

IMPACT OF BACHELOR RESEARCH PROJECTS BY DESIGN STUDENTS

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ABSTRACT

For ten years, the curriculum of the Industrial Design Engineering (IDE) bachelor program at Delft University of Technology contained a bachelor research project. This 8 ECTS course consisted of a small block of research theory, while the majority was taken up by a practical research assignment. These assignments were provided by individual researchers within the faculty. This allowed students to be introduced into the research of the faculty, while simultaneously allowing researchers to have some assistance in the execution of their own research.

This paper presents an assessment of this course, in order to gain insight into the effect it has had both on the research skills of students, as well as on faculty research. The used data consists of quantitative and qualitative student feedback from the regular course evaluation system. Secondly, an assessment is made of the contributions that these bachelor research projects have had to scientific publications by faculty members. Furthermore, a number of faculty members that supervised multiple of these projects, as well as master students were asked to reflect on the usefulness of the course.

Results show that, from the faculty perspective, there has been a clear added value of the course, as faculty members used it to explore research questions on the periphery of their own research, or used the projects as pilot studies for follow-up research. From the perspective of the students, the majority of students questioned in the year of taking the course are positive about the research project. Retrospective reflections with a small group of master students gives a mixed picture, indicating that, if such a course was to be re-instated in the new curriculum, some improvements in the set-up could be made.

Keywords: Design research, research program, design curriculum, publications

1 INTRODUCTION

University-level design programs often aim to train designers in scientific thinking and methods, in order to distinguish their graduates from art and craft-based designers; see for instance [1]. However, the connection between design and research in an academic context remains challenging [2]. Part of the training in scientific thinking and methods may be achieved through bringing students into contact with (doing) research. However, in traditional design curricula, research as an area of study could hardly be found. Nowadays, the relevance of design research is accepted everywhere, although there is an ongoing discussion about what design research is and whether it differs from the traditional ideas about research. Most obviously, design research encompasses elements of both natural and social sciences, mixed with its own flavour and based on its own epistemology.

Within the bachelor program of Industrial Design Engineering (IDE) at Delft University of Technology (DUT), design research used to be implemented in the form of a third year Bachelor course. This 8 ECTS (European Credit Transfer System) course was taught for roughly ten years (for the period 1999-2008) as a compulsory subject, meaning that through the years about two thousand students took it.

In the pre-1999 situation (starting from 1995) there was already a research course in which students had to execute 5 small pre-cooked experiments, in order to allow them to familiarize themselves with the wide range of different research themes and research methods that were in use within the faculty.

However, this set-up was evaluated as unsatisfactory, due to the fragmented approach and the low commitment of researchers from the different departments of the school. Also, it was acknowledged that students particularly had trouble with exam questions related to research design, as this topic was ill-addressed in the teaching. This was due to the fact that the experiments, which the students had to execute, were handed to them as fixed, without room for their own initiative and with a time limit of one day each.

In the 1999-2000 academic year, the then-existing research course was changed into the set-up that was developed and implemented by the second author of this paper. The goal of the research course was to familiarize students with the type of research carried out in the faculty, both regarding content and methods used. Also, students should learn how to set up and execute a scientifically sound research project. Instead of 5 pre-cooked experiments, the students would do one larger research project, directly in collaboration with a faculty researcher. That way, by really having to go through the process of setting up and executing their own research project within the context of ongoing faculty research, the course objectives would be met effectively. While at the same time the size of the project (a team of two students, each spending 100 hours on the project), meant that it became useful for the coaching researcher, thereby raising commitment for the course throughout the faculty.

The research project, resulting in a scientific report, was not the only subject of the course. Together with this project a series of seven lectures about research methodology, a book to be studied [3], an individual computerized examination, and two practicals, one about methods for literature search and the other about how to write and present a scientific report, added to a total of 240 study hours.

