



2011

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Kevin Delaney

*Dublin Institute of Technology, [kevin.delaney@dit.ie](mailto:kevin.delaney@dit.ie)*

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## Recommended Citation

Delaney, K.:Evaluating "Independent" Assessment of Capstone Projects by Mechanical Engineering Students in DIT. Proceedings of Edulearn 2011, Barcelona (Spain) 4th-6th July 2011.

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# EVALUATING “INDEPENDENT” ASSESSMENT OF CAPSTONE PROJECTS BY MECHANICAL ENGINEERING STUDENTS IN DIT

**Kevin D. Delaney**

*Department of Mechanical Engineering, Dublin Institute of Technology, Bolton Street  
(IRELAND)  
kevin.delaney@dit.ie*

## **Abstract**

Capstone projects by mechanical engineering students in Dublin Institute of Technology (DIT) are designed for students to showcase their skills and technical knowledge. To successfully complete capstone projects, students must typically demonstrate skills of project planning, time management, negotiation, component sourcing and an awareness of the multi-disciplinary nature of engineering in addition to the application of technical knowledge. A key element is that students explain and justify their work before a panel of technical experts.

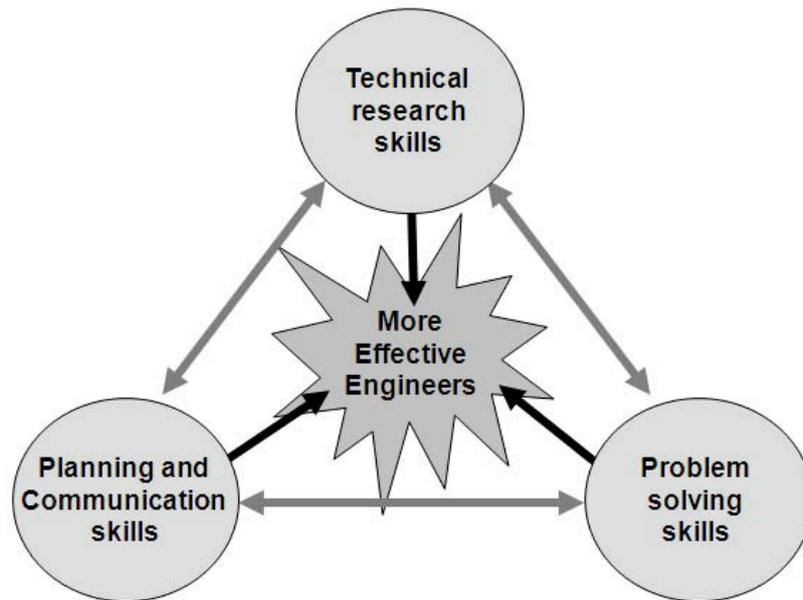
The Mechanical Engineering Department at DIT introduced “independent” assessment for student presentations on a pilot basis for the Bachelor of Engineering technology students in 2010. Under this system, assessors of a particular project are not ordinarily involved with teaching or mentoring the student, or with any other part of that student’s project, on a day to day basis. Consequently, assessors are unaware of specific project details in advance of the assessment session and they must rely on the student to describe and defend the project and the approach taken. More specifically, the student’s supervisor does not attend the sessions at which students present their work. This approach is closer to the post-college environment in which most engineers work and therefore simulates workplace experiences for students.

A review has recently been conducted to evaluate the process from the perspective of both students and staff with a view to determining whether or not this structure should be continued with. This paper documents the rationale behind the concept, the logistical challenges, and an analysis of the feedback received from both students and staff as part of the review. In addition, future plans to improve the fairness, consistency and transparency of the assessment process for such projects are outlined.

Keywords: Capstone project assessment, independent assessment.

## **1 INTRODUCTION**

Capstone projects are completed by final year Bachelor of Engineering Technology students in the Mechanical Engineering Department of Dublin Institute of Technology (DIT) to give them an opportunity to work on a “real life” project. These projects help learners make connections between classroom experiences and real world engineering practice. In order to successfully complete the projects students must apply technical knowledge, and demonstrate skills of project planning, time management, negotiation, component sourcing and an awareness of the multi-disciplinary nature of engineering. The importance for engineers to develop such skills has been highlighted by several authors such as Kamm [1]. These skills also feature on the list of programme outcomes expected of level 7 graduates laid down by Engineers Ireland and used when accrediting engineering programmes [2]. As illustrated in Figure 1 it is through the appropriate combination of such skills that students are expected to become more effective engineers when they graduate and enter the workforce.



