Advancing Architecture’s Capacity through Education to Embrace Changing Technologies, Resources and Traditions

Professor Gordon Holden
Foundation Head of Architecture
Griffith University,
Australia

g.holden@griffith.edu.au

Abstract

It is widely acknowledged that the built environment contributes approximately half of global energy use and that many past and current design and construction practices are unsustainable. Education is obliged with a responsibility to prepare future generations of graduates with capabilities to address the challenges. Accreditation criteria incorporate aspects of sustainable design but change is needed for the sustainability agenda to be taken sufficiently seriously to impact on the future. A conceptual framework for education in sustainable design is needed. Pedagogical techniques that encourage clarity of outcomes evaluated against explicit criteria with critical reflection can prepare the new graduate with values, knowledge and skills appropriate for the responsibilities that will be expected of tomorrow’s professional. This paper discusses three educational case studies that demonstrate the capacity to address changing technologies, resources and traditions. They offer transferable guidance for architecture education more widely.

Keywords: Architectural education, Sustainability
1. Introduction

In Australia and New Zealand the degree to which architecture programs engage with sustainability appears to be variable. A content scan of the Australian Institute of Architects document ‘Architecture Schools 2012’ shows that of the twenty accredited programs, only six explicitly refer to sustainability in their program structures. All programs are assessed against the competencies required for accreditation under the Architects Accreditation Council of Australia requirements including: 1.1.2 (09) The design concept demonstrates respect for the natural environment and awareness of the issues of sustainability, and 1.4.1 (52) The detailed design demonstrates that all building elements are sufficient and appropriate for construction intentions and environmental sustainability.

The problem with architectural education for sustainability in Australia and New Zealand is seen to have four dimensions: first, uncertainty as to how and with what rigour the accreditation policy requirements for architecture graduates to be competent in the design of sustainable buildings are evaluated – the solution to this appears to lie in the development beyond broad policy, of more explicit criteria and expectations? Second, and with deep respect to accreditation panel members, there appears to be too-few panellists who have expertises in the field of sustainable design to deeply engage with the subject – the solution to this lies in improving panel competency. Third, there is an absence of a conceptual framework for considering sustainability education and finally there are too-few published resources available to inform architectural educators about ways to teach sustainability – the solution to the two latter dimensions is seen to lie in establishing a conceptual framework and in publishing case examples. The recent documents directed at the European community ‘Sustainable Architectural Education’ and ‘Criteria for Professional Qualification’, both edited by Dr Sergio Altomonte, University of Nottingham, offer valuable contributions but the equivalent is needed for other parts of the world. On the face of it sustainability matters appear to receive insufficient attention in architectural education accreditation in Australia and New Zealand, with consequential too-little attention in the schools.

The intent of this paper is to within a briefly discussed conceptual framework add to teaching awareness and resources through discussing three very different types of student projects that explore aspects of sustainable design in architecture.

2. Conceptual Framework for Education in Sustainable Design

Accreditation criteria in Australia and New Zealand are not intended to be prescriptively rigid. The philosophical milieu for accreditation embraces the concept that each architectural program should be encouraged to interpret the criteria and explain their approach to accreditation assessment panellists, who in turn exercise professional judgement as to the relevance and quality of the outcome. This is intended to encourage diversity and creativity across architecture programs, which is considered to be robustly healthy for the architectural profession with flow-on benefits for the wider community. However increasing legislative requirements for the performance of buildings are impacting on the diversity of approaches to curriculum. A conceptual framework that scopes from principles to detail as well as incorporating values and identifying challenges is required. A framework that accommodates legislative requirements, yet facilitates creativity is considered to be appropriate in developing the knowledge, skills and competencies needed to address the complex field of sustainable design (Altomonte, 2012).

The foundation stage for sustainable design education should address principles and values from a global environment scale to site detail followed by pragmatics about buildings and knowledge of architecture and human habitation. This establishes core knowledge, upon which design projects can be selected that facilitate the development of design skills influenced by contextual, cultural and theoretical matters as well as legislative constraints, possibly with different emphasis across course levels. Progressing through the program, the student gains experience with concomitant higher competency expectations at senior levels.
This framework embraces knowledge and skill maturation, reflective critical abilities and increasing sophistication of communication.

The cases that follow build on the foundation stage, ordered from medium to advanced level. They demonstrate different knowledge, skills, and competencies and they collectively show numerous dimensions to sustainability. They engage with wider architectural issues as well as social, environmental, economic and technical matters and overall they seek to develop in students a research underpinning to design. The pedagogical approaches have in common that they integrate knowledge and establish evaluation criteria for design solutions.

