

# Collaborative design education with industry: Student perspective by reflection

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## Abstract

This study suggests that student reflection on academic and industry collaborative projects can enhance student's understanding on the design process to solve live industry problems. It contributes to the body of design literature to support students learning of explicit and implicit knowledge (Boling et al., 2016; Land et al., 2016; Salama, 2015). A 2017 learning-by-making (LBM) unit in the School of Architecture and Design, at the University of Tasmania, Australia, developed a unit for students to collaborate with Neville Smith Forest Products Pty. Ltd. (NSFP). NSFP is a local Tasmanian timber product manufacturer who currently stockpiles out-of-grade timber that has limited market applications. Undergraduate design students from second and third year Furniture, Interior and Architecture degrees collaborated with NSFP to value-add to their out-of-grade resource in the LBM unit. A series of design challenges, observations of industry practice and access to out-of-grade timber from NSFP exposed students to live industry problems and provided them the opportunity to build professional design skills. Students reflected on the collaborative LBM unit in a reflection journal, which was used to provide evidence of their learning experiences. The collaborative environment between academia and industry allowed students to acquire an understanding of timber product manufacturing that helped them develop empathy towards the industry problem and influence the development of new products. This study presents how student reflections influenced a change in their design process as they progressed through sequential design challenges to address an industry problem by adopting Valkenburg and Dorst (1998) reflective learning framework.

*Keywords: Academic-Industry collaboration, learning-by-making, live project, design process, reflection.*

The School of Architecture and Design, University of Tasmania, Australia, has a reputation for its learning-by-making (LBM) classes having conducted over 100 projects, over 20 years (Burnham et al., 2015; Salama, 2015; Carpenter, 2011). LBM units are designed to expose students from all design disciplines to real design work and allow them to explore design practice through thinking, making and reflecting on these processes. LBM units focus on live community or industry problems and facilitate the process of design from ideation through to fabrication whilst collaborating with peers in groups and a client. This study presents the change in student design process after participating in design challenges to address an industry problem. The change in process was substantiated through student reflections expressed both explicitly in a journal and tacitly through observations. These reflections demonstrated students transformative learning from design students to novice designers with industry experience.

In February 2017, a summer semester LBM unit was offered to School of Architecture and Design students for them to collaborate with Neville Smith Forest Products Pty. Ltd. (NSFP)—a Tasmanian oak hardwood timber product manufacturer who supplies local, domestic and international appearance markets. NSFP currently manufactures a diverse range of Tasmanian oak products and flooring profiles for interior applications. Their current manufacturing process produces a series of Australian standard graded timber products, as well as out-of-grade products that fail to comply with *Australian Standard 2796.2* (2006). This material has limited secondary product applications thus generating a stockpile of low value timber with little market demand. A brief was developed for students to design, develop and prototype new products utilising NSFP current stockpile of out-of-grade timber. The aim was to value-add to the resource and thus provide new market opportunities for NSFP. The NSFP design challenge presented in this study provided students with a live industry problem that gave them experience in identifying an opportunity to develop new products and to recognise the expectations that industry has for commercialisation.

## Literature Review

Current literature claims pedagogical design exercises that present opportunities and experiences to students such as industry project-based learning or live projects are key threshold concepts for students to transition from student designers towards competent and confident design professionals (Boling et al., 2016; Burnham et al., 2015; Blumenfeld et al., 1991; Hokstad et al., 2016; Osmond & Turner, 2010; Salama, 2015).

A characteristic of the assessment and activities associates with the transitional moments where students appear to progress through the threshold concept, appear to be problem-based, experimental, related to work and ‘real-world’ design activities and often involve group work; in other words there is a focus on ‘doing as learning’ (Osmond & Turner, 2010).

There is no denying that real-world design activities differ from typical academic studio-based activities given the difference in industry and academic approach to design projects and design processes (Hokstad et al., 2016; Kim, 2016; Kotlarewski et al., 2016; Salama, 2015). In circumstances where industry seeks to engage with design and designers, the intention is to create value that can help gain a competitive advantage (Fonseca, 2016; Gemser & Leenders, 2001).

