REQUIREMENTS FOR PROJECT UNITS

IN THE

DEPARTMENT OF ELECTRICAL AND

COMPUTER ENGINEERING

CURTIN UNIVERSITY OF TECHNOLOGY

PERTH, WESTERN AUSTRALIA

Fifteenth edition, 2008  D.G. Myers
Synopsis

This Guide outlines the regulations for project units within the Department of Electrical and Computer Engineering at Curtin University in these programs:

Bachelor of Engineering

Double degree courses in which the Department participates

Masters by coursework

The Guide covers requirements and expectations in all areas of project work and defines all procedures used. It specifically addresses Bachelor of Engineering projects, but where these significantly differ from masters then comments are made.

Note too, the course coordinator is the projects coordinator for the masters theses.

With their course coordinator’s approval, some Bachelor of Technology Students will be permitted to enroll in the one semester unit Computer Technology Project 392. This has very different conditions to what is outlined here although much of it may be useful in guiding your work. You should seek clarification from your course coordinator on exactly what is required of you.

This Guide is not intended for research postgraduate students. However, they may wish to note the sections on writing a thesis. All graduate students should also note the requirements in the University Graduate handbook for all graduate theses.

This Guide is in the required format for the presentation of project theses and, with some slight variation, in the required style.
<table>
<thead>
<tr>
<th>INDEX</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Why project work?</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Objectives and outcomes of project work</td>
<td>4</td>
</tr>
<tr>
<td>1.3 An overview of the Guide</td>
<td>9</td>
</tr>
<tr>
<td>2.0 CHOOSING A PROJECT</td>
<td>10</td>
</tr>
<tr>
<td>2.1 The selection process</td>
<td>10</td>
</tr>
<tr>
<td>2.2 Academic staff nominated projects</td>
<td>13</td>
</tr>
<tr>
<td>2.3 Student nominated projects</td>
<td>14</td>
</tr>
<tr>
<td>2.4 Industry-based projects</td>
<td>16</td>
</tr>
<tr>
<td>2.5 Enrolment in project units</td>
<td>23</td>
</tr>
<tr>
<td>2.6 Summary</td>
<td>26</td>
</tr>
<tr>
<td>3.0 PLANNING FOR THE PROJECT</td>
<td>27</td>
</tr>
<tr>
<td>3.1 Introduction</td>
<td>27</td>
</tr>
<tr>
<td>3.2 Guidelines for creating a plan</td>
<td>31</td>
</tr>
<tr>
<td>3.3 Time allocation</td>
<td>41</td>
</tr>
<tr>
<td>3.4 Changing the plan</td>
<td>43</td>
</tr>
<tr>
<td>3.5 The project notebook</td>
<td>45</td>
</tr>
<tr>
<td>3.6 Your Project Supervisor and your plan</td>
<td>45</td>
</tr>
<tr>
<td>3.7 Summary</td>
<td>46</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>4.0 EXECUTING THE PROJECT PLAN</td>
<td>48</td>
</tr>
<tr>
<td>4.1 Introduction</td>
<td>48</td>
</tr>
<tr>
<td>4.2 The role of your Supervisor</td>
<td>48</td>
</tr>
<tr>
<td>4.3 The initial steps</td>
<td>50</td>
</tr>
<tr>
<td>4.4 Cost estimation and ordering</td>
<td>50</td>
</tr>
<tr>
<td>4.5 Use of the Laboratories</td>
<td>53</td>
</tr>
<tr>
<td>4.6 Some general comments on construction</td>
<td>57</td>
</tr>
<tr>
<td>4.6.1 Overview</td>
<td>57</td>
</tr>
<tr>
<td>4.6.2 PCBs</td>
<td>57</td>
</tr>
<tr>
<td>4.6.3 Mechanical work</td>
<td>57</td>
</tr>
<tr>
<td>4.6.4 Packaging</td>
<td>57</td>
</tr>
<tr>
<td>4.7 Fault analysis</td>
<td>58</td>
</tr>
<tr>
<td>4.8 Summary</td>
<td>61</td>
</tr>
<tr>
<td>5.0 THE SEMINAR</td>
<td>62</td>
</tr>
<tr>
<td>5.1 Introduction</td>
<td>62</td>
</tr>
<tr>
<td>5.2 Creating your multimedia presentation</td>
<td>63</td>
</tr>
<tr>
<td>5.3 Creating your oral address</td>
<td>65</td>
</tr>
<tr>
<td>6.0 WRITING THE THESIS</td>
<td>67</td>
</tr>
<tr>
<td>6.1 Introduction</td>
<td>67</td>
</tr>
<tr>
<td>6.2 Another view of a thesis</td>
<td>70</td>
</tr>
<tr>
<td>6.3 The hows of writing</td>
<td>77</td>
</tr>
<tr>
<td>6.4 The draft</td>
<td>80</td>
</tr>
</tbody>
</table>
### 6.5 Format of the thesis

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.5.1 Introduction</td>
<td>81</td>
</tr>
<tr>
<td>6.5.2 Physical presentation</td>
<td>82</td>
</tr>
<tr>
<td>6.5.3 The thesis binder</td>
<td>83</td>
</tr>
<tr>
<td>6.5.4 Writing style</td>
<td>85</td>
</tr>
<tr>
<td>6.5.5 The written structure of the thesis</td>
<td>89</td>
</tr>
<tr>
<td>6.5.6 Numbering in theses</td>
<td>100</td>
</tr>
<tr>
<td>6.5.7 References</td>
<td>105</td>
</tr>
</tbody>
</table>

### 6.6 Theses for projects that are software-based

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.6 Theses for projects that are software-based</td>
<td>111</td>
</tr>
</tbody>
</table>

### 6.7 Graduate theses

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.7 Graduate theses</td>
<td>112</td>
</tr>
</tbody>
</table>

### 6.8 Attachments to the thesis

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.8 Attachments to the thesis</td>
<td>113</td>
</tr>
</tbody>
</table>

### 6.9 The electronic copy of your thesis

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.9 The electronic copy of your thesis</td>
<td>113</td>
</tr>
</tbody>
</table>

### 6.10 Summary

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.10 Summary</td>
<td>115</td>
</tr>
</tbody>
</table>

### 7.0 ASSESSMENT OF THE UNDERGRADUATE PROJECT UNITS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0 ASSESSMENT OF THE UNDERGRADUATE PROJECT UNITS</td>
<td>118</td>
</tr>
</tbody>
</table>

### 7.1 Introduction

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 Introduction</td>
<td>118</td>
</tr>
</tbody>
</table>

### 7.2 General requirements for projects

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2 General requirements for projects</td>
<td>119</td>
</tr>
<tr>
<td>7.2.1 Enrolling in Project units</td>
<td>119</td>
</tr>
<tr>
<td>7.2.2 The first semester checklist</td>
<td>120</td>
</tr>
<tr>
<td>7.2.3 The second semester checklist</td>
<td>121</td>
</tr>
</tbody>
</table>

### 7.3 Patents and copyright

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.3 Patents and copyright</td>
<td>122</td>
</tr>
</tbody>
</table>

### 7.4 Public disclosure

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.4 Public disclosure</td>
<td>126</td>
</tr>
</tbody>
</table>

### 7.5 Assessment in the first semester unit

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5 Assessment in the first semester unit</td>
<td>127</td>
</tr>
</tbody>
</table>

### 7.6 Assessment in the second semester unit

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6 Assessment in the second semester unit</td>
<td>127</td>
</tr>
</tbody>
</table>
7.6.1 Introduction 127
7.6.2 The seminar 128
7.6.3 Assessment of the thesis 133
7.7 Completion 139
7.8 Research graduate theses. 139
7.9 Summary 141

8.0 GENERAL COMMENTS 144
8.1 Are you going to solve the world’s problems? 144
8.2 Extensions, deferments and supplementaries 146
8.3 Changing projects 148
8.4 The Projects Coordinator 148
8.5 Suggestions or complaints 149

APPENDICES
Appendix 1: A quick guide to writing your draft thesis 150

Appendix 2: Checklists for the presented thesis 152
1.0 INTRODUCTION

1.1 Why project work?

Engineering schools throughout the world require undergraduate and postgraduate coursework students to undertake a major project in their program. Why relates to the nature of professional education. At University students gain a broadly based theoretical knowledge and some skills plus an insight into professional and ethical issues. Then they enter a second phase of education in employment where they gain ‘practical experience’ in a very specific area. Learning continues, but now on specifics related to the enterprise’s activities and under the supervision of experienced Engineers of that enterprise. Some problems result from these two educational phases being so different. Thus the fact a student is academically capable does not imply they will be professionally competent. How then, to judge whether the course has been suitably designed to make this transition as easy as possible and whether students will become competent professionals?