The explicit learning objectives of this new course that ran for a decade were (combined for the smaller theoretical part and the larger practical part):

- Getting acquainted with the research portfolio of the faculty, both content-wise, and regarding the methods used,
- Getting acquainted with the most important concepts and methods of research,
- Develop skills in formulating a problem definition, search plan and search strategy for literature research,
- Develop the ability to critically assess, select and apply the information that is found,
- Develop skills in setting up and executing a scientifically sound research project,
- Develop skills in scientific reporting (in English),
- Develop insight into the usefulness and nature of research, in particularly within the context of Industrial Design Engineering.

In a recent revision of the bachelor program, the course was moved to the first-year, with the aim of bringing students into contact with research even earlier. This relocation caused it to be no longer relevant for faculty members, as first year students have too limited experience to execute useful research efficiently. Subsequently, representatives of the PhD candidates within the school have already complained about the demise of this option of having bachelor students do a project with them. Currently, doing a research project is only available as a third-year elective to bachelor students (which means about 20 projects per year are executed, instead of the previous 100+). However, in the decade that the course existed, roughly 2000 students took the course, meaning that about 1000 research projects have been executed.

In order to facilitate the faculty-internal discussion on the need of a research project within the design curriculum, a review of the usefulness of the old research course was conducted, including the research projects executed with faculty members. This paper is based on that review. It presents an assessment of the third-year research course, in order to gain insight into the effect it has had both on the research skills of students, as well as on the faculty research. The used data consisted of:

1. Quantitative and qualitative student feedback from the regular course evaluation system,
2. An assessment of the contributions that these bachelor research projects had to scientific publications by faculty members,
3. Interviews with faculty members that supervised multiple of these projects,
4. Interviews with master's students on their retrospective perception of the usefulness of the course.

2 COURSE EVALUATION RESULTS

After the first time the third-year course ran (the year 1999-2000), the new set-up was evaluated, using a moderated panel discussion with ten students and five coaching researchers (which was the standard

procedure for new courses at that time). The responses were quite positive. The objective of familiarizing students with faculty research was deemed to be well achieved. Students acknowledged the usefulness of the project for their curriculum, while coaching researchers acknowledged the usefulness of the student's work for the development of their own research.

In subsequent years, the course was evaluated several times through the regular course evaluation system, once in the 2002-2003 academic year, and once in the 2003-2004 academic year. This evaluation was done by means of a questionnaire that combines quantitative and qualitative analysis. As the course was offered multiple times per academic year, per period there were 50 to 100 students involved. The course evaluation results discussed here were based on 51 and 48 respondents (which represents a 90% and 62% response rate, respectively). In general, students were positive about the course, especially the practical project. Criticism was directed mostly to the theoretical part and some organizational issues around the course. Tables 1 and 2 give some of the scores, regarding the evaluation of the research project (translated from Dutch by author, italic added). These again confirm student satisfaction with the research project part of the course.

Table 1. Extract from course evaluation 2002-2003. (N=51)

Statement	Response by students (in %)					
	++	+	0	-	--	n.a.
The relevance of this course for the entire program is clear to me	27	65	6	2	0	0
I gained insight into doing research	35	57	6	2	0	0
I gained insight into the type of research that is typical for this faculty	22	47	20	10	0	0
I am enthusiastic about the <i>entire course</i>	15	63	19	4	0	0

Table 2. Extract from course evaluation 2003-2004. (N=48)

Statement	Response by students (in %)					
	++	+	0	-	--	n.a.
The relevance of this course for the entire program is clear to me	37	57	2	4	0	0
I gained insight into doing research	38	51	11	0	0	0
I gained insight into the type of research that is typical for this faculty	17	32	19	13	8	2
The <i>research project</i> was fun	28	41	15	15	0	0
The <i>research project</i> is useful for my entire study program	30	49	13	6	0	2

3 CONTRIBUTIONS TO FACULTY RESEARCH

Within the context of the current review, two additional studies were performed, one focused on faculty members, one on students who have further advanced in their curriculum. For the first of these studies, several faculty members were interviewed about the ways that past research projects contributed to their own research, in order to assess the usefulness of the course for the university. Faculty members were asked which of their publications were (partly) based on research projects (and to what extent). As mentioned in the introduction, over the years roughly 1000 research projects were executed. The current review represents a sample of those projects. In total 76 projects were included, which represent all research projects supervised by the 5 interviewed faculty members.

