Design that Builds Industry Skill and Capacity

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Abstract: This paper explores the potential for innovative architectural design to build industry skill and capacity, and support resilient regional economies. It is a result from a final-year student Advanced Design Research (ADR) project at the University of Tasmania’s (UTas) School of Architecture and Design that focussed on the University’s $300m Northern Transformation program (NTP). The students followed a mixed methods approach to seek to understand the potential for collaborative building design processes to develop Tasmanian industry, and through their findings, support those active in overseeing the building program maintain the conditions for this to occur. By the process’s end, the team was able to generate and present a cohesive document, outlining aspects of innovation and capacity building through design as well as providing 15 guidelines for the potential implementation of innovation. This paper sets out the team’s methodology and the five major themes and fifteen guidelines for improving the likelihood of successful design and construction innovation are presented and discussed.

Keywords: Design; innovation; research; industry.

1. Introduction

This paper explores the process undertaken by final-year Masters of Architecture students who explored the potential advancement of innovative architectural design through their involvement in a structured research process and distribution of results to the project’s clients, potential design and construction professionals, as well as other members of the wider community. Innovation is the process by which organisations successfully transform the products of research, new concepts and ideas, into improved products, services or processes, in order to advance, compete and differentiate themselves (Baregheh et al. 2009). However, innovation is not a simple linear process. Building design innovation is particularly messy, uncontrollable, unpredictable, and difficult to define (Loosemore 2014). For innovation to be achieved, it needs to be thought of as much more than an outcome. The complexity of the innovative process needs to be understood and the likely consequences of innovation need to be recognised and addressed from the start of the project. Successful innovation cannot be an afterthought. It has to be intertwined and realised during the building’s procurement process.

As part of the government-funded $300m Northern Transformation Program (NTP), the University of Tasmania (UTas) is developing new or largely enhanced campuses at Burnie and Inveresk in Tasmania’s north. One of UTas’s aspirations for the included building projects is to increase the productive capacity
of Tasmanian industry and local communities where possible, and its design brief for the first project encouraged tendering design teams to adopt ‘innovative construction methodologies... supporting the development of Tasmanian industry...’” (Castles, 2017). In response to this call, an Advanced Design Research (ADR) selective titled “Design that builds industry skills and capacity” was proposed for final-year Architecture students from UTas. An ADR selective is unit structured to allow students and supervisors to work together to undertake research projects that engage with both empirical and applied processes, as well as speculative and theoretical investigations (Norrie and Owen 2013). Eight students joined the ADR team and expanded the selective’s title to a key question of: how can architectural teams use their skill in innovative public building design to collaboratively develop regional industry skill and capacity, and community resilience?

The team’s research sought to understand the potential for these processes and, through their findings, support those active in the NTP to maintain the conditions necessary for innovation and regional capacity building. As the ADR was held before any of the project consultants were appointed, the team’s activity focused on the initial process stages where client and user groups, building design and construction professionals, and community members, were coming to grips with the opportunities and challenges that a large and potentially transformative building construction program presents.

2. Methodology

The ADR team used a mixed-methods research process to explore these questions, and followed a common process for a project of this type. This contained a review of literature and current practice, interaction with an active project to test the themes uncovered in the review, synthesis of the findings and observations into a report, and refinement of these findings and observation after external review into a document suite for distribution. This process aligned with the unit’s assessment tasks which required a research proposal and literature review initially followed by a research report.

The first project stage was the literature review and this occurred concurrently with the first round of project interaction. Without experience in innovative design or industry development, the ADR team began by developing its expertise through a broad literature review and repeated discussions of the uncovered findings and themes. To effectively manage this process, the literature reviews initially focused on documents covering four areas: the UTas building program; the profile of Tasmania’s productive building-focused industries; the broad process of innovation; and case studies of innovation in building design and construction. As the literature review progressed and findings were discussed, the team uncovered several consistent shortcomings in the available documents. Firstly, while the literature showed that universities and similar organisations regularly stated the desire to encourage innovation and develop local capacity through their building processes, papers and case studies avoided discussing how this was or could be achieved. Available documents were regularly simple statements of design achievement or declarations of capability. Critical assessment or reflections on the process were lacking. Second, little documentation was available on the UTas building program or on the profile of industries who may benefit from interaction with it. The group realised that understandings about these areas would have to be developed through research-in-action interviews.

