Design/build and interior design: engaging students in technical development

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Projects that employ the full-scale fabrication of design proposals have been implemented successfully in various spheres of design education, especially as design/build projects within architectural education. Among the various benefits offered by projects that encourage full-scale fabrication, students are presented with the rare opportunity to engage directly with the physical fabrications of their conceptual imaginings. As a result, these projects offer learning opportunities that go beyond a purely conceptual and intellectual understanding of their surrounding environments and designs. Interior design studios could employ design/build projects with success, yet judging from the lack of relevant research, the benefits of design/build projects within this discipline seem to have been neglected within the discourse of interior design education. This article employs a case study to investigate the learning opportunities, specifically related to the technical development of design, offered by design/build projects in interior design education. The case study refers to a design/build project implemented in the second year interior design studio at the University of Pretoria in response to students' lack of engagement with the material aspects of their designs. The successes and shortcomings of the project are evaluated using data obtained from questionnaires completed by students. This data was supplemented by the recorded observations of studio lecturers and retrospective design reports. Students' experiences are discussed under the following four themes: (1) improved confidence; (2) exploration; (3) on-site construction; and (4) design process.
Key words: design/build, interior design education, technical development, full-scale fabrication

Ontwerp/bou en binne-ontwerp: daarstelling van studentebetrokkenheid by tegniese ontwikkeling

Projekte wat die volskaalse vervaardiging van ontwerp voorstelle aanmoedig, word met sukses in verskeie areas van ontwerpopleiding geimplementeer, veral in die vorm van ontwerp/bou projekte in argitektuur opleiding. Onder die verskeie voordele wat projekte wat volskaalse vervaardiging aanmoedig inhou, word studente die skaars geleentheid gebied om direk betrokke te wees met die fisiese produkte van hul konseptuele beelde. Gevolglik bied sulke projekte leergeleenthede wat verder strek as die blote konseptuele of intellektuele begrip van hul omringende omgewings en ontwerpe. Binne-ontwerp ateljees kan ontwerp/bou projekte met groot sukses aanwend, maar te oordeel aan die gebrek aan relevante navorsing, word die voordele wat ontwerp/bou projekte vir die dissipline inhou, misken in binne-ontwerp opleiding. Aan die hand van 'n gevallestudie ondersoek hierdie artikel die binne-ontwerp leergeleenthede, spesifiek tot die tegniese ontwikkeling van ontwerp soos verskaf deur ontwerp/bou projekte. Die gevallestudie verwys na 'n ontwerp/bou projek wat in die tweede jaar binne-ontwerp ateljee by die Universiteit van Pretoria geimplementeer is. Hierdie projek is geimplementeer in antwoord op studente se tekort aan betrokkenheid by die materiele aspekte van hul ontwerpe. Die sukses en tekortkominge van die projek word aan die hand van vraelys data geevalueer. Die data is aangevul deur ateljee dosente se aangetekende waarnemings en retrospektiewe ontwerpverslae. Die ervarings van studente word onder die volgende vier temas bespreek: (1) verbeterde selfvertroue; (2) ondersoeking; (3) konstruksie op terrein; en (4) ontwerpproses.
Sleutelwoorde: ontwerp/bou, Binne-ontwerp opleiding, tegniese ontwikkeling, volskaalse vervaardiging

Projects that employ the full-scale fabrication of design proposals have been implemented successfully in various spheres of design education, especially as design/build projects within architectural education. For the purpose of this paper design/build is defined as the designing and fabrication of a full-scale final spatial product which may be temporary or permanent in nature. Canizaro (2012) mentions that educational institutions adopt design/build projects for various reasons that can range from community service, enhancing collaborative skills, to various forms of construction experience. Although the benefits of projects that encourage full-scale fabrication are varied and are dependent upon context and implementation, such projects almost always offer students an opportunity to gain information about their designs that would not have been available in two dimensional representations alone (Yang, 2005: 650). Design/build projects offer students the rare opportunity to experience their own designs. Thomas (2010: 15) mentions that the process of full-scale fabrication offers designers the opportunity to construct immersive environments where they can examine how bespoke spaces of their imagining might be inhabited, both physically and emotionally.