2.1 Case Study 1 – Eco Retrofitting

This second year level case study describes a course in eco-retrofitting of the built environment, which is seen is an essential prerequisite of true sustainability. The course shares some aspects with case study 3 – building on top, but is more focused through mainly addressing technical aspects of sustainability.

From a whole systems perspective, the built environment drives about half of energy use, greenhouse emissions, and solid waste and material flows. Only 2% of buildings are new each year, and only half the energy consumption of building is in operating energy (the rest is used in construction). So even if all new buildings were green they would do little to reduce the growing rate of consumption and pollution. Given that development has exceeded the Earth’s ecological carrying capacity, a significant reduction in negative environmental impacts is only possible if we retrofit existing urban areas. Built environment professionals should appreciate that, through better planning, engineering and design, we can retrofit the built environment to save money, increase ecosystem services and the life support system, while improving human health and productivity and social capital.

The aim of the course was to make students aware of design and innovation strategies, mechanisms and incentives for eco-retrofitting the built environment - from building components to cities and bio-regions. Students explicitly learn to:

1. Appreciate the ongoing impacts of the existing built environment and the need for eco-retrofitting to achieve sustainability;
2. Recognize the positive potential of eco-retrofitting on all scales to improve human health and increase natural, cultural, and social capital;
3. Understand how eco-retrofitting can save money and resources, pay for itself in energy and water savings, and provide opportunities for designers;
4. To look beyond the narrow choices framed by conventional debates on building types and urban form to discover more creative design options;
5. Realise the potential to create incentives for adding value to existing environments through low-risk and profitable investments in eco-retrofitting

Students participated in small groups each week in short (2hr) design exercises based on weekly readings. This gave students experience in interpreting theoretical and technical understanding whilst working collaboratively. Later in the semester students selected a design that they had prepared in an earlier semester, in another course and with their new knowledge about sustainability they retro-designed their project to lift its sustainability performance. They needed to demonstrate improved performance.

By working on their own design, students cemented ownership of the upgraded design and engaged in critical reflection of their own earlier design proposals, which otherwise would not have been revisited. This is considered to be an attribute of value for future architects.

Images 9 and 10 show two of eleven panels by student Zhengyi Liu which illustrate his ecological retrofitting proposals for a field station design that he had prepared for a different course the previous year. His analytical reflection and new knowledge led him to propose design refinements including: better use of natural ventilation; substitution of high embodied energy building materials for those with low embodied energy; use of advanced technologies
for water collection, treatment and recycling; improvement in the site’s biodiversity through selective planting and surface treatments; establishing a ‘green’ roof for better insulation; modifying eaves overhang to better control sun; and, installing solar energy collectors and solar water heating.

The knowledge gained from this course prepares graduates with valuable abilities for the design of new buildings but highly significantly it will also give them the capability to engage in an effective and positive way with the existing built environment, potentially adding to its sustainability performance. Based on a pilot survey of expression of interest, it is planned to offer a similar course directed at professionals in practice for continuing professional development.

Image 9, student Zhengyi Liu eco-retrofit proposal for a field station design (Zhengyi Liu, 2012)

Image 10, student Zhengyi Liu eco-retrofit proposal for a field station design (Zhengyi Liu, 2012)
2.2 Case Study 2 – Urban Design and Public Health (Kurko, 2012)

A independent research project undertaken by third year architecture student, John Kurko, investigated the relationships between urban design and public health. This was sparked by Australian Government data showing that over the next thirty to forty years the country will be heading toward a situation where expenditure demands on public health will compromise all other areas of national need. Through literature research the student concluded that if public health expenditure can be reduced then the gap between projected expenditure and revenue can close giving greater economic capacity and security for the nation. The key point is that Australia should be seeking to assist the community in gaining a healthier profile for the well-being benefit of all citizens. Improving the performance of the built environment so as to encourage people to exercise more is arguably a very effective way to benefit public health, with there also being potentially significant positive flow-on to the benefit of the economy.

It is widely understood that the lack of physical activity is one of the major risk factors for a range of diseases several of which are life threatening. It is also known that regular walking and cycling promote health by providing physical activity as well as contributing to decreases in environmental factors related to noise and air pollution. Design of the built environment has implications for social, economic and environmental factors. Significant health benefits accrue from as little as 30 minutes of walking or cycling several times per week, related to obesity, heart diseases, diabetes, hypertension, osteoporosis, depression and anxiety (WHO, 1999).