Table 3 presents the results of this analysis, showing that a considerable number of publications were (partly) based on the projects executed by our third year bachelor students. (Here it should be noted that several publications consist of a joining of several research projects; for instance, two projects which together form the full basis for a conference paper, are each categorized in the 25-75% category in Table 3). In this table, planned papers are included between brackets, e.g. (+4). The category "book or thesis contribution" means that the project yielded or will yield a small contribution to such a publication. Here one should think of a single graph, table or a single paragraph.

Table 3. Scientific publications out of student research projects.

Number of projects	Not useful	Useful, but unpublished	Wider media publication	Small part of conference paper (<25%)	Medium part of conference paper (25-75%)	Large part of conference paper (>75%)	Small part of journal paper (<25%)	Medium part of journal paper (25-75%)	Large part of journal paper (>75%)	Contribution to book (chapter) or thesis
76	10	31	0	4	1	9 (+2)	2 (+2) [4,5]	0 (+4)	2 (+1) [6,7]	1 (+3)

Table 3 only assesses publications coming from the research projects. However, the projects have been useful in other ways as well. In several cases, research projects led to master graduation projects. Other projects were executed in collaboration with industry and yielded useful knowledge for those companies. Finally, several projects contributed to the securing of external research funding, such as several projects on littering leading to a follow-up project funded by the Dutch industry-funded anti-littering organization ‘Nederland Schoon’. The combination of the student projects and the follow-up projects led to [4].

The analysis in Table 3 looks at the number of publications that are (partially) based on research projects. A different perspective is to look at what percentage of the total number of research projects contributed to publications in proceedings and journals. For the reviewed sample of projects 32% of the projects have contributed in some way to publications, while an additional 17% is expected to be used in publications by the coaching researchers.

4 EVALUATION BY FACULTY MEMBERS

Several researchers who have coached multiple projects were interviewed (N=5, the same faculty members, whose projects were evaluated in Section 3). They were asked about the extent to which they felt the learning objectives of the course (see the Introduction) were achieved in general. Furthermore, they were asked about their motivation for handing in the projects as they did. On the first point, researchers indicate that in general, the learning objectives have been achieved to a large extent. Below, each learning objective is discussed in more detail:

- *Getting acquainted with the research portfolio of the faculty, both content wise, and regarding the methods used.* All interviewed researchers agree that this objective has been achieved, although the project executed by the students is of course but one example.
- *Getting acquainted with the most important concepts and methods of research.* Here, a mixed picture emerges. The general impression seems to be that the students’ knowledge and understanding have improved, especially within the context of their specific project, but not all important concepts were covered.
- *Develop skills in formulating a problem definition, search plan and search strategy for literature research.* This remains difficult, but that is also due to the fact that, for many of the research topics addressed within the course, there was little or no scientific literature available. Students need a lot of support on this.
- *Develop the ability to critically assess, select and apply the information that is found.* This remains a challenge. Some groups are very good, but for most students this remains difficult, also in later courses.
- *Develop skills in setting up and executing a scientifically sound research project.* The general impression is that these skills certainly improved through this course, but that these skills should be further improved later on in the curriculum. As one researcher put it: “All my groups (12), executed at least one aspect very well, but none were excellent on all aspects of their project”.

Another researcher stressed that students have a too limited understanding of the extent to which their results can be generalized.

- *Develop skills in scientific reporting (in English)*. Here, especially the limited control of English was stressed by the researchers. It requires a lot of coaching time, but the course seems to have improved their skills (be it in some cases from ‘zero skills’ to ‘limited skills’).
- *Develop insight into the usefulness and nature of research, in particularly within the context of Industrial Design Engineering*. The general impression is that this has happened.

