

THE WARMAN STUDENT DESIGN COMPETITION: ELEVEN YEARS ON

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SUMMARY

The Warman Student Design Competition is now in its eleventh year. During this time, it has become an important event on the engineering calendar. Surveys of participating students at UNSW in 1991 and 1993 found strong support for the competition, together with many perceived learning benefits derived from the project. Over the years, students' general attitudes have changed perceptively. However, a survey of the students at all campuses who participated in the Competition in 1997 shows their support and enthusiasm continuing at the same levels as in earlier surveys. As a result, it is strongly recommended that the Competition should be continued in its present form.

INTRODUCTION

Design-and-build projects as part of an undergraduate engineering course have been in use in Australian universities for more than thirty years, and a number of investigations into the learning benefits which they bring have been reported [1,2,3,4,5]. The Warman Student Design Competition falls squarely into the design-and-build category, with a number of innovations distinguishing it from earlier forms of design-and-build projects. Now in its tenth year, the Warman Competition is open to second-year students in

mechanical-engineering courses (broadly defined) in universities in Australia and New Zealand, with 20-22 campuses competing annually.

We have already reported the learning benefits gained by students competing in the Warman Competitions up to 1993 [4,5]. In closed-end questionnaires (yes/no/unable to say), we demonstrated at least 14 identifiable aspects of the design process which students believed they had gained, or improved, or had become aware of, by taking part in the competition. There were also a significant number of perceptive responses to open-ended questions which indicated the depth of learning associated with the experience.

The past few years have seen changes in the ethnic and gender mix of the undergraduate student population. Students are also under greater pressure in their courses and it seems that many more than previously now undertake ten or more hours of regular paid outside work per week. The widespread adoption of computer modelling as the medium of engineering design and communication probably occupies more course time than the courses it replaced, and has certainly not increased students' exposure to hands-on activities. The net result of the factors listed may well be a significant decrease in the time students have available for university activities, and perhaps a significant change in their overall attitude to engineering design, including their acceptance of the Warman Competition. It was for these reasons that a survey was conducted of the students who took part in the 1997 Warman Competition, using the same format and questions as used earlier. The main thrust of this paper is a comparison of student responses and attitudes in the three surveys.

THE WARMAN COMPETITION – ITS ETHOS

The set task for the competition changes year by year, so that students always face a new creative problem for which there is no established solution. Setting the scene on Planet Gondwana, where Earthling students are supposed to go on work experience, helps to break "set" thinking. The project specification is developed by the National Organiser (no mean task) and issued to the Campus Organiser at each competing campus, usually about 20 in Australia and 3-4 in New Zealand, in February each year.

Campus Organisers are responsible for the timing and running of the project on their own campus, and may relax the specifications or performance criteria slightly if considered desirable. Students normally work in groups of 2-4, giving weaker students a chance to make a contribution to the design. Each group works through the design process, including creative thinking, construction, testing, and modification, culminating in a public competition with their peers. The best group on each campus is selected to compete at the National Final.

National Finalists are flown to a central venue, usually coinciding with a major engineering conference. They are provided with reasonable accommodation and generally treated as conference delegates. The two heats of the National Finals are timed to coincide with morning and afternoon tea breaks, so that senior members of the profession can watch the event. Our sponsors have been very generous, not only in

financial support, but also in ensuring that very senior engineers are present at each National Final, acting as judges, talking to and encouraging the students, and presenting prizes at the conference dinner.

THE 1997 WARMAN PROJECT

The 1997 project, upon which the current student survey has been based, described priceless antiques in a Gondwanan museum, which were being destroyed by a radioactive gas. An available "de-ionising capsule" would neutralise the radiation if it could be placed in a precise spatial location within the museum. The only practicable entry was through a window, some distance above ground level. The capsule had to be delivered remotely on account of the radiation and it was essential for the window to be closed again after positioning the capsule. Solutions generally fell into three categories: "cranes" which swung a jib through the window, dropped the capsule (complete with a stand of the required height) at the required location, then retracted the jib; devices part of which climbed completely through the window, dropped to the floor and then moved to the specified position within the museum; and devices which attempted to throw the capsule, mounted on a self-righting base, directly into the desired position. Devices of the second type were the most successful.