Where possible, it is argued that student exposure to real-world design activities is a key experience and opportunity that can assist student’s transition through threshold concept learning (Burnham et al., 2015; Land et al., 2005; Land, Meyer & Flanagan, 2016; Meyer & Land, 2005; Meyer & Land, 2006). It is common for students to become frustrated, lose confidence or stuck in a cycle of the unknown early in design exercises. It may be better for students to experience such difficulties in a controlled environment earlier in their degree to learn how to overcome such difficulties and therefore learn how to approach challenges in future learning and employment opportunities. Student reflection upon these difficulties, opportunities and experiences in a reflection journal is an integral learning activity that demonstrates evidence of student learning (Ellmers, 2006; Moon, 2004; O’Connell & Dymont, 2006; Clifford, 2002; Webster, 2004).

The process and reflection assessment task encourages the student to identify critical incidents from the design process and contextualise them within the outcomes of the

final design artefact. This is significant in that the student assumes responsibility for identifying important moments of the design process there by encouraging them to be independent learners (Ellmers, 2006).

A study by Valkenburg and Dorst (1998) was influenced by the work of Schön (1983). They indicate Schön's (1983) work has proven itself useful for describing design activities and focus their attention to describing reflective practice in team designing in figure 1. They illustrate four different activities that design teams exercise as the mechanism of reflective practice.

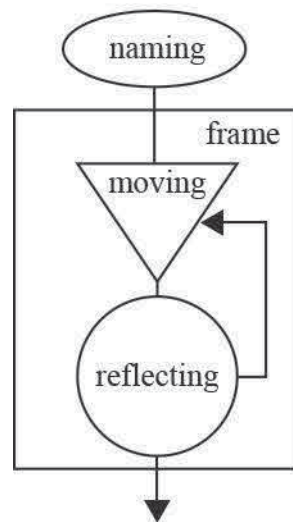


Figure 1 The mechanism of reflective practice; the four design activities and their interplay (Valkenburg & Dorst, 1998)

The four activities, naming (identifying important parts of the design task), frame (focusing on the context), moving (generating ideas), and reflecting (explicit documentation of actions) are presented as a flow diagram. Valkenburg and Dorst (1998) use this flow diagram in their study to present reflective practice in team designing, compare two case studies and quantify the time spent by design teams in each activity. Mapping the mechanism of reflective practice was applied to this LBM study to indicate the transformative learning experience that students gained from the industry project-based unit. The overall mapping of the student reflective practice is illustrated and presented in the discussion on this study.

## Research Methods

Observations of students and reviewing student reflections were used to substantiate transformative learning in the LBM unit. These research methods provided evidence that students were developing their ability to approach design challenges both explicitly through critical analysis of their key learnings and tacitly through making, as an individual and a group member. The LBM unit presented in this study ran intensively over 10 days, consisting of 13 students divided in five groups.

This LBM unit exposed students to three design challenges that gradually introduced new variables in a controlled environment to provoke threshold concept learning. The first design challenge—ran on day one—was a short three hour activity used to expose students to the overall design expectations of the unit. In three hours, students were expected to follow a set of rules to design and prototype a scaled cardboard product. While students worked,

observations of the students design process and design skills were noted and recorded as photographs by the lecturer. Students were also encouraged to record and document their design process and product developments—typically as photographs and sketches—throughout the design challenge. This evidence was later compiled in student's reflection journals to highlight critical thinking and key learnings.

The second design challenge—ran on day two—was another short three hour activity, again bound by a set of rules to design and prototype a scaled timber product using timber off-cuts. Before the second design challenge started, students were given a tour of NSFP mill to observe the manufacturing process of timber products. The exposure to manufacturing constraints was intended to add another variable to the student learning experience to assist the development of their design process and timber product. It was expected that the tour of the mill would highlight key industry constraints such as production lines, resource management and product handling.

The third design challenge ran from day three to day 10. This design challenge gave students more time to move through the design process and develop more products with timber that NSFP specifically supplied. This challenge presented a live industry problem to the students as they had to meet a dead-line, consider implementing the product into NSFP production line and develop a range of products with the specific timber supplied.

