

A Bias-Neutral Approach to Major Project Assessment in Mechanical Engineering

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Abstract

All engineering students completing the final year of manufacturing and mechanical engineering at Swinburne University of Technology (SUT) must undertake a comprehensive final year project. The project may encompass many areas of design, analysis, research, development or management. Often the projects integrate a number of these aspects. It is often the assessment of the project, not the pursuit of it by the student that presents difficulties for the academic faculty. In the past, techniques of assessing the project have proved difficult, particularly where the faculty supervisor has control over the execution of the project and has some positive or negative bias towards either the student or their project. This bias is often introduced in the final assessment, making it difficult to compare and quantify the final results of a cohort of projects resulting from many different supervisors. In an attempt to make the assessment process bias-neutral a comprehensive set of criteria have been introduced; in all seven steps are involved in the assessment procedure, only one of which is dependent on the supervisors, thus reducing their influence on the final grade. The assessment is classified according to the quality of the work (two assessments), a formal verbal presentation (two additional assessments), a large poster display (two further independent assessments) and a project performance assessment by the students' supervisor (the only direct influence by the supervisor).

The results of this assessment procedure have produced a "bell curve" series of grades or results, whereas in previous years a skew towards one end of a bell curve was usually obtained. This has been shown to be bias-free with regards to high or low grades and was a reflection of students; grades in other subjects. Overall, there seems to be satisfaction by both faculty members and the student cohort in the final grades achieved

1. Introduction

All engineering students completing the final year of manufacturing and mechanical engineering at Swinburne University of technology (SUT) must undertake a comprehensive final year project. The project may encompass many areas of design, analysis, research, development or management. Often the projects integrate a number of these aspects. These

requirements constitute 25% of the overall final semester assessment. The students are encouraged to tackle real problems to which they can contribute solutions and to develop personal values including a respect for the thoughts and methods of others as well as the rules of the physical universe as exemplified by their involvement in major final year projects. Either industrial sponsors or academic supervisors or both define or suggest the theme of the project. The recognition and incorporation of major projects in the final year of an engineering course have recently been implemented in universities like those at the Universities of Aachen¹ and Uppsala², Greenwich³ and Nanyang, Singapore⁴ and many universities in the USA and Australia.

It is often the assessment of the project, not the pursuit of it by the student that presents difficulties for the academic faculty. In the past, techniques of assessing the project have proved troublesome, particularly where the faculty supervisor has control over the execution of the project and has some positive or negative bias towards either the student or their project. This bias is often introduced in the final assessment, making it difficult to compare and quantify the final results of a cohort of projects resulting from many different supervisors⁵. The integrity of the academic process requires fair and impartial evaluations and honest academic conduct on the part of the faculty staff and the student. In engineering design (similar to the requirements of design in mechanical engineering) it was also perceived to be an assessment task which was difficult⁶. This assessment was entirely based on oral (20%) and written presentations (60%) with 'client' (student performance during the project) contributing 20%. Thereby resulting in a balance amongst marks awarded for presentations, performance and written work.

The awarding of marks were based on set criteria(e.g. "poor, fair, good, very good and perfect") using a different approach, but recognising the difficulties of awarding grades, a systemic approach to assessing final year projects was implemented for an electrical engineering course⁷. This was a computerized management system for the processing of final year projects involved an automated processing of marks. The marks were calculated by a "weighted linear conversion" procedure. The results showed a consistent approach to a standard marking scheme. However, little importance was attached to the oral presentation (5%) and there was no component attached to a poster assessment. The majority of mechanical engineers have to give oral presentations to a variety of personnel in industry as well as providing a summary of their work through posters (wall charts or simple presentations). The present paper discusses a comprehensive approach to project implementation and appraisal which incorporates a variety of assessment tasks as well as a diversity of student assessable requirements.

