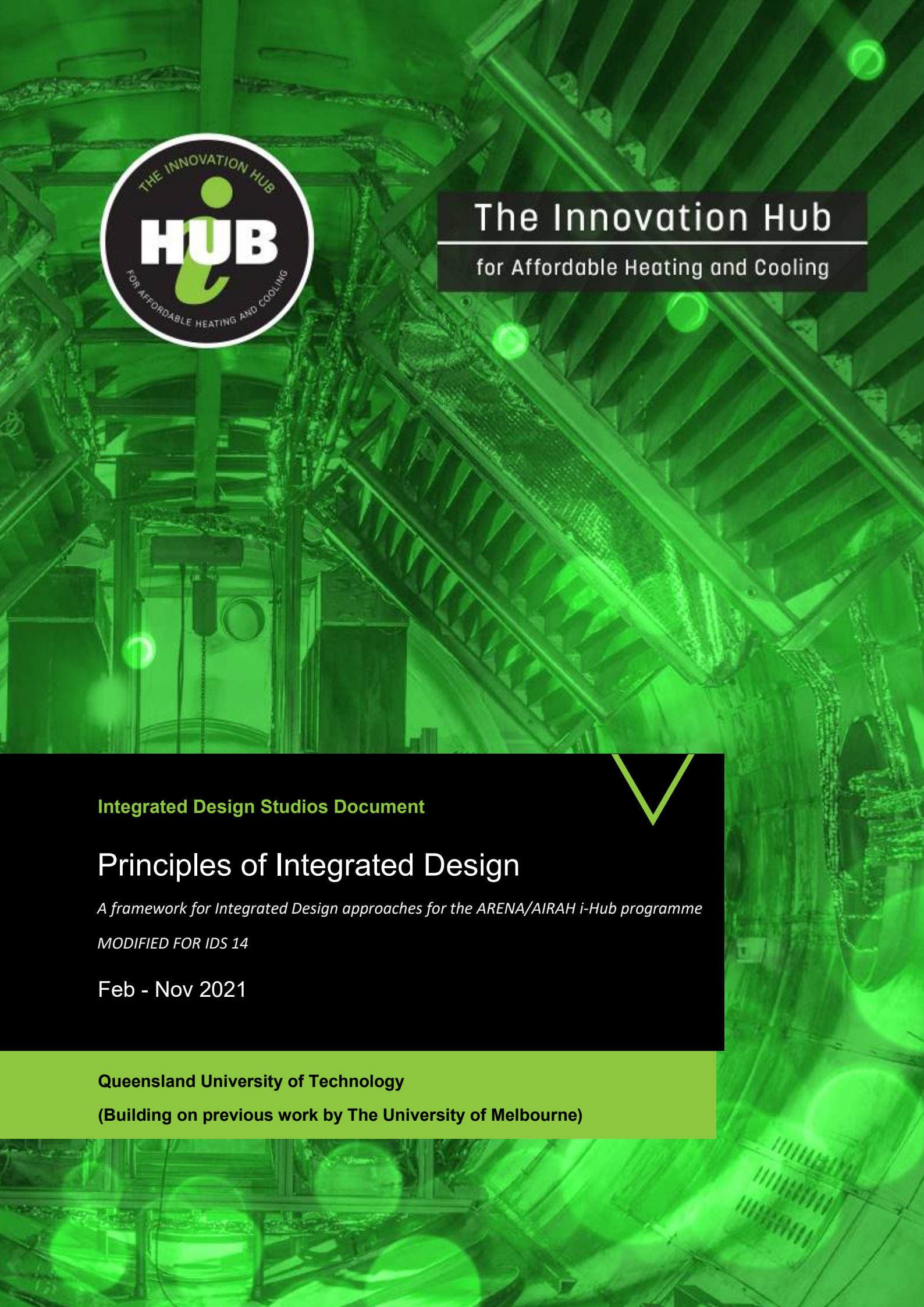


The Innovation Hub

for Affordable Heating and Cooling

Integrated Design Studios Document

Principles of Integrated Design

A framework for Integrated Design approaches for the ARENA/AIRAH i-Hub programme

MODIFIED FOR IDS 14

Feb - Nov 2021

Queensland University of Technology

(Building on previous work by The University of Melbourne)

