The Innovation Hub

for Affordable Heating and Cooling

Lesson Learnt Report

IDS-04 Ambulance Victoria

Project IDS-04 v2.0

21st May 2021

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.

i-Hub Lessons Learnt Report

Guidance notes for completion of the Lessons Learnt Report:

- This report is intended to be made public.
- Please use plain English, minimise jargon or unnecessary technical terms.
- Please use your organisation's branding for the report.
- The report should meet your organisation's publishing standards.
- Please use one template per each major lesson learnt and include as many as are relevant for your sub-Project. If what you learnt is more technical, this is the section to include technical information.
- The content of these Lessons Learnt Reports can be compiled (and updated, where necessary) for inclusion in the (public) Project Knowledge Sharing Report, for submission at the completion of your sub-Project.

Lead organisation	The University of Melbourne		
Sub-Project number	IDS-04		
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Note: The purpose of the integrated design studios is to progressively learn more with each studio as lessons are incorporated into the studio format and tested. As such lessons learnt reports include a summary of previous learnings (in greyed out format), with updates where added included in highlighted (boxed) text.

Summary of relevant lessons learnt from previous IDSs.

(Refer to the 'Lessons Learnt' reports for studio referenced for more detail).

Category	Technical – Integrated Design

IDS-01 #1	Good integrated design requires a 'design co-author' mindset in all participant designers.

Current design paradigms often place engineering as following architecture in the design process. This encourages a consulting type approach to the engineering where engineers are asked to comment on preformed ideas. Design integration can occur in this model however to a reduced potential with the initial ideation missing ideas founded in engineering aspects of the project. The studios found this consulting model to be difficult to break free from. Attention needs to be paid to create a mindset of 'design co-authorship' in all participants (engineers and architects alike). The reasons for this are not immediately clear however we believe may be related to:

- Potential deficiencies in creative thinking education in degree content.
- Established practices in industry (i.e. accepted established role as consultants).
- Early career stage (more experienced engineers were found to be better at ideation that younger engineers).
- Disparity in time available to be dedicated to studio ideation.

Lessons to be incorporated into future studios:

- Emphasise the concept of co-authorship in ideation more heavily.
- Aim for a better balance in numbers between architects and engineers.
- Aim for a better balance of seniority between architects and engineers (to encourage approachability and reduce fear of failure in putting ideas forward).
- Introduce common tasks at a detailed analysis level as well as the high aspirations level to encourage interaction between architects and engineers with common goals. This is anticipated to foster more detailed generation of ideas between the two disciplines.

IDS-01 #2	Integrated design ideation happens in a limited time window after designers reach a level of base understanding of the disciplines to be integrated.

In a 13-15 week design programme much of the front end is taken up with briefing and bringing design parties up to speed with each other's discipline (in general knowledge terms), the back end is conversely dominated by design development and documentation type activities. In-between these two general phases is a brief period when core design ideas are generated and formed. Once design ideas are formed it is difficult to materially change direction due to the momentum involved. Designers hold preconceptions after this initial ideation and the natural tendency is to adjust direction rather than to discard totally to start again. It is important to recognised when this ideation period is happening ensuring everything and everyone is in place to make it as successful as it can be.

Lessons to be incorporated into future studios:

In future studios more attention will be placed on this important ideation time. We may even give it a name so that the participants are aware of it and treat it with the degree of importance and priority it requires.

Additional Learnings from IDS-03 #2 & #5

Base level of understanding required in disciplines to be integrated before integration can happen effectively. Student designers solutions at mid semester were found to be pedestrian reflecting upskilling to understand what BAU is in each discipline. It was after this point that design integration and innovation was able to be productively pushed. This reflects research on polymath creativity across knowledge domains by Kaufman et al., 2010, Creativity polymathy: What Benjamin Franklin can teach your kindergartener. Likely for the same reason more experienced designers are quicker to commence, and more effective at integrated design ideation.

IDS-01 #3	Balance between architecture and engineering requires active curation.

IDS-01 took the approach of asking designers to approach the design from the two disciplinary extremes (architecture and engineering), from the beginning producing designs they felt represented each (ignoring the other). This approach emphasised the differences in the two approaches in designer's minds and articulated the prospects of needing to navigate the spectrum in-between the extremes in future design. Once equipped with this perspective it was easier for designers to understand that it is a balance between the two. Observations in the other IDS observed found that designers tended to follow the information in front of them without necessarily understanding the extents of the design spectrum.

This learning is a subset of the larger learning that active curation of the process is beneficial. There were conflicting opinions coming out of the interviews as to where this curation should sit. Some believed this should be the job of the architect, others believed a third party.

