The Innovation Hub

for Affordable Heating and Cooling

Lesson Learnt Report

IDS-07 Aged Care (UoM)

Project IDS-07 v2.1

19th November 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-07		
Sub-Project commencement date	20th January 2020	Completion date	19th November 2021
Report date	19th November 2021		
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IMPORTANT NOTE:

The integrated design studios are repeating format studios conducting research on two levels:

1) Integrated Design: Each studio builds upon previous studios to explore how best to facilitate integrated design between architects and engineers. Lessons are cumulative across studios.
2) Zero Carbon Research: Each studio explores zero carbon design measures that are relevant to the building typology featuring in that studio. Lessons are specific to the building typology used in the studio.

To improve readability (for readers reading multiple reports), material that has been repeated from previous reports as cumulative learnings has been delineated and identified as such. These lessons are shown on a greyed-out background.

New lessons learnt this IDS.

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Lesson learnt IDS-07 #1	Face-Face interaction is an important factor in facilitating integrated design.					
Category	Technical – Integrated 'Design					
Choose from:	*Technical*	*Commercial*	*Social*	*Regulatory*	*Logistical*	*Other (specify)*

Describe what you learnt about this aspect of the Project.

A notable increase in the engagement and interaction between student designers (particularly engineers), was observed in IDS-07. This is thought to be attributable primarily to the face-face mode of delivery. 'In studio' interactions were far stronger due to communication mode and sense of commitment in a physical environment. The number and nature of conversations increased (i.e. formal and informal).

Anecdotal evidence from consultants on projects requiring remote delivery (i.e. international design teams or teams remote from project location) supported this. The practice of ensuring initial face to face interactions with a degree of social interaction between project members prior to them continuing to work together remotely on a project was noted as a method of strengthening communication and collaboration.

A secondary influencing factor was the changed nature of recruitment in IDS-07 for the engineers. Greater detail was provided on the purpose of the studios. This it was felt resulted in a degree of self-selection as students with particular interests in sustainability and integrated design were attracted.

Quote from RA observations: "Face-to-face contact of students allowed for social bonding and the establishment of a proper 'group mentality' among architecture and engineering students".

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

Promote face to face interactions where possible, particularly early on in interactions to establish collaborative relationships.

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

None.

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.

In industry face to face may take the form of physical meetings but also co-location in common project offices.

Lesson learnt IDS-07 #2	Easily accessible software tools for interrogating technical performance is important to early design/integration process.					
Category	Technical – Integrated 'Design					
Choose from:	*Technical*	*Commercial*	*Social*	*Regulatory*	*Logistical*	*Other (specify)*

Describe what you learnt about this aspect of the Project.

IDS-07 demonstrated the importance of designers having access to decision making tools in the form of software that enabled them to assess outcome. This both provided a common language that designers could use to interact and enabled quantifiable prioritisation of various solutions (options).

RA direct observation: "Students were found to be most likely to engage with and understand the impact of environmentally focused design decisions through the process of iteration. With the introduction of the Ladybug Tools platform to the students, tangible environmental impacts were able to be discovered within the student's design tool of choice. Significant uplift in comparison with previous semesters regarding the student's excitement and engagement were found as they developed their skills within this parametric software, which is easily translated into other aspects of their design skills. Further development of the base tools and strategies involved with the introduction of these tools are recommended for further studios, as it's relevance to the students' growth is recognised both within the studio and beyond. …These activities allowed designers to better understand the relationship between good design and performance and inform their understanding of how buildings work together".

Atelier 10 (sustainability consultant) direct observation: "hands-on experience of testing the performance of their designs gave students a heightened awareness of the full impact of their design decisions"

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

Ensure students have access to concept level assessment tools (software).

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

None.

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.

Available software in the form of 'plug-ins' to documentation platforms such as Revit and Rhino are growing all the time meaning this facet of design integration will become more easily facilitated with time.

Lesson learnt IDS-07 #3	Consolidation of lessons from previous studios (note only)					
Category	Technical – Integrated ‘Design					
Choose from:	*Technical*	*Commercial*	*Social*	*Regulatory*	*Logistical*	*Other (specify)*

Describe what you learnt about this aspect of the Project.

