Systems Engineering Courses

Fourth Year Team Projects
2002-2003

Project Handbook

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1.   Overall Structure

The fourth year projects on the Systems Engineering courses are meant to create an environment in which students develop and display their professional engineering skills – both technical and managerial. Emphasis is placed on the development of project management, planning, design and implementation skills. The design and implementation skills required will cover aspects of systems engineering, software engineering and hardware engineering. Project assessment is based on performance against objectives and achievement of goals – these are measured by the quality of the project deliverables.

Projects will naturally vary but one aspect will remain constant; namely, the theme of a team working closely together to achieve a *company objective*. These terms of reference are open to wide interpretation, and in theory, the company objective may cover the spectrum from being largely of a research nature, evaluating novel techniques or components, through the development stages of a prototype system, up to the production of an actual product. Any project within this spectrum may have very laudable aims and be of importance to a company, but the final deliverables would be very different. The scope of each project, and hence, the final deliverables may vary, but all projects have a common assessment scheme and timetable.

In practice, the short duration of a project means that it cannot generally attempt to produce an actual marketable product from scratch. The time and skills required to conduct market research or to perform the necessary production planning are beyond the scope of both the course and the team projects. Projects, therefore, will normally be organised as R&D activities within the longer term product plans of a company. In discussion with company representatives – usually from the organisation sponsoring the project – a product idea is developed. Further negotiations identify a prototype product, which is deemed to be worth constructing for reasons such as

- modelling novel features of the proposed product.
- exploring technically difficult parts of the proposed product.

This means that a project may build on earlier research or project work and would terminate with the development of the prototype. Even within this framework there is considerable scope for variation between specific projects, but the objectives of any project must be to generate a final result of value within the longer term product plan.

It is probable that a life cycle model similar to the one below will be adopted by project teams:

Stage 1	User Task Analysis
Stage 2	System Engineering
Stage 3	Design Modelling
Stage 4	High-level Design
Stage 5	Implementation
Stage 6	Test and Validation

Note that the activity at each stage of the cycle is steered by documented input from the previous stage. Tracking of the progress of a project by higher management will be based on this documentation, together with a project plan. Further note, however, that not all projects readily conform to this design style, and projects teams may use other models if this is agreed by their project directors. For example, further prototyping stages may be required. In such circumstances, the documentation titles will have to be adapted – again this must be agreed beforehand by the project directors.

2.   Project Plan

All project teams will produce a project plan in order to provide a realistic framework in which to identify, schedule and resource the required project tasks. Both team and individual workplans will be produced.

Further information is provided in the document "Guidelines for Project Planning". These guidelines are to help teams in the planning of their projects and provides pointers as to what should be included in a realistic plan.

It is vital for successful completion of the project that teams maximise the use of the time allocated. The project plan is intended as a tool to help with this, never a chore to be fabricated in retrospect.

3.   Project Documentation

The project documentation is used to track the progress of a project through its various stages. As such the documentation is a major deliverable for the project. A summary of the required documents, together with their delivery dates, is given below:

- Project specification and requirements analysis (D1):   semester 1, week 7

- High level design and project plan (D2):   semester 1, week 10

- Detailed design and test plan (D3):   semester 2, week 8

- Final project report (D4):   semester 2, week 16

    Note that it is inevitable (and expected) that interim working documents will be produced during the course of the project. A final report, which is merely a collection of such documents is **not** acceptable. A plan for producing the project documentation must, therefore, be included as part of the overall project plan.

- Individual progress reports: co-incident with D1 to D4

Further details on the contents and production of the group project reports are given in Appendix A. Details of the individual progress report are given in Appendix B.

4.   Project Management

A *Student Project Group* should behave as if it were a small R&D team within a commercial organisation. The company has a *Board of Directors*, which consists of a number of academic staff, who are ultimately responsible for the assessment of the projects and the generation of the final project marks. The role of *Chair of the Board* is taken by the Chair of the Systems Engineering Board of Studies.

The role of *Chief Executive* is taken by the Fourth Year Project tutor. The responsibilities of the Chief Executive are to adjudicate on project proposals, assign students to projects, collate assessments, liase with industrial and external academic assessors, perform any tasks associated with the collective management of the projects, and liase with each project team in the development and maintenance of their project plans – see Appendix C.