> ***Additional Learnings from IDS-03 #3***
> The importance of the design curation was found to be even more important than first thought in IDS-03 to IDS-05 as relayed by stakeholders interviewed (Refer Lesson IDS-03 #03). Further investigation is required to establish if this is heightened due to the studio leader's joint role as 'teacher' in the studios. Differing opinions on where this design curation role best sits were also evident. Some believed this role should in the architect's remit, others believe it should be a third party independent to the architect and engineer.

Lessons to be incorporated into future studios:
In future studios we will consider adjusting the integrated design process to encourage this exploration of the extremes between the two disciplines views of the project and also discuss where this curation role bests sits.

IDS-01 #4	There is a high level of excitement and buy in to the concept of integrated design.

A high level of excitement and buy in to the concept of integration was observed in all involved (demonstrated by studio popularity with students and keenness to be involved by participants). It is clear that the benefits are recognised. This may suggest that existing failures to follow a design integration path in industry occur as it is simply not an up-front agenda item.

Lessons to be incorporated into future studios:
Further work identifying the gap between practitioners and clients buy in, and the failure to see integrated design realised more in industry is worthy of further research.

IDS-KS #1	Integrated Design Process - one size does not fit all

In taking the integrated design process consolidated from the literature search and applying it to the first two integrated design studios (IDS's) in practice, it was clear that the process needed a high degree of customisation. Variations between the studios included tailoring for:

- Studio Leaders style/preferences. While the studio leader is an IDS specific role and will not exist per se in practice, the individual styles and preferences of the players involved in leading design will. We felt it important to let the leaders dictate aspects related to their style of working to get buy in and maximise chances of success. We expect this will be an element that needs to be considered in implementing successful integrated design teams and environments in practice.
- Technical content. The high level of technical content involved in data centre design and achieving efficiency meant that addit. measures had to be taken to ensure architecture received adequate air time.
- Willingness and available time to be involved. All parties were keen however subject to various constraints. It was important to consider this in the input (frequency and duration).
- Ability to see the forest for the trees. The presence of a third party design leader or curator was important in providing perspective to the designers, someone outside and removed from the design who could provide feedback if the design was straying too far towards one discipline or the other.

IDS-KS #2	Establishing Integrated Design extremes (or discipline goal posts) helps.

One of the preliminary observations in relation to process was that the curation of balance between architecture and engineering looks like it will be more successful when there is an element of inherent way finding. One of the studios asked designers to produce two designs, one from an architect's view ignoring engineering, and vice versa.

This appears to have offered some benefits in assisting the designers to set the goal posts – i.e. what might pure architecture look like, and what might pure engineering look like and how do we balance and achieve the best outcomes from there. Designers who did not do this tended to be taken along a narrower path following their noses in design development rather than knowing the possible bounds.

IDS-03 #1	Precedent disparities exist in the working frameworks architects and engineers bring to projects.

Disparities exist in the frameworks architects and engineers work within when involved in design.

Lessons to be incorporated into future studios:

- Introducing smaller task specific activities with common goals helped in bringing individuals (architects and engineers), together. An example of this were tasks set to work with a common software tool to analyse performance of a small manageable part of the building.
- More closely aligned definable goals. Efforts were made to establish common goals in design however these were usually general in nature, i.e. zero net energy, better sustainability, more renewable energy etc. Design under these 'loose' aspirational goals often strayed whereas design in more defined tasks such as teams researching specific solutions (say labyrinth's or heat pumps etc), provided better focus. A part of this will be pre-semester efforts to try and more closely align assessment criteria between disciplines.
- Straight out reductions in disparities establishing as level a playing field as possible. Efforts will also be made in this front, i.e. achieving similar time allocations between students through the formation or adjustment of subjects between the faculties.

IDS-03 #2	Experience levels of designers is an important consideration in integrated design.

Experience levels were found to impact on integrated design capability. Student (and early career consultants) were found to be capable in analysis but not necessarily design. This learning came from observing the nature of design development. Designs were found to be 'pedestrian' or Business as usual' (BAU) in nature up until the mid-semester critiques. We feel this is because the first half of semester is the time students required to become 'familiar' or 'comfortable' with the problem definition and the new cross discipline skills/appreciation they are acquiring. It is only after this point that designers felt more at ease experimenting and pushing boundaries. The more experienced consultants in the design team were observed to be much better at integrated design in this respect (although not exclusively).

The learning from this is an increase in the initial familiarisation time required before the 'sweet spot' of design integration is able to productively occur.

Lessons to be incorporated into future studios:

Educate designers about the process of developing an understanding of the fundamentals before experimentation and productive design integration can effectively occur. Note that this does not mean that thinking about potential creative ideation and design integration should be ignored or not happen early on, just that it is unlikely to be productive until a sound understanding of the fundamentals is gained.