Design/build projects engage students directly with the physical world and as a result offer learning opportunities that go beyond a purely conceptual and intellectual understanding of the student's surrounding environment. The technical development of design proposals can be enriched by the experiences offered by full-scale fabrication. For the purposes of this article, technical development can be equated to detailing, defined by Ballast (2010: 3) as a "creative process of problem solving with constraints and choices aimed at translating broad design concepts into construction reality". This creative process is informed by an understanding of materiality and construction methods. Materiality refers here to both the physical characteristics of materials and the metaphysical experience of materials through sensory involvement. Design/build projects "attempt to demystify the construction site and help students realize what is involved in taking architecture from a drawing to a building" (Canizaro 2012: 22). Design/build projects could help students to gain a better understanding of materials and their role in design, whilst offering opportunities for hands-on exploration with detailing.

Projects that employ full-scale fabrication are however limited by the time, financial support required and risk involved in their realisation. As a result, the types of projects suitable to design/build projects in an educational environment are limited. Carpenter (1997: 9) mentions that projects that fit well into construction studios include a small modular house, an outdoor chapel, and garden pavilions. This list is not exhaustive, but it serves to indicate that design/build projects are typically smaller in scale and should have manageable levels of liability and structural complexity. This may seem restrictive to educators, however "…a reduction in building scale, at times, is balanced by an increase in creative liberation, encouraging experimentation with materials, texture and proportion while stressing play and whimsical exploration" (Thomas, 2010: 10). Interior design could employ design/build projects with great success, yet judging from the lack of discipline specific research, the benefits of design/build projects in interior design education seem to have been neglected by interior design educators.

The IFI Interiors Declaration[1] (IFI, 2011) states that "interior designers and interior architects determine the relationship of people to spaces, based on psychological and physical parameters to improve life". The discipline of interior design is therefore intimately engaged with the effect that designed spaces and objects have on users. This 'closeness' to the human body, behaviour and perception implies that students of interior design can benefit greatly from the opportunity to immerse themselves in their own designs: to walk through, sit in and observe the use of their conceptions. Design/build projects can offer students this valuable learning opportunity. Interior designers also address the technical aspects of space making, which includes an understanding of, and exploration with, construction methods and materials. Although Scott (2008: 174) states that the designer is more inclined than the architect to experiment with new materials, this remains a skill that should be taught. Both these knowledge areas can be strengthened through the implementation of projects that encourage full-scale fabrication of design proposals.

Design/build projects employ hands-on learning practices such as modeling and prototyping as part of the design process. These activities often precede final full-scale installation on site. According to Ankerson and Pable (2008: 143) modeling and prototyping are activities common to all interior design studios. They state that these activities "help learners understand both the problem and the solution in ways that more typical linear and analytical processes cannot". Lemons, Carberry, Swan, Rogers and Jarvin (2010: 290) state that model building aligns well with Kolb and Fry's theory of experiential learning:

> There are hands-on concrete experiences during model construction, observation and reflection through testing and evaluation, and the opportunity to form abstract concepts from which new analysis and implications can be drawn. During model building the learner is encouraged to reflect on his or her actions and the results of those actions in order to validate their solution or formulate a better one. The effects of similar actions can then be anticipated in future similar situations.

Design/build projects can be effective forms of experiential learning. These projects have the ability to engage interior design students in a complete learning process which relies on the creation of multiple solutions for both spatial and technical design issues.

This article employs a case study to investigate the learning opportunities, specifically related to the technical development of design, offered by design/build projects in interior design education. The case study refers to a design/build project conducted in the second year interior design studio in the Department of Architecture at the University of Pretoria. The organisation and aims of the project will be discussed to provide a background against which the learning experiences of the students involved in the project can be discussed.