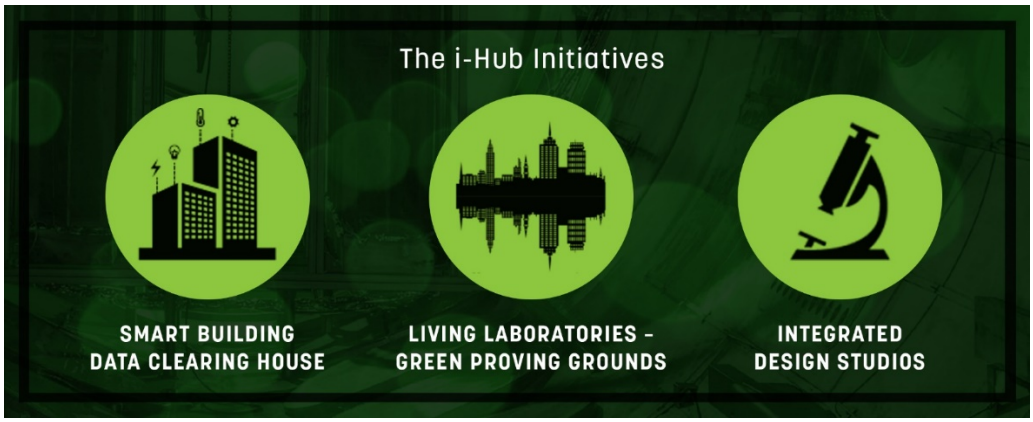
About i-Hub

The Innovation Hub for Affordable Heating and Cooling (i-Hub) is an initiative led by the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) in conjunction with CSIRO, Queensland University of Technology (QUT), the University of Melbourne and the University of Wollongong and supported by Australian Renewable Energy Agency (ARENA) to facilitate the heating, ventilation, air conditioning and refrigeration (HVAC&R) industry's transition to a low emissions future, stimulate jobs growth, and showcase HVAC&R innovation in buildings.

The objective of i-Hub is to support the broader HVAC&R industry with knowledge dissemination, skills-development and capacity-building. By facilitating a collaborative approach to innovation, i-Hub brings together leading universities, researchers, consultants, building owners and equipment manufacturers to create a connected research and development community in Australia.

This Project received funding from ARENA as part of ARENA's Advancing Renewables Program.
The views expressed herein are not necessarily the views of the Australian Government, and the Australian Government does not accept responsibility for any information or advice contained herein.

Primary IDS14 Partner



1. Introduction

In a collaborative process, such as architectural design, one would assume that activities are by nature integrated across different stakeholders. Achieving common design goals requires a high degree of collaboration and cooperation across professional boundaries, typically unfolding on a project level. Yet, feedback from design practice, as well as in-depth studies in existing literature, illustrate that design across disciplines is often *not* integrated. There exist many reasons for this schism. Some relate to tight project timelines, budget constraints, and contractual frameworks in practice. Others relate to professional boundaries that are deeply rooted in a disciplinary cultural context of isolation, a 'traditional mindset', and an education that occurs predominantly in silos.

The *Principles of Integrated Design* presented here offer an alternative to the status quo often encountered by both professionals and tertiary students (emerging professionals). It describes a pathway for design processes that embrace co-rationalisation rather than a sequential exchange of information that sits segregated within individual (professional) boundaries. It encourages connections to be made across disciplines, bringing new insights and ideas that would not have been apparent in one discipline alone. It encourages design outcomes where "the whole is much larger than the sum of the parts" (Aristotle). The way integrated design unfolds is as much about generating the right context, as it is about promoting and nurturing the integrated design process itself.

This document serves as a guide to the establishment of integrated design processes in multi-disciplinary design teams, in the context of the IDS research program. One of the early findings of the research was that integrated design processes need to be adaptable so as to cater to individual designer's preferred methods of working. This document should therefore be used as a flexible framework for discussion with the design team in question to structure an integrated design process that is bespoke to the situation at hand.