Members of the Board of Directors will normally be associated with a particular project as *Project Directors*. This is not, however, an absolute requirement for membership of the board.

Each project group will have **two** Project Directors. The Directors are responsible for matters relating to the overall project plan –*Strategic Direction* – and on a day-to-day basis will provides support and guidance for the detailed design –*Technical Direction*. Both project directors are responsible for providing feedback at the formal assessment points to the Board of Directors on individual/team performance. A description of the roles of the directors – forming guidance for members of the academic staff fulfilling these roles – is also given in Appendix C.

In order to provide a degree a moderation between projects, two *Independent Directors* will be appointed to the Board of Directors. The role of an Independent Director is also given in Appendix C.

The *Project Manager* is a student from the project team with responsibilities for the overall management and co-ordination of the project. The role of project manager may circulate throughout the group during the year; for example, for a fixed period or as the project progresses through its different stages. It is acknowledged that not all students will assume this role, although each team member will be responsible for individual tasks within the overall project plan. For example, responsibility for the maintenance of the project documentation, and the design and implementation of the user interface may be specific tasks.

A *Student Project Group* will be responsible for all planning proposals and for day-to-day project management, involving
- Assignment of responsibilities within the project plan.
- Development and maintenance of the project plan.

- Identification of resource and cost requirements.
- Reporting plans and progress to higher management.

5.   Project Timescale

The time scheduled for the team projects is given below:

<u>Semester 1</u>
    Weeks 1 to 12   one full day per week
    Week 14   full time

<u>Semester 2</u>
    Weeks 1 to 12   one full day per week
    Weeks 14 to 16   full time

Note that week 13 in both semesters is allocated to examinations.

Whereas the curriculum formally specifies 240 hours of scheduled time, it is inevitable that more time will be spent on this activity. Additional time is not discouraged, but students must be aware of the other, equally important, academic work that is required of them.

Students **must** be present on all scheduled project days, and project directors should endeavour to minimise the amount of time spent in routine meetings on these days.

6.   Project Assessment Process

Team working is generally accepted as one of the most difficult of all forms of assessment to quantify accurately. In the case of these projects, the problem is exacerbated by the fact that each team is addressing a different task. One feature of the projects undertaken in past years has been that each student group has had to present their work to industrialists and academics at set points during the project. The feedback obtained at both the intermediate and final presentations for a project is considered to be very valuable. It not only provides students with a different perspective on their work and progress, but also to the staff supervising the projects.

The assessment process aims to derive an equitable mark for each student, dependent on his/her contribution to the overall project, together with the group's performance in relation to other project groups and general standards. The mark for an individual student is, therefore, derived from an assessment of an individual's contribution to the project, weighted by a mark for the project as a whole. The following formula is used:

$$SM = PM\left(\left(\frac{IA - AIA}{2AIA}\right) + 1\right)$$

where   *SM*   = Student Mark
                IA   = Individual Assessment mark
                AIA   = Average Individual Assessment for the group
                PM   = Project Mark

The project mark PM is generated primarily by the Project Directors – see below. Overall moderation between projects is carried out by the Board of Directors, with particular guidance from the Independent Directors.

IA marks for each student are produced at the same time as each documentation and review deliverables, according to the following schema:

Well above average   5

Above average   4

Team Average	3
Below average	2
Well below average	1

This set of marks is produced at appropriate times by the Project Directors. To help them with this process, students are asked to return a *individual progress report* at each of the these deliverable points, stating the major activities they have undertaken since the last such review point, as appropriate. A standard form will be produced to aid this. This should be passed to their Project Directors before the associated review meeting. It will be used as part of the assessment process and also to aid feedback to the student as to their own progress. Students are encouraged to submit these individually rather than discussing them with the group. It is in the student's own interest to submit these reports, so that marks are awarded based on the actual progress rather than an external view of it.

It will be noted from this description and the formula above that it is the difference between individuals score and the average mark for the group that is important. A group that are working consistently well would produce individual marks of 3 but a high group mark. A group that is working consistently badly would again produce individual marks of 3 but a low group mark. More likely, some students will work better than others and the individual marks should reflect this. The IA marks for each student should reflect not so much workrate as the work achieved in fulfilment of group objectives – students who work as individuals, without reference to the group, should not expect to achieve high marks. Marks of 1 and 5 will be the exception rather than the rule, as they may lead to excessive swings in the final marks.