Figure 1 Social, economic and environmental benefits deriving from Mixed Use & Connectivity (MfE, 2009).

Figure 2 Community cost deriving from traditional urban-sprawl development (MfE, 2009).
A key impediment to more people regularly engaging in physical exercise is the quality and utility of the designed environment especially relating to mixed use and connectivity of elements of the built environment. This is shown diagrammatically in figure 1, while the implications of maintaining the status quo ‘sprawl’ of Australian and New Zealand cities is shown in figure 2.

Local Government has a range of built environment responsibilities and through leadership can play a crucial role in increasing physical activity by creating enabling environments and opportunities for activity that are tailored to local community needs (Edwards and Tsouros, 2006). Generally across Australia the link between public health and the built environment has been inadequately addressed (Matysek, 2011). However Billingen Shire on the mid North coast of NSW is one local government that has engaged with improving active living opportunities through revised legislation, through new initiatives and through modifications to existing urban form (Heart Foundation and Billingen Shire Council, 2011).

Following a literature review and analysing survey data initiated by the student that showed that there is a wide public preference for healthier urban development, the student investigated the Billingen town case study. Informed by Australian Heart Foundation workshops that investigated urban design improvements that have been shown to encourage people to walk and cycle more, Billingen established a Local Environmental Plan that strengthened the statutory basis for healthy planning. This included: the Community Facilities and Open Space Contribution Plan; the Pedestrian Access and Mobility Plan; and, the Local Roads and Traffic Infrastructure Developer Contribution Plan. Collectively these plans provided for developer and council contributions for the building of a network of cycle and pedestrian paths, the provision of seating, drinking fountains, bicycle racks, lighting, signs, tree planting and shade structure. Billingen has created for itself a more aesthetically pleasing, more safe, more convenient and accessible and a more pedestrian friendly town with the consequence that people are healthier.

The work crystallised understanding about key links between urban design and public health. The student formally communicated this to an audience of academics, researchers and practitioners at the 2012 Architectural Science Association Conference. This work contributes to architecture’s body of knowledge focusing on urban sustainability and is an example of research underpinning more sustainable urban design practice. The student showed that there is sufficient evidence to conclude that modifications to the built environment are needed to support the health and well-being of the community as well as addressing the economic crisis (Heart Foundation, 2009). He showed that it is at the Local Government level where meaningful action must take place but he also found that this is not where the resources are normally available or where the cost burden sits. He advised that unless State and National health policy and funding priorities are changed to strengthen preventative health expenditure as well as to direct resources to local government, there may be insufficient take-up at local government level to make a positive difference.

This case study demonstrates an aspect of architectural education for sustainable design that is wider in scope than that described in accreditation policy, but which is highly relevant for the built environment. It is an example of research-led education that has the potential to broaden the sphere of architectural practice.

2.3 Case Study 3 - Building on Top (Holden, 2005; 2007)

Noticeable in Wellington, New Zealand, are the relatively high number of new apartments constructed on the top of older buildings. Building-top apartments are a relatively recent phenomenon, dating only from about the mid 1990’s. Several are of high architectural quality, a few are eccentric, but most of them don’t excite architectural imagination (Images 1, 2, 3, 4). However, building-top apartments in Wellington communicate something special, possibly an emerging architectural character for a part of the city. Of significance is that by constructing new space on top of existing buildings a valuable contribution to sustainability is made.
It is well understood that the architectural design studio is the prime setting for students to acquire both explicit and tacit knowledge under guidance and support from tutors and colleagues. Most studio projects relate to buildings for which there are published precedents that contribute material for research reference. However the special characteristic of the building-top apartment studio was that there were very few published precedents, just a few case-study examples, and there is no significant material about the typology available. A key achievement of the studio was that unique research material was created.

This fourth year level studio research process included investigations into relevant historical and contemporary theory about architectural expression related to buildings being regarded as conceptually and physically complete objects. Other research investigated theoretical implications of additions being made to existing buildings and the challenges this presents to ‘building as object’ understanding. As a conjectured emerging typology, building-top apartments have received little published critique and the students identified important issues for their own project as well as for further research. Each group member undertook detailed research into existing building-top apartments, assessing them against a set of criteria developed from a critical assessment of case studies as well as being informed by legislation and urban design guidelines. By identifying criteria, students established the basis against which they could evaluate their design decisions and ultimately the performance of their completed design (Images 5,6,7,8).

