WORKING KNOWLEDGE: INDUSTRY-BASED PROJECTS IN AN INDUSTRIAL DESIGN / ENGINEERING PROGRAM

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ABSTRACT
This paper describes three industry-based projects that were undertaken by final- year students in the Industrial Design program at UWS, Australia. Drawing on the experiences of the academic supervisor, the students and industry partners various themes are identified that need to be considered when initiating this type of program. Rather than suggesting a fixed model for industry-based projects it is recommended that these themes be used to trigger further discussion around challenges and opportunities presented by this approach so that a better understanding of workbased knowledge and learning can be developed.

Keywords: collaborative learning, industry partnerships, product design education

1 INTRODUCTION
Cross-functional product development teams are increasingly being used in contemporary workplaces [3, 4]. In order to prepare upcoming industrial designers to be able to operate successfully in these increasingly complex work settings, the Industrial Design program at the University of Western Sydney (UWS) is teaming up with industry to provide final year students with industry-based projects. This paper describes three industry collaborations that were undertaken during 2003. The experiences of an academic supervisor, students and the industry partners will be drawn on to discuss the challenges and opportunities that have arisen from the introduction of industry based projects into the final year course.

2 DESCRIPTION OF WORK
The industrial design program which is run by the School of Engineering and Industrial Design offers a final year-long compulsory course for two of its undergraduate degree programs, the four year Industrial Design and five year Industrial Design Engineering. The aim of this final year course is for students to integrate and apply the knowledge, skills and experience they have obtained from their previous years of study by initiating an innovative solution to a particular design related problem. This is done by encouraging students to explore areas/issues/activities that people/industry are facing in their day-to-day activities [5].

In the past, industry involvement in final year projects has been limited to in-kind sponsorship, for example, providing a theme for the project, supplying model making materials and/or assisting with industry know how. Industry involvement tended to be minimal as it had a very little stake in the overall success of the project and its final outcome. However in 2003, two of the new industry partners in the UWS final year industrial design program offered projects that went beyond a simple project sponsorship model. The industry partners provided projects which had commercial implications, thereby substantially increasing their stake in the successful completion of these projects. This resulted in the forging of closer working relationships between the industry partners, students, and academic supervisors. As a consequence, a new collaborative approach has been developed between the industry partners and university which has led to unexpected opportunities and challenges.

2.1 The collaborative projects

2.1.1 UWS External Signage project (UES)

The industry partner for this project was UWS Capital Works and Facilities (CWF) [2]. Before the start of the academic year one of the industrial design academic staff members approached CWS to inquire whether they would be interested on sponsoring a final year industrial design student project, focusing on ways to improve the existing external directional signage system. Coincidently, at that time, the University was in the process of implementing a new corporate image. This also included an upgrade of the overall University signage system. After a number of discussions between CWS and the final year academic supervisors it was agreed that this would be a suitable final year project. However, because of the project size and its requirements it was recommended that two students should be engaged on this project. This initial agreement was followed by the development of a project scope in consultation between CWS, two final year industrial design students and their supervisors. This project scope was based on guidelines from the UWS Project Manual [6] and it included: project objectives; organisational requirements; approach, timeframe and milestones (timeline); inclusions and deliverables; exclusions; assumptions; constraints; and risks.

It was envisaged that students develop detailed design solutions to a level that would enable CWF to commission prototypes to be installed at one of the University campuses. The plan was that students would conduct a user survey to evaluate the prototypes and if necessary modify the designs prior to going into full production. It was agreed with the students that this evaluation was going form most of their research (theoretical) assessment component. Unfortunately, this evaluation did not take place as expected as the external subcontractors who were given the task of producing the signage prototypes had substantially delayed the delivery and installation until the end of the academic year. This meant that students were not able to conduct their user evaluation and testing. Even though alternative research components were explored with the students, and it was an academic requirement that some form of research be undertaken, one of the students saw the theoretical research component as a waist of time and lost motivation to complete it. Also, at the same time the students were in the process of competing an external signage audit for all six UWS campuses. This was additional unpaid work that was negotiated between the students and the industry partner, without consulting the academic supervisor.