IDS-07 Observations provided reinforcement of a number of the earlier integrated design learnings. These included the following quoted remarks from the research assistant observations:

- “Striking a balance between architecture and engineering requires active curation”.
- “Observations around the benefits of working in groups, within a well-defined project context, emerged”
- “Early opportunity for group-work around foundational aspects of projects – client, site context / analysis, brought high value in founding a productive cross-disciplinary working relationship” (importance of task based common goals as well as high level).
- “Engineers were initially uncomfortable without clearly defined scenarios and clear outcomes. Some engineers expressed uncertainty about their skillset and ability to contribute to the group work efforts” (architects and engineers think differently).
- “Producing extreme ‘solutions’ afforded groups an opportunity to see the impact of optimising engineering aspects over the architecture and vice versa and this context coerced designers to think in different ways”.

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

Nothing.

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

None.

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.

This learning is more of reinforcing note on previous learnings.

Lesson learnt IDS-07#4	Zero Carbon Design Measures Suitable for Aged Care Centres.					
Category	Technical – Building Typology Zero Carbon Design					
Choose from:	*Technical*	*Commercial*	*Social*	*Regulatory*	*Logistical*	*Other (specify)*

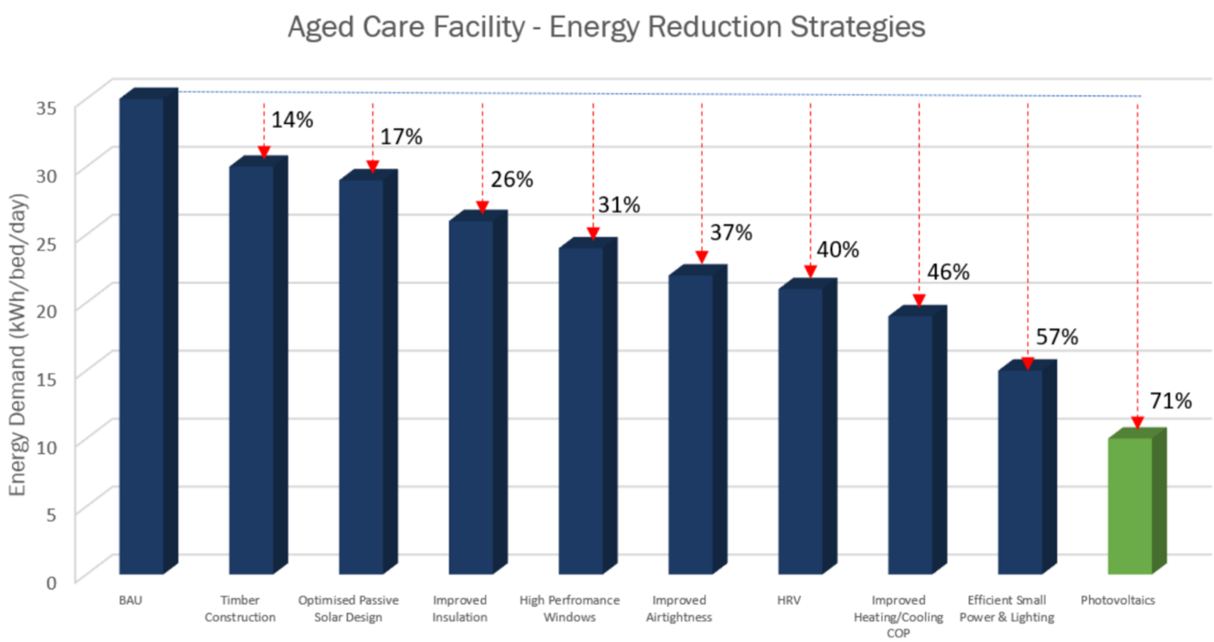
Describe what you learnt about this aspect of the Project.

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 more detail on the building typology specific technical learnings.

Work in the studio was able to show that energy savings of up to 60-70% could be achieved. This is especially significant considering the energy intensive typology which is inherent to aged-care homes. To cover the remaining energy which was to be drawn from the grid in the months which solar power could not meet the entirety of the demand, offsets and selecting green energy sources was identified as a pathway towards carbon neutrality in operations.