The second project stage was project interaction. This was a vital part of the research and involved the collection and assessment of first-generation information through interview, site inspections, and other observation. The University client group, key government and community participants, members of industry and the design professions, and interested stakeholders were interviewed. While instigated by the ADR team, interviews were largely two-way affairs. Those being interviewed wanted to learn about
the NTP as much as the ADR team wanted to learn about their views and activity. While not an intended outcome, the ADR team effectively encouraged those interviewed to consider how they could shape or benefit from the program. The interviews and site visits also allowed the team to begin to develop and test an understanding of local industries or industry sectors available and open to development, and the form this development might take. The interactions with local professionals helped them realise the type of experiences that they may encounter post-graduation. They found that a common misconception with those interviewed was that innovation only relates to a product. Although innovation can involve products such as building materials, mechanical components, or services, the literature showed that innovation includes improved methods of construction, documentation precision or approaches by the designers, organisational methods of communication and skills, and risk management procedures.

The project interaction stage revealed other factors important in shaping the form of the final project report. Firstly, many people involved in the process had very little understanding of the building design and procurement process. Secondly, very few people had a broad understanding of the Tasmanian industry and its capabilities. Most industry members could speak confidently of their own sector but had very limited knowledge of other closely aligned industry sectors. Next, there was considerable uncertainty in how the building procurement process should be structured to enable the client group, the designers and industry to work together to achieve innovative outcomes that also built industry capacity. Lastly, the potential beneficiaries of innovation and capacity building were poorly recognised. As such, this group could not be mobilised to support the process. Recognising these factors, the group identified that their final report could be a valuable tool on overcoming these constraints on innovative processes. This was where the document could be most useful.

The final stage of the project was a synthesis of the findings and observations into a report. This began with the discussions held during the literature review and project interaction stages, and continued through to the report’s final review and dissemination to stakeholders. The ADR team originally planned a report based on thematic briefing papers and case studies. However, after viewing an initial case study paper, members of the University client and stakeholder group encouraged the team to make a bold pitch of ideas on how the concepts of innovation and capacity development could be advanced during the design process. In effect, they wanted a series of propositions to which they could respond and distribute to others for their response. In its final form, the document contains a suite of fifteen guidelines included in Part 4, five thematic briefing papers described in Part 3, four building case studies linked to the briefing papers’ themes and an appendix of addition case study summaries and interview notes.

In response to the potential constraints identified during the project interaction stage, the ADR team prepared a flexibly formatted document. Written for a general audience and designed as stand-alone documents, the briefing papers and case studies sought to encourage a greater understanding of the potential for innovation and capacity building while providing examples of it in action. Simple illustrations were used to communicate each of the guidelines. These guidelines were a crucial part of the document as they summarised the ADR research findings into a digestible format for easy communication with all parties involved with the project. After reviewing the papers, a member of the University client group stated that all the briefing papers would provide them with a solid starting point for their own thinking about the possibilities of the NTP, and in addition, gave new ideas about different types of approaches to “building as research”; “research by design”; and “innovation” (Kirsten Orr, pers. comms, 14 June 2017).
3. Thematic Briefing Papers

The final ADR report included five thematic briefing papers covering: sustainable development in buildings; the participants in the building procurement process; risk handling and procurement; and two aspects of innovation in construction. Unlike the case studies which simply reported key aspects of other building projects, these briefing papers were a direct result of local industry feedback, observation of participant capacity and the academic reviews of literature directly relevant to the implementation of innovation. Though the students had limited knowledge on each of the themes prior to engaging with local industries, they developed each of the papers for a general audience. The double A4 format of the briefing papers aimed to both inform and prepare the multiple participants in the involved industries, and aid the relevant professionals to understand the complexity and sensitivity needed in the design process if the full advantages of innovation in the NTP are to be developed.