The ideal vehicle to make this judgement is a simplified example of professional practice, thus a project. It is simplified in the sense it is usually individual, the problem is not as detailed as those in industry or research projects and time is far more limited. However, it is still an example and will give students insights into professional practice and what they need to address so that they can succeed. Given that, you will not be surprised by the fact the principal educational objective of project work for undergraduate project units, is to allow you to demonstrate your potential as a professional. For coursework masters degrees, it is to allow you to demonstrate your competency as a professional engineer in a new field.
There is an important implication of these objectives. Demonstrating your professional abilities means all your abilities and that includes your attitudes, the way you manage time, your approach to solving problems of various kinds, how you discover current practice in a given field, how you learn new skills as well as technical ability.

The form of the project varies according to the course in which you are enrolled. Masters students will be looking at advanced development of which design is a part. For most students though – those undertaking an engineering undergraduate degree including those doing double degrees – design will usually be the focus. Why? Design integrates all the work done over your course and that makes it ideal for projects. That aside, it is at the core of engineering. If a design is poorly executed, then this will impact on maintenance and operation of that equipment and indirectly on sales and installation. An appreciation of what is involved with design and its many facets is therefore of benefit no matter what aspect of the profession you ultimately enter, or at what level.

Design is not the only means for achieving the objective. Design itself is a process. Therefore, the process itself can be an object of study to demonstrate your professional ability. That is to say, a project can quite legitimately be the development of a new design method or a careful examination of one recently proposed. It can also be design at various levels. Most projects look at the lowest – the component level – but it can be design at the systems level where, for example, you integrate various elements of common technology to create a new and useful
system. A project can also be a study of a new method of manufacture or a new means of operating existing systems. It can be a research project although this is not that common at an undergraduate level. It could also be a forensic examination to determine why a given system fails. It can take other forms, too, but no matter what a project may be it must be a task requiring systematic work and so allowing you to demonstrate your ability. Most projects for engineering students are design projects simply because that is the most convenient path for this.

There are four critical activities in all projects:

1. **Selecting a project**
   This is not as simple or as straightforward as it may seem and you need to approach it carefully.

2. **Creating a project plan**
   Any engineering project is first carefully planned, then the plan is implemented, thus the importance of the discipline of Project Management to Engineering. If the project is to reflect professional practice, then you need to identify how you will spend your time and available resources to solve the problem allocated. You will need to write this down. You also need a regular review process to determine if you are on-plan or not, and if not then you need to determine appropriate action to take – in consultation with your supervisor – so that your project can reach a satisfactory conclusion. An importance point. By creating a plan, both you and your supervisor know exactly what you will achieve.
3. **Executing the project**

Naturally, the plan must be implemented. This must be done in a professional manner, and as part of that you are required to keep a log book to record activities, data, thoughts and so forth.

4. **Communicating the project outcomes**

For most of you, this will involve two actions. First, you will give a short seminar to your peers and the academic staff. Second, you will write a thesis. There are some conditions on both outlined later in this document.

Various sections of this document will discuss each of these issues in detail. However, a comment on the last of these.

Your thesis is a public document of the Department. You are required as part of the conditions of the project units to submit an electronic copy of your thesis and that is placed on one of our servers. Why? For one, it demonstrates the capabilities of our course and of its graduates. From a personal point of view, though, it serves another quite important purpose. On graduating, many students ask the question how do I prove to an employer that I am the person they need? One way is point to our server so they can assess you and your peers. That gives them a very good idea if you have the intellectual and professional skills to fit into their organisation, and then in interview they can discover if you have the personal skills as well. Your thesis, and those of your fellow students, is the best advertisement you have on graduation.

**1.2 Objectives and outcomes of project work**

As outlined, the key objective of undergraduate project work is as follows:
To give students the opportunity to demonstrate their potential as a professional in their chosen field

In the case of coursework masters, the objective of project work is as follows:

To give students the opportunity to demonstrate their competency as a professional area in a new field of endeavour

Given these broad objectives, then project is asking you to demonstrate your ability in these directions:

1. *Process skills*

   Your ability to:

   i. to analyse a complex problem and identify the key issues in its solution;

   ii. review and develop an understanding of current and related practice in solving problems of this general type;

   iii. formulate requirements and then design specifications for solving the problem where this includes design studies to identify the best specific approach to solving the problem;

   iv. formulate a plan to solve the problem subject to the time and resource constraints set by a project unit;

   v. carry out a design according to that plan that will solve the problem in accordance with specifications.
2. Activity management

Your ability to:

i. realistically use the time available to you;

ii. review progress with others and to formulate appropriate remedial action of this is needed.

3. Professional skills

Your ability to:

i. exercise appropriate judgment;

ii. demonstrate appropriate interpersonal skills in dealing with others who you need to assist you in solving your project problem;

iii. employ IT appropriately for completing your project;

iv. demonstrate an appropriate understanding, where applicable, of the social implications, the environmental considerations, the ethical constraints and related concerns of your project.

4. Learning skills

Your ability to:

i. identify new knowledge and/or skills you require to solve your project;

ii. learn that knowledge and/or skills.

5. Communication skills

Your ability:

i. to make an effective oral presentation;

ii. to support an oral presentation through an effective multimedia presentation;
iii. to produce a well-written thesis that precisely conveys the work you have done;

iv. in some cases, to clearly demonstrate to others the features and capabilities of your project.

In an overall sense, you need to address all of these in your project work, but there is a small complication. Project is conducted over two semesters and each is separately assessed. Assessment is the process of determining if you have met the unit outcomes. Clearly, you need to be aware of what specifically are the outcomes of each semester. This is discussed in a later chapter, but the broad division is that:

1. the first semester is devoted to the execution phase of project and so the outcomes applying are all those except those related to communication;

2. the second semester of project work is devoted to the communication aspects of project, and while only the communications outcomes apply there are clearly they are influenced by the others.

Looking back at the previous divisions, you will notice there are four elements to project work but these outcomes only address two. For the other two:

1. Undergraduate students are expected to select your project at least one semester ahead of when you begin work. (It can be more.). Masters students are assumed to have some experience of planning engineering projects and need to create a plan immediately on enrolling.

2. You are required to develop your project plan between selection and commencement. You cannot proceed unless your plan has been approved, and the final date for that is the HECS cut-off date in that first
semester. Unless a project plan is presented, your enrolment will be automatically cancelled. You will not suffer any HECS penalty, but there are AusStudy implications plus VISA implications for international students.

In undertaking project, you are undertaking a rather unusual pair of units. For most units you cover exactly the same material, as every other student, you are assessed in exactly the same way and your opportunities for gaining a high grade are the same. None of that applies to project. You do an individual project, you are individually assessed and the opportunities depend on you, the project and your supervisor. All that can be said to be common is that you and your peers all do a unit covering ‘professional practice’ and that in turn provides you with some ‘practical experience’.

In the course of doing project you will discover you need to learn new skills. You will also see some subjects in an entirely new light. The frustrations of obtaining components, of making something work when ‘there is nothing wrong with my design’, of trying to remember material covered some years earlier and now rather important to complete a task, of soldering without burning fingers and of removing insulation off wires without cutting them through are all wonderfully character-building. So, for that matter, is discovering that components are not the nice, simple mathematical models discussed in books, that wires aren’t really wires, that connectors have a habit of making cables into something a little different from a transmission line, that thermal problems are problems and that EMC is more than
three letters of the alphabet. There is also the joy of working to a strict time and financial budget. When it is all finished, you will then wonder how something so simple could involve so much pain and exasperation. Then enlightenment will fall and you will realise that in spite of years of effort, there is still much more to learn before you can truly call yourself a professional. But you will have shown your potential or abilities.

1.3 An overview of the guide

Your need for information will vary over the course of the project. Chapter 2 defines the selection process and enrolment conditions. Chapter 3 is concerned with the project plan. Chapter 4 defines how to actually execute the project, Chapter 5 outlines the requirements for your seminar and then Chapter 6 defines how to write your thesis. Of course, how the project is assessed is of some interest and this is discussed in Chapter 7. Note this chapter very carefully! Finally, some general comments on project work are discussed in Chapter 8. The Guide concludes with a number of appendices. The first of these gives you a checklist for ensuring your submitted thesis is acceptable.
2.0 SELECTION OF PROJECTS

2.1 The selection process

There are three mechanisms for selecting a project:

1. You may select a project nominated by one of the members of the academic staff of the department.

2. You may nominate your own project.

3. You may choose an industry-based project.

A number of conditions apply to each of these and they are discussed in the following sections. PLEASE NOTE THESE CONDITIONS CAREFULLY.

When do you select a project? This depends on the project:

- A masters by coursework project has to be selected quickly in the semester in which you are first enrolled. That tends to favour staff-nominated projects unless you have negotiated with a staff member prior to that or your course coordinator to approve an industry-based project.

- **Ideally, at least one semester before you plan to begin.** Why is that? Because your enrolment is conditional on you presenting an acceptable project plan and you need time to do that.