6.1   The Project Mark

The project mark is derived mainly from a series of formal assessments and documented deliverables. The timetable for the presentation of deliverables and their assessment , together with the associated percentage mark component, is given below:

TIME	DELIVERABLE	ASSESSMENT		PROJECT MARK COMPONENT
Semester 1, Week 7	Progress Report Project Specification	Documentation	(D1)	10%
Semester 1, Week 10	High Level Design Requirements Analysis	Documentation	(D2)	10%
Semester 1, Week 12	Formal Presentation	Presentation	(P1)	10%
Semester 2, Week 5	Progress and Workplan for remainder of project	Review	(R1)	10%
Semester 2, Week 8	Detailed Design Test Plan	Documentation	(D3)	10%
Semester 2, Week 16	Formal Presentation Project Demonstration	Presentation Demonstration	(P2) (DE1)	10% 20%
Semester 2, Week 16	Final Project Report Individual Project Report	Documentation	(D4)	20%

There are four types of assessment:

Documentation Deliverable

> Both directors associated with a project meet the group (60 minutes). At this meeting the progress of the group is determined against both the objectives identified in the group workplan and the quality of the documentation deliverables. The required documentation will be delivered to the Project Directors on the day before the documentation review. A

group project mark will be generated by the Project Directors, following the review meeting.

In addition, the progress of each student is individually assessed. *Individual progress report forms* should be completed and returned to the Project Directors before the meetings. Individual marks will then be generated by the directors after the meeting.

Formal Presentation

A formal presentation - 40/60 minutes duration per project, including 10/20[1] minutes for questions - in the presence of other project groups, the Board of Directors and a panel of external assessors from industry. Each group will prepare a one page executive summary of progress made against workplans which will be distributed to everyone on the presentation day. Everyone present will be invited to complete a presentation assessment form.

The Independent Directors must attend the presentation given by each project group. They are solely responsible for generating the presentation mark component for each project, although it is expected that the views of the students, project directors and external assessors – as expressed in the assessment forms – will be taken into account when arriving at an equitable presentation mark for each project group.

Project Demonstration

Each project group will both prepare and undertake a demonstration of their working prototype system in order to establish the standard of their engineering skills. Each group must be ready to defend their work to both the Board of Directors and a panel of external assessors from industry. Everyone present will be invited to complete an engineering skills assessment form.

The Independent Directors and the Project Directors must attend the project demonstrations as they are jointly responsible for generating the engineering skills mark component for each project group. The marks from the Independent Directors and the Project Directors will have equal weighting when arriving at the final Demonstration mark. It is expected that the views (as expressed in the assessment forms) of the other project directors and the external assessors will be taken into account.

Review

Each group will be interviewed by the Board of Directors[2] – approximately 15 minutes duration. The objective of the interview is to allow the Board of Directors to determine the progress of each group in relation to the other groups. To assist in this process each group will prepare a one page executive summary of progress made against workplans. This summary will be delivered to all members of the Board of Directors on the day before the review. The Project Directors may also wish to have a brief, formal, meeting with the project group before the review meeting.

An agreed mark component will be generated by the Project Directors for each project group, taking into account the views of other members of the Board of Directors.

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[1] For P1, projects are allocated 60 minutes including 20 minutes questions. For P2, 40 minutes including 10 for questions.

[2] At least one director from each group, together with the independent directors, should be present.

Appendix A

Project Documentation : Group Report

The group report is the final assessed documentation for the project. It must be developed and maintained throughout the duration of the project. A group folder should be maintained to the extent of including hand-written documents prior to finalisation.

The report consists of the following suggested sections, which will be added throughout the project and which should reflect the "current-state" of the project at any time:

1. Introduction

This section consists of four sub-sections:

1.1	*Functional Overview*
1.2	*Design Objectives*
1.3	*Design Constraints*
1.4	*Non-functional Requirements*

The section should be brief – no more than six A4 pages. The production of this section is a major task undertaken in the initial stage of the project. The section is a deliverable for the first assessment (D1).