3.1. Briefing Paper 1: Sustainability

This briefing paper attempted to outline the benefits of sustainable design considerations for the NTP. The term ‘sustainability’ is often talked about with little understanding of its meaning in the built environment. The briefing paper identified five areas of environmental considerations that can reduce the reliance on energy, benefiting the environment, and reducing the running costs. The paper summarised sustainable approaches that could be introduced into the NTP design to develop a healthy working and learning environment, and decrease cost of construction and cost of operations. The outcome of this briefing paper was consolidated into a series of guidelines aimed at achieving carbon neutrality during the building’s construction and operation, and developing a driver for the use of local materials and systems to help improve industry skill and regional economic growth.

3.2 Briefing Paper 2: Participants in the building procurement process

This paper examined the participants of the building procurement process and discussed their potential relevance to work planned under UTas’s NTP. The briefing paper outlined the role of each participant and their actions in different phases of the building procurement process. Every building procurement process includes many participants acting together through a series of seven distinct phases, ranging from the brief formulation to construction. When innovation is a desired outcome during this process, collaboration between building professionals and other participants is critical for its successful implementation. The general nature of the research was established to help communicate where innovative ideas and strategies could flourish within a real-world scenario, dividing the construction and documentation process into the different parties involved in the various stages and identifying which party has influence at each specific stage.

3.3 Briefing Paper 3: Managing the risk of innovation

This paper attempted to identify common risks that arise during innovative procurement processes, as well as how these risks could be managed to reduce setbacks and cost implications. To fully understand how innovation can be developed during the procurement process, an outline of common risk management techniques was investigated and framed in ways relevant to potential innovation in the UTas NTP’s design. The work identified three areas of critical risk during the procurement stage that can be managed through an analysis of their potential to arise and the severity of their effect. Through identifying, quantifying, and finally controlling risk, innovative techniques could be included in the NTP’s
design without the potential for them to be heavily revised or eliminated, in favour of more conservative options due to risk. This briefing paper helped in establishing the guidelines on risk vs reward, as well as encouraging innovation through managing risks, and establishing a framework for assessing risk.

3.4 Briefing Paper 4: Innovation in design

This paper attempted to define innovation and the connections it could have to the procurement process. It discussed the relevance of innovation for universities, outcomes to relevant industries, quality of practice, innovation’s messy tendencies, and the collaboration between participants in innovative design compared to traditional methods. Within this paper, innovation is described as a multi-stage process through which design can be modified into three aspects; new/improved products, services or processes, to distinguish, improve or to be competitive within the industry. The paper also examined innovation within the industry through incremental improvements from poor, standard, best, and innovative practices. The paper resulted in the guidelines for: demonstrating UTas’s research capability in the building, enabling further education for the broader community, encouraging innovation and manage the risks, and enabling effective collaboration between industry and design teams.

3.5 Briefing Paper 5: Capacity of innovation

This paper identified different practice methodologies to understand where innovation could be developed during the projects’ construction and procurement phases. In response to UTas’s brief, as well as the ADR team’s research question, the issue of quantifying the capacity of local industries become apparent. While the construction industry is a key player in this process, the review focused on the capacity and capability on broader local industry development, and discussed how various players can collaborate to drive improvements in productivity through new innovative technologies. The paper indicated that the NTP could act as a catalyst to Tasmania’s economic growth, while also building up community resilience by adoption of innovative construction methodologies. Through the examination of cross industry participation in improving the efficacy of innovation, the NTP could adopt these strategies by enabling cross disciplinary consultation through various inputs by surrounding local industries. This is included in many of the guidelines that focus on collaboration and organisational improvements to benefit the implementation of innovation.

4. Guidelines

In addition to above briefing papers on key themes uncovered in the literature review and project interaction stages, the ADR final report included fifteen guidelines grouped under their focus on innovation and capacity development during the building, engagement, and procurement phases. The guidelines proposed strategies and opportunities for potential professionals and building client groups to adopt to encourage innovative practices during the NTP.