What sort of project do you select? That depends on your course. For the engineering degrees, the project is usually focused on design in some way, but it can be a research problem. For a masters degree, it is more inclined to an advanced development or research problem. Project topics listed by academic staff indicate at whom they are targeted.
You are not obliged to undertake a project in your specialist area, but it is expected. Some areas, though, are not precisely defined. For example, networks cover both communications and computing issues. A project may also cross boundaries such as a microprocessor controlled instrument for use in the power industry.

A very important point. Can you choose a joint project? The answer to that is both yes and no and that requires some explanation. The project objectives refer to you as an individual. Therefore, you CANNOT work as a team on a project and present a single thesis. What you can do, though, is something like the following. Assume a group of students wanted to develop an electric car. Then a power student could make a project from the motor drive systems and possibly the power electronics associated with it, a computer engineering student could look at the overall control system examining ‘intelligent’ control and an electronics student could develop the sensors. Thus a group project is fine PROVIDED each student can do work where they exercise their own judgement and so are able to present an individual thesis.

The key decision in selecting a project is ensuring that it is going to offer you enough challenges to gain the grade you wish. Therefore, before making your final selection, you may wish to read the later chapter on assessment. Once you have selected a project, your will now proceed through the following stages:

1. There will be an exploration stage where you and your prospective supervisor try and determine if you are compatible and that you can indeed create a worthwhile project.
2. There is a planning stage where you determine the project plan in detail according to standard project management principles. Executing that plan is what you will actually do in project.

3. There is the enrolment stage where you actually become enrolled in the first project unit.

It needs to be emphasised you do not simply pick a project. What happens in exploration varies according to the nature of the project, but the stage finishes with you submitting a **Project Registration form** – signed by you and your supervisor – with the Projects Coordinator. This is, if you like, a letter of intent and, apart from keeping the Projects Coordinator aware of what is happening, commits you both.

You now begin planning your project with your supervisor. A key point in this planning is that you need to define what you will have achieved at the end of the first semester – that is, at week 12 – and also on completion of the project.

Once you have completed the plan, then you need to send a copy with a cover sheet signed again by you and your prospective supervisor to the Projects Coordinator. The Coordinator will normally accept it but may seek clarification. Note that the plan is important to you in executing the project and it is also used in assessment.

The enrolment stage has several elements. You need to go through the usual enrolment process, but the Projects Coordinator can cancel your enrolment for various reasons. Enrolment is discussed in detail at the end of this chapter.
2.2 Academic Staff nominated projects

At the beginning of each semester, a list of projects academic staff have nominated projects will be placed on the (web) projects notice board. In some cases, these projects may actually be nominated by a graduate research student and your project will be to assist them. Similarly, some projects may originate from the technical staff, or there may be projects supervised within the Department but actually conducted for another. In these cases, there will usually be a co-supervisor nominated. That means the co-supervisor usually handles the day to day supervision, but the key decisions are still made by the academic staff member. Then:

1. Academic staff nominate projects of interest to them. They are generally in their area of specialisation, but not always. Thus you need to look carefully at each project to ensure it is suited to your interests.

2. You should discuss any project that seems interesting to you with the relevant staff member to determine their expectations of the project. They should also be able to advise on information sources.

3. Staff nominate project topics. They are not fully fleshed out so it is quite possible a topic may not present the range of challenges expected of a project. For that reason, you need to investigate it and satisfy yourself that you can frame an acceptable project based on that topic.

4. Because you wish to do a given project does not mean that the staff member has to accept you. Therefore, a very important issue to raise in your first meeting is what conditions apply to selection? Is it first come-first served, the staff member intends to maintain a list and select one student from those interested, or must you be in a given speciality?
5. Please note that until the staff member’s signature - and yours - is on the Project Registration form, then you do not have a selection. By signing, the staff member is indicating their willingness to supervise you subject to you preparing a satisfactory project plan.

2.3 Student nominated projects

You are encouraged to nominate your own project topic. Be warned, this is going to take more effort than the other options, but then you will be doing exactly what you want to do. How do you go about that? Follow this sequence of actions:

1. Read this Guide very carefully to see what is expected of a project.

2. What is your particular enthusiasm? Almost certainly it will be a vast field. So, go to the library and the web and see what professional activity is occurring. Then search out specific topics highlighted in papers or articles that are of interest and which you think meet the project criteria.

3. A good starting point is often to look at the literature of about 5 years ago and identify problems that were highlighted, then see if anyone has tackled them since. You will be surprised at the number that have not. Another option is to look at some brand new technology and see if that suggests a new way of performing an old action.

4. List the topics in which you are interested. Now sketch out for each what you think are the detailed problems of the topic that you will need to solve and then sketch out:

   the time you think will be needed to do that

   the resources you think you may need
5. If the time seems excessive, then you can reject that topic. The resources issue is more complex and will probably require some investigation. You will also need to carefully identify exactly what those resources may be:

i. If they are physical components, then you may be able to purchase them through the Department under the projects budget. Check with the Projects Coordinator on this.

ii. If you purchase components yourself you get to keep the final prototype developed. However, please note that you are NOT entitled to the intellectual property rights. That is, you cannot go out and sell your development to a company. The reason is simple; the project was supervised by a University employee and so the University maintains those rights.

iii. You may need a resource and discover there is a company that can create this for you. You can pay for that yourself of you wish or perhaps encourage them to do it for free, but you cannot commit the University to make any payment. Unless there are exceptional circumstances, this would NOT be supported.

iv. You may need to use CAD software. **You may not use illegal software.** That includes any that you might have acquired on a visit overseas or through friends who may have international contacts. Evidence of illegal use of software will see your results annulled. Thus your option is to use a public domain version. If you use a licensed owner’s software, check that you can access it for your project and acknowledge that support.
6. Once you have a topic, then you need to flesh it out. It is an idea to write a short proposal, with references, on what you plan to do.

7. Your next step is to find a supervisor. In the booklet or sheets issued each semester for staff-nominated projects, you will find a list of interests for each staff member. Approach those who seem to best fit, and if they agree to supervise then all that remains is to fill in the Project Registration form.

8. What happens if a staff member refuses your project? The obvious answer is find another, but before doing that, it is always an idea to find out why. It may be a simple reason like that staff member already has a number of project students, they are going on sabbatical or the topic is not their field. However, they may see deeper problems and it is in your interest to know those. It may be you can rework the project and try again at a later time.

9. What happens if no matter what you do no staff member is willing to supervise? Then you need to change the topic.

2.4 Industry-based projects

The Department encourages you to undertake industry-based projects. However, there are particular conditions that apply and you need to consider these carefully. The Department does not actively seek industry projects. If a company approaches the Department, we will discuss the project with them and if we find it acceptable then we will list that project on our web noticeboard or in the project lists.
How else may you gain an industry project? To be quite frank, it is difficult. Usually, it results from vacation employment or because you are working part-time for the organisation. You can approach companies directly, but expect many rebuffs. They don’t know you or your abilities, so you have to present a very attractive case for support. Thus a project of this form is really a student-nominated project seeking industrial support. In general, the organisations likely to support projects are:

1. small companies that need someone to examine feasibility of a new approach;
2. charitable organisations or companies that need technical expertise in an area that is not part of their normal activities;
3. companies who see project as a way of identifying possible future employees.

You will probably have to target the first group to follow this course, you will need to find out what they do then market yourself well, and show a great deal of tact.

An industry-based project must be conducted according to the same principles and policies as an internal Curtin-based project. That is to say, an industry project must be a supervised project. Therefore, in approaching an external organisation, you need to do two things initially:

1. You need to bring this Guide to their attention and ensure they accept the requirements listed.
2. You must ensure there is someone in the organisation who can supervise. That means someone with experience of the process such as a professional engineer or a scientist. It does not necessarily have to be an
engineer in your field, but of course if they are going to supervise they need to know something of the topic. A supervisor cannot be an accountant, a technician, a foreman, a manager or similar. If there is any doubt over the potential supervisor, then seek clarification from the Projects Coordinator.

Two critical legal issues associated with industry-based projects. The Department’s only interest is that you are properly supervised in an activity that demonstrates your potential or abilities and that you can be assessed in the same manner as any other project student. Issues of payment for services, assigning of intellectual property rights and so on are entirely an issue between you and the organisation concerned.

If you have concerns, especially over the latter, then you might find it prudent to seek legal advice. However, a company is extremely unlikely to get you to engage in product development. Rather, it is more likely to be interested in you proving feasibility. If they genuinely want you to develop a product, then you should seriously question whether you wish to work with them (unless you are experienced). Further, you are very strongly advised, if for some reason you wish to proceed in this circumstance, to see a lawyer and ensure that appropriate steps are taken so you are not subject to any legal liability over that product. That is a serious issue and not to be treated lightly.