As all projects that ever ran in the course were proposed by the supervising researcher of those projects, the interviewed faculty members were also asked to indicate for each project they have supervised what had been their reason for proposing this project. Answers to this question indicate that the reason for submitting a project ranged all the way from ‘simply answered a call for projects to help fill the course’, via ‘allowed the exploration of a side issue in their own research’, to ‘used as a pilot study for my own planned research’ and even ‘constitutes an essential component of a PhD thesis’. For most projects it can be concluded that the resulting publications would not have existed without the option of having students from the research course execute (part of) the experiments.

5 EVALUATION BY GRADUATE STUDENTS

The second study that was conducted, within the context of the current review, was aimed at assessing the usefulness of the course to students. To this end, students, who took the course several years ago and are now working on, or towards, their master’s graduation project, were asked about their retrospective perception of the usefulness of the course. The aim was to assess to which extent the skills in: 1. literature research, 2. assessment, selection application of information sources, 3. set-up and execution of research projects, and 4. scientific reporting, have enabled the students to do higher quality work in later courses and their graduation project. Several students out of this group were randomly selected and asked to reflect on these aspects. From their responses (N=8), a mixed picture emerges. The level to which they feel they actually obtained the intended skills, and used those skills later on in their program differs strongly. Some claim that especially the practical execution of the research project, doing an empirical study with subjects/participants, has taught them a lot, while other students indicate that they especially learned a lot in justifying the used methodology, presentation of results and the use of information sources. It appears that the spread is strongly related to the specific faculty member with whom the project was executed, and than in particular the amount of coaching provided and the freedom allowed in making project decisions. Projects where the coach allowed freedom in relation to the content, while at the same time demonstrating commitment by being actively involved on a regular basis, seem to result in more and higher-level learning with students. Compared to the predominantly positive results from the aforementioned qualitative and quantitative faculty evaluations (with 109 students in total) the retrospective interviews with these eight students give somewhat different results, partly caused by personal factors. And besides, it is only a very small sample.

6 DISCUSSION AND CONCLUSIONS

The research course in the third year of the bachelor was meant to provide a win-win situation for both students and researchers. It has ran for almost 10 years, and perished as a consequence of curriculum revision. Quite a number of researchers in the faculty regretted the decision, reason why an evaluation of the course makes sense. Furthermore, during the period of existence of this course the approach was an example for other design schools, and several of them, both in the Netherlands and abroad, adopted the course in their curricula.

It can be concluded that the bachelor research project has had a profound effect on faculty research, in the sense that it has yielded (or will yield in the near future) several publications that would not have existed without there being such a course. Other publications, which would also have been written without the research project, still were either enhanced or finished sooner. Furthermore, the projects have contributed in other ways, for instance through yielding master’s graduation projects. On the other hand, the learning effects for the students present a slightly more mixed picture. There is wide agreement that the project was useful for both students and researchers, but the coaching researchers indicate that on average they are unsatisfied with the level of research attitude achieved with students at the end of the project. Also the small sample of students who were interviewed present a mixed

picture on the applicability of skills obtained during the research project in the later stages of their program.

An inherent conflict is observed between learning and research objectives. From a learning perspective, it is better to give students more responsibility over their research project, even if that leads to less useful or even invalid results. From a learning perspective that is not a problem, just as long as their evaluation ensures that they become aware of the limitations of their research, and they reflect on how they could have done things differently and more effectively. However, from the perspective of the faculty member, their commitment to the course is based on the hope of obtaining valid, publishable studies that fit seamlessly with their ongoing research. From that perspective, a more pre-cooked assignment, and/or strict coaching, steering students into a certain direction are more effective. Within this research course there was a clear spread of projects that were more open, and thereby more aimed at allowing student to learn more, and projects that were controlled more by the faculty members, and thereby fitted their research objectives better. Such a spread is inherent to a set-up with many faculty members participating, each coaching their own group(s). Clear instructions to faculty members, and involvement of the course coordinators should minimize this spread. However, a manual specially made for the researchers got less and less impact after they had coached several projects within the context of the course.

All in all, the course set-up, with students doing a project linked to actual faculty research, with the relevant faculty member, seems to be very effective in achieving research-related learning objectives within a design curriculum.

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