IDS-03 #4	Architects and engineers have different preferences in communicating and engaging.

Difference in personalities and preferred methods of communicating and engaging is becoming evident. Students from the two faculties engage differently on a number of fronts:

- Engineering students prefer more defined problems and better-defined problem-solving frameworks in which to work on them than architects.
- Engineers tend to be less communicative in open studio forums (more likely to have video switched off etc.).
- Engineers tend to be more comfortable with analytical tasks involving and metrics and specific outcomes.

It was felt that these differences hindered collaborations. The differences reduced over time in the studios. Further investigation as to the reasons underlying the differences and potential amelioration is required including exploring the benefits of introducing socialising activities external to the design process. It was noted that engineers in one studio (IDS-04), were highly engaged and this may have been due to the presence of one or two individuals with 'more collaborative and energetic attitude' acting to encourage others.

IDS-03 #5	Base level of understanding required in disciplines to be integrated before integration can happen effectively.

A base level of understanding was found to be required in the disciplines to be integrated before integration can happen effectively. Student designer's solutions at mid semester were found to be pedestrian (average) in quality reflecting student's upskilling to understand what business as usual (BAU) is in each discipline. It was only after this point in the studio that design integration and innovation was able to be productively pushed.

This reflects research on polymath creativity across knowledge domains by Kaufman et al., 2010, Creativity polymathy: What Benjamin Franklin can teach your kindergartener. Likely for the same reason more experienced designers are quicker to commence, and more effective at integrated design ideation.

Category	Logistics (related to running IDS studios)

IDS-01 #5	Extended time required in gaining agreement to contractual terms (due to unfamiliarity with research risk profiles by industry organisations).

Negotiation of terms and conditions took much longer than anticipated due mainly to industry partners being unfamiliar with risk profiles around research orientated projects. The main sticking point was unlimited liability with engineering consultants (architectural consultants were less concerned with this aspect of the contracts).

Lessons to be incorporated into future studios:
Next time around we will be a position to advise of terms previously accepted in other IDS's much earlier and should do this starting as early as possible and focusing on the engineering consultants.

IDS-01 #6	It was more difficult recruiting engineers to the integrated design process than architects.

We found that we had a much higher application rate on the architectural side than the engineering one.

Lessons to be incorporated into future studios:
Next time we would do more advertising with the engineers to articulate the benefits of taking up an integrated design studio. We would also tailor the subject to be a better fit (either a dedicated IDS 'elective', or a one semester design orientated core alternative), and open it up [as an elective to Mechanical engineering.

More up-front effort should also be applied in aligning the assessment criterion between architectural and engineering students as much as is possible.

New lessons learnt this IDS.

IDS-04 has contributed to learnings on the integrated design process encapsulated in lessons presented in the IDS-03 Lessons Learnt report.

In addition to this building typology specific lessons were learned:

Lesson learnt IDS-04 #1	Zero Carbon Design Measures Suitable for Emergency Response Facilities.					
Category	Technical – Building Typology Zero Carbon Design					
Choose from:	*Technical*	*Commercial*	*Social*	*Regulatory*	*Logistical*	*Other (specify)*

Describe what you learnt about this aspect of the Project.

Reference should be made to the 100% Studio Outcomes Reports which summarise the Feasibility Vetting carried out by consultants (and include a copy of the vetting reports in the appendices) for detail of building typology specific technical learnings.

Zero carbon design was found to be possible for emergency response facilities along similar lines to the schools building typology. This was achieved through a combination of energy consumption (EUI) reduction (envelope, orientation, use of heat pumps etc.), and provision of locally generated renewable energy (typically solar PVs).