The gradual increase in responsibility of students was intended to build student design competencies and prevent overwhelming the students with a live industry problem at the commencement of the LBM unit. The controlled exposure to design activities was used to review their explicit individual journal reflections and to observe evidence of these developments in students tacit knowledge in response to the industry brief, as well as their learning.

## **Discussion**

The opportunity and exposure to industry that students gained from the LBM unit helped them develop valuable insights that assisted individual reflection and the development of tacit knowledge on the underlying industry problem, the design process and their design skills. Outcomes from these key areas helped students develop design competencies that assisted their approach to the design challenges in the LBM unit.

Design challenges one and two encouraged students to be creative, try something new, fail quickly, reflect on the outcome and then further develop the idea. This process was both sequential and iterative. The first design challenge was a product design cardboard activity conducted on day one. Students had three hours to design, prototype, develop and reflect on their process, product, and group collaboration. The design challenge was broad yet constrained by rules, giving the students the freedom to design any product—in groups of two and one group of three—at 1:4 scale, using only cardboard. The restriction to cardboard only, was to challenge students to develop a product that was aesthetically pleasing, structurally capable of holding 5 kg and could be easily manufactured within the design studio environment. Figure 2 depicts the student reflective process through the cardboard design challenge.

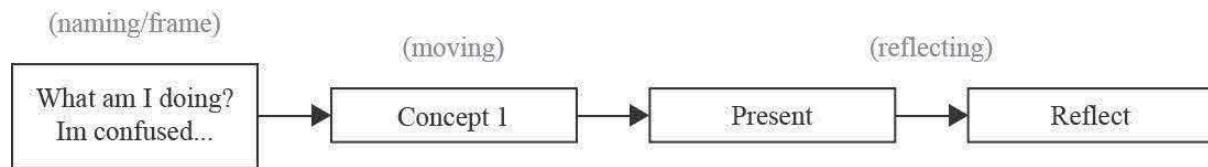


Figure 2 : Student reflective process use to address cardboard design challenge

As observed during the first design challenge and shown in figure 2 students were inevitably confronted with the cardboard design challenge and became confused. In-line with Valkenburg and Dorst (1998), students approached the design challenge by first identifying the important aspects of the activity (naming): what am I doing? They then began framing the context of the design challenge: to design and develop a product out of cardboard. A lack of understanding the relevance of the cardboard design challenge limited student confidence and added to the task frustration that led students to fail to let go of the first concept they produced (moving): generating an idea. At the end of the challenge, students presented their product and reflected on the journey (reflecting). Initial reflections of the design challenge as anecdotal evidence was: What was the intention of the challenge? Why are we designing a product with cardboard when the unit is about timber product development? In response to the first design challenge, students identified their lack of exploration and conservative approach was a constraint to developing a cardboard product that taught them something new by making. Explicit student reflections later highlighted:

- *Today helped me realise the importance of failing early and not becoming attached to the point that it prevents further innovation and critical thinking.*
- *Too much time was spent finalising the design, therefore when it came to making/testing we were rushed for time and had little time for corrections.*
- *It is possible to over plan. Continuing to design without trial is a pitfall.*

The second design challenge was to develop a product with NSFP timber off-cuts. Prior to the design challenge, students were given a site tour of NSFP where they observed the management of green timber and processing of dry timber to manufacture interior fit-out and flooring products. Students observed NSFP facilities and manufacturing processes and began identifying opportunities to implement new product manufacturing lines for out-of-grade timber. After the site visit students were briefed on the second design challenge. They again had three hours to design a product, prototype and develop it and reflect on the process and product development. Given the students had a similar experience the day before they were equipped with the knowledge and expectation of the challenge. Unlike the cardboard design challenge, student groups were allowed to use additional products such as glue and fasteners to manufacture their 1:4 scale product out of timber-off cuts. Figure 3 depicts the student journey through the timber design challenge.



