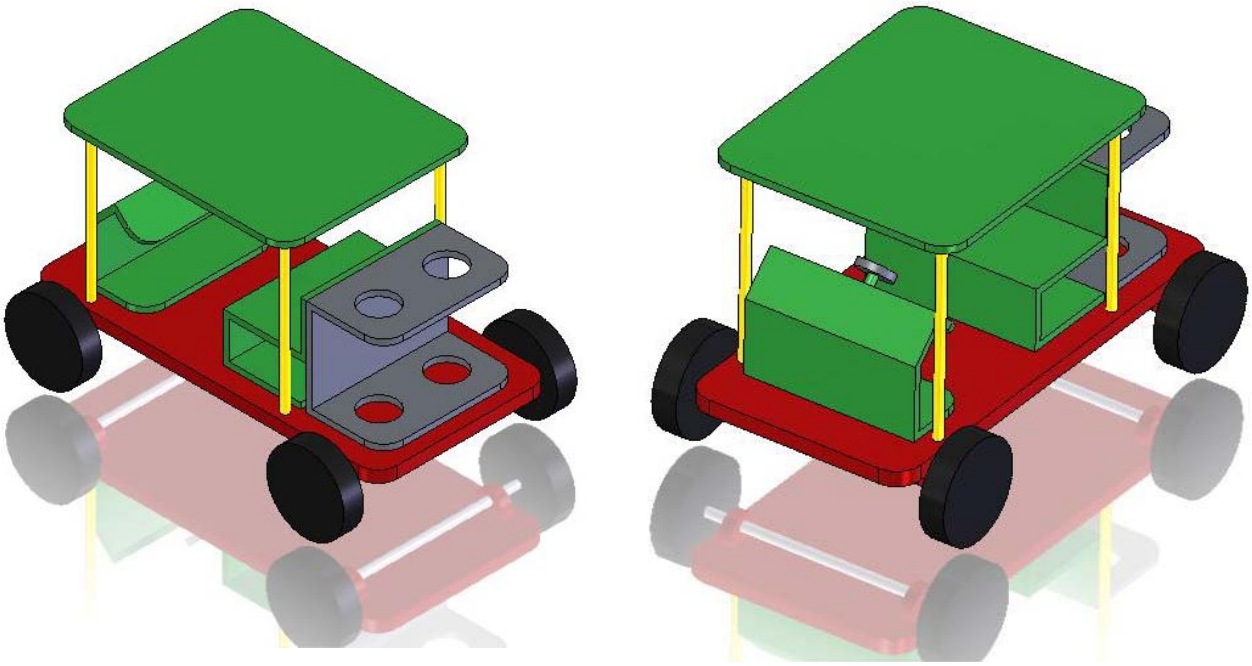
The working drawings should present all of the information required to make the model. Some or all of the following views of the artefact may be presented;

- An assembled 3D view.
- Different views of each component complete with dimensions.
- An electronic circuit diagram using appropriate symbols.

Drawings of electronic components such as: motors, LEDs, batteries etc. do not need to be included in the working drawings. However, their shape and sizes need to be considered in the design of individual parts.