2.1.2 CSIRO-TIP's student projects

Five industry-based projects were established in collaboration with Commonwealth Scientific and Industrial Research Organisation, Division of Telecommunications and Industrial Physics (CSIRO-TIP) [1]. CSIRO-TIP's deputy chief initiated the partnership by contacting one of the final year industrial design academic supervisors before start of the academic year. The CSIRO-TIP, while providing innovative scientific and technical solutions for product development, were experiencing difficulties in getting products to market. It was envisaged that the combination of science and design disciplines would benefit both parties. Meetings were arranged between the key decision makers at CSRIO-TIP and UWS staff members from the School of Engineering and Industrial Design, the Office of Business Development, and Cooperative Programs. A number of students were contacted by the academic supervisor and were asked to visit CSIRO-TIP for a brief summary of the projects on offer. During this phase students were encouraged to ask questions and start identifying which projects interested them. Students were then asked to submit project preferences with a brief summary of why they felt the project best suited their interest and skill set. From this information the project allocations were made. I will focus on three of the five projects that were conducted with CSIRO-TIP.

2.1.3 Portable scientific testing instrument (PSTI)

CSIRO-TIP developed technology for non-destructive composite material testing which is used in the aeronautical industry. The initial proposition was for the student to generate a good-looking housing for the CSIRO-TIP's technical package. However, the student established very early into the project that the technology, which CSIRO-TIP had developed, was sound but neglected to take into consideration human factors. The instrument's reading reliability was compromised as each of the tests depended on the user's steady hand and correct posture. Also, the instrument could not be used on anything other than a flat surface, yet most surfaces on airplanes are curved. Therefore, the student conducted user task analyses (e.g. ergonomic position of workers performing non-destructive testing and user interface was also explored) to reduce the human error and by doing so, this student was able to propose a new design solution that not only overcame the user inconsistency, but the newly designed instrument could be also used on curved surfaces. This innovation let the CSIRO-TIP to apply for a provisional patent. This student worked closely with the CSIRO-TIP project team members to ensure that the technical package was redeveloped in parallel (alongside) the external instrument housing. As a result of this close teamwork a test prototype was produced to ensure that the modified instrument's technical package fitted within the newly designed instrument's housing and that overall it functioned as intended. This was then followed by construction of a number of fully working prototypes, which are currently been field-tested with the end-users.

2.1.4 Scientific testing instrument (STIM)

The Scientific Testing Instrument Machine (STIM) is used to perform material properties testing on a nanoscale. Two students who expressed interest in undertaking this project were selected to examine the extensive number of issues that could potentially be improved. These students were briefed by the project leader on what he thought was wrong with the current design, but it was left to the students to identify whether there were other problems. The students undertook market research and a usability study and identified additional issues. They decided that one would focus on the software interface which is used to control the instrument and other would focus on the instrument's housing which functioned mainly to keep a constant environment around the specimen while the test was in progress. The project leader left students "open" space to set the design direction. The two students reacted to this in different ways. The student working on the software interface took full advantage of this and took full control of the design direction while keeping the project leader informed on progress of the software interface. Whereas, the student working on the instrument's housing interpreted this lack of direction as the project leader's disinterest in their progress. One of the results of this was that at times this student felt lost and without direction. When the project leader provided feedback to this student, the student reacted by constantly reworking the concept design each time and as a result was unable to move from the conceptual design phase until the very end of the final year. This substantially delayed the construction of the presentation model which was traumatic for the student.

The project leader commented "the final program interface was exactly what we wanted and represents a significant step upwards from our present offering and those offered by our competitors. The new interface will be a trend-setter in scientific software." But on the other hand noticed that student working on the instrument's housing was anxious, "especially when it appeared that no one liked [the] earlier designs." The project leader also felt that there was not enough contact between academic supervisors, the students and himself.

2.2 Project outcomes

2.2.1 A student perspective

Students have identified both challenges and opportunities of working on industry-based projects when asked to provide feedback on their experience. All identified the following benefits: work in cross-disciplinary teams; refine their time management skills; gain experience in project management; and work on real life projects and problems.