2. Context

The initiators of the Integrated Design Studios activity stream (University of Melbourne) spent nearly two years liaising with key parties to fine-tune the development of the IDS structure in its initial form that cut across architectural and engineering domains. It foresaw the involvement of design students from architecture and engineering backgrounds, who jointly developed ideas and design concepts with input from industry professionals and academic experts. The IDS 14 program builds on this initial IDS process by adding sustainability and construction management domains into the process. It provides a low-risk environment for emerging professionals and seasoned professionals from multiple disciplines representing the design-construct process of a building. This mixed-discipline, mixed-experience team will work collaboratively on common goals whilst closely observing the key moments/instances that lead to integrated design outcomes. As with the initial IDS projects, the intent of IDS 14 is to examine how early career and experienced professionals engage in both the process and outputs of strategic co-design. The general principles of Integrated Design Studios are shown in Figure 1. The IDS structure incorporates the

six levels of learning as presented in the modified Bloom's Taxonomy: remember, understand, apply, analyse, evaluate and create.

The Integrated Design Studio Process should...

Articulate common goals that are (equally) relevant to all professions (over individual goals by any individual profession).

Regard all participants as co-designers with joint ownership and shared responsibility.

Aim to remove all barriers between disciples and individuals (language, work methods, customs, availability, time, previous experience, seniority etc).

Develop empathy through allowing every participant to understand *what* the other does and *why* it is important.

Facilitate an environment where creativity and innovation can unfold. Too many, or too tight deliverables may constrain participants and limit their ability to explore novel design solutions.

Give all co-designers 'permission to fail' when searching for innovative and integrated design solutions.

Trigger participants to reflect on *why* they design in a certain way, over *what* the immediate output might be.

Facilitate an appropriate balance of group thought (time interacting) and individual thought.

Encourage co-designers to understand what the 'other' has to offer, and to value this in the interest of embracing and incorporating it into their own ideas.

Embrace design as an open-ended solution-finding process, not a process to solve well-defined problems.

Avoid focusing on detailed solutions too early as well as the production of captivating visuals that mainly address aesthetic aspects of the project.

Accept that integrated design can be messy, with many options to be explored and discarded early on, and results emerging from interactive collaboration.

Incorporate a flexible and non-judgemental structure to enable different skills and ways of working to be brought to the collective table to extract the best input from all co-designers.

Figure 1 General principles of Integrated Design Studios

The IDS process guidelines for IDS 14 are detailed in the following section. In brief this project consists of the bringing together of final year engineering and construction management honours students (emerging building services and construction professionals), Masters of Architecture students (emerging building designers), experienced practitioners in the same fields, and academics with industry and research expertise. This engagement process is undertaken for a period of 10 months (February – November 2021). IDS 14 will undertake this co-design process for a vertically integrated client who develops, owns and operates buildings that incorporate various aspects of aged care. The two sites nominated by the client are in tropical and subtropical Queensland (Cairns and Caboolture), presenting different climatic challenges.

The objective of this IDS process (shown in Figures 2-4) is to produce innovative and detailed design solutions that:

1. Are people-centred, improving residents' health, independence and quality of life
2. Integrate technical and functional performance and 'constructability' with the many other design aspects of mixed-use buildings
3. Appropriately address the climatic contexts (tropical and sub-tropical climates)
4. Demonstrate understanding of architectural, engineering and construction interdependencies resulting in prioritisation of passive solutions over equipment (mechanical/electrical).
5. Present an integrated systems approach to energy services in mixed-use buildings that take into account:
    a. The various and sometimes competing needs of building occupants (at any one time and over the life of the building)
    b. The provision of energy services, energy supply and demand technologies and profiles; and
    c. Interactions with other buildings, the electricity grid and the energy market
6. Enable flexible management of cooling demand and optimisation of renewable energy, as a step towards (near) net zero energy buildings.
7. Evaluate proposed solutions from a whole-of-life perspective that includes constructability, operation, maintenance, refurbishment and end-of-life.