*Figure 1: How engineers' technical knowledge must be underpinned by other non-technical skills to make the engineers more effective*

Capstone projects undertaken by the DIT mechanical engineering students can be broadly categorized as design and make, design only, and investigative and/or software-based projects. Regardless of which project category the students take on, the projects motivate students to synthesize and apply knowledge that they have accumulated through their courses. The module learning outcomes, as outlined in the module descriptor, are listed in Figure 2.

**Learning Outcomes:** On completion of this module, students will be able to:

1. Analyse, schedule and resource engineering tasks at senior technician / junior engineer level.
2. Independently research an engineering topic
3. Design experiments and carry out tests where necessary
4. Analyse engineering data
5. Apply technical and scientific knowledge to an engineering task
6. Choose between technical alternatives
7. Communicate technical results, information and conclusions to others by means of formal presentations, drawings and reports

*Figure 2: Learning outcomes for the Final Year Project module.*

The capstone projects for this class group are completed during a single academic year. During the first week of the academic year students are assigned a project supervisor/mentor and are expected to meet him/her for at least 30 minutes per week. A small number of marks are allocated to ongoing progress which the students demonstrate each week. Most marks are awarded when students are assessed by means of formal assessments by internal staff panels, a poster presentation and a completed project dissertation. Such variation of assessment methods is quite common when looking at capstone projects in an international context [3]. An overview of the assessment review sessions and their sequencing for 2010-2011 is presented in Figure 3.

The academic year in DIT is semesterised. Each semester has 12 teaching weeks and an additional review week approximately half-way through the semester which is used for formative assessments, additional tutorials, etc. Project assessment 2 has previously been scheduled for the first week of the second semester. It was envisaged that students would have a full week after their written examinations during which they could devote all their time to their projects.

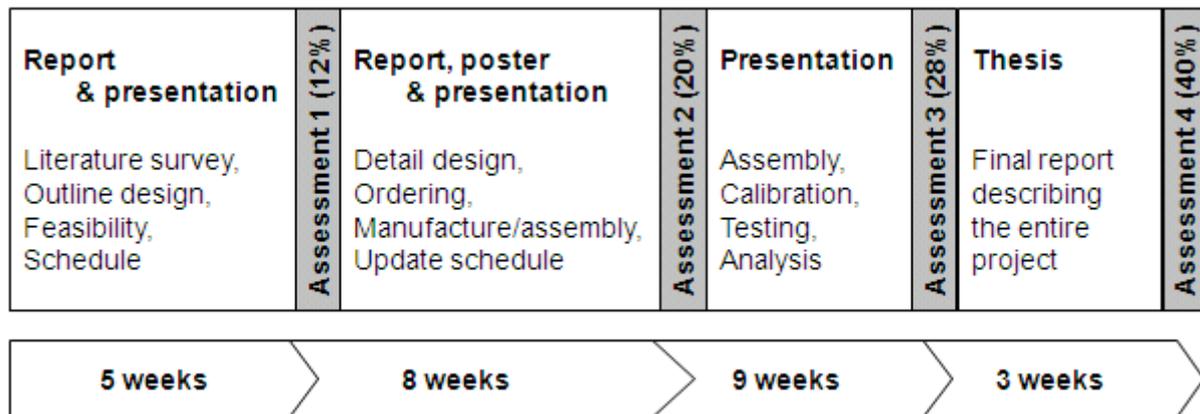


Figure 3: Assessment deliverables, generalised list of tasks, the number of weeks between assessment sessions and the marks allocation (for the 2010-2011 academic year).

One learning outcome of the project module is that students be able to communicate technical results, information and conclusions to others by means of formal presentations, drawings and reports. A key element stressed during review milestones is that students be able to explain and justify their work before a panel of technical experts. In previous years students presented their work in front of their own supervisor, two other supervisors and also a group of about ten of their peers. Presenting to peers gives students an opportunity to benchmark their own projects and progress and is an important element of the assessment approach followed over several years. Assessment panels are arranged, where possible, to ensure that staff members with several years experience of supervising and assessing students are on panels with less experienced staff members.