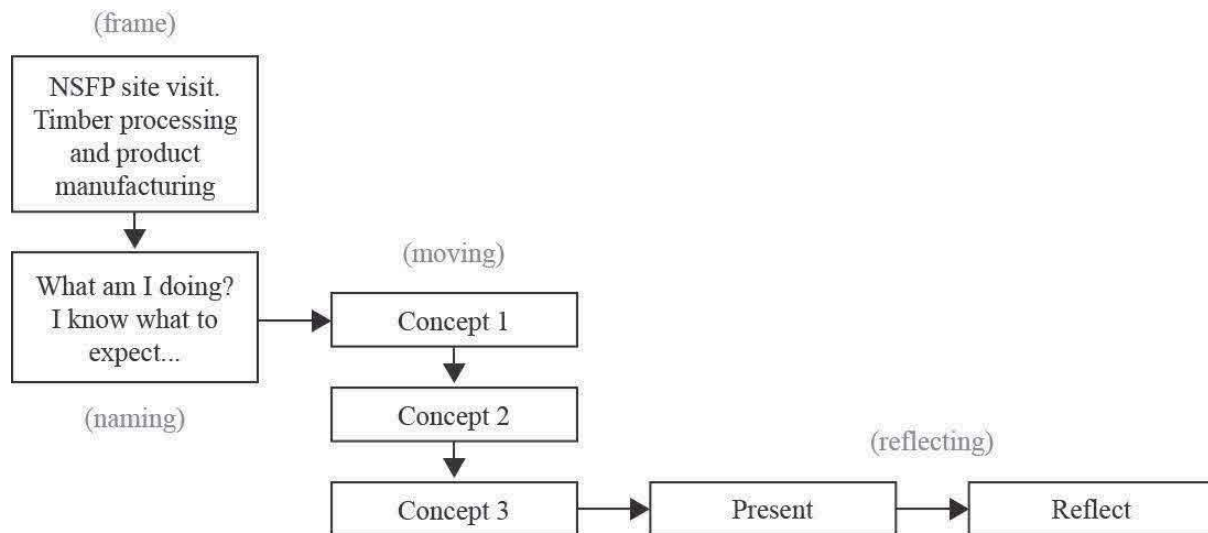


Figure 3 : Student reflective process use to address timber design challenge

An obvious difference existed between the first and second design challenge. Students were given background knowledge of NSFP timber processing and product manufacturing through the site visit and were aware of the expectation to generate a series of concepts. This change in structure allowed the students to “frame” the context of the project before “naming”. Students immediately began generating ideas (moving). Observations noted that students were better equipped with experience and expectations from the first design challenge. Students even combined concepts to develop hybrid products that incorporated a series of features and functions. The experience attained from the previous design challenge through reflection gave the students the courage to try something new and accept that the first concept that they produced was likely to be discarded and forgotten or developed into another concept generation. In relation to the timber design challenge students noted:

- *Great process of design development today. The product field opened up many more ‘potential use’ opportunity’s rather than narrowing the options (as it felt like I did on day 1). I believe I can already feel an increase in design flow and critical thinking since yesterday’s cardboard challenge.*
- *Making/experimenting with our own ideas in the first prototypes we were able to bring our knowledge together. By bringing my idea about using the high feature knots for natural light and hangings, we were able to build on this for prototype two. From todays design challenge and the visit to NSFP I started to realise [that] the natural aesthetics [of] these high feature products have a future in interior lining [products].*

By day three, students had a better understanding of the type of process and product developments that were expected. Each group of students created a return brief that highlighted their perspective of NSFP, the industry problem, opportunities they considered worthy of exploration and how they proposed to address them (framing and naming). Again, students immediately began exploring concepts by making (moving). Observations noted students typically spent a day developing each concept. Between concepts students would confidently and naturally reflect on the product and process. This reflection was later documented explicitly in their reflection journals (reflecting). Figure 4 illustrates the process the students used to satisfy the NSFP design challenge.