4.1 Building 1: Demonstrate UTas’s research capacity in the building

The NTP buildings can demonstrate UTas’s capacity in research and development to provide a test platform for material and physical sciences, health, education, and other research areas. One way to achieve this is to allow research or experiments based on altering, adapting, or assessing various parts or components of the building. The briefing paper of innovation...
stated that universities can create platforms for researcher to build and test the outcome of innovation. Researched case studies illustrate the building as a test bed to improve research findings through continuous development and expansion of the building (Johnson, 2016).

4.2. Building 2: Use local material and systems to develop industry skill

The buildings’ design, construction techniques, and component configuration could be based on the innovative use of local materials and fabrication skills. This can increase economic growth in communities and build regional capacity and capability. The briefing paper of capacity suggested ways to improve industry capacity through innovation. These include supply chain integration, technology refinement, and skill development (Loosemore, 2015). The case study of Bioscience Nottingham University shows the use of local materials in order to reduce the transportation cost and time. This building acted as a constructed example for local industry (Welch, 2010).

4.3. Building 3: Achieve carbon neutrality during the building’s construction and operation

Aspiring to achieve carbon neutrality in the buildings’ construction and operation can demonstrate a commitment to a low carbon future. Preisig et al. (2001) suggested that environmental damage can be controlled and reduced if the designs corresponds to no more than the need required for space, comfort and technology. The case study on the UTas School of Architecture demonstrates various way in achieving sustainability through construction and operation with a high-technological approach, and retaining original building structures (Owen, 2007).

4.4. Building 4: Incorporate data and sensor connectivity

Local industries and practitioners have suggested that technological capacity could drive change in the further development of a building’s design. Such cumulative data recorded could be analysed by researchers, with adjustments made to the corresponding areas of the building’s fabric (Williams, 2017). Participating in data and sensor-based research and developing uses for the information is a world-wide trend and one from which the University and the State could benefit.

4.5. Building 5: Enable varied teaching and learning methods

Modes of teaching are varying with the increased potential of digital communication and the needs for students to learn additional skills. Alternative teaching methods need varied teaching spaces that stimulate teacher and student activity, and increase the value of their interactions.
4.6. Building 6: Employ a modern, prefabrication construction process

Site based construction is subject to unexpected delays due to its exposure to the elements, and its reliance on a site-based tool kit. Precise and more efficient construction is possible through advanced prefabrication and assembly techniques. Experience with prefabrication can build industry’s capacity to deliver improvements on these and other projects. The process of prefabrication allows one to conduct material testing and enable the production to work with the supply chain capacity more easily. Case studies (NRAS Inveresk, TRUTEC, etc.) demonstrated that this process can avoid unexpected on-site conditions.

4.7. Engagement 1: Recognise the profile and capacity of local industry

Tasmanian industry is capable of manufacturing building materials, assembling them into components and sub-assemblies, and combining these efficiently into buildings of different scale. Recognition of industry’s current capability and capacity can allow designers to work to industry’s strengths, and develop an understanding of what the community can achieve. Design teams can selectively cooperate with local businesses based on their potential development (Leibinger, 2006).

4.8. Engagement 2: Enable further education for the broader community

Considerable potential exists to increase the community’s educational aspirations and remove barrier to its achievement. Innovation within the building can be explicit and draw the community’s interest. Thus, the design of the educational precinct and its buildings can contribute to broader acceptance of the University and the benefits of ongoing education. The Dr. Chau Chak Wing building was used as a test bed for research and widely published to the public. (Calzini, 2015).

4.9. Engagement 3: Use the buildings for industry-connected research

Effective research collaboration between industry and universities is important to regional development and economic well-being. Innovation within universities can take the form of a continuous exchange of ideas and experiences. When these are shared through collaboration between academic and industry players, significantly higher success rate for research implementation can result. Meaningful collaboration of this type requires spaces where industry feels comfortable and welcome, and equipment that either complements industry’s suite or demonstrates additional capacity. This collaboration is illustrated in the University of Wollongong’s Sustainable Buildings Research Centre (Huntsdale, 2014).
4.10. Engagement 4: Consider the impact on local housing provision and commercial services

The developments at Inveresk and Burnie will generate demand for housing and increased commercial activity near the campuses. While provision of these services is private enterprise’s responsibility, the University and local councils have a role in encouraging orderly and balanced provision, and safeguarding student well-being and community benefit. For example, UTas’s’ Markers’ Workshop in West Park Precinct is a major investment by the Burnie City Council to link and enhance the scale of self-manufacturing industries and delivery port services (Maker’s Workshop, Burnie, Tasmania., 2017).