After the 2009-2010 academic year project supervisors raised concerns that some students were overly-reliant on their own supervisors to address and clarify issues raised during the questions and answers phase of the assessment process. Other staff commented that they would like the opportunity to see a broader range of students' projects in addition to the students they were mentoring. To address these issues the final year project committee for the Bachelor of Engineering Technology students implemented changes. On a pilot basis a system of "independent" assessment was introduced for the first two assessment sessions of the academic year 2010-2011.

It is important to clearly define what is meant by the term "independent" assessment. Under the system piloted in DIT assessors are not ordinarily involved with teaching or mentoring the student, or with any other part of the project they are assessing, on a day to day basis. Consequently, the assessors are unaware of the project details in advance of the assessment session and rely on the student to describe and defend the project and the approach taken. More specifically, in the format that was piloted the student's supervisor does not attend the sessions at which students present their work. This approach is closer to the post-college environment in which most engineers will have to work and therefore gives them simulated workplace experiences.

This paper summarises an evaluation of the process from the perspective of both students and staff with a view to determining whether or not this initiative should be continued. Section 2 documents the rationale behind the concept and section 3 details the challenges of implementing it. Section 4 explains the need for a review and summarises the feedback received as part of the review. Section 5 describes future plans to improve the fairness, consistency and transparency of the assessment process for such projects and section 6 presents concluding remarks.

## 2 RATIONALE BEHIND THE CONCEPT OF "INDEPENDENT" ASSESSMENT

To be successful with the presentation component of assessment sessions students must clearly describe their project to a technical audience which has no prior knowledge of the project. This encourages students to be clear and concise about their project and resembles how graduate engineers present their work to clients or senior management in an industrial environment. Such simulated industrial experiences are comparable to the "approximations of practice" described by Grossman et al [4] in other areas of professional education.

According to Grossman et al “such experiences are designed to focus students’ attention on key aspects of practice that may be difficult for novices but are second nature to more experienced practitioners” [4]. It is clear that these are “approximations” of practice and the benefit for the students is that the assessment sessions are designed to give them the opportunity to experience sitting in front of an unknown panel. However, contrary to what graduates might experience in industry, the panels are not “hostile”. Academic staff members assess the students in a structured and supportive manner.

The concept of independent assessment is also commonly used in manufacturing companies where independent or “blind” assessors, often from outside the company itself, are engaged to assess products based on specific criteria.

It is important to distinguish the form of “independent” assessment defined in this paper to the concept of “blind marking” where the assessors are unaware of the identity of the person being assessed. The usefulness of the latter was questioned by Brown [5] who wrote that “Double blind marking doubles the administrative and assessment load yet evidence from studies at secondary level (e.g. Murphy [6]; Newton [7]) indicate that it is no more reliable than single marking and moderating based on borderline and central samples for each grade”.

The introduction of independent assessment for the initial assessment sessions has several potential benefits for the project students, the academic staff involved and for industry despite the logistical challenges for the staff involved. For convenience Table 1 summarises these benefits. Students benefit by receiving opinions and feedback from additional staff members. Several students reported finding this formative feedback to be advantageous. Such feedback is particularly useful in situations where staff members without supervising experience are mentoring students.

<b>Potential benefits of “independent” assessment</b>		
<b>For students</b>	<b>For lecturers and DIT</b>	<b>For Industry</b>
Increased understanding of their projects.	Lecturers see a greater range of projects.	Improved communication skills of graduate engineers.
Students can get feedback and advice from a larger pool of lecturers.	Particularly beneficial for staff new to supervising students on this programme.	Graduates have an ability to present in front of a full group of strangers.
Increased ability to explain their projects in detail.		
Increased confidence.		

*Table 1: A summary of the key benefits of “independent” assessment.*

In addition to the benefits listed in Table 1 there are also risks of this approach. A specific risk of this approach is that students may twist the facts and may be inclined to say things such as “my supervisor told me to do....” or “we couldn’t do that because...”. During the after-assessment review sessions by staff concerns were raised about a small number of such situations. Other potential risks/disadvantages of the approach are listed in Table 2.

<b>Potential risks/disadvantages of “independent” assessment</b>		
<b>For students</b>	<b>For lecturers and DIT</b>	<b>For Industry</b>
Students do not get feedback about their presentation directly from their own supervisors.	Lecturers do not see their own students presenting their work for the first two assessment sessions.	
Increased self-pressure.	Increased workload for staff.	