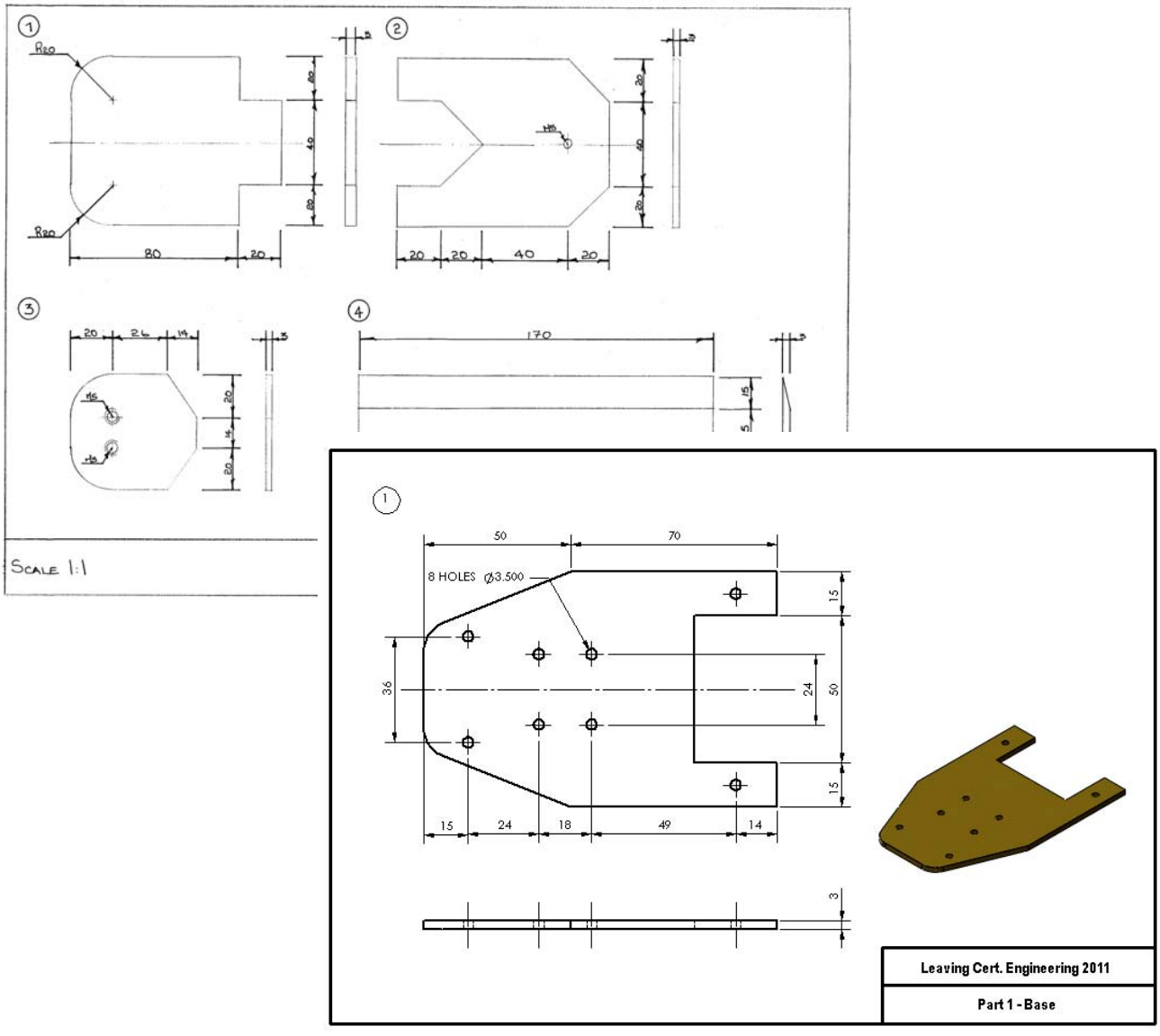
3D Pictorial View.

An assembled 3D view shows the reader an overall view of the model. This view can be presented on a sheet on its own, or included with orthographic views. SolidWorks is useful for creating a 3D model of the design prior to making it.



Orthographic view: (Including Dimensions)

These working drawings represent planning which will enable the model to be made in the time available. For that reason, various views must be presented for each component part along with part numbers. Appropriate views of each component are chosen to give all of the necessary information. The advantage of modelling the design in SolidWorks is that the various views may be produced from the 3D part model. If changes are made to the design of the part these views will update without having to redraw them.

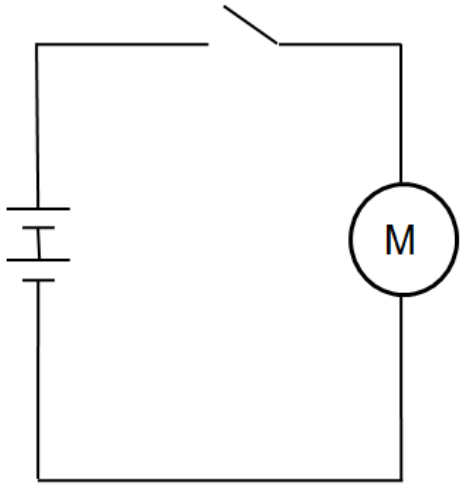


Orthographic views of components detailing the shape, sizes and positions of holes using hand drawing techniques and SolidWorks.

Electronic Circuit Diagram

The circuit diagram used in the model must be presented along with the working drawings. The correct symbols must be used to represent each of the electronic components. Wires joining the components are represented as straight lines.

A students electronic circuit diagram used in the Model Recovery Truck (Engineering – Technology Project: Manufacture 2011) is presented below.



Circuit Diagram

Parts List

A parts list must be produced which details the following;

Part Number, Part Name, Material Used, Overall Dimensions and Quantity Required.

The parts list may be produced once all working drawings have been completed.

An example of a parts list is shown below.

The parts list should be produced before starting to make the model.