2. Assessment scheme for final year projects

In an attempt to make the assessment process bias-neutral a comprehensive set of criteria have been introduced; in all seven steps are involved in the assessment procedure, only one of which is dependent on the supervisor, reducing their influence on the final grade. The assessment is classified according to the quality of the work (two assessments), a formal verbal presentation (two additional assessments)⁸; a large poster display (two further independent assessments) and a project performance assessment by the students' supervisor

(the only direct influence by the supervisor). The contribution of each section of the assessment to the overall ultimate score is given in Table 1 where it is seen that the marks are averaged over at least seven sets of scores. The overall or final assessment is calculated as follows:

$$\text{SCORE} = L + E + (C1 + C2)/2 + (P1 + P2)/2 + (T1 + T2)/2$$

Student ID	Lit. review	Performance	Report supervisor assessor 1	Report assessor 2	Poster assessor 1	Poster assessor 2	Talk assessor 1	Talk assessor 2	Total
12345	10	10	50	50	15	15	15	15	100
CODE	L	E	C1	C2	P1	P2	T1	T2	SCORE

Table 1. Detailed breakdown of mark allocation where SCORE is the total or overall score

3. Organisation of Major Project Assessment

All projects are organised for completion by groups of two students. In exceptional circumstances, either groups of three students or an individual student undertaking the project.

1999 SEMESTER2, MAJOR PROJECT EXAMINER'S MARK SHEET

Examiner _____ DATE _____

Candidate(s) _____

Please give a score for each criterion. Other intermediate marks are acceptable.

Report Item	Possible Mark	Actual Mark
Do the abstract and introduction clearly and concisely outline the nature and scope of the project?	5	
Was the literature survey or survey of "prior art" critical and appropriate for the project?	5	
Were the methods of investigation adequately explained?	5	
Were the results clearly presented and logically ordered?	5	
Were the results adequately analysed and critically evaluated?	5	
Was there a balance between the introductory, results and conclusion components of the report?	5	
Did the candidate appear to understand clearly the area of study and significance of the results?	5	
Were the appropriate conclusions drawn and did they relate to the objectives of the investigation?	5	
Was the report presented in a professional manner?	10	
TOTAL	50	

Student Performance and literature review (only to be filled in by the Supervisor):

Item	Possible	Actual
Student performance during the project	10	
Initial literature review or "survey of prior art" - a critical analysis of the area including timeline/project plan	10	
TOTAL	20	

Figure 1a. Marking criteria based on report structure and content.

CHECKLIST FOR ASSESSING A PROJECT REPORT

Introduction and Problem Statement
 Is the problem stated both in a general and in a specific way?
 Is the purpose of the study stated?
 Are the questions or hypotheses stated?
 Does the reader get a general view of both the rationale for the investigation and its relationship to a theoretical background?
 Is the beginning fairly broad and does the section narrow to a focus at the end? Is there a transition to the next section?

Review of the Literature
 Does it show thorough knowledge of the research, theory, concepts, ideology, and opinion related to the topic?
 Is the reader made aware that the review has been selective and are the criteria for selection and relevance explained?
 Is there any critical assessment of the reviewed literature?
 Does the review reveal the relation between what has previously been done by others and what is proposed in the current study?
 Are suitable headings used to help the reader sort out the sections of the review? Is each section summarised?
 Are transitions provided from one section to another?

Method or Procedure
 Does it explain what was done to gather the information essential to the investigation?
 Would it be possible for another person to gather data and analyse it exactly in this study?
 If human subjects are used, are they adequately protected? (may apply for ergonomic or biomedical projects)
 Are the variables in the study identified and described?
 If controls are used, are they explained in sufficient detail?
 If materials or apparatus are involved, are they described, illustrated, and their history and usefulness indicated?
 Is the setting of the study specified?
 If any directions or explanations are given to subjects by the investigator in the course of the study, are they explained?

Results and Discussions
 Are the meaning and importance of the results indicated?
 Are alternative explanations for the findings identified and discussed?
 Does the reader learn how information in raw form was summarised? Descriptive statistics? Content analysis?
 Do tables contain all essential information so they can be read without references to the text?
 Does each table stand on its own, clear and self-explanatory?
 Do figures contain all essential information so they can be read without references to the text?
 Does each figure stand on its own, clear and self-explanatory?
 Are results grouped in relation to questions or hypotheses?
 Are incidental findings not immediately related to the questions or hypotheses reported?
 Are there unforeseen results?
 Is redundancy eliminated or minimised?
 Is this section free of interpretations of results?