The challenges identified varied depending on the project. Fro example, one student felt that "the requirements became an issue both in terms of workload and mental anxiety, as the requirement to complete a particular task for one party will be completely different for another party. Worse still is having to repeat and explain all procedures (Academic) when the pure essentials is all that is needed to complete the practical side of the project (Industry)."

2.2.2 Academic perspective

UWS academic staff members supervising students and students working on the projects felt that they have gained a wealth of information through knowledge sharing across disciplines. For example, gaining an insight into scientific methodologies has broadened both staff and student approach to design problems. The industry based projects provided the opportunity for academic staff members to learn what issues and problems designers face while working in a Science based environment, and then adapt the curriculum to better prepare future students for similar types of workplaces.

2.2.3 Industry perspective

CSIRO-TIP have also benefited from the industrial design approach to problem solving and the commercialisation of products. This is evident in the CSIRO-TIP shift in focus from product orientation to a focus on designing for the consumer. CSRIO-TIP staff involved in the projects were initially completely unaware of what industrial design is and how it might be used. The co-ordinator of the CSIRO-TIP collaboration communicated that "whilst some were aware of the benefits of design for manufacturing none appreciated the types of other research that lead to an improved product or how that research should be conducted. The learning experience was profound and the project inspired immense respect for the profession amongst the engineers and physicists."

Through examining the challenges and opportunities gained from our experience in working collaboratively with industry on the final year projects we are able to consider some of the broader implications this model may have for students, industry partners and the academy. These are explored in the following section of this paper.

2.2.4 Student learning and client requirements

The final year industrial design program is structured to encourage the students to approach the problem they are exploring from a broader problem definition. Therefore, they are asked to explore social issues and activities that people/industry are facing rather than solving specific product based problems. This is done in order to shift the student's attention from product-based solutions to user-based solutions which in turn should stimulate innovative design resolution to a given problem.

Striking a balance between student learning, as proposed by the academy and producing a product that the industry partner was happy with was an issue especially with projects where the industry partner had a fixed idea about an outcome solution. For example, the initial PSTI project brief was to design a good-looking instrument housing. This raises, the question of: What is more important – satisfying the client's requirements for a particular product or addressing student-learning outcomes? For example, on the signage project one student neglected some parts of their academic work and focused on the industry requirements.

2.2.5 Resources

The industry-based projects are very resource intensive. Substantial academic staff time, including the initial setting-up of projects with the industry partners, getting necessary approvals from the various university stakeholders and maintaining ongoing interactions with the industry partner, is required to ensure that it takes off and is competed.

For example, feedback from one industry partner indicated they would have liked more contact with the student supervisor (see STIM). One way of addressing this issue is through charging a project management fee. However, this increases the number of people that need to approve formal consulting contracts between the university and the industry partner thus requiring even more set-up time and effort.

2.2.6 Choice of industry partner

Another important point is to choose industry partners who understand that this is a student project. Therefore, they need to take into consideration the academic requirements of project and also allow room for failure to complete the project to their expectations. That is, the student might not provide the industry partner with a specific and tangible solution at the end of the design process addressing their initial problem. So, the projects that are well suited to this type of collaboration are those if unsuccessful are not going to break the industry partner. For example, all CSIRO-TIP projects were in this category, that is, if the project was not successful it was not going to affect the CSIRO-TIP bottom line. However, if successful they had the potential to increase it.

2.2.7 Collaborative learning between industry partner and academy

It was evident student, industry partners, and academic comments that all parties were learning from the industry collaborations – learning about how each other operates so that the program was complementary to all parties, e.g. timing the project's phases and managing expectations so that they coincide with student's assessment requirements. It was found that inviting industry partners to the university to attend the students' assessment presentations and having students presenting at the industry partners premises to the CSIRO-TIP staff was one way of informing the industry partners about the academic requirements. Another, way was for students to produce detailed project proposals with guidance from their academic supervisor which were then presented to the industry partner so that they understood what is intended to take place.

Academic staff members during this collaborative partnership were also learning how to explain to both the industry partners and to students the value of taking a broader research perspective to a given problem, and how this could potentially lead to innovative design outcomes (e.g. PSTI).