The case study: background and organisation

The undergraduate interior design programme[2] is organised as a three year course. The first year studio component is taught as a generic studio for architecture, interior design and landscape architecture students alike. From the second year onwards students split into their various discipline specific studios. The second year interior studio is therefore aimed at introducing students to the broader discipline of interior design. Design theory and projects aim to equip students with discipline specific vocabulary, knowledge of precedents and designers, skills and experiences upon which subsequent learning experiences can build. Design projects are therefore formulated to stimulate an extensive design process within which students' concept formulation, design development, technical development, design description, communication and self-appraisal abilities can be tested.

Cross (2007) states that a central feature of a design activity is its reliance on generating a satisfactory solution fairly quickly, rather than on any prolonged analysis of the problem. In doing so, designers tend to produce any one of what might well be a large range of satisfactory solutions rather than attempting to generate the one hypothetically optimum solution. Lawson (2005: 43) supports this understanding by describing designers as having a solution-focused strategy and not a problem-focused strategy. Although students in the second year interior design studio illustrated clear signs of generating numerous possible solutions during the conceptual and spatial development stages of their first semester's design projects, they tended to neglect this process when confronted with the technical development of design solutions. Student projects not only illustrated a lack of technical investigation, but illustrated the tendency of students to postpone the technical development of projects to such an extent that exploration and experimentation became virtually impossible. This lack of experimentation led to a reliance on 'standard' details often sourced from precedents or construction-based publications. Although their use is by no means wrong, lecturing staff observed that students used these details without questioning their relevance and applied them without a real understanding of their structure and/or aesthetics. If any condition within the design changed, students found it impossible to adjust the detail and instead sourced a new detail. These issues indicated a lack of confidence in individual's technical design abilities as well as an inability to relate technical aspects to the design concept.

Second year studio lecturers and mid-year examiners also commented on students' lack of enthusiasm for the technical and material issues of design. Discussions in studio with the second year students indicated that they viewed this as a 'difficult' and 'boring' stage of the design process. Students viewed technical development merely as a means to an end, i.e. detailing could solve design and conceptual problems, but was rarely viewed as a generator for design. Design was treated as a partly linear process, where concept and spatial development were dealt with as interrelated processes, but where technical development took place at the end of the spatial development. This not only led to weak technical solutions, but also indicated a lack of understanding of the interdependence of design drawings, working drawings and the physical realisation of the design. Second year students did not engage in a complete technical development process – technical solutions were divorced from the overall design intent and very few alternatives were developed, reviewed or revised. Studio lecturers felt it imperative to address this lack of engagement with the technical development of design through the introduction of a focused studio project.

Based on the various benefits and opportunities offered by projects that employ full-scale fabrication, a design/build project titled: "A place of refuge and retreat" was implemented in the second semester of 2012. The purpose of this project was to generate enthusiasm for technical investigations in interior design and encourage a deeper engagement with the technical development of design projects. The project was designed to focus attention on three interrelated issues: improving technical knowledge, encouraging hands-on experimentation and stimulating a comprehension of a complete design process. The project brief did not list learning outcomes, but clearly stated that material and detail experimentation was critical and encouraged students to construct maquettes, scale models and prototypes. In order to root the project in the realm of interior design, it was formulated to be spatial in nature and required, to some degree, an engagement with site. The project offered students the opportunity to experience the synthesis of touch, movement, sound and visual stimuli within their conceptual designs – an intimacy in use that is fundamental to interior designers. A multi-sensory approach to materiality was encouraged in the conceptual phase of the project, but was not deemed a requirement for successful completion.

Students were required to complete the project in groups. This saved time during the construction phase and the financial burden could be shared amongst students. Group work also offered the students an opportunity to be exposed to the complex collaborative nature of spatial design. Although invaluable, it was not viewed as a major outcome of the project and will therefore not be discussed in this article. The project required students to design and construct a full-scale spatial experience in an allocated site and was organised in two parts.