Conclusions
 Are conclusions drawn about each question or hypothesis?
 Are the limitations on conclusions specified?
 Does the reader learn how successful the investigation was and what further study might be needed on the topic?

Figure 1b. Marking sheet details for the report structure and content.

This would occur where the project brief is very large for three students or where the student is working part-time and it would be difficult to organise additional partners (single student). The marking scheme does not take into account the number of students attempting a project, but merely the situation that one project is being investigated requiring one overall report. Because one assessment is developed for the overall report, the project partners attempt to achieve excellence in their work-they are dependent on each other to achieve a good assessment.

They learn to work in groups and interact with each other. They learn both dependence and independence in of their work (written, oral and display). Two copies of each report are collected from each student or group of students. The reports are given to the student's supervisor, and an independent assessor who may not be familiar with the thesis subject but is allocating marks based on strict criteria of report structure and content, as outlined in Figures 1a and 1b. What is important is not only the students' understanding of their work, but also their comprehension of report structure and cohesion in developing a thesis topic which is able to be easily understood and reported upon.

4. Introductory Assessment and Performance

The only section of the assessment which is dependent on the supervisor, is the general performance during the conduct of the work and the initial literature review or survey of prior art (although this is further assessed within the overall written report presentation). These constitute only 20 percent of the overall assessment, reducing the supervisor influence considerably (both in a positive and negative sense).

5. Oral Presentation Assessment

The presentation of the students' work is organised into the format of a conference. Two faculty members are present as chair and co-chair, as well as the assessors for those presentations during their session. Neither of these is the project supervisor. An abstract booklet is produced to highlight the individual projects. All presentations are allocated twenty minutes and all participants of the project must take part in the presentation – their assessment mark is dependent on their involvement. There are nominally four presentations in one session. There are four sessions per day, resulting in 16 presentations. There can be up to forty presentations with a large cohort of students. It is, however, usual to have approximately thirty presentations. All students are required to be present for at least the half day in which their project is scheduled. Supervisors are present as well as invited members of the academic community together with industrial visitors who may have sponsored the projects.

The oral presentations are assessed in a different manner to the written presentations. There are no prescriptions for marks, there is an overall mark required (averaged over the two independent assessors); however, they are required to take a number of factors into account as detailed in the guidelines for oral presentations, shown in Figure 2.

**School of Engineering and Science Major Project
Oral and Poster Presentation Assessor's Mark Sheet**

Assessor _____

Candidate(s) _____

	Possible mark	Actual Mark
Oral Report Assessment	15	
Poster quality	15	

***Points to consider in the assessment**

- Was the candidate's presentation clear and audible?
- Did the candidate address the audience, avoid reading and distracting mannerisms?
- Did the candidate express enthusiasm for the topic and engender your interest?
- Were visual aids clear and helpful?
- Were the overheads/computer presentations easy to understand?
- Did the presenter(s) give an overview or summary of the project?
- Did the candidate keep to time whilst presenting material at a comprehensible rate?
- Did the candidate answer questions clearly and knowledgeably?
- Was the paper professionally presented?
- Was the candidate's poster clear and informative?
- Was the poster easy to understand?
- Did the poster give an overview or summary of the project?

ANY OTHER COMMENTS?

Figure 2. Criteria for oral and poster presentations

6. Poster Presentation Assessment

The poster presentations are also assessed in a different manner to either the written or oral presentations. Again there are no prescriptions for marks, with an overall mark required. Moreover, all the poster presentations are displayed together in one central area. Up to four faculty members spend time to determine which are the best projects, and which are the worst – allocated full marks and half marks respectively. The remainder of the projects is classified within those two upper and lower limits. It has been found from experience that a comparative assessment was the only way to allocate reasonable marks. Because of the variation in quality of presentation, it is suggested that if a poster is submitted for assessment it is initially allocated half marks, and then scaled according to its relative merits, again a subjective assessment. However, the assessors are required to take a number of factors into account as detailed in the guidelines for poster presentations, shown in Figure 3.