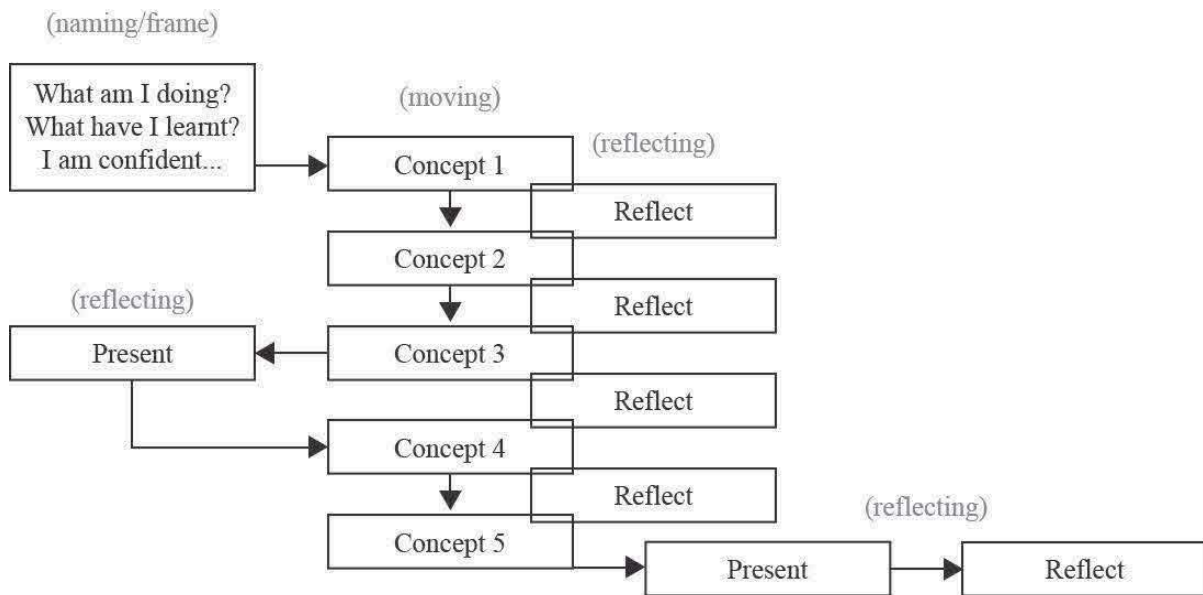


Figure 4 : Student reflective process use to address the NSFP design challenge.

Since the first design challenge the students expanded their design skills and ability to critically reflect on their process and product development. They were more confident with their concept execution and presented their work professionally to NSFP. More time was spent making and reflecting during the third NSFP design challenge as the students had learnt what the expectations of the academic studio outcome should resemble and what industry collaborators desired. The progression through figure 2-4 demonstrated that the students increased their ability to develop concepts beyond the initial ideation stage and were able to reflect on their practice. The act of reflection allowed students to justify their process and product developments confidently which assisted with their concept deliverance to NSFP. Final student reflections highlighted:

- *I have truly enjoyed the process of learning by making over the course of 10 days. I believe my ability to develop, analyse and critique both myself and other student's designs has progressed greatly.*
- *It felt good to produce something that would work in a commercial situation as opposed to only seeking budget solutions.*
- *Overall, the unit has me thinking so differently about how I go about my [future] work.*
- *I personally found this unit worked really well from a collaborative point of view.*

At the conclusion of the design challenges, NSFP representatives were present during the student presentations. While the focus of this study is not the student product outcomes, the use of tangible products proved useful to demonstrate student creativity and the LBM process to NSFP. This was an opportunity for students to engage in their groups with NSFP for feedback. This was also an opportunity to demonstrate the capacity of student skills to NSFP. This constructive reinforcement of industry engagement was important for the students to build a relationship with NSFP and to build student confidence in the lead up to the main NSFP design challenge. The same could be said for the experience gained from industry with design students, as they typically do not engage with designers.

#### Research Contribution

Student reflection on this academic and industry collaborative project demonstrated

enhanced student willingness to explore innovative timber design outcomes by using a product design and development process to solve a live industry problem. Initial design challenges that were simple in nature yet challenging enough to demonstrate the design process and the importance of understanding and addressing the design problem were critical to prepare the students for the main project. By resolving the design process through modelling and making, students had a better success with the tectonics as they are not removed from the abstract world of paper or digital modelling (Burnham et al, 2015; Hokstad et al., 2016; Salama, 2015; Wallis, 2007). Furthermore, student exposure to real-world practice in an industrial context substantiated this, as did involving key industry partners in student presentations and reflections. From the first to third design challenge, student's confidence and their ability to make informed decisions without guidance from studio lecturer increased.