The second legal issue requires some explanation. In general, any design or research you do is the property of the University because you have used University property...
and you are under the supervision of University staff. If you believe that work has commercial potential or is patentable, then you are obliged to approach the University on this. Your supervisor can assist. The University may choose to commercialise in which case you receive a royalty, and a quite generous one at that compared to what industry normally offers. If it decides not to proceed, then you may request all rights are assigned to you and do what you wish.

Now in the case of an industry-based project, the University will not pursue its rights provided you use no University property or seek advice from staff. That means effectively no association with the University over any matter related to the actual execution of your project. That includes you making Internet access via University machines and using Departmental CAD tools. If you ignore this, then in blatant cases your results could be annulled. However, the more important point is that the University would be in its rights to seek compensation from the company concerned. That could be very embarrassing all around.

There is an exception to this, but there are further conditions. The Department sees ‘industry’ as any organisation external to the University. That not only includes private profit making concerns, but also charitable organisations and public research agencies like the CSIRO. In these latter cases, you may use University resources. However, again there is the issue of whether the project is proving feasibility or developing laboratory equipment, or whether it is likely to be a commercial product. If the latter, then again the question of liability arises and rights over intellectual property. You need a ruling from the Projects Coordinator.
Then:

1. Your first step in organising an industry project is to ensure you and the organisation accept the conditions listed.

2. Once you have reached your private arrangements, then the next step is for your industry supervisor to write a letter to the Projects Coordinator (on the organisation’s letterhead). That letter needs to state the following:
   i. The organisation is prepared to conduct a project in accordance with Departmental rules.
   ii. The qualifications and experience of the person who will supervise. This does not have to be very elaborate. For example, it can be as simple as “XXXX has been a member of the I.E. Aust for seven years and is currently responsible for selecting and managing the installation of instrumentation”. The objective is simply to allow the Department to establish that person understands the supervision process, has some experience of it and can supervise.
   iii. Where appropriate, the organisation accepts that there has to be a separation from University activities and that it has or can make available all resources needed.
   iv. An indication on whether the industry supervisor wishes to be a co-examiner of the thesis. This is not necessary, but many do and the Department has no objection.
   v. Critically important, the organisation **MUST** accept the publication requirements. (See ahead)

The Projects Coordinator will reply to this letter.
3. You should separately submit brief overview of the project plus a Project Nomination form. **NOTE YOU DO NOT HAVE TO FILE A PLAN WITH THE PROJECTS COORDINATOR.**

That is all that is required. Please also note the following:

1. You **MUST** submit your project plan to your industry supervisor and in turn they need to indicate to us that it is acceptable by the due date.

2. You are **NOT** required to submit a patent assignment form with Curtin.

The second semester of your project work is to write a thesis. This is a **public** document; we keep a physical copy in the Department and we put an electronic copy on our servers. **We will not keep it confidential nor will we limit its distribution.**

The Projects Coordinator will respond to the letter informing the organisation that we accept the project supervisor and project, and that the organisation will conduct the project according to our regulations. That means public disclosure of the thesis. This letter gives the Department legal protection if at some later time they claim this prevented a patent claim or that information was disclosed to a competitor.

What can you do if this is not acceptable? First, try and find out why. If your project is indeed to prove feasibility, then they may later commission a detailed engineering design. In that case, they would certainly desire the information be kept confidential. The Department recognises that. Therefore, it will, **for a short time only**, keep a thesis confidential. We expect the organisation to nominate for how long they require confidentiality and why. Simply stating “commercial reasons” is not adequate. Further, the maximum period the Department will consider is three semesters.
What to do if this is still unacceptable. That would be surprising. However, should it happen - and it can if you are a full-time employee - then an option to explore is to change the project so it now covers only part of the activity, or you explore a related method that for various reasons you do not intend to follow commercially. You may try and convince the company that the thesis is not that public as few people would think to look to us. Otherwise, you have few options.

It is worthwhile noting you do not have to identify a project as being industry based in your thesis. Normally, in the acknowledgements section of the thesis you would include a statement of the form:

*This project was supported by XXXX. The author thanks the company for making its facilities available, and particularly thanks YYYY, his/her supervisor. In addition, ZZZZ who assisted in ....*

It may be diplomatic to ask if there is an issue over publication on this should be reduced to something like:

*The author gratefully acknowledges the support of XXX of YYYY for part of the supervision of this project and for making particular resources available. ...*

Industry-based projects differ from those within the Department as follows:

1. The first semester assessment is entirely conducted by your industry-based supervisor. They need to send the Projects Coordinator a letter at the end of your first semester telling us whether progress has been satisfactory or not in accordance with the regulations listed later.
2. For your second semester, you need an academic supervisor at Curtin to help you give your seminar and write your thesis. You need to organise that supervisor thus it is advisable to approach staff during the first semester of your project.

3. Please note that any draft of your thesis must be vetted by your industry supervisor to ensure you are not disclosing any confidential or proprietary information.

### 2.5 Enrolment in project units

Given the previous objectives, you may only enrol in a project unit at the end of your course. More specifically:

1. For Bachelor of Engineering degrees, when you have completed at least 5 semesters, but preferably 6.

2. For double degree students, when you have completed at least five equivalent semesters of the engineering degree in which you are enrolled, but preferably 6.

Coursework masters programs are such that unless you are doing some preliminary work, you will enrol immediately.

Enrolment in the project units is a little complicated and needs some explanation:

1. Submitting a Project Registration form does not necessarily mean you can – or for that matter must – enrol in project units.

2. You begin work before actually being enrolled, namely you prepare a project plan. This is important for reasons given below.
3. You cannot enroll until your course coordinator signs your enrolment form. However, this is only **conditional** enrolment.

The Projects Coordinator determines whether you remain enrolled. At the HECS cut-off date, a student’s enrolment will be automatically cancelled, if they have not:

1. signed the patents clearance form (but if you are doing an **approved** industry project with an industry supervisor this is not required);
2. presented an acceptable project plan, meaning one signed by you and your supervisor submitted to the Projects Coordinator.

If your enrolment is cancelled, this has implications for HECS, for AusStudy and if you are an overseas student your student visa.

Most project work is done as two units. You can also begin project in either semester provided your supervisor is available. Your first project unit is assessed pass/fail meaning that your **progress** is satisfactory. If you fail, then you may not proceed to the second project unit. Further details are given later in the section on assessment.

A question often asked is can you do both project units in one semester? Yes, and if you do and present an acceptable thesis, then clearly your ‘progress’ in the first semester unit was satisfactory thus you automatically pass. However, if your thesis is not satisfactory, you can be failed in **both** project units. Another question along similar lines is can you do the first project unit, wait a semester and then do the second. A key point of project as is discussed later is how you manage time effectively. Such an approach does not enable you to do that and so is discouraged.
A final issue to raise is deferment. The nature of project is that you work to a plan you have devised. Further, you meet regularly with your supervisor to report on progress, to seek guidance if needed, and, if the project is not being executed according to the plan, to jointly devise a plan of action to amend the plan. If you suffer slight illness - a viral infection or the like - then you should be able to adjust your plan to compensate. If you have a more serious illness or problem - you are in a road accident, a close relative or friend dies, the company you work before goes bankrupt, you are involved in a lengthy court case - then you need to consider withdrawing. You suffer no penalty for that and in such circumstances you can make a good case for a special late withdrawal. You CANNOT seek a deferment and none will be considered. Your ability to manage time effectively is a critical part of project. To ask for a deferment is a clear statement you cannot. Please note the later sections on assessment and the conditions for submission of theses as they have a bearing on this and the issue of supplementaries.

2.6 Summary

Enrolment

Leave it to your last semester or as close to that as possible

Do the units either together or consecutively

Sequence

Begin planning a semester ahead

Read, investigate, negotiate

Begin work on the project plan

Submit a Project registration form to the projects coordinator.
The project registration form

An agreement between you and your supervisor to work together

Outlines what is expected of you

Conditions

You do not have to do a project in your area, but it is expected.

YOUR ENROLMENT IS NOT ACCEPTED UNTIL YOU SUBMIT THE

REGISTRATION FORM AND THE PATENTS FORM

Types of projects

Staff supervised

Your own

Identical to staff, but you have to find a willing supervisor

Industry supervised

You must work at their premises

We need a letter saying they can supervise, they have the facilities and

they accept the final thesis is a public document
3.0 PLANNING THE PROJECT

3.1 Introduction

Engineering may be creative, but it is also very disciplined. At the heart of good engineering is planning and that is why project management is such an important topic. To simplify the situation, any engineering problem begins with some task to achieve. Two immediate issues have to be addressed:

- What resources are available?
  That is, what materials, skills, money but especially time.
- What constraints exist?
  When can certain people or resources be available?

Then the planning itself is two stage:

- How to reach the goal?
  Define a sequence of activities that will do this. Note which can be done concurrently and which are dependent on each other.

- Allocate resources
  Determine what resources, and again especially time, can be allocated to each.