Firstly, students were divided into pre-selected groups of five[3] and were asked to conceptualise a 'Place of refuge and retreat' for the *Boukunde* building (the permanent location of the students' design studio). Excerpts from the text "Architecture of Refuge and Retreat" (Thomas, 2010) prepared by the curator of the exhibition "1:1 Architects build small spaces", held in 2010 at the Victoria and Albert Museum in London, was included in the project brief.

This text laid the conceptual foundation for the project and introduced students to the writings of Juhani Pallasmaa[4] on full sensory engagement in architectural spaces. Students were allowed two days to complete additional research related to the topic as well as to compile their personal observations of the *status quo* in the building. On day three, each group presented their findings and initial proposal to the class.

Secondly, a site (figure 1) within the building was assigned to each group. Students were informed that they needed to design and build a full-scale version of their conceptualized 'place' in any paper-based material.[5] Each group received two sheets of 3050x1220x16mm X-Board Print (printable paper liner with inner reinforced honeycomb paper base). Students had access to basic woodworking tools. Each group's budget for additional tools and materials was restricted to an amount of R2500. Students had to complete any construction activities on site or in their studio. The project was completed over the course of four weeks (figure 2 illustrates the design/build process of Group E). Assessment took place in groups in the form of verbal critiques by studio lecturers and external evaluators. After the final installation, an opportunity for self-appraisal was introduced. Students were asked to evaluate the success of their group projects by preparing individual retrospective design reports which offered an opportunity for individual assessment. Students were allowed one week to complete these reports.

Figure 1
The five sites *(from top left)*:
Group A - Honours studio; Group B - Level 1 stairs; Group C – Level 2 vending; Group D – Stairs to roof; Group E – 1st year studio.

Figure 2
Complete design/build process of Group E:
modeling, prototyping and fabrication *(top)*; installation, use and evaluation *(bottom)*.

The case study: data

Creswell (2007:93) mentions that extensive, multiple sources of information are used in data collection of a case study to provide a detailed in-depth 'picture' of the project being studied**.** The successes and shortcomings of the project were evaluated through data obtained from questionnaires completed by students at the end of the design/build project. This data was supplemented by the experiences and observations of studio lecturers as well as information compiled from the retrospective design reports.

The questionnaire was aimed at obtaining qualitative data about the learning experience through appreciative inquiry. Appreciative inquiry engages participants in a process of reflection by posing open questions or statements to identify the best of 'what is' to encourage participants to envision 'what might be' (Cooperrider, Whitney & Stavros, 2008). Students were asked to respond to the following statements by referring to the design/build project:

1. I enjoyed or liked…;
2. I found … informative or helpful in the project;
3. I learned…
4. I recommend that…

The open statements focus on extracting information that illustrates what enabled the participants to complete the project successfully, rather than to look for problems or weaknesses. Weaknesses or difficulties are revealed through the process of envisioning what might have worked more successfully.

Tesch's descriptive method of open-coding (in Creswell 2009: 185) was used to analyse the data. Four main themes related to the project's aims and outcomes were identified from the analysis of students' responses, namely: (1) improved confidence; (2) exploration; (3) on-site construction; and (4) design process.

The case study: results

Student's learning experiences are discussed under the above mentioned themes and their related subthemes. The themes align with the project's aim of generating enthusiasm for, and encouraging engagement with, technical development of design projects by focusing on the improvement of technical knowledge, encouraging hands-on experimentation and stimulating a comprehension of a complete design process.

Theme 1: improved confidence

Student comments indicated that they enjoyed "investigating", "experimenting", "testing" and "exploring" paper-based materials and their relevant construction methods. Even though the project was challenging, students illustrated enthusiasm for the "learning by doing" process as can be observed in these responses (emphasis by author):

> I *enjoyed* getting to make the installation, working with our hands and experimenting with the material.
> I *super loved* the investigation, exploration and construction process. The challenges of making each piece fit, along with checking/calculating the 'science' behind each required piece was *awesome*.
> I am specifically not good with the construction or structural aspects of a design. It goes without saying that it is an extremely important aspect of design. The challenge of physically building made me *excited about construction*.