Key systems which were common across the studio which held the greatest benefits include:

- Optimised Passive Solar principles for winter heating and summer control.
- High-performance building fabric through reduced 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.



In addition to the clearly demonstrated carbon reduction benefits, significant improvement to the health and well-being of occupants is associated with some of the strategies put forth. Health and well-being are of the highest priority when considering the use-case of the development, ensuring that the elderly occupants have access the best indoor environment quality possible. Implementations such as considered daylight access, thermal comfort control, airtightness and well-designed ventilation systems can be leveraged to improve the quality of life within the facility.

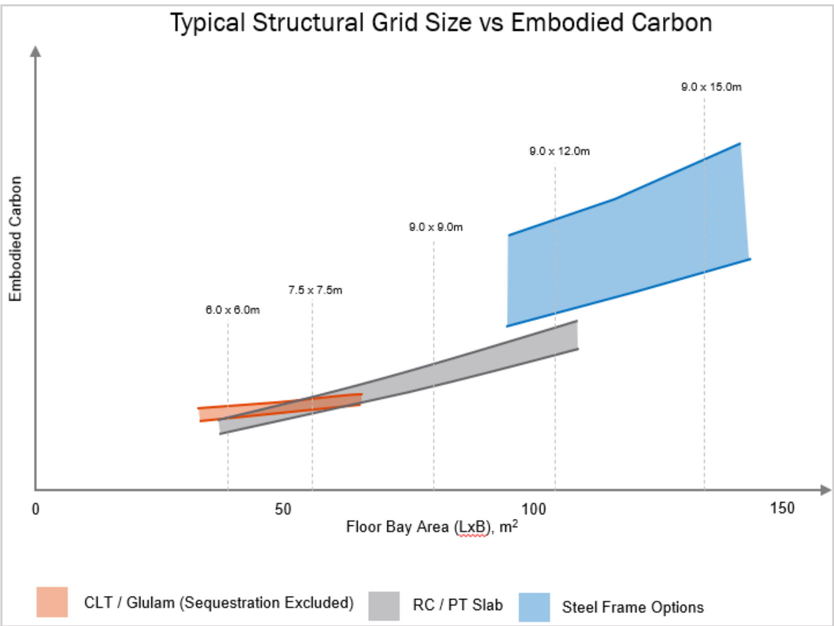
Detailed solutions deemed appropriate and achievable included:

- Cross Laminated Timber (CLT), and Glulam structural materials
- 30% fly ash concrete slabs
- Prefabrication of units
- Appropriate floor depths for passive natural ventilation (<20m)
- Double / Triple Glazing
- Photovoltaics and battery systems
- Ground source heat pumps
- Recycled water-cooling towers
- Hydronic underfloor heating
- Onsite food growth
- Organic material recycling

Solutions which were found to be less appropriate in terms performance and cost include:

- Greenhouse style building for heat control
- Biodigesters

A study on structural material and grid size was carried out. at grid sizes larger than 6x6m, the benefit of CLT, without considering carbon sequestration, quickly falls in line with concrete structure. As such, whilst the student uptake of low-carbon construction methods was to be commended, further consideration of the results impacts in each of their proposals could be recommended for further studies.



Note: Images / technical findings extracted from consultant vetting report

Please describe what you would do differently next time and how this would help. What are the implications for future Projects?
Nothing, process was successful in providing integrated design and technical (carbon zero) learnings.
If your Project learnings have identified any knowledge gaps that need to be filled, please state it below.
Furthermore extensive studies on grid size versus embodied energy would be useful. The current study provides a good base however more sophisticated structural arrangements and systems (i.e. truss or composite hybrid material systems) could be examined.
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.
None – refer to 100% Studio report containing consultant feasibility vetting report for more detail on the above summarised learnings.

Lessons on Integrated Design learnt from previous IDSs.

The lessons reproduced below present the cumulative learnings built across subsequent studios. They relate to generalist learnings on 'Integrated Design' and are applicable to all studios.

For 'Zero Carbon Design' learnings specific to the building typologies chosen as case studies for the studios, refer to the lessons learnt report for each specific studio.

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.