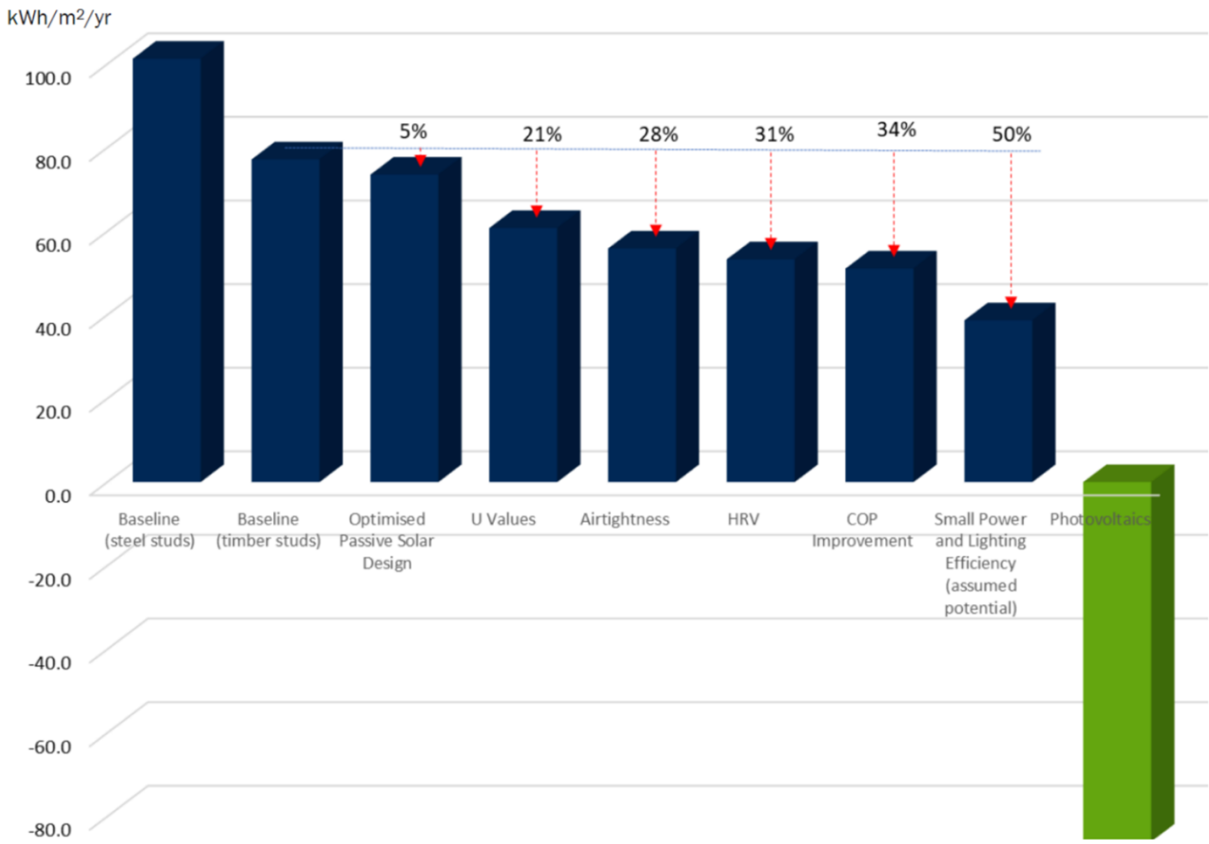
Differences with the schools typology centred around different building and programme planning. Emergency response facilities have a higher diversity of use requirements including garages, sleeping facilities, and respite areas. The specific technical requirements of each of these uses (acoustics, light, proximity to response etc.) were all considered in the architectural planning.

Design solutions that are on a credible pathway toward net zero carbon performance are shown in the graph below of annual energy (electricity) consumption. It can be seen that up to 50% energy saving compared to business-as-usual could be achieved through a cumulative combination of high-performance passive design measures, optimisation of HVAC systems, and consideration of on-going operational energy management.

A number of strategies and technologies were consistent in recommendations. Their prevalence across a wide variety of different design proposals indicates their suitability and achievability within the scope of a typical Ambulance Station. Key systems which were common across the studio and which offered the greatest benefits include:

- Optimised Passive Solar principles for winter heating and summer control.
- High-performance building fabric through enhanced U-values of the building fabric
- Reduction in thermal bridging and airtightness construction quality Assurance
- Mechanical ventilation with heat recovery for energy saving benefit in addition to other indoor environmental quality and health benefits.
- Photovoltaic panels were consistently applied across projects for on-site renewable energy generation.
- Selection of materials which minimise the impact of embodied carbon across the development.

With such implementations, it was found that energy usage across the site could be reduced by up to 50% when compared against current business as usual statistics. Furthermore, when tied in with a photovoltaic system, the students have shown that energy production potential can entirely meet and exceed the demands on site. As such, the student body of work has shown that with current and existing technologies, a net-zero carbon approach is possible.



Extract (Figure 24) from vetting report (Atelier 10) – Benchmarking Student Proposals.

Please describe what you would do differently next time and how this would help. What are the implications for future Projects?

Future studios or designs (designers) in industry can use the findings from both IDS-02 and IDS-03 as a starting platform to inform the development of future ambulance station designs.

If your Project learnings have identified any knowledge gaps that need to be filled, please state it below.

None, however future on-site verification of design initiatives would assist in establishing value.

Please include any other information you feel is relevant or helpful in sharing the knowledge you learnt through this stage of the Project. This may be qualitative or quantitative and may include a graph, chart, infographic or table as appropriate.

As well as improvements in energy, integrated design initiatives will likely improve IEQ bringing related health benefits to staff.