What is important to stress is that this last stage is NOT identify what resources are needed; it is what can be allocated. This is especially true of time. If the resources needed are identified, then this pre-supposes an approach to the task. Knowing what is a reasonable allocation of resources, though, forces a search for the optimum approach in the context of the overall project.
This last point is very important to stress. To give a crude example, you may need in your project some software to do something. Now you could write it yourself but that would take a lot of time. You could find something on the web and modify it, and that would take some time but perhaps not a lot depending on the quality of the code. Hence there is uncertainty here. It may happen you are a dab hand at Matlab programming. A third option for you may be to create the code in matlab – which you can do quickly, but it may then take a long time to generate the required result. Which of these to choose is an engineering decision that you make on the basis of what your plan tells you is best in an overall sense.

Some students will argue they must develop the software or they will be failed or get a low grade because they did not ‘so the work’. Rubbish! You are judged on your engineering decisions – your intellectual achievements - and your plan backs you. On the contrary, those who develop the code will probably fail as they could not get near to their project objective and failed to recognize after some years that engineering is an intellectual discipline not manual labour.

If planning is central to the practice of engineering, then given the objectives outlined earlier it must feature prominently in project work. Creation of a plan, the quality of that plan and your ability to keep to that plan contribute significantly to your assessment. To emphasise again, a plan is created before an activity to guide it, not something created afterwards to act as a record of what was done. If you are unaware of the principles of project management, then begin reading on the subject immediately.
Recent changes to project policy and assessment have further strengthened the project management aspects of project work. There are now two critical requirements.

Your enrolment is dependent on you submitting an acceptable project plan. You must submit that to the Projects Coordinator with a cover sheet signed by your supervisor showing acceptance and you. You may submit the plan from any time after project selection. The final date for submission however, is the HECS cut-off date. At that time, all students who have failed to submit an acceptable plan will have their enrolment in project units terminated. To stress again, this is the final date. It is in your best interests to submit as soon as possible. There can be NO deferment of this submission.

There is a very important implication of this that may have escaped your attention. If you are required to submit the plan prior to or at the beginning of the first project unit, then you must develop the project plan in your own time. That is why you need to select the project early. This of course does not apply to masters students who face more stringent requirements. They must select a project immediately after enrolment and develop the plan as a priority.

The second issue relates to changes in your plan once you commence the project. In industry, once a plan is in force, then there are periodic reviews of progress to identify delays, omissions, unidentified problems and so forth. At each review, appropriate corrective action is identified. In most cases, there will not be a need to
change the plan as any change has ramifications for time, budget resources and outcomes. A similar situation applies to you. **YOU MAY NOT CHANGE THE PROJECT PLAN AT WILL.** A later section discusses what to do if you need to change the plan. Please note that if the thesis you submit differs from the last approved plan, then you will be failed.

There are many implications of planning. Clearly, one is that the plan must be documented listing all intermediate objectives to be reached plus the final outcome. A plan also implies some control mechanism to judge whether work is meeting the resource constraints laid down. That control mechanism implies a quantitative assessment and thus it implies progress and information related to that is recorded. That is to say, an implication of fulfilling a plan is that a project notebook is kept.

In industry, project notebooks are mandatory for another reason. A notebook can be produced in court to justify precedence in patent litigation, or in malpractice or similar suits. A notebook, then, provides an important degree of legal protection. Note that this implies each entry is carefully dated.

If engineering is planned, then it implies there must be management. In industry, the group leader, chief engineer or whoever is providing the management function, guides the project and assesses each person’s contribution so deciding what future projects they would work on as well as what salary and other benefits they gain. Similarly, your Supervisor guides you, largely decides your final assessment and argues your case at the Board of Examiners for honours or prizes.
At the start of any project, nothing is committed and nothing is accomplished. As it is executed, there is commitment as well as some accomplishment. However, the options for change become more and more limited. If a mistake is made and not detected towards the end of a project, then it becomes extremely difficult to correct. That can see pressure for unethical behaviour involving deliberate violation of the specifications laid down. The space shuttle accident, Chernobyl and countless other ‘mishaps’ are obvious examples, but ‘fudged’ student projects merely differ in scale. Careful planning and change planning can avoid such problems. Methodical work at the start of the project is time very well spent.

3.2 Guidelines for creating a plan

In one sense, creating a plan is quite straightforward as:

1. established principles of project management need to be followed;
2. the final stage is writing a thesis and that is quite prescribed and the same for all students;
3. projects are very similar in the sense they all essentially revolve about a posed problem, determining a solution to that problem and then verifying it, plus they are all targeted at a similar means of assessment.

There is some slight variation in that in practice projects tend to fall into two classes:

1. The majority involve a design of some form and that means recognised engineering design processes need to be followed.
2. The remainder are more experimental, and so tend to revolve about a test to examine a proposition, reviewing the implications of the results and using those to frame a further test.
Technology of any form does not exist in nature. It is the product of human imagination and endeavour refined and evolved over time. It serves some human purpose for a while, but there is inevitably some time at which it becomes part of history. Technology is not science. It is constrained by physical laws, but it owes much more to social and economic factors than to scientific. Equally, the demands on technology are rarely that it utilises particular scientific principles, but rather that it meets given ergonomic, reliability and maintainability standards.

The ancient Greeks developed the principle of making decisions on the basis of evidence rather than supposition. That became the foundation of the scientific method, an analytic intellectual discipline focussed on developing an understanding of phenomena of all forms. It also became the basis for the design method, a synthetic intellectual discipline focussed on generating technology and all the processes linked to that. These philosophical links suggest to many that the two are closely linked, or even that the design method is an outgrowth of the scientific. Certainly there are similarities – especially in that both are effectively problem-solving techniques - but the fact one is analytic and other synthetic highlights that there are major differences.

One similarity frequently overlooked, though, is that both are planned activities. The planning naturally differs, but at the core are the same concerns of time, budget and resources, especially in an era when most scientific - and engineering - research is conducted under grant schemes of various kinds.
The design method is focussed on creating some form of technology for which there is a need. That technology can be an artifact, physical or conceptual, but it may also be a process such as a design process for an extremely complex system. It could also be pure knowledge such as a plan to create an underground rail system when the existing rail system must continue operating.

In very stark contrast to the scientific method, the design method is focused on need not on understanding. Consequently, a key issue it addresses is how to deal with uncertainty and risk. Uncertainty is internal issues; the degree of skill of designers, their understanding of the problem, whether CAD tools are adequate and so on. Risk is external issues; the market has changed, the political climate has changed, money is more expensive and so on. A common cause of uncertainty is where there is no real understanding of some underlying physical principles. In these cases, the design method emphasises the concept of systematic test. That is, a test of specific technology in specific circumstances to gain sufficient information to ensure design decisions are soundly based. That may seem a link to the scientific method, but whether any understanding results is secondary to verifying the design.

The broad thrust of the design method, its particular constituents and its pivotal, disciplined role in the creative, synthetic profession of engineering are easily outlined. Design can be described as a process with four broad steps:

- **Needs**
  Identify who needs this technology and why
  Form requirements specifications; qualitative desires for what the
prospective technology should do.

Identify the constraints on any solution; time, budget, other resources
such as test instruments needed or fabrication facilities required.

Idea

Determine the current ‘state of the art’.

Examine possible solutions to the problem

Decision

Choose the solution that meets the constraints and best meets the
requirements.

Frame the design specifications

Action

Undertake the detailed high, medium and, if necessary, low level design

Design for test and manufacture

Operational design; reliability, maintainability, usability, serviceability,

Any design can be described as a process of first defining a ‘black box’, black
because it is unknown and then moving forward so that it becomes known.
Requirements identifies what is required of the solution and usually focuses on what
inputs will exist, the required outputs, performance of the system and costs. In a
modern industrial context, forming requirements is quite involved and time
consuming, and so tends to be costly. However, you should not face such problems
with your project.
In your case, most of the requirements should be well-defined. However, in some circumstances you may find that like an industrial situation, the requirements are unrealistic, conflicting and incomplete. That may seem to present a problem, but in fact not. Requirements are only expressing wishes; they are framed in terms of more of or less than, maximize or minimize, include or omit. Further, you should be able to frame priorities. At a later time you need to form design specifications and these do need to be exact, but by following requirements you can be sure you will be providing the solution that best meets the stakeholder’s needs.

An important action that usually occurs with forming requirements is identifying the constraints. The obvious are the time to complete the activity and the budget involved. However, other resources are subject to constraint. For example, you may not know very much about how to design a given element that looks like being part of every solution, or you may need a specialized test instrument that may not be readily available. If you are buying in components, then think of the time it will take to acquire them.

You are now almost in a position to begin the ideas phase of design. This is a conceptual design stage. Knowing the requirements and constraints, several designs are sketched, then each is examined in the context of the compromises it represents, resources needed, trends and so on. This is creative. Do note there is NEVER one solution to an engineering problem. To illustrate, there are more than 10 possible designs for electronic oscillators. However, there can and often is a best solution.
Before you can be creative, though, there is another step to follow. Henry Ford once commented that he was all in favour of working hard but didn’t think much of hard work. Note the distinction. In this context, it means learning from the experience of others. Thus an essential part of project work is identifying what similar or related work has been done to solve all or part of the problem that is the core of your project.