Figure 2 Nine Priority Dimensions (Source: Burton, Iftikhar)

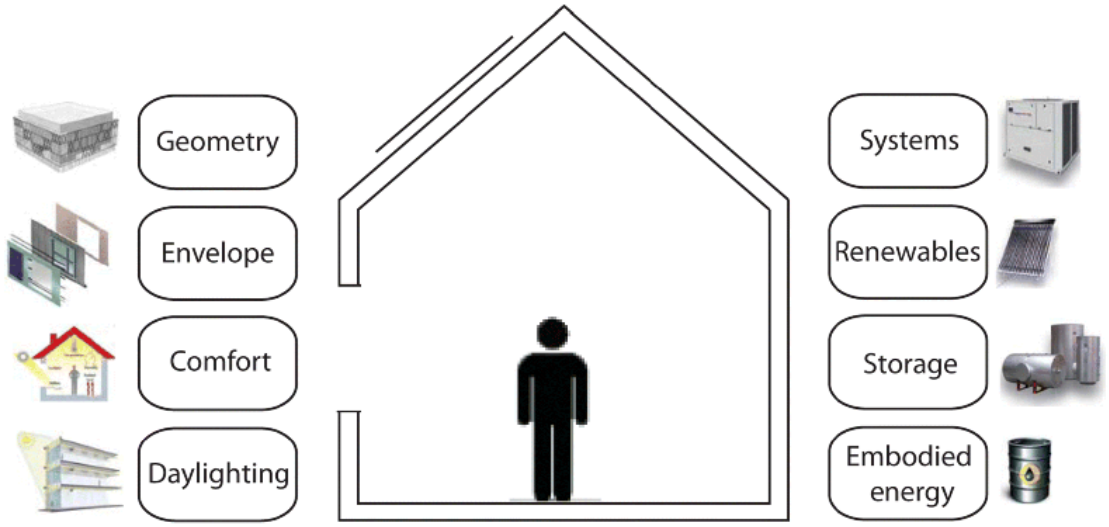


Figure 3 Architectural. Engineering and construction interdependencies

(Source: Modelling, Design and Optimisation of Net-Zero Buildings, 2015)