STUDENT SURVEYS

The student survey form used for the present survey was identical to that given to our students at UNSW in 1991 and (except for one question) 1993. It comprised mainly closed-response questions which were derived from an earlier open-response survey at UNSW [1]. In all surveys, students were given the opportunity to make written responses to a number of key questions as well as general comments at the end.

Of about 1,000 students participating in the 1997 Competition, 318 or 32% responded to the survey, with responses from 10 campuses. At UNSW, 106 responses were received from 155 competing students (68%). The low overall response rate was partly due to the survey being conducted in 1998, some months after the 1997 competition had been completed.

RESULTS

Table 1 presents the results of the fourteen closed-end survey questions. Students were asked "Did your experience of participating in the design-and-build project result in significant learning in each of the aspects listed?". The percentages shown refer to the proportion of 'yes' responses to each item (alternative responses were 'no' and 'unable to say'). The results for the 1997 survey have been split into "UNSW campus" and "Other campuses" to allow direct comparison with the 1991 and 1993 surveys. The results from the 1997 survey show high proportions of students claiming significant learning in almost all of the 14 listed aspects of engineering design. Also, comparisons with results from the earlier 1991 and 1993 surveys indicate that there has been no diminution of the impact of the Warman design-and-build project experience on perceived learning benefits.

Table 1 Proportion of students claiming significant learning attained.

	National 1997 Warman Survey			Previous Surveys	
	All respondents	Other campuses	UNSW campus	UNSW 1991	UNSW 1993
<i>Item</i>	% Yes	% Yes	% Yes	% Yes	% Yes
How to work in a group	84	84	85	90	87
How to carry out a project	77	75	83	88	83
Importance of simple design	86	85	87	89	81
Importance of organization	74	67	87	88	80
How to translate design to product	86	84	90	79	78
How to recognize design deficiencies	65	65	66	85	77
Practical experience of design	74	71	78	85	77
Skills in problem solving	57	60	49	76	71
How to put theory into practice	58	57	59	68	69
Skills in organization	63	61	65	75	66
Importance of initial concepts and calculations	70	67	75	81	64
Estimating the time required for completing project	52	49	58	56	64
Importance of cost considerations	76	75	78	74	55
The need for a prototype	83	82	85	76	50
<i>Number of respondents</i>	<i>N = 318</i>	<i>212</i>	<i>106</i>	<i>72</i>	<i>87</i>

Following these closed questions, students were invited to make written comments on experiences which were particularly valuable in developing their understanding of the design process. Of the 153 written comments advanced, the most frequent category identified was "translating design into practice", nominated by 35 students. This was followed by "prototype development and testing" (27 students), and "teamwork and group collaboration" (21 students). The following quotations illustrate the comments volunteered by students.

"The value of a good initial concept is something I learned a lot from."

"There's a massive difference between ideas and actually realising them as a working prototype."

"The importance of testing reliability, efficiency and functions by building a prototype."

"Working with others, and accepting that your idea was probably not best; combining ideas."

A following question (Q15) sought information from students about whether their participation in the competition had resulted in any fundamental changes in their conception of 'good design'. This same question had also been asked in the 1991 and 1993 surveys at UNSW. As shown in Table 2, 52% of all respondents to the 1997 national survey answered 'yes', with 23% answering 'unsure', and 25% 'no'. The responses from UNSW students in 1997 show that the percentage answering 'yes' (62%) was marginally higher than that found in 1991 and 1993.

Out of 92 written comments advanced by students in answer to Q15, 43 cited an increased appreciation of the need for "simplicity in design", while "translating design into practice" appeared in 16 responses and the need for the chosen design concept to be "functional and workable" drew 15 comments. Some comments were:

"I now realise that if you cannot see the simplicity in a design, then it needs more work."

"The good designs are designs that work, but simple - easy to manufacture and have options for changing mechanisms or room for adjustment or improvement. It is also a design that produces constant results and lasts longer."

"Communication between members was vital and this outlined the importance of how communication leads to success or failure."

Table 2 1997 National Survey: Responses to questions on 'change in conceptions' and 'support for continuation of the Warman design-and build project': National survey 1997 and previous UNSW surveys.