Part No.	Name	Material	Dimensions	Quantity
1	Chassis	Aluminium	160 x 60 x 2	1
2	Body	Aluminium	125 x 60 x 1	1
3	Windscreen	Clear Perspex	55 x 40 x 2	1
4	Axles	Brass	Dia 4 x 80	2
5	Seat	Acrylic	75 x 50 x 3	1
6	Wheels	Nylon	Dia 40 X 10	4

Work Plan/Manufacturing Processes

Work Plan

At the start of the project a work plan is produced to make best use of the time available to complete the project. Manufacturing is allocated a significant amount of time within this plan. It is important at this stage that the time for manufacturing is broken down into smaller amounts and allocated to each component part. This will ensure that the student has work allocated to each week and class.

This may be organised in a table detailing the week number and work to be completed. This may be updated or changed, as necessary, as the project is being manufactured. A portion of a student's manufacturing work plan is detailed below.

Week No. / Work	Manufacture					
	WK. 5	WK. 6	WK. 7	WK. 8	WK. 9	WK. 10
Chassis						
Axle Supports						
Axles						
Wheels						
Body						
Mudguards						

A portion of a work plan for manufacturing of the model.

Manufacturing Processes

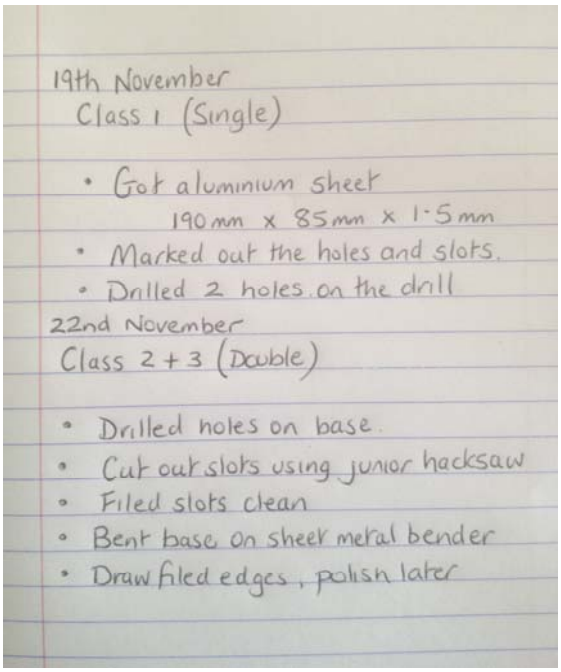
The project is an opportunity for the student to display the practical skills they have developed through their study of Engineering at Second Level. The student should use the tools and manufacturing processes they have access to and are most comfortable with. Students should display a wide range of bench manufacturing skills including marking out, sawing, bending, tapping, filing and polishing. Along with these, they should also use a wide variety of machining processes including drilling, lathe work and bending to complete the manufacture of their project.

Joining methods should be carefully considered as part of the planning of the completed solution. It is important that the correct joining methods are chosen for the various elements of the model. The project should be joined in a way that allows for access should it be needed.

Adhesives can be a quick solution but not always the best. Adhesives should be used appropriately and sparingly.

The position of the wiring for the project should be considered from the outset of production. It is important from presentation and safety view points, that all wiring is neat and tidy. Cable ties are useful for tidying up loose wiring.

Each part will require different manufacturing processes to be produced. The processes used in manufacturing each individual part must be outlined and detailed.


19th November
Class 1 (Single)
- Got aluminium sheet
  190mm x 85mm x 1·5mm
- Marked out the holes and slots.
- Drilled 2 holes on the drill

22nd November
Class 2 + 3 (Double)
- Drilled holes on base.
- Cut out slots using junior hacksaw
- Filed slots clean
- Bent base on sheet metal bender
- Draw filed edges, polish later

It may be useful to record the work done, each day, in a class-by-class diary and use this information when presenting the manufacturing processes on completion of the model. This classroom diary may also be presented along with the folio. An example of a student's diary for a portion of a week spent manufacturing is shown.

The Work Plan and Manufacturing Processes could be combined into one table as detailed below. Presenting the information in this way makes it easier to read. Keeping the class-to-class diary up-to-date will make this part of the folio much easier to do once all manufacturing has been completed.

Part No.	Part	Week	Class	Work Done	Manufacturing Processes
1	Chassis	Week 5	1	Marking Out	**Marking out using;** Pencil, Rule, Engineers Protractor Scriber, Spring Dividers, Centre Punch **Started Drilling on Drill**
1	Chassis	Week 5	2 & 3	Drilling & Bending	**Drilled remainder holes on drill** **Cut out slots using Junior Hacksaw** **Bent to shape on Sheet Metal Bender**
2	Wheels	Week 5	4	Lathe Work	**Face off front face** **Centre Drill** **Drill diameter 3.2** **Taper Turn 1 x 1** **Part off 10mm long** **Tap m4**

Materials and Finishes

Materials should be chosen carefully. It is very important that the material is suitable for what it has to do. When choosing a material the following points must be considered:

1. **What material is available?**

A stock of material will be available in the school workshop. Speak with the class teacher to find out what materials are available and suitable to use.