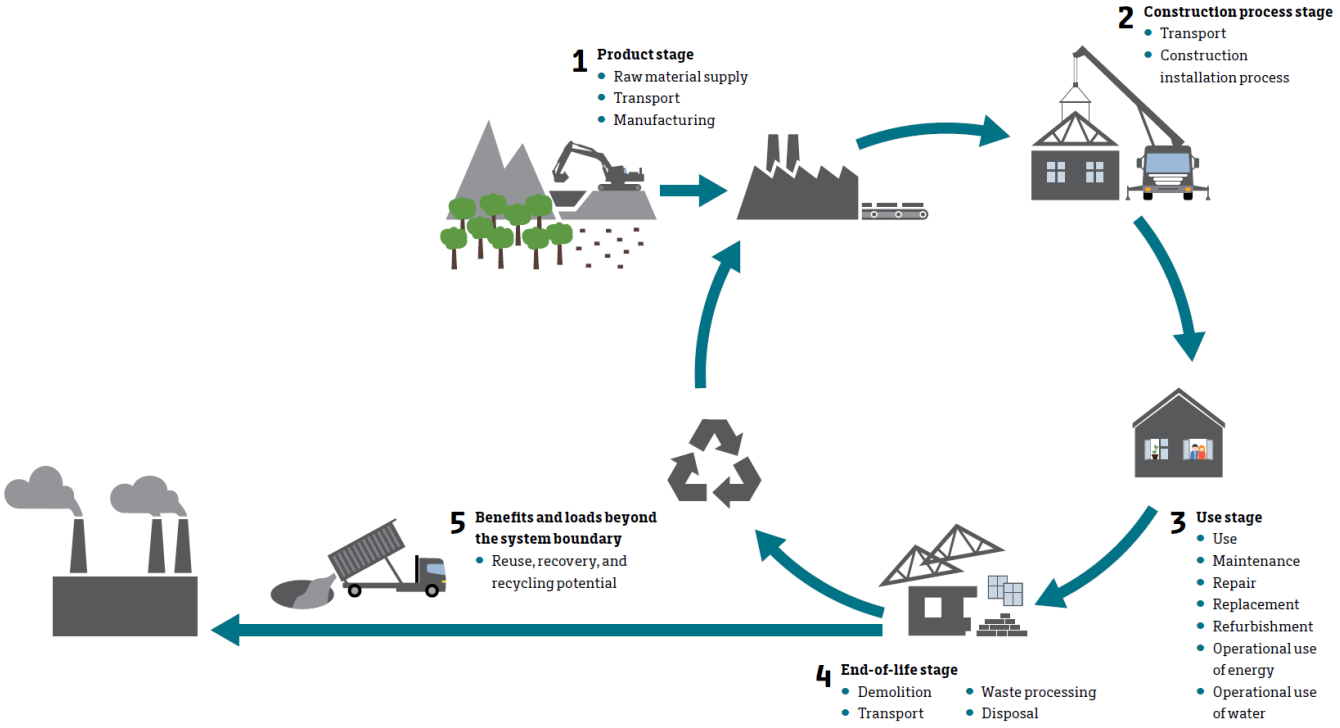


Figure 4 Whole of life considerations (Source: Introduction to LCA of Buildings, 2016.)

3. Integrated Design Process Guidance

This guidance is intended to be transferable to practice.

3.1 Integrated Design Process development

The IDS process will be in 2 stages to optimise the involvement of early-career non-architecture disciplines with minimal design experience. Stage 1 represents real-world practice where emerging professionals in mechanical or electrical engineering, and in construction management, are incorporated into a consultancy via a graduate program or similar. These young professionals learn from more experienced professionals the nature of the profession and how the consultancy is involved in building design and construction projects. This knowledge and understanding develops over time and enables future participation in integrated design projects (e.g. when an engineering consultancy, construction management company and architecture firm combine with a client on a specific brief.). Table 1 outlines the development of knowledge and understanding of these young professionals (the first two stages of Bloom's Taxonomy). This will enable them to more successfully contribute to the co-design workshops with architecture professionals and emerging practitioners in stage 2.

Table 1 Stage 1 Development of knowledge and understanding

Week	Studio type	Activities
1	Co-design workshop (engineering and construction management students and academics)	Introduction to project Relationship building Mind maps
2	Co-design workshop (engineering and construction management students and academics)	Background research
3	Combined Workshop (client and ENG/CM students, professionals and academics) **Understanding the client brief and building users** Relationship / Trust building	
4	Co-design workshop (engineering and construction management students and academics)	Topic investigation
5	Combined Workshop (client and ENG/CM students, professionals and academics) **Discussion Forum on Health and Sustainability** Presentations on Air Quality and Health; Energy Efficiency; Thermal Comfort; Building Simulation; Sustainability Rating Schemes Discussion regarding implication for IDS process Padlet: implication for the 2 design sites	
6	Co-design workshop (engineering and construction management students and academics)	WELL Building Standard
7	Combined Workshop (client and ENG/CM students, professionals and academics) **FOCUS: Climate / HVAC / energy modelling**	
8	Co-design workshop (engineering and construction management students and academics)	NABERS / Green Star
9	Combined Workshop (client and ENG/CM students, professionals and academics) **FOCUS: Construction management, project management, cost estimation**	
10	Co-design workshop (engineering and construction management students and academics)	Pragmatic solutions
11	Combined Workshop (client and ENG/CM students, professionals and academics) **FOCUS: How to evaluate options; Integration**	

12	Co-design workshop (engineering and construction management students and academics)	Own work; academic / group feedback
13	Student presentations of early research / analysis / design ideas	
15	Student presentations (Engineering) to broader engineering group	
Post-semester	Reflective workshop (capture the IDS process learnings)	

Stage 1 participants will join emerging and practicing architects in Stage 2 to develop integrated solutions that respond to the client brief and objectives of IDS 14, and to present detailed design solutions to the client and experienced professionals. This process is shown in Table 2. Note that selected solutions will be selected and subject to further feasibility analysis / vetting, adding value to the client and to the emerging professionals.