You need to search out papers, articles, reports, books and handbooks. How many? For an undergraduate thesis, enough for you to claim you understand most of the field. For a masters thesis, almost all relevant work. For research degrees, it should be every source related to the topic. How do you do this. Look at key recent work, note who they are quoting and work back. Possibly find out if authors of a few years ago have published recently. Put all the keywords found into a search engine.

You need to carefully evaluate each of these contributions and record what you have gained from that in your project notebook. One approach is to record the authors, title, location and a few keywords, and then summarise the paper under some key headings of interest to you. For example, what theoretical work was produced or used? Who is quoted? What results were achieved? What comments do they make on alternative approaches or future directions? What are the advantages and disadvantages of the approach used? With what authority do they communicate? What is positive, negative or just interesting about this work?

Eventually a decision has to be made on which is the best solution. You should be looking to devise at least three. A vitally important step here is when you do decide which is the best, record your reasons why. These need to be part of your thesis.
To emphasise again, you should just have a concept at this point. To illustrate, your project may be the design of a rear sensor for a car. Then in your reading and analysis, you have decided the best option is to issue a modulated acoustic pulse and then detect it with a band-pass filter. Your analysis shows this will reduce the impact of ambient sound. In demodulating, you can detect through the Doppler shift of the rear object is moving or not and that increases safety. You have also decided to detect the pulse waveform and integrate it as that will overcome any distortions. In short, you have decided on a series of actions that will give a good result, but there is not need to say, for example, what acoustic frequency to use. Nevertheless, you should have some idea of what is possible and what is not, the costs and so forth.

In many modern fields, particularly areas of digital electronics, the next stage of design is called design space exploration. The aim is to frame design specifications; exactly the focus for your work as a designer such as in the above example, the modulating frequency, the signal o noise ratio of amplifiers, bandwidths and so on. The problem is that there can be numerous options for parameters and they all look good. Note this is not making a decision; you have already decided the best concept. A further point to note is that additional constraints have to be taken into consideration here. In particular, standards and regulations.

Once design specifications are in place, detailed planning can begin. The design proper will carefully follow this plan subject to periodic review. Detailed planning needs to focus on the specifics of your project. Nevertheless, all projects will include some element of high, medium and possibly low level design.
High level design is simply looking at the system as a whole and translating the specifications to the individual sub-systems. For example, if you were designing a very high performance audio system, then you would create a noise budget from the specifications and determine what should be the noise figure for the pre-amplifier and the power amplifier to meet that. Similarly, there is the question of allocating total allowable distortion to the power amplifier, power supply and so forth. This is usually completed in quite a short time.

Medium level design is looking at the sub-systems. So in this example, what form of pre-amplifier – or more to the point, what chip to select – and what form of power amplifier out of the many circuit options available. Again, this is quickly accomplished. Most effort is spent in low level design. That is, what transistors are to be used in the power amplifier, what are the actual circuit values and so on.

In broad terms, your project plan will almost certainly need to address the following:

1. **Design**

   As mentioned, most projects centre on design in some form, but in a more general sense this is whatever forms the core of your project work. Recall that what you are doing here is demonstrating your potential and ability. Consequently, recording what you do is important. That is to say, recording your *intellectual* activity - the critical decisions you are making – is important as you need to write those up for a thesis.
An aside. You are not developing a product, but if you were you would need to consider issues such as reliability, maintainability, ease of manufacture and so forth as well as packaging. That is not part of project work. What you are essentially doing is ‘proof of concept’; showing some idea does seem feasible. If that involves creating an artifact, then at best that can be described as a prototype.

2. Implementation

An important part of the project is verifying that your design meets requirements. That can be done by simulation in a number of cases, but for many projects it is achieved by actually constructing the design in some form and testing that. Some comments on this:

i. The time spent in solving problems in the design stage is at least one fifth that in solving the same problem in the debugging stage.

ii. The idea your implementation will work first time is highly amusing and could almost be said to violate a fundamental law of nature. Therefore, as part of design, evaluate how you will test sub-systems; what input signals to apply, how to generate them, how to measure the outputs in response to those inputs and what outputs are expected if the system is functioning normally. You might note one of the many meanings of the acronym DFT is design for test.

iii. If testing is essential, then it is fair to assume a design will need to be modified in the light of those tests. The implementation should therefore permit easy modification and that implies paying close attention to how the design will be created.
3. **Verification**

In many respects, the most important part of a thesis is not the description of the design, but the description of the verification process used to show that the design meets requirements. Failure in an engineering context does not necessarily mean failure to function. It most certainly means, though, a failure to meet specifications. Thus the design of the verification procedure is an intrinsic and critical part of the overall design. In addition, it means the final thesis must detail the test procedures employed, which must conform to accepted standards, plus the test result showing all claims made are justifiable. Note that this alone may not be enough. Those results should be repeatable. Hence you can be asked to demonstrate your design to your Supervisor or another member of staff to verify that it does meet the specifications laid down.

4. **Modification**

Just because a design needs to be modified does not imply failure; most designs require modification for a host of reasons. Therefore, how modification was tackled is an important way you can demonstrate your professional skill. Far from disguising this, you should highlight how you identified what modification was needed, how you implemented it and the subsequent tests completed to verify the modification achieved the desired result. The points to stress are the maturity of your approach and the systematic way in which you tackled the problem.
5. **Writing the thesis**

The last phase of the project is writing the thesis. This major activity needs careful planning in its own right. A later chapter is devoted to this.

Your plan in most cases may be summarized by a **Gantt chart**. (You should know what that is. If not, then find out quickly.) A key point to stress here is that you need to identify on this chart the key **milestones** of your project. Particularly important is identifying what you will have achieved - and that you can **demonstrate** what you have achieved - at the end of the first semester. It is important because it related to assessment. More is said of this in a later chapter.

### 3.3 Time allocation

A critical component of planning is allocating time to the different parts of the plan. At first glance, time may seem the least of your problems. After all, there are two units over two semesters. However, time is, in fact, **very** limited. You do have, after all, quite a number of other commitments and each semester is now only 12 weeks!

To illustrate, consider the second project unit. In this semester you have to present a short seminar and write your thesis. Consider the latter. Try this simple exercise. Write or type a one page summary of any chapter of a textbook. In general, this will probably take about half an hour per page. Would you agree this is similar to looking up information in different books and your notebook in order to produce one page of your thesis? Taking a thesis of about 80 pages, then that is at least 40 hours just to produce a draft. Therefore, a reasonable allocation of time for the thesis is:
1. writing the thesis and editing it 5 weeks
2. draft review by Supervisor 1 week
3. correction of the draft 1 week
4. final production of the draft, including drawings 1 week

8 weeks

This is two thirds of the semester and so far no consideration has been given to the seminar. Do you think you can slash the time by simply ‘borrowing’ from other units? What about the assignments, lab reports and the host of other things to complete for them? The possible question, then, is how many nights per week and how much of the weekend are you prepared to commit? What does this suggest on how to organise the project notebook?

How much time do we expect you to spend on project? Crudely, note the credit points for your project unit and divide by two and that gives roughly the number of hours per week on average you need to spend on project.

Some guidelines on creating a plan:

1. Note your academic commitments including examination periods, likely assignment due dates and so forth. These mainly occur towards the end of the semester, so commit heavily to project at the beginning.

2. Find out the delivery times of components you plan to use. This needs to be taken this into account when planning.
3. Do not scrimp on the time needed to write the thesis as its presentation and the information within it plays a large part in your final assessment.

4. As a crude rule of thumb, for each hour of design, you will probably spend one and a half or two hours in fabrication (be this construction or programming) and three to five hours in debugging and testing.

A critical mistake many students make is to assume they can ‘catch up’ in the mid-semester break. There are two problems with this. First, you are assessed on your first semester’s work. Indeed, on what your plan said you were going to achieve. Second, there is not nearly as much time in that break as you might think and you will probably have a range of other commitments. Bank on the mid-semester break only as a time just to finish off and plan on that basis alone.

### 3.4 Changes to the project plan

In any engineering, once a project plan is created then it must be rigidly followed. The reason is very simple. Not to do so can lead to overruns, cost blowouts and then probably penalties of various kinds. However, there are always problems of the form particular components are unavailable or delivered late, unforeseen events occur, sudden staff changes take place, equipment fails or is unavailable, and so forth. Project management, therefore, emphasises regular reviews of the plan. Issues are examined. What is ahead of plan, what is behind, why, does anything need to be done in terms of remedial action?