2.2.8 Equity issues

From an educational point of view the industry based projects provided students with a number of added advantages and challenges in comparison to the students who did not have an industry partner. For example, students engaged on the industry-based projects commented on the exposure to an industry-based environment, such as being part of a product development team, which has provided them with additional support and resources. However, this increased the project's complexity as the students had to deal with and satisfy more stakeholders, and to deal with professionals who may have different backgrounds, focus and expectations, as was the case on all the above projects.

In addition, students without industry partners would not have the financial resources to produce fully working prototypes. Therefore, they generally did not go further than producing well-developed conceptual models. Students having industry-based partner support have generally been able to present professionally executed prototypes and presentation models, paid by their industry partners. Therefore, some of the academic assessment panel members felt that these students had been substantially advantaged by this. On the other hand, the industry partners have the ability and resources to produce fully working prototypes. Therefore, it was expected that students working on industry-based projects would produce design solutions and proposals which would enable the industry partner to commission the construction of a fully working prototype. This required students working on the industry-based projects to go beyond the conceptual and/or system-level design phase in order to produce detailed design(s), e.g. complete set of technical drawings, tolerances and material selection [for description on generic product development phases see 7]. This enabled students to produce well-developed detailed design proposals, and it also became clear when the student lacked the necessary knowledge and skills to carry out the detailed product development design phase.

Because of the above issues the Industrial Design academic staff members are in a process exploring the following questions:

- Are students working on the industry-based projects advantaged over their classmates who do not have the access to the same level of resources or are they disadvantaged, as their timeframes are much tighter because of the industry-based partner requirements?
- How are the projects distributed and how are students selected to undertake the project?
- Industry partners are prepared to spend various amounts per project. However, should all students involved on industry-based project to be reimbursed the same amount?

- Are students undertaking industry-based project advantaged by having industry support such as resources; including materials, working space, tools, monetary, team members assistance, access to “hard to get” (e.g. confidential) information and industry partner contact network and know-how? Should their grades to be scaled to reflect this?

2.2.9 Intellectual property

Currently students “own the Intellectual Property that they generate” [8, p 139]. In the instance “where a student’s supervisor makes a contribution to the Intellectual Property,” it is then jointly owned “by the student… and the University” [8, p 139]. However, as many of the student projects that are proposed by the industry partners are part of a larger ongoing development, the industry partners claim ownership of the Intellectual Property generated by the student/supervisor.

2.2.10 Confidentiality

As many of the industry projects have commercial implications confidentiality clauses are included in the initial agreements with the students and the academic supervisors. As students have not been exposed to this type arrangement they are uncertain what they can and cannot discuss in class discussions.

2.2.11 Developing future relationships

The student industry-based project could also be a catalyst for developing research relationships with industry partners. For example the academics supervising the CSIRO-TIP research projects uncovered through discussions with the project leaders a place of industrial design.

3 CONCLUSIONS

While there are still many issues to be worked through in terms of incorporating industry-based projects into the final year program, the overall advantages provided by this model of industry collaboration means that this approach will continue to be developed. Interestingly, neither of the industry partners discussed in this paper had worked with industrial designers previously. However, both of the industry partners were so impressed with the outcomes that they both agreed to continue with the collaborative partnership in the future. Two out of the six industry-based projects that were conducted in 2003 have moved into the production phase, and two others are planned to be in production trial by the end of 2004. One of the partners has offered employment to two of the students and has organised a collaboration between another division of their organisation and the School of Engineering and Industrial Design.

This paper draws attention to various issues that need to be considered when establishing collaborative partnerships with industry on final year industrial design projects. The following themes have been identified:

- Balancing student learning and client requirements
- Providing resources for the collaborative projects e.g. initial setting-up and ongoing interactions
- Choice of industry partner
- Collaborative learning
- Equity issues
- Intellectual property
- Developing future relationships

- Overall course structure

Rather than proposing a fixed model for a final year industry based project we suggest that a more flexible approach be adopted that takes into account the requirements of the industry partner, the academic institution and the student. The various issues described in this paper need to be considered when planning and implementing these projects. We propose that a more flexible approach will enable the specific learning needs of the students to be incorporated as they arise during the course of the project. Rather than these gaps remaining submerged as they can in student projects, they can be quickly identified in industry-student collaborations and appropriate learning solutions adopted.

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