All the students are required to be present for the whole day. Refreshments are available and various members of staff, students and industrial guests are able to discuss the work performed by the students. Additional criteria for each section described in the assessment requirements were distributed to all staff and students and are given in Figure 2.

7. Assessment Results

A correlation of the marks by the external assessors for the oral presentations and the posters resulted in a correlation coefficient of between 0.8 and 1. However, the largest discrepancy occurred between the two assessors for the major written report. Shown in Figure 3 are the

results of the analysis, with a correlation coefficient of approximately 0.5. As shown on the graph, there is a large scatter of results, again indicating an inconsistency in allocating marks which may also be interpreted as a form of bias on the part of one of the assessors.

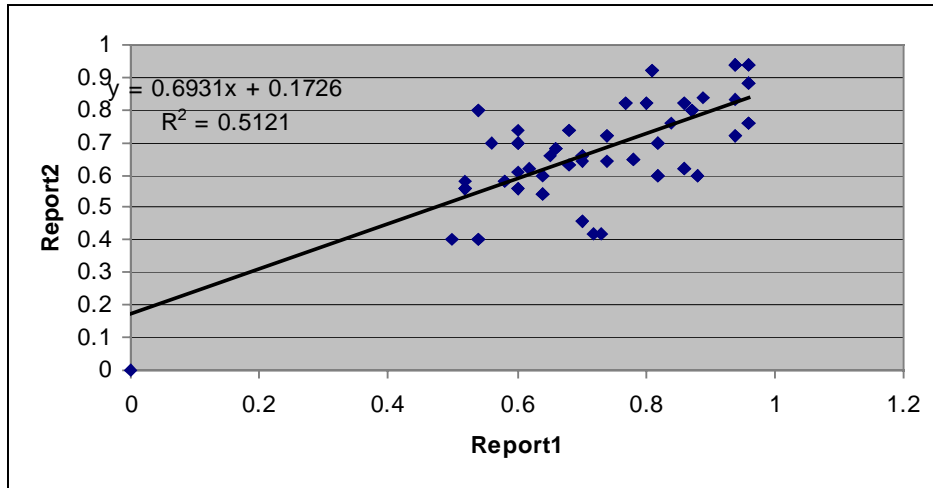


Figure 3. Correlation of assessor 1 (supervisor) and assessor 2 written report scores.

The results of a statistical analysis of the form of marks allocated by the different marking procedures are shown in Figures 4(a,b,c and d).. Figure 4a represents the distribution of marks given by the student’s own supervisor for the major written report. It can be seen that all that there is a uniform trend and well balanced distribution of marks. With the majority being over 70%.

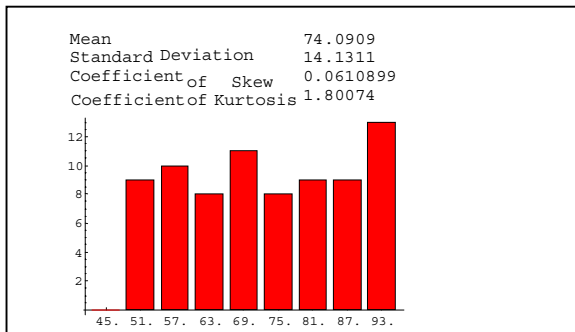


Figure 4a. distribution of marks given by the student’s own supervisor

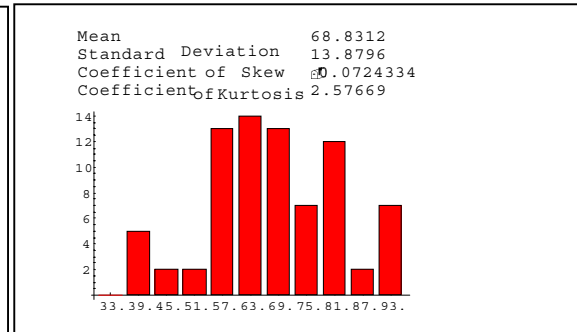


Figure 4b. second assessor’s mark

However, when the second assessor’s marks are examined, Figure 4b, it can be seen that there is now a greater distribution of marks towards the middle range and less towards the outer extremes, resulting in a form of a bell curve with outliers, the best and the worst. This suggests that the assessment by report alone is moderated by the second assessor, who often has little or no knowledge of the students involved with the project.