If the evidence suggests it is necessary, then a change to the master plan is initiated. This is a deliberate, carefully considered activity as there are several implications of
any change and they must be considered. Clearly, one of those is whether the requirements can still be met, but just as important is the cost of the change, the impact on timing and the resource implications. There are numerous examples of how this wasn’t done and the consequences. The Sydney Opera House was planned to take 3 years to build and cost $17 million, but due to frequent changes, political interference, change of contractors, etc, it eventually took 12 years to build and cost about $300 million. It isn’t very difficult finding similar examples elsewhere.

You need to follow the same process of careful change. **YOU MAY NOT CHANGE THE PLAN AT WILL.** You are required to meet regularly with your supervisor and one reason for that is so both of you can review progress. If as a result of that it seems necessary to change your plan, then you need to:

1. identify a change that ensures the project is still viable as a demonstration of your potential and abilities;
2. assess the implications of that change in terms of time and resources.

You need to make a dated, written submission with signed cover sheet from your supervisor to the Projects Coordinator. Please note that your final thesis may be judged against the current version of your plan. If the two differ, then you fail.

Changing a plan should be seen as an important part of your project work. It is very unlikely any plan will remain static. Changing your plan, then, is quite normal. Further, your reasoning and approach to remedial action is another opportunity to demonstrate your potential and ability.
3.5 The project notebook

A project notebook **MUST** be kept and presented at each meeting with your supervisor. Further, it **must** be submitted at the end of each semester to your supervisor as an assessment requirement. The contents of the notebook **must** include:

1. your project plan and amendments;
2. information which needs to be reported in the project report;
3. clear evidence of the systematic development of the project where this includes weekly reports of progress, designs, tests and so forth;
4. full details of the reasoning behind designs or tests;
5. full details of test procedures as well as the results of tests.

A loose-leaf folder is often useful as it is easier to include photocopied articles.

3.6 Your project Supervisor and your plan

If you have selected a project nominated by an academic staff member or from industry, then your prospective Supervisor will have very clear idea of what is required. They will also usually know what can be achieved, what has been done in the past and what problems may be encountered. Consequently, getting started on planning means meeting with your prospective Supervisor to discuss the project and define the requirements specifications.

Your Supervisor, though, is not going to prepare a plan for you. Their role at this stage is to advise, to review what you have done, comment on your reasoning and so forth. The plan is and must be your own effort. It demonstrates your ability and figures in assessment.
3.7 Summary

**Why a plan**

Identifies how to use your time most effectively – a Gantt chart

**Managing the plan**

Create before starting work

Review regularly

Upgrade as necessary BUT you must gain your supervisor’s approval for any changes

**Creating a plan**

Identify constraints

  Academic – exams, assignments.
  Labs – availability
  Time
  Components, test equipment, software, etc

Identify key actions to reach the project goals

  Specify – what do you think is needed and can be done
  Investigate – what is the ‘state of the art’

Design

  Options
  Decide the best
  Do systems, medium, low level design
  Implement – build, program, simulate – verify
  Write the thesis

Determine reasonable time that can be spent on each
Allocate time within them for sub-activities, subject to approaches you can follow

*Record your decisions as you execute the plan*

Have a log book

*Your supervisor and your plan*

Is there to guide; its YOUR plan
4.0 EXECUTING THE PROJECT PLAN

4.1 Introduction

Execution of the project means working through each stage of the Project Plan, culminating in the preparation of the thesis. This sounds simple, and it should be, but there will be many frustrations. Many are predictable and good planning will minimise their impact. That cannot be stressed enough. Others are not. A commonsense approach, though, can reduce these to minor annoyances.

Please note again that a project plan is created before you start and you MUST file a copy of that plan with the Projects Coordinator. Further, you may NOT change your plan at will, but follow the change procedure.

4.2 The role of your Supervisor

Your Supervisor plays many roles in project work. In broad terms, though, your Supervisor’s major roles are to:

1. assist you in formulating a Project plan;
2. guide you in the execution of your plan;
3. approve all expenditures;
4. assist you in accessing the resources you may require;
5. offer technical advice;
6. review the draft thesis and correct stylistic and factual errors;
7. assess your overall performance and make a recommendation to the Projects Coordinator on the grade to be offered.
Note that these words are guide and assist, not direct. You are not working for your supervisor, but with. To emphasise again, the objective of project work is for you to demonstrate your potential and abilities, and that means you being able to:

1. accept an outline of ideas and make them into a workable proposal;
2. show initiative;
3. take responsibility;
4. demonstrate a range of intellectual skills;
5. keep a notebook in good order.

Project is not just about achieving the end point defined in your project plan, but how you reached that. That counts in the general assessment of your performance.

The relationship between you and your Supervisor can be described in many ways. It should be a professional relationship. The term often used overseas - Thesis Adviser - is extremely apt. What all this implies is that the more work you do, the more proposals you present, then the more responsive will be your Supervisor. Part of your task is to convince your Supervisor of your ability. You want to give the impression of a keen but methodical mind, a hard worker, someone who has considered every possibility and therefore someone who deserves the highest result.

You MUST meet regularly with your project Supervisor. Project work is supervised; the issue is not what you might be able to achieve on your own. You need to organise a mutually acceptable time for these meetings as a first step in undertaking the project. It is your responsibility to meet with your supervisor; your supervisor will not seek you out. If you fail to attend meetings, then you lack a professional
attitude and so are failing to meet the requirements of the unit. If you cannot attend a meeting, then there is always the option to telephone, Fax, leave a note or email.

**4.3 The initial steps**

The initial steps in executing your project are very simple. Look at your plan and start. There are only 12 weeks in the semester, thus each week lost is 8% of the total time lost. **Begin on Monday of the first week of semester.**

Make sure you have everything you need by orientation week. That is to say:

1. your notebook;
2. ensuring you have access to laboratory space if you need it;
3. ensuring you can access software or other IT you may need;
4. checking there are no timetable changes that might require some action.

**4.4 Cost estimation and ordering**

During your course, staff will have encouraged you to explore design. Through personal encouragement, assignments, examinations and laboratories, you will have been strongly encouraged to study innumerable ways of accomplishing a task. New components will have been frequently brought to your attention and new design techniques. This is vital in an engineering education. Your personal creativity must be developed and your excitement at being an engineer and enthusiasm for your chosen field encouraged. Unfortunately, this has nothing to do with real engineering.
Real design has limited freedom. It is the art of working within constraints and it requires considerable self-discipline. It is a skill to be learned and that is one of the primary objectives of the project. The primary constraints should be obvious; time and money. Regrettably it may be, but the most important symbol in engineering is $ and the most important measurement is time. The time constraint on projects has been outlined. It is what in foresight seems an age and in hindsight seems an absurdity. The money part must be imposed by the Faculty. Our resources simply do not extend to large numbers of students buying whatever they like. Thus we impose a control mechanism to ensure you will consider costs very carefully indeed.

As part of a project where you will create hardware, you should:

1. include a cost analysis of each of the design alternatives you propose;
2. include cost as a factor for selection of any approach or alternative;
3. create a parts list - covering the quantity and type of each item - and cost it, meaning costing the individual components and the total cost;
4. justify the cost of your project to your Supervisor and only when your Supervisor has agreed, fill out an order form (which will need to be countersigned by your Supervisor);
5. include that costing in your project report as an appendix.

As a practicing professional, you will usually find the best design alternative is the one with lowest total cost - manufacturing plus sales plus lifetime maintenance. You would be wise to assume that at Curtin, the best alternative is the one involving the lowest parts cost. Further, note there are limits to expenditure. If you wish to exceed
them you need to present some very cogent arguments to your Supervisor, possibly the Projects Coordinator and even the Head of the Department or the Dean.

In industry, determining costs is very complex indeed. Consider some of the factors:

1. Component manufacturers offer quantity discounts, thus it is an advantage to use as many of the one type as possible;
2. Many components are sold only in indent quantities, meaning a minimum number must be ordered for the order to be filled;
3. If a system requires a large number of components, then a store must be set up which means there is now an inventory and clerical cost to be added to the cost of each component;
4. If a system uses a large number of components, then field service personnel need a large repair inventory which must increase repair costs.

In general terms then, it is best to minimise the number of components used. That may mean using more expensive items in places, but that cost can be covered by the quantity discounts obtained, the lower inventory costs (or even lack of it if Just In Time manufacturing is used) and the lower maintenance costs.

The point is that design *per se* is relatively simple and quickly done, but designing for utility is not. It requires much back-tracking, re-evaluation of approaches and considerable re-design. Hence the reason for design reviews. Coupled with that is the delay in actually obtaining physical components and its potential impact on meeting your time requirements. If your project involves a physical design, then, the sequence of events you will need to follow in the early stages are as follows:
1. check delivery times with suppliers and any indent requirements and re-design if necessary;
2. when satisfied with the design, write it up in detail with a parts list and submit it to your Supervisor for comment;

This is an area where change to your project plan is quite likely.

Please note you may not order any item for a project in its second semester.