Students gradually become self-motivated and driven to develop their ideas by prototyping and actively reflecting on their work. In addition to studio observations, explicit reflections in student journals provided evidence of transformative learning. The act of making followed by the act writing allowed students to better identify what they had achieved, what did not work and why, and justified how well they had address the industry and design problem. The reflection journal ultimately outlined the process that the students employed to development, prototype and refine their design outcomes. Reflections on sequential learning outcomes from design challenge one, through to three also helped the students prepare for the next design challenge and to address the unit outcomes.

### **Future studies**

This study reinforces the design literature that collaborative student learning environments between industry and academia can assist students build design competencies and therefore prepare them for industry employment. However, previous LBM studies by Wallis (2005) and Moon (2004) on reflective learning suggest difficulties are experienced in transferring knowledge to another educational context or workplace. This indicates the need for further research and developing ways that allow students to develop greater independence from educational contexts. Another limitation in this study was not all students explicitly communicated their new knowledge attained from the LBM unit in their written reflections. This suggests that while the opportunity was presented through the LBM unit, it may not always be immediately enacted by students who know how or why to reflect on these events. Other mediums of capturing student transformative learning could be explored such as daily video reflections and time-lapse of development work in studios and workshops. It would also be beneficial to conduct future studies with the same students prior to their graduation to see how they continued to develop their approach to industry projects as they gained more experience throughout their degree. There is also an opportunity to consider what impact student exposure to a global industry in two different context has on their professional development. Furthermore, incorporating and testing different methods to engage students in reflecting—taking into account the vexed issue of the influence of assessment—could be explored.

### **Conclusion**

Collaborative learning environments between industry and academia exposes design students to live industry problems that can help them develop new processes and built



confidence to approach design opportunities in the real-world. In this study, students generally improved their process and approach to design challenges as they progressed through the three design challenges presented. Key to this improvement was individual reflections by the students that highlighted new knowledge attained from the experiences. Student reflections documented in journals and observations of students in the LBM unit demonstrated evidence of design developments and an increase in design competence as students became more independent and self-motivated to develop products to satisfy an industry problem. This was illustrated by incorporating Valkenburg and Dorst (1998) mechanism of reflective practice against student's transformative learning process development. Industry collaboration also added to the students learning process as industry typically grounded the students work to ensure the outcomes were feasible and commercially relevant to the business. The authors of this study hope the findings in this research to be useful for developing student learning experiences and may help prepare students for industry employment after their studies.

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Nathan is a Postdoctoral Research Fellow from the ARC Centre for Forest Value, at the University of Tasmania. He is an Industrial Designer with a background in Timber Product Design and Development. His research delivers new knowledge on Australian plantation hardwood timbers in order to develop innovative applications with industry partners for the built environment.

### Dr Louise Wallis

Louise is Lecturer at the School of Architecture & Design at the University of Tasmania. She is active contributor to design learning and teaching research in architectural education as evidenced by her roles in national teaching grants (2006, 2009 & 2011) in Australia. Her published work focuses on influence of Higher Education Institutions on architectural studio models, instruction methods and the effectiveness of design/build studios.

### Michael Lee

Michael is a Senior Technical Officer for the Centre for Sustainable Architecture with Wood (CSAW) at the School of Architecture & Design, University of Tasmania. He has years of experience in the timber industry, predominantly in senior testing, technical and project management positions. Michael coordinates the daily running of technical aspects of CSAW's Tasmanian Timber Promotion Board and provides a vital link to the timber industry, general public, designers and architects.

### Associate Professor Gregory Nolan

Gregory is an Associate Professor at the University of Tasmania's School of Architecture and Design, and is the Director of the University's Centre for Sustainable Architecture with Wood (CSAW). He has published in books, journal articles, and conference publications, all with a key focus in sustainable design, environmental aspects of construction and building performance, as well as the broader use of renewable materials in the built environment.

Gregory is an experienced research manager and has directed and conducted numerous industry funded projects.

### Megan Last

Megan is a marketing professional, who at the time of the LBM unit was the Marketing and Product Development Manager at NSFP. She currently runs her own timber company working with industry to develop new products and markets connected to out-of-grade timber for the purpose of fully utilising and adding value to Tasmania's forestry assets.