2. User Task Analysis

This contains one sub-section:

2.1	*User Interface Specifications*

A brief specification of the user interface which may be refined during the course of the project. The section is a documentation deliverable (D2).

3. System Architecture

This contains two sub-sections:

3.1	*Overview*
3.2	*Interface Specifications*

A description of the hardware/software architectures of the proposed system, together with their interface specifications. The section is a documentation deliverable (D2).

4. Test Plan

There are two sub-sections:

4.1	*Module Tests*
4.2	*Integration Plan*

Whereas this section is not required as a deliverable until fairly late in the project (D3), the initial test plan must be developed at an early stage in the design cycle.

5. Software Design

There are five sub-sections, which refer to the individual software modules identified in the system:

5.1	*Structured Analysis*
5.2	*Data Structure Design*
5.3	*Dialogue Design*
5.4	*Structured Design*
5.5	*Test Specification*

This *structured analysis* and *data structure design* sub-sections are required as deliverables for each software module at the second documentation assessment (D2). The remaining sub-sections for each

module are deliverables at the final documentation assessment (D4) – with intermediate checks being made at D3.

6. Hardware Design

There are five sub-sections, which refer to the individual hardware modules identified in the system:

6.1   Design Analysis
6.2   Interface Specification
6.3   Detailed Schematics
6.4   Components and Assembly
6.5   Test Specification

This *design analysis*, *interface specification* and *detailed schematics* sub-sections are required as deliverables for each hardware module at the second documentation assessment (D2). The remaining sub-sections for each module are deliverables at the final documentation assessment (D4) – with intermediate checks being made at D3.

7. Next Phase Design Proposals

For most projects, the system produced will be a prototype or evaluation system. These systems must, however, be driven by an identifiable, final marketable product. This section should propose the design steps which are necessary for the next – or final – phases of the product development and included in the final documentation assessment (D4).

Appendix 1 : Project Planning and Management

All project management documentation is contained in this appendix - including Gantt charts, minutes of group meetings, financial accounts, etc.

Appendix B

Project Documentation:
Individual Progress Report

The individual progress report is a confidential report submitted by each student in a project team. The report should comment on what the student perceives as being their contribution to the progress, or otherwise, of the project – plus any pertinent observations.

Reports should be submitted prior to each formal documentation review (D1 to D4).   Forms will be distributed for this purpose, but additional sheets may be attached if desired.

The report should consider the following aspects:
- A retrospective view of the project from a *technical* viewpoint.
- A retrospective view of the project from a *management* viewpoint.
- A retrospective view of the project from a *team issues* viewpoint.
- A summary of the individual's role in the project.
- Assessment of the individual's contribution to the project. Any differences between this assessment and the project group assessment should be highlighted.
- Comments on how the individual's performance could have been improved.

Appendix C

The Roles of the Directors

Project Directors
1. Meet with the students on each project day in order to review objectives and advise on forward planning.
2. Provide technical, managerial and logistical support for a project.
3. Maintain control of the project budget and support the purchasing needs of the group.
4. Responsible for resolving personnel difficulties within the group.
5. Responsible for liaison with the sponsors of the project.
6. Produce the individual assessment marks for each student. These marks are determined by performance against targets, quality of deliverables and contribution to the group activity. This is a continuous assessment mark.
7. Generate the group project marks at each assessment point.
8. Ensure that the documentation deliverable meetings are held on time.
9. Provide an input to the marks for the project Demonstration, DE1.
10. Provide an input to the marks for the Review Session R1.

Independent Directors
1. Provide a degree of moderation between projects.
2. Award marks for the project Formal presentations, P1 and P2.
3. Provide an input to the marks for the project Demonstration, DE1.
4. Provide an input to the marks for the Review Session R1.

Fourth Year Project Tutor (Chief Executive)
1. Publicises the project scheme.
2. Approaches companies to obtain projects.
3. Adjudicates on project proposals.
4. Assigns students to project groups.
5. Convenes meetings of the Board of Directors.
6. Organises the project presentation days (P1) (P2), the mid-term review (R1), and the kick-off event.
7. Collates the project assessments.
8. Liaises with external assessors.
9. Responsible for overall management of the projects.