Assessment of the oral presentations by two independent assessors produced the distribution of marks as shown in Figure 4c. Here it is seen that indeed the traditional bell-type curve of data is obtained (with the exception of one outlier-a student who did not present). The range of marks was between 55% and 95%. A similar distribution was obtained for the poster assessment, Figure 4d.

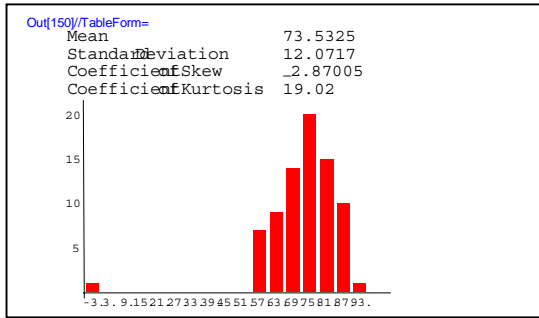


Figure 4c. Distribution of marks for the oral presentation.

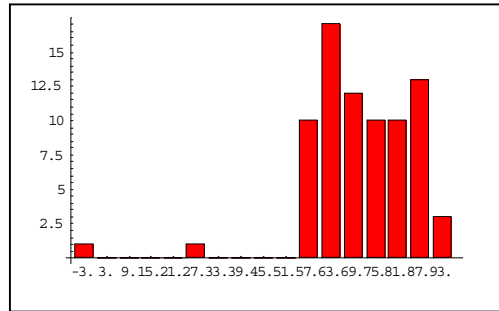


Figure 4d. Distribution of marks for the posters

When all the marks were assembled, the distribution again followed a normal distribution with some outliers (inconsistent work or outstanding work), Figure 5. The results of this assessment procedure have produced a “bell curve” series of grades or results, whereas in previous years a skew towards one end of a bell curve or a flat trend was usually obtained.

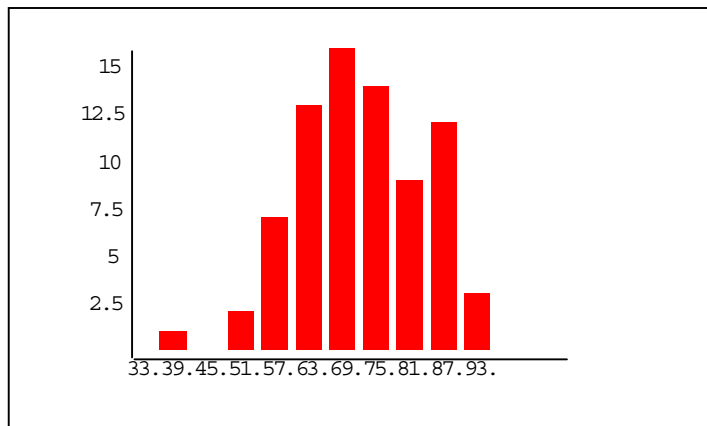


Figure 5. Overall distribution of final scores for the major project incorporating all the assessments.

This has shown to be bias-free with regards to high or low grades and was a reflection of student’s grades in other subjects. It has been found that students who perform well in the final year major project tend to perform well in their other subjects. In particular, when students present for job interviews, it is their major report which shows the employers their well developed writing skills.

It is their verbal skills which were honed to a fine point through their oral presentations and allowed for successful interview performance

Closing Remarks

The incorporation of seven assessment procedures has resulted in a normal distribution of results. The bias attained by reliance on one assessor has been removed from the assessment process. Overall, there seems to be satisfaction by both faculty members and the student cohort of the final grades achieved.

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