*Table 2: A summary of the key risks/disadvantages of “independent” assessment.*

### **3 IMPLEMENTATION OF THIS ASSESSMENT CONCEPT**

Students are expected to submit their presentation and report files by 9am on the Monday of the week during which the assessment sessions have been scheduled (students make their presentations on Wednesday afternoons). The files are submitted through “webcourses”, course management software in use throughout DIT. Receiving files two days before the presentation date gives staff an opportunity to review the content of the student’s reports before the presentation. It also gives students experience of meeting deadlines and time to practice their presentations.

Assessment panel members propose and review marks as a group before an agreed mark for the presentation and report is returned to the project co-ordinator. Separately supervisors read their own students’ reports and also submit a mark to the project co-ordinator. The average of these marks is recorded for the students. Where there is a significant difference between these two marks an additional assessor is assigned to review the report of the student concerned (without knowing the marks given by the previous assessors) and provide a neutral, deciding, opinion.

The most important feature for students, particularly for the first assessment, is the formative feedback that they receive from the assessment panel. Sample feedback from 2010-2011 advised students to restrict the broadness of their projects, refocus the direction of their projects and to research specific literature. Other students were advised about the existence of specific equipment, previous projects and the research interests of specific staff who may be able to help and advise them in more detail. Sometimes this feedback is given to the students directly during the question and answer sessions following their presentation. In addition a formal record of the feedback for the student’s presentation and report is retained and given to the students’ supervisor after the assessment session.

### **4 THE NEED FOR A SURVEY AND ITS KEY FINDINGS**

Independent marking was implemented by the programme committee on a pilot basis in 2010-2011 with the expectation that it would be reviewed after the first year to decide on whether or not it should be continued. The objective of this research was to investigate the opinions of students and staff regarding their experiences of the process.

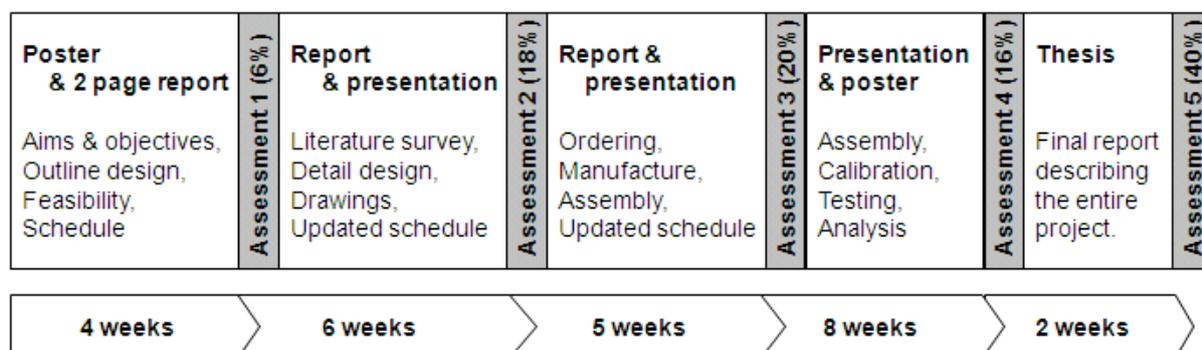
DIT quality assurance procedures require that students complete a student survey questionnaire (Q6A forms) each year. This is a standard list of questions covering details of the module such as the effectiveness and communication of the lecturer, organisation and management, assessment and feedback, academic support, learning resources and general evaluation and suggestions. While useful for more general feedback it was felt that this general form did not solicit answers which would be useful in reviewing specifics of the assessment process piloted. Accordingly another survey was prepared with questions which were specific to the implementation and assessment of the projects.

All students registered to engage in the capstone projects for 2010-2011 were asked to complete a questionnaire. Forty three out of a total class of sixty one (70%) students responded. The questions probed several aspects of the programme and including their name was optional for the students. Many of the responses will be used in course development to ensure that the courses help students develop the skills needed to successfully complete such capstone projects. Responses reported here relate only to the review of the independent assessment concept trialled during the 2010-2011 academic year.