Apartment typology was also studied broadly from international literature. Of significance to sustainability, students investigated the impact of constructing on top of existing buildings comparatively with demolishing the host building and building anew the same volume as the existing building plus the on-top additions.
Key findings follow:

2.3.1. Life Cycle Assessment
While recognising that building material extraction, manufacture and transport takes time, by far the longest phase in the life cycle of a building is the period of occupation. Costs associated with occupation include maintenance as well as energy consumed.

2.3.2. Cost of Demolition
Demolition where none of the materials are salvaged causes dust, noise, vehicle movements and disturbance in the immediate area. Demolition costs are assessed based on the likely volume of waste material that would be generated and transported from site in the demolition process.

2.3.3. Cost of Footings and Foundations
Complete demolition of the host building, removal of waste and construction of a new foundation takes time as well as incurring costs which could represent savings if the building is retained. An approximate 6% saving is available through avoiding the direct cost of demolition and of new foundations.

2.3.4. Landfill, Demolition and Construction Waste
Construction and demolition waste comprises a significant amount of the waste that goes to landfills, estimated at 17%. It can be argued that any project that reduces the quantity of waste going to landfill would be seen to improve national sustainability objectives.
2.3.5. Embodied Energy and CO2 Emissions
Embodied energy is the energy consumed in all activities necessary to establish a building, including direct and indirect energy. Direct energy includes that required to assemble the building while indirect energy includes energy embodied in the materials and products brought in from off-site (Alcorn 1998, 2003). Embodied energy quantum is sensitive to location of the project, mainly due to the energy required for transport of materials and workers to and from the site. Another significant factor is the source of energy. It can be confidently concluded that a significant volume of greenhouse gas will be avoided with any strategy to reuse an existing building rather than to demolish.

2.3.6. Overall Potential
The students concluded that compared with demolishing and building anew, to renovate and build new apartments on top of existing buildings represents a potential cost saving of up to 40%. Sustainability improvements derived from landfill, materials and embodied energy savings, with consequential reduced CO2 emissions, additionally contribute to this typology’s higher economic performance and sustainability than conventional redevelopment.

This student project achieved multiple objectives of research-led learning as well as contributing to architecture’s knowledge about typologies. It showed students an aspect of sustainable design that while not mainstream has the potential to significantly contribute to higher performing urban development while also expanding architectural theory knowledge. The knowledge that students gained was integrated across the relevant theoretical, social, technical and economic domains and it was assessed against student generated relevant performance criteria. Such an approach strengthens independent thinking and responsibility thereby preparing students for future practice.

3. Conclusion
The three educational case studies shown here were selected from a wider range within the author’s experience. Across these cases emphasis is placed on: research-based knowledge and skills development; integration of social, environmental, technological and ecological domains; and in preparing students to embrace creative change through critical independent thinking and accountable reflection. It is speculated that there are many other examples from other architectural programs that are likely to be valuable in preparing the next generation of architects to advance architecture’s capacity. But insufficient cases are being researched, categorized, critically discussed and disseminated to inform education and practice. The growing urgency from the looming energy and public health crises demands that architects and schools of architecture lift their knowledge and skills to ameliorate the situation. Essential in this is the need for accreditation policy development and monitoring to strengthen sustainability education within architecture programs. In parallel, continuing professional development for architects in practice that focuses on sustainability should be established.

Collectively architectural education and practice domains must take responsibility for built environments of the future equipped with the best knowledge and design skills available. Leadership response is needed to revise architectural education and practice with all participants agreeing on benchmarks.

The CAA is committed to advancing sustainability through education and knowledge transfer but even this body has scope to develop more explicit accreditation criteria and to disseminate further materials; thereby advancing architectural education’s capacity to embrace changing technologies, resources and traditions. Useful steps would be to develop and disseminate a conceptual framework for sustainable design education and to ensure that accreditation of architecture programs under CAA’s responsibility are meeting recognition criteria objectives regarding sustainability. Integral with this would be to lift the expectations of architecture education through revision of the current, somewhat broad, policy statement which calls for students to have “an adequate knowledge of the means of achieving environmentally sustainable design. Through its validation of architectural education that is
overseen by national procedures, CAA’s future work on sustainability will influence the Australian and New Zealand processes and outcomes.

References