4.11. Procurement 1: Structure project scope for local participation

Completing the NTP’s building projects in the expected delivery time may stretch the capacity of Tasmanian design, construction and building component manufacturing sectors. Based on practice experience, local industry practitioners suggested that attention is required in project scope and structure method by considering the local economic scale and means of operation (Higgs, 2017). Grouping projects into one package may effectively exclude local participants. Separating projects into discrete packages can improve local participation and generate diversity in the solutions.

4.12. Procurement 2: Encourage innovation and manage the risks

Innovation can deliver rewards through construction saving, quality improvement, or efficient building operation. However, innovation generates risks for the participants as new processes may not deliver expected outcomes. Recognising and managing these risks is part of any successful innovation process. The briefing paper -Managing the Risk of Innovation examines literatures and outlines several types of risk and methods of management. These concepts are commonly practiced in the industry and are evident across of different successful case studies such as the Dr Chau Chak Building, and the Visual Art Building, University of Iowa.

4.13. Procurement 3: Enable cross-disciplinary innovation

It is pointed out that an integrated cross disciplinary cooperation is essential for successful procurement of innovation (Loosemore, 2014; Nolan et al., 2016). Academic researchers, industry and building design professionals can each gain from contributing to innovation in the buildings’ design, construction and operation. Mechanisms should be in place to facilitate their participation. Case studies (NRAS Inveresk, RMIT, etc.) demonstrated different ways of engagement and some of the methods that can be potentially adopted into the NTP. Researchers acts as catalysts in the process and can assist participants to understand innovation and its risks.
4.14. Procurement 4: Enable effective collaboration between industry and design teams

Collaboration is an essential ingredient for successful innovation, yet effective collaboration requires time for relationships to develop and for options to be explored. Tight project schedules and complex tendering requirements can restrict open collaboration and limit the potential for participant benefit. It is important to organise and engage major participants in the early stage of the process where solutions can be jointly developed (Loosemore, 2014). However, the industry participants pointed out that procurement can be messy and unpredictable (Higgs, 2017). Case studies such as the Dr Chau Chak Building, and the Visual Art Building, University of Iowa show that active engagement and collaboration across participants are essential for successful innovation procurement.

4.15. Procurement 5: Share the risk and reward of innovation along the supply chain

Collaboration minimises the risks that innovation generates. However, this demands each collaborator invest time and resources on the hope of future benefit. Loosemore (2014) raised the point of sharing risk and reward along the supply chain, where the processes should insure that those exposed to risk and who invest in collaboration share in innovation’s rewards. This creates a motivational environment across all participants for active collaboration and innovation procurement.

5. Conclusion

This paper explored the potential for final-year architecture students to act as catalysts for innovative architectural design practice through their involvement in a structured research process and active dissemination of results to the building clients, potential building design professionals, and members of the wider community. The use of a mixed-methods research process to explore the team’s research question through multiple reviews of literature and current practice and interaction in an active project to test the themes uncovered in the review, enabled them to synthesis the findings and observations into a report, and refine that output through external review. The ADR report discussed five thematic briefing papers covering sustainable development in buildings, the participants in the building procurement process, risk handling and procurement, and two aspects of innovation in construction. These briefing papers were a direct result of local industry feedback, observation of participant capacity, and the academic reviews of literature directly relevant to the implementation of innovation. The final stage of the ADR report included fifteen guidelines grouped under those that focused on innovation and capacity development through the building, engagement, and procurement processes. These proposed strategies and opportunities for potential professionals and building client groups to adopt innovative practices during the procurement, community engagement, and building construction processes of the NTP.

Through this continual process driven research, the team were able to effectively prepare a document that could be disseminated to multiple professionals with the aspiration to inform them, as well as the local community, on the importance of innovation and local participation.
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