2. **What material is most suitable?**

The material chosen must work without becoming damaged. For example, the base of the project must be strong enough to carry the weight of the other parts without bending, over-flexing or breaking.

3. **What thickness of material do I need?**

Some materials are stronger and heavier than others. Brass is stronger than aluminium but is much heavier. If the project needs to be light, heavier gauge aluminium may be more suitable than a lighter gauge brass.

4. **How can I join this material to other parts?**

Some thought must be given to joining methods when choosing materials. Certain materials limit the joining processes that may be used e.g. Aluminium parts cannot be joined by soldering.

5. **Is the material easy to work with i.e. drill, bend, file etc.?**

Harder materials are more difficult to work with. It will take more time to cut, file and shape these materials. If a softer material is suitable it should be considered for use.

6. **What finishes can I apply to the material?**

There are appropriate finishing techniques for all materials. Acrylic may be finished by polishing, therefore the appropriate colour should be chosen at the start. Aluminium may be finished by polishing or painting however it is inappropriate to paint decorative metals, such as brass.

7. **How will this material look with my other chosen materials?**

Having chosen all materials it is important to consider how these individual colours will look together. It may be necessary to reconsider your choice of material/colours for some parts to improve the overall appearance of the project.

Finishing

Finish and presentation of the project is very important. The finish applied to the project will depend on the materials used. *"High quality finishes may significantly improve the appearance of the component as well as contributing to the overall presentation of the completed artefact."(Chief Examiners Report: State Examinations Commission, 2011)*

It is very important that time is given to finishing as part of the work plan.

In general all parts should;

- be free of sharp corners
- be filed smooth with all burrs removed
- be cleaned and ready for polishing
- be polished to a high shine

Metals may be given a protective coating of paint, or clear lacquer to avoid subsequent tarnishing. Plastic dip coating is also a possibility. Screws should be cut to an appropriate length. All wiring should be neat and tidy.

Materials and finishes must be detailed in the folio. This may be presented in the form of a table as shown below;

Part Number	Part Name	Material	Reason for Choice	Finish Applied
1	Base	Aluminium	Light Weight Strong Easy to work with Looks Well	Draw Filed Sanded Polished Painted
2	Axle	Brass	Easily threaded Will not bend Will not wear easily Nice polished finish	Polishing
3	Roof	Acrylic (Red)	Rigid - will not flex Attractive Looks well with painted aluminium	Drawfiling Polishing

Testing & Evaluation

Testing

Having finished making, assembling and wiring the next step is to test the project to see how well it works.
The tests chosen must identify whether the project meets the requirements identified at the start.
The tests used must be described and the results outlined.

An example of a student's outline of one of the tests carried out for the drive mechanism of the Recovery Truck (Engineering – Technology Project: Manufacture, 2010) is detailed below.

"When I finished my project I tested it to see if it would drive along the ground. I connected the battery to the battery clip and turned on the switch. The motor turned and the front wheels spun around. When I put it on the ground it would not move it was too heavy. If I had used lighter materials or a stronger motor it would have worked better."

Similar tests should be used to test other requirements of the project.

Evaluation

Evaluation gives the opportunity to look at the planning process and the finished project. Successful elements should be identified as well as areas for improvements.

The following points may be used to guide a complete evaluation:

- How well the model satisfies the brief based on the tests performed
- How well the model works
- Choice of materials and finishes
- Manufacturing processes used
- How the project was assembled
- How safe is the model
- Quality of the work and presentation of the model

An example of a student's evaluation of the lifting mechanism in the model Recovery Truck (Engineering – Technology Project: Design 2010) is detailed overleaf.

"I am very happy with the lifting arm at the back. The winch works well when a toy car is attached to it. The brass hook is heavy and looks well with the black spray paint on the body. The handle is easy to turn and the string wraps around the pulley easily. If I was to make this again I would have drilled holes and attached it to the body using screws and nuts instead of the glue. This would mean that I could take it apart if I had to."

Similar evaluation should be completed for the other requirements of the project.

Appendices

Appendices may be included to present other relevant information e.g. photographs of the completed artefact.

A guide to the Engineering – Technology Project: Design

Leaving Certificate Engineering affords students the opportunity to develop skills in creativity, problem solving, innovation, research, enterprise, design, manufacture and reflection. ICT is an integral part of this learning environment.

The student project provides the medium through which some or all of these skills may be expressed and assessed.

The purpose of this document is to offer guidance to both teachers and students on possible approaches to successfully completing the Engineering – Technology Project: Manufacture.

PDST Professional Development Service for Teachers

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