The physical building process proved to be "enjoyable" and "motivational" as well as empowering. The project provided an opportunity to physically experience the development of design ideas and to showcase the work of the studio as a whole. Students also indicated that the project offered opportunities for personal discovery, as evident in the last two responses:

> It was very *rewarding* when other people would visit and be surprised at the comfort of our cardboard seats.
> [I enjoyed] the challenge and the unexpected discoveries – the <u>reward</u> of an installation that worked.
> The INT's [interior design students] also get the chance to <u>brag</u> with what we do. (translated from Afrikaans).
> [I learned] that *I'm actually not that bad* with the practical part…
> …it is an excellent experience and really fun, as well as an important opportunity *to discover your own strengths and weaknesses…*

Theme 2: exploration

2.1 Technical knowledge

Students commented on the fact that "…exploring and just playing with the material really helped me to make informed contributions". Experimentation illustrated the physical properties and nature of the material as well as the relationship between these properties and detailing: "It is amazing how structurally stable cardboard can be if you use the correct joints and explore with different connections". The improvement in technical knowledge was partly evident in an observed increase in the use of technical vocabulary such as "strength", "withstand large loads", "structurally stable", "flexibility" and "joints and stresses". Although the knowledge gained was specific to paper-based materials, students expressed awareness that this knowledge could be applied to other materials: "…I learned about different joining ways that could be applied to other materials". This was particularly evident in the experiences of Group D. Their design necessitated the use of a repeated modular cut-out for the seat. The group tested various patterns per sheet prior to fabrication to optimise material usage, but were still left with wasted off-cuts. In an attempt to utilise these, the group fabricated a footstool from some of the off-cuts, as illustrated in figure 3. Although novel, the footstool was less successful than the seats and resulted in a valuable lesson about the relationship between a material's profile and the design: "When working with a board product like cardboard, cut outs on the board should be planned as to limit waste".

Figure 3
Group D's modular cut-out for the seat *(left)*; the resultant off-cuts and improvised footstool *(right).*

Student comments also indicated a deeper level of understanding about the value of obtaining or possessing such technical knowledge. The following are examples of their responses:

> Developing an understanding of the material is *very important.*
> [I learned that] every material needs greater understanding then it will be easy to *manipulate the material* so that the design can be achieved.
> Learning to understand the materials we used – different characteristics of the cardboard and x-board helped us *refine our concept and design* as we *understood how to cut and use* the different pieces

2.2 Technical innovation

Students realised that experimentation improved design innovation. One student commented that she learned that "innovative design can be made from simple materials" (translated from Afrikaans). The process of testing the limits of the material and its connections expand students' conceptual range and encourage them to be more innovative:

> I learned that experimenting with the material *pushes you to try to test things* that you would not otherwise have done. (translated from Afrikaans)
> I came up with *better solutions* to concerns that I ordinarily would not have thought of had I not had to build the full-scale prototype.

Group B worked extensively with cardboard tubes and explored various connections before settling on a final solution (figure 4). The group made the following comment about their process: "Looking at precedents and playing around [with various options] generated the best ideas / gives inspiration".