	National 1997 Warman Survey			Previous Surveys	
	All respondents	Other campuses	UNSW campus	UNSW 1991	UNSW 1993
<i>Q15. Fundamental change?</i>					
Yes	52%	46%	62%	58%	48%
Unsure	23%	25%	21%	19%	29%
No	25%	29%	17%	23%	22%
<i>Q16. Support continuation?</i>					
Support	78%	76%	81%	92%	n.d.
Unsure	18%	20%	16%	8%	n.d.
Do not support	4%	4%	3%	0%	n.d.

The final question (Q16) asked students if the Warman Competition should continue as part of their course. As shown in Table 2, 78% supported its inclusion, 18% were unsure and 4% did not support it. Whilst there is still strong support for the Competition in 1997, there has been an increase since 1991 in the numbers of students expressing uncertainty. Of the 54 written responses to this question, 22 students mentioned the disproportionate time required for the project, 15 felt more course marks should be allocated to the project on their campus, and 13 criticised the time at which their campus heat was held. Only 4 students considered the cost to be excessive.

DISCUSSION

We have previously pointed out [6] that the design process requires at least four main stages: conceptualising; configuration or layout development; supporting analysis; and detailing. Since by far the greater part of engineering degree courses is devoted to analysis, one might expect students to have little difficulty with the third stage of the design process. Despite this, it is commonly found that they are unable to make the jump from a theoretically-posed analysis to an actual design situation; they need to encounter design analysis in an actual design context. The fourth activity, detailing, is extremely time consuming and is seldom well done, or anywhere near completed, in university design projects, except on those rare occasions the part is actually going to be made. Nevertheless, it is the first and second stages which present the greatest difficulties in teaching engineering design in the university context. It is not easy to devise design projects which are realistic yet allow creative thinking, which need to reach a workable solution yet are within the capability of students in the early years of the course.

One way to bring reality to a university design project is to embark on a joint project with industry. There have been a number of reports of highly successful joint ventures [7,8] from which fourth-year students have learnt much about the way design is carried out in industry, and industry has benefited from the input of bright young minds. However, it is ingenuous to expect a single "capstone" design experience of this type to equip students for an engineering-design career or, for that matter, even a general-engineering career. It is in going some way towards plugging the "design-experience" gap in the early years of the course that we see the major benefit of an activity such as the Warman Student Design Competition. If students are to "catch" design [6], it is vital that they be nurtured in a "design ambience" and the time to start this is as early as possible in the course. Not all students will become designers, but all will at least experience the full design process, and that in a "fun" environment, at least once in their course.

On the basis of our survey results, and from our contact with students from around Australia and New Zealand, we believe that the Warman Competition plays a vital role in the early years of undergraduate engineering education. It has been shown to focus student attention on the importance of the factors underlying creative design and it provides an avenue and the incentive for a creative-design experience in the second year of the course.

Student enthusiasm for the project has remained undiminished over its ten-year life, with up to 86% of students claiming significant learning benefits in a number of aspects of the project. The fact that 78% of students actively supported the continuation of the project and only 4% opposed it is strong encouragement for its continuation. As one student commented:

"The more practical elements built into a mostly theoretical course the better. It gives you some idea of where you are heading, and maintains interest."

Those who opposed its continuation generally did so on the grounds that it required too much work for too little reward in the form of marks in their design course and/or the time at which it was held conflicted with other work loads. There were similar comments from the 18% who were "unsure", but there was also an occasional response indicating deeper concerns:

"The project involved real problems faced in design, but didn't help in the teaching methods to tackle the problems. With the time constraint, we only learnt how difficult design can be, not about the solutions. Many times we felt at a loss of what to do."

We have so far discussed the responses of the 1,000 or so students who competed in the Competition at campus level. From our 1993 survey [5], we concluded that there were significant additional benefits to those students who won their campus heats and had the experience of competing in the National Finals, particularly in improving their concept of "good design". We believe it is difficult to overestimate the potential benefits of these students meeting with, comparing notes with, and competing against similarly talented peers. This is an important aspect since this group might be considered as amongst

Australia's top student creative designers and hence as the future of Australian engineering designs. The limited data available in the 1997 survey do not allow us to confirm the 1993 findings, but we have no reason to suppose that these conclusions have changed in any way.

Our overall conclusion is that the Warman Student Design Competition remains, as it has been since its inception ten years ago, a very popular and a very worthwhile creative-design experience for the 1,000 second-year students throughout Australia and New Zealand who undertake the project each year. In the interest of fostering an ongoing pool of creative Australian engineering designers, long may it continue!

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