4.5 Use of the laboratories

While you are on campus, the University is legally obliged to ensure you do not come to harm. If you are hurt and if you can prove the University failed to exercise due care, then you can sue the University for damages. Naturally, we do not want that to happen and to ensure it does not, we must have a set of laboratory rules. Copies of the general Laboratory rules are in each laboratory and on the Department’s web site. In addition, though, there are some specific rules listed below. Note that these rules are designed to protect your interests and ours. Our laboratories are potentially hazardous, but with a little care need be no more dangerous than the Student Cafeteria.

In general in supervised laboratories, if you do not understand how to use equipment and damage it due to negligence, then, usually you are not required to pay. However, the situation is a little different in project work. If you deliberately damage equipment, either maliciously or just through ignorance, then the University can take legal action and exclude you from your studies or otherwise penalise you.
We do not wish to do that and we are sure you do not want it to happen. Note the paragraphs below.

You will often find in project work that you are asked to sign for things. The legal significance of this is that:

1. you are accepting the item on loan from the Department and agreeing to return it by some due date or at the University’s request
2. by your signature, you are agreeing the item is in good working order on acceptance and will be returned that way.

In short, you are now completely responsible for that item. If it does not work when you return it, then the Department has the legal power to send you the bill for repairs. If you fail to return it, then the Department can take legal action against you for the cost of that item. Of course, such drastic action is unlikely. However, look after anything assigned to you very carefully. ( It is a very good idea to check that it is in working order. ) If you do lose something, then we do expect you to replace it.

There is a problem with using laboratories but there is little we can do about it for legal reasons. Most Laboratories are available from 7.00 AM to 5.00 PM on weekdays only. The exception is the computer laboratories. You may not work in a Laboratory without the express permission of a member of the academic or technical staff. Once in a laboratory, it is a good idea to keep the door closed ( for reasons discussed below ) and admit no-one except a member of staff. Only academic or technical staff are permitted to turn on power and you must obey their directions at all time as a legally responsible University official.
We would like to say that you can leave belongings in a laboratory untouched. Regrettably, thefts occur on campus and our areas have not been immune. If your tools are stolen, then you are responsible. If your personal possessions are stolen, report it to campus security. If you see anyone taking anything, please do the same. Only members of staff are permitted to move things from one building to another, so anyone leaving the building with anything tucked under their arm is behaving suspiciously. Unfortunately, there is no opportunity for students to claim off a University policy for theft and even more unfortunately, it is very difficult for the Department to claim also.

Do note the conditions on footwear and eating in laboratories. Please be neat and tidy. You cannot ‘claim’ any laboratory equipment for your personal use, so do not be offended when staff remove it. If a point is reached where in the opinion of one of the academic or technical staff you are endangering the good order of the laboratories, then it may be necessary to exclude you. That implies you have not demonstrated a proper professional attitude and so you will probably be failed.

If you are going to use computer facilities, please note you are not permitted to install any software. If you need software installed - and it must be licensed to the University or be freeware - then see the IT support staff and they will install it for you provided they are satisfied it is legal to do so and that it will not damage our systems.

If you are going to work in a Laboratory, then please note the following:
1. You are not permitted to disassemble any equipment. If anything at all is wrong - even a blown fuse - then call on the technical staff.

2. It may be prejudice on our part, but we feel that Hewlett Packard, Tektronix and the other suppliers of our test equipment have a better understanding of how to design it than you. NO modifications are allowed such as soldering wires to contacts. To do so is a deliberate act of vandalism.

3. If you do not understand the operation of a piece of equipment, feel free to ask the technical staff for a handbook. If you still do not understand it, then ask for someone to demonstrate it. All our technical staff are warm-hearted individuals only too keen to assist!

4. Equipment must not be moved from one area to another without the express permission of a technical staff member. If agreed, then your name and the unit will be entered into a loan book and you must sign it.

5. As a general rule, technical staff will not nor should they be expected to assist in the construction of the project. If a particularly difficult problem does arise which may call for some intervention, such as precision mechanical work, then outline your needs to your Supervisor.

6. Scheduled classes naturally take precedence.

If you do not wish to work in the department’s laboratories, then note the following:

1. We cannot make equipment available for you to take home. For an industry project, the organisation may be able to rent equipment if they wish.
2. Regardless of where you perform the project work, you will be required to demonstrate it to your Supervisor. That may mean using the Department’s facilities in some way so check if we have what you need.

4.6 Some general comments on construction

4.6.1 Overview

Some miscellaneous comments are in order concerning particular aspects of project construction work. Clearly, these comments do not apply to all students.

4.6.2 PCBs

No matter what you may think, your project is invariably best described as prototype development, not product development. Thus the emphasis is on proving concepts rather than designing for manufacture. As such, printed circuit boards will not be produced for electronic projects unless specifically requested by your Supervisor.

4.6.3 Mechanical work

Where mechanical work needs to be done, then students are encouraged to do it themselves. If that is not possible, then your supervisor will need to arrange it.

4.6.4 Packaging

The Department recognises students do want to present a neatly packaged unit at the end of the project. However, your Supervisor’s task is to assess how well you have fabricated the project. Thus do remember to remove all packaging when you demonstrate the project unless, of course, your Supervisor specifically requested it.
4.7 Fault analysis

As mentioned, it is extremely unlikely any project will work exactly as planned. That is, a test designed as part of planning to verify performance shows the unit will not meet the specifications laid down. Thus now the problem is to determine:

1. how it fails to meet specifications and why;
2. where in the system the problem lies;
3. how to correct it;

and then repeat the test to verify the modification succeeded.

The first part of this, in contrast to some student opinion, can be a simple, logical procedure. For example, if the test results are not what is expected, then first:

1. check the test procedure to ensure it can measure what is desired;
2. if it is a physical system, check ranges, probe impedances, instrument calibration and so forth.

If the test procedure seems satisfactory, then for a physical system now check the:

1. components to ensure they are the correct ones;
2. component values;
3. constructed layout against the paper schematic.

If these obvious steps find no fault, then the problem is clearly a little more serious. Therefore, now gather information for fault detection and rectification. That is:

1. measure, record and relate to the appropriate part of the circuit all DC voltages in the system;
2. measure, record and relate all signal waveforms in the circuit when you test signal is applied at the input
Now complete the process by checking the:

1. paper design and comparing the test data against what was predicted;
2. paper circuit really is the implementation of the design.

Foremost in this process is the recording of information. In the design stages, recording why particular circuits or circuit functions were chosen as well as how they are expected to work, both in general and with the specific test signals planned. In the test stages, recording test information show exactly what the circuit is doing. It is preposterous to assume that the white heat of inspiration will hit within microseconds of a measurement and you will identify faults. Rather, a great deal of thought will need to be given to identifying why faults have arisen, their causes, their remedy and an effective cure. That cannot be done via memory alone.

Software fault-finding is almost identical. Here, though, it is more important to identify a set of test inputs and the values they generate at all your proposed test points before you begin the design proper. You would be well advised to use a modern IDE for any software development and become very familiar with its checkpoint, stepping and other debugging and checking capabilities.

There is a distinct possibility you might not be able to find the fault. Then you will need to call on others to assist. That is, possibly your fellow students, although they are often as unskilled as you, the technical staff or your Supervisor. Now your fellow students may be very sympathetic and prepared to tolerate almost anything. However, put yourself in the position of the staff. They have numerous things to do...
and very little time to do it in. There are all sorts of pressures upon them. Then up comes a student and says plaintively, "it doesn't work, can you help". Yes, that is possible, but what was the test procedure, what were the results and where is the circuit? Well, the circuit is on this bit of butcher’s paper, and when a signal generator was attached, there was nothing on the CRO. That's it? Yea. Wouldn’t you get a trifle annoyed? Wouldn’t you also think that this was someone who the engineering world could do without?

As mentioned, engineering is not about symbols on pieces of paper. It is about real technology. That means any reporting must show the design - what it is supposed to do - with the test results showing what it really does. Again, would you buy a car because the salesperson said ‘its good’? Would you buy a hi-fi because the dealer says ‘its better’? Would you, if you were an examiner, pass a student project in engineering, which merely said a system ‘worked’ without any proof whatsoever or enough information for you to duplicate exactly what was done?
4.8 Summary

*Working through the plan*

Keep your log book up to date

Regularly see your supervisor

Your supervisor guides not directs, so take proposals to those meetings

Review your plan periodically and seek approval to update if necessary

Keep checking the resources you need will be available

A constraint

You cannot order anything in the second semester; all development must be complete by then

*Using laboratories*

You can only work there with permission

Don’t work alone and don’t touch power switches

You CANNOT borrow equipment so plan to use it in the lab

Do NOT install software on laboratory computers

Do NOT modify any lab equipment or attempt repairs

*Construction*

We cannot offer much assistance, but then this is just ‘proof of concept’.

*Fault analysis*

Before asking for assistance, observe, measure test and record