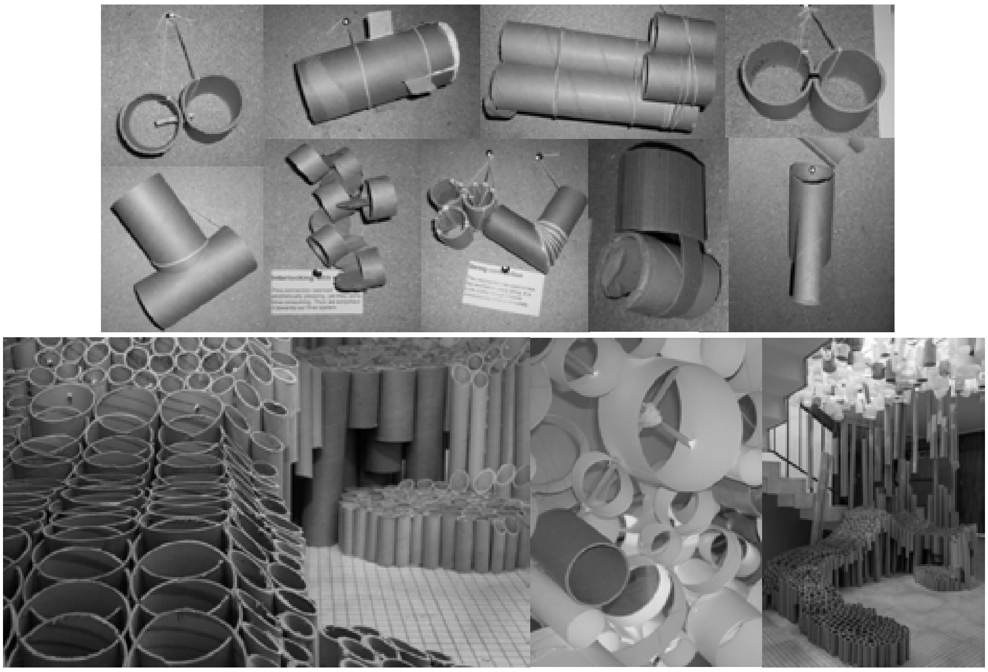

Figure 4
Group B's joint explorations *(top)* and final solution *(bottom).*

Theme 3: on-site construction

The installation of full-scale components on site revealed additional design considerations which were not anticipated by students, as can be seen in the responses below:

> [Full-scale fabrication] is relevant because then you have an *understanding* of your design (what works, what doesn't). You don't get such an understanding when just doing a presentation/model.
> That true innovation is found on site – the process from paper to maquette to full scale model leaves gaps that you can *only realise on site*.

Being on site confronted students with unexpected site conditions, offered opportunities to "test various weather, light and human factors" and allowed students the chance to "feel the space". One group spent a lot of time designing on site (see figure 5) and members commented that "being able to work on site and experiment with the site really helped me to visualise possible designs and solutions".

Working on site proved to be both inspiring and enlightening. The group that designed a seat for the stairwell was inspired by the users of the space (the site was used by the cleaning staff as a resting space), the existing rhythm and form, as well as the surrounding context (see figure 6). Students commented on the need to survey the site thoroughly prior to construction to avoid discrepancies. Site conditions also illustrated that successful construction requires tolerance for error:

> Because in interior architecture we work with existing structures, we need to *adapt our designs to fit what exists*. Due to human error during construction, there is no such thing as modular.
> [The most informative thing] was finding out how critical measurement is in this case. We literally had to measure all aspects of our site.

Figure 5
Figure 5 Group C's explorations on site

Figure 6
Responses to the existing use *(top)* and context of the site *(bottom)* by group D.

Theme 4: design process

Being involved in a complete design process, from concept generation to full-scale fabrication, proved to be a "very good learning process". Students commented on the relationship that exists between the initial spatial concept and its translation into a constructed reality: "the difference between conceptual design and implementing the design is vast. I learnt that it is very difficult to implement a concept successfully without diluting it." Developing the design however proved that "it is difficult to stick to the concept, but it is possible" (translated from Afrikaans). Students also commented on the necessity of considering construction whilst working on spatial development.

> [I learned] the importance of *designing with structural details / construction in mind.*
> …designers should not only think of themselves as designers, but we should also *consider the construction* of the design and the *people who put it together.*

One group investigated the possibility of using a folded paper 'textile' to create a spatial experience on their site. The initial conceptual proposal was pleasing, but required development (figure 7). The group settled on a fold very quickly and started fabrication before installation was considered in detail. Two days before the project was due, the group realised that they had underestimated the number of folded forms needed by several thousand. The group failed to finish and produced an undesirable final product. This however resulted in a valuable learning opportunity – the group members discussed the necessity of considering both construction and concept during the development phases in their individual design reports.