1. 60% of students expressed a preference that their supervisors be present at all assessments.
2. About 25% of the students expressed an opinion that it was a benefit that their supervisor was not present at the first two assessment sessions. (citing reasons that they received better/varied opinions which helped their projects and the opportunity to improve their communication skills).
3. About 70% of the students felt that having their supervisor present at the third assessment was beneficial. Students stated that this was so that their supervisor “knew how much work they had done”.
4. Three students stated that they wanted to know their actual results and that knowing their score was more important than the formative feedback and advice that they received. One student felt that they could have received “better” feedback with no additional explanation.
5. Over 90% of the students stated that the assessment process, specifically the questions asked of each student after their presentations and the overall handling of the assessment process, was fair and consistent.
6. A majority of staff commented that supervisors should be present for the second and subsequent assessments in future.
7. Approximately a fifth of the students suggested that they would like to have their final presentation after their thesis submission. Over half of the students stated that they got feedback from the third assessment presentation which helped them to optimise their thesis in terms of content and structure. It is also noted that the exact timing of the latter assessments are dependent upon the timing of Easter each year. The time delay between the third assessment presentation and submission of the final thesis was longer than usual in 2010-2011.
8. In a surprising development several students suggested that there should be an additional assessment between the first and second assessments. The reason given was that the gap between these assessments was excessively long. Students reported finding it difficult to maintain focus on and enthusiasm for their projects with other assignments and more pressing deadlines competing for their attention.

## 5 ACTIONS ARISING FROM THIS REVIEW

In response to the students’ comments regarding assessment sequencing, the project committee are proposing to change the sequencing of the assessments for the next academic year. A summary of the proposed changes is shown in Figure 4.



*Figure 4: Assessment deliverables, generalised list of tasks, the number of weeks between assessment sessions and the marks allocation (proposed for the 2011-2012 academic year).*

In addition the committee is considering the potential that students should do preliminary research on their chosen project area during second year. The benefit of such an approach is that students could then “hit the ground running” and be able to make more substantial progress with their projects.

Several training sessions such as using library resources and health and safety are already organised for project students by the project committee. For 2011-2012 additional formal sessions regarding

project report writing and project planning will be introduced to help students revise and apply what they have learnt in previous years.

Students also commented on experiencing difficulties in accessing resources to actually manufacture the components for their projects. Part of this problem can be traced to excessive numbers of students arriving into the workshops with their completed drawings at the same time. It is hoped that the modified timing of assessments, particularly having assessment 2 towards the end of semester 1, will help students to focus on having their drawings prepared more promptly and help to stabilise the demands on workshop resources. This is also an important learning experience for students.

A number of students complained that having to submit files at 9am on Monday morning was not appropriate. The project committee has endeavoured to accommodate all students even those without internet access at home by having the submission deadline at a time that students can access the DIT campus buildings. A significant number of files were submitted in the middle of the night so in future students will be asked to submit their files by 5pm on the Saturday before their presentations.

## 6 CONCLUDING REMARKS

“Independent” assessment was implemented and trialled on a pilot basis for the first two capstone project assessments in 2010-2011. To evaluate the effectiveness of this trial a structured review of the process was conducted. As part of this each student submitting a project was asked to complete a survey. The vast majority of students who responded reported that they had received useful and constructive feedback from their assessment teams. Staff members also commented that their students benefitted from the comments and fresh perspective of the “independent” assessment teams. Students responded that they felt the assessment process is fair and consistent for all students.

Acting directly on the proposals of current students changes are already planned for the next academic year and are close to receiving final approval from the relevant authorities in DIT. Even with such changes it is likely that continuous refinement will be needed as the project assessment team strives to improve the fairness, consistency and transparency of the assessment process for all students.

Evaluating this specific capstone or “final year” project module in isolation from the overall engineering program is difficult since (1) it is difficult for employers to relate skills development to specific modules, (2) students’ lack of experience of alternative learning methods may affect student objectivity in conducting a student evaluation and (3) the absence of a control group may affect the interpretation of any results obtained. How such a formal evaluation may be performed is under consideration.

It is hoped that this experience of capstone project assessment in DIT may be beneficial for those involved in assessing such projects both within DIT and also in other institutions.

## ACKNOWLEDGEMENTS

Thanks to the students and supervisors involved with the capstone projects this year. A special thanks to the Department of Mechanical Engineering for the support and opportunity to simulate industrial experience for our students and to the (Learning Teaching and Technology Centre) LTTC for the advice and encouragement to pursue such improvements.

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