Table 2 IDS application, analysis, evaluation, creation

Week	Studio type	Activities
1	Co-design Workshop (all students / academics)	Meet and greet Existing perceptions of climate, age, energy Non-architecture early design ideas (from stage 1) Understanding old age
2	Strategic Workshop (all participants): Focus on client brief	Relationship and trust building Client brief (interview / Q&A) Understanding the 9 design principles
3	Own work (public holiday)	
4	Strategic Workshop (all participants): focus on analysis of sites/users and functional agenda	Developing empathy Feasibility analysis of early ideas Understanding the 9 design principles
5	Co-design Workshop (all students / academics)	Early design ideas
6	Co-design Workshop (all students / academics)	Schematic design ideas; concept plan
7	Presentation of concepts to client and feedback	
8	Strategic Workshop (all participants): focus on integration	Design development: discussion and critique
9	Co-design Workshop (all students / academics)	Finalisation of schematic design
10	Strategic Workshop (all participants): focus on feasibility (evidence to support viability of solutions)	Design development: discussion and critique
11	Co-design Workshop (all students / academics)	Design development: detailing
12	Co-design Workshop (all students / academics)	Design development: detailing
13	Co-design Workshop (all students / academics)	Finalise design / reports Revisit perceptions
14	Reflective Workshop (capture IDS process learnings)	
15	Presentation of design solutions to client, consultants and academics	
Post workshop activities	Selection of 4-6 design solutions for each site Feasibility Assessment / Vetting of selected design solutions	
	Evaluating IDS process and outputs	

Appendix 1.0 – Extracts from *Roadmap for the Integrated Design Process*, BC Green Building Roundtable, Canada, 2007

In conventional design, "the architect (or designer) and the client agree on a design concept consisting of a general massing scheme, orientation, fenestration, and the general exterior appearance of the building. Then the mechanical, electrical and structural engineers are asked to implement the design and to suggest appropriate systems. The problem with conventional practice is that this design process is too quick and simple, often resulting in high operating costs, poor comfort performance and very few sustainable gestures that fall within the client's restrained budget." (Pearl, 2004)

"The Integrated Design Process (IDP) is a method for realizing high performance buildings that contribute to sustainable communities. It is a collaborative process that focuses on the design, construction, operation and occupancy of a building over its complete life-cycle. The IDP is designed to allow the client and other stakeholders to develop and realize clearly defined and challenging functional, environmental and economic goals and objectives." (Larsson, 2002)

Mindset	Principle	Strategies
• Inclusion and collaboration	• Broad collaborative team	• Careful team formation
• Outcome oriented	• Well-defined scope, vision, goals, and objectives	• Team building
• Trust and transparency	• Effective and open communication	• Facilitation training for team • Expert facilitation
• Open-mindedness and creativity	• Innovation and synthesis	• Visioning charrettes (with comprehensive preparation) • Brainstorming
• Rigour and attention to detail	• Systematic decision making	• Goals and targets matrix • Decision-making tools
• Continuous learning and improvement	• Iterative process with feedback cycles	• Post-occupancy evaluation • Comprehensive commissioning

Integrated Design Process		Conventional Design Process
Inclusive from the outset	vs	Involves team members only when essential
Front-loaded — time and energy invested early	vs	Less time, energy, and collaboration exhibited in early stages
Decisions influenced by broad team	vs	More decisions made by fewer people
Iterative process	vs	Linear process
Whole-systems thinking	vs	Systems often considered in isolation
Allows for full optimization	vs	Limited to constrained optimization
Seeks synergies	vs	Diminished opportunity for synergies
Life-cycle costing	vs	Emphasis on up-front costs
Process continues through post-occupancy	vs	Typically finished when construction is complete