Figure 7
Group A's initial concept sketch *(left)*, folded paper forms *(centre)* and final installation *(right).*

Students indicated that the project "was a challenge that changed [their] perception of design completely" and that the project introduced them to a "new approach" to design. The exploration process highlighted the need to "plan for" and accept mistakes, as well as the fact that design requires the development and testing of various possible solutions:

> Always have a plan C, D and E and accommodate for errors and re-design (in terms of time and material.
> I *understood the process* of design and how the [development] process is very important. Application or installation made it clear that *mistakes can be made and resolved.*

Learning experiences, however, are meaningless if students do not apply the knowledge and experience gained to future design solutions. Comments indicated that students grasped the value of the project and felt that they could apply lessons learned to future design projects:

> …we had to change the way we think and adapt our designs to fit realistically and we should *start to do that to all our designs.*
> I really enjoyed this project and it was extremely valuable and has definitely *added to how I will design from now on.*
> I felt that I definitely learned a lot about how to develop an actual design to ultimately create a product that is realistic and that works from an initial idea that may have started off as very unfeasible. I have definitely *improved my thinking process;* which is much more systematic and thorough than it has been in the past.

Discussion of the results

The purpose of this project was to generate enthusiasm for technical investigations in interior design and in so doing, to encourage a deeper engagement with the technical development of design projects. Students, lecturing staff and external evaluators deemed the goal accomplished. Students' learning experiences indicated that the project generated high levels of enthusiasm. Orr (2008: 4) mentions that enthusiasm is important as it has been 'shown to facilitate deep learning.' The project also led to improved levels of confidence when dealing with technical development. This is evidenced by the diminished reliance on lecturer guidance during the development phase as well as an observed increase in student comfort when discussing technical solutions with external examiners in succeeding projects. During the design/build project lecturers promoted critical reflection on design solutions and processes. Lecturing staff positioned themselves as facilitators and advisors; offering advice and enabling rather than instructing. Malmqvist, Young, Hallström, Kuttenkeuler & Svensson (2004: 4) refers to the shift from 'lecturer as authoritarian' to 'lecturer as mentor' as a positive shift which enables a less constrained learning environment where students dare to discuss, reason and explore. Fowles (1984: 11) confirms this change in roles by stating that 'the decision-making responsibility for the design solution is ultimately the students'. The increase in confidence in ability and the level of responsibility taken for technical decision making resulted in meaningful learning experiences.

Canizaro (2012: 26) states that design/build projects have been used as a '…vehicle for students to explore the uses, characteristics, and potential within building materials, their assembly and tectonic/spatial possibilities.' The design/build project discussed here illustrated to students that technical knowledge is based in both theory and continuous hands-on experience and experimentation with materials and detailing. The project cultivated students' awareness of the value of technical knowledge in generating innovative design solutions. According to Orr (2008: 1) prototyping activities have been incorporated by schools of architecture for a number of years:

> as a means of enabling students to oscillate between the abstract and the concrete, and to develop the intellectual agility to tackle the complexities of architectural innovation and experimentation that they will use in professional practice.

The student experiences documented here indicate that design/build projects can be used in a similar manner in interior design education.

A noticeable shortcoming related to knowledge gained, was the limited realisation that the knowledge can be applied to other, similar materials. Although mentioned by some students, this aspect of the project could be enhanced. This can be done by focusing students' attention on the embedded 'geometric rules' (Sass & Oxman, 2006: 336) of materials *versus* focusing attention on the specific properties of the material at hand. If students understand that cardboard, a flat sheet of stock material, is embedded with similar geometric rules as plywood, they should, in principle, be able to apply knowledge gained to future interior design projects.

The design/build project encouraged hands-on experimentation with materials and detailing. All five groups participated in a process of testing and reflecting, by using models and rough prototypes. Studio lecturers, however, observed a decrease in the use of sketching over the course of the project. Although modeling is an invaluable tool in technical experimentation, sketching should be used as a supplementary design tool. This shortcoming should be addressed in future iterations of the project to avoid a reliance on modeling as the only means of technical exploration.

Full-scale fabrication exposed students to budget and time restraints – issues that are often only discovered during the first project in practice. Canizaro (2012) states that design/build projects are grounded in various 'realities' and as a result decision-making is made more informed and responsive. He continues by saying that 'such training, it is assumed, will result in more informed and responsive future architects'. Design/build projects confront students with problems (or less satisfactory solutions) virtually immediately. Steve Badanes from Yestermorrow Design/Build School (in Carpenter, 1997: 32) expands on this notion: "We try to do a good set of drawings, but if an opportunity presents itself or if a mistake is made, we brainstorm right there. You get a certain feedback from what you are building, like a sculptor does".

Students not only learn to adapt quickly and develop technical solutions whilst on site, but also that perfect solutions are not developed on the first try. Technical development necessitates the creation, analysis and subsequent revision of solutions. In the succeeding project, students seemed more comfortable with exploring various technical solutions before settling on a final resolution.

Building the design on site exposed students to the realities of working with existing structures. Students were confronted with the inaccuracies inherent to existing spaces and had to respond by adapting design proposals, either in the studio or physically on site. The site was also viewed as a space of inspiration. Students commented on the design potential inherent in existing spaces and could gain an enhanced awareness of place by physically experiencing the site they should respond to.

The project introduced students to the complexities of engaging with a complete design process. Students were offered the opportunity of "…dreaming of possibilities, discovering limitations, making compromises, coming to realizations and reflecting on the process." (Luescher, 2010: 20). In doing so, students produced innovative technical solutions and illustrated a deeper understanding of the relationship that exists between conceptual thinking and technical resolution.

The postponement of technical development was however still evident with some students, especially those at the lower end of the marking scale. Future iterations of the project would benefit from rigorous evaluation of the engagement with, and time spent on, technical development in the projects that follow the design/build exercise. Results from such evaluations may add to the validity of implementing design/ build projects in interior design education.

Conclusion

The case study presented here concludes that projects that encourage the full-scale fabrication of spatial solutions can be implemented in interior design education to encourage a deeper engagement with the technical development of design proposals. It is however recommended that future projects place a more pronounced focus on helping students to understand how the skills and knowledge gained may be applied to similar situations and materials. Future projects would also benefit from a continued emphasis on the complementary role of sketching and modeling during the technical development process.

Although the case study is contextual in its aims and organisation, and its findings restricted due to the limited number of students involved, it illustrates the potential inherent in design/build projects. Fundamentally, these projects allow students the opportunity to become "participants, not merely spectators, and (in theory, at any rate) understand design and construction as an integrated process that begins with the consideration of material" (Luescher, 2010: 25).

Designers rarely make the objects they design themselves and as such it might be argued that a design/build project sets an unrealistic precedent in professional education. However, Pallasmaa (2009: 63) observes that designers in fact need to 'understand the possibilities and limits of materials and crafts, and communicate their ideas and intentions to the specialist craftsman, whose hands become the designer's surrogate hands in the execution of the work.' Such design communication can greatly benefit from the hands-on experiences offered by full-scale fabrication. Pallasmaa (2009: 69) goes on to say that

> …a wise architect [and by extension, a wise interior designer] today searches deep personal friendships with craftsmen, artisans and artists in order to reconnect his/her intellectualized world and thinking with the source of all true knowledge: the real world of materiality and gravity, and the sensory and embodied understanding of these physical phenomena.

Full-scale fabrication presents students with an opportunity to connect with the material realm of design. Interior design education can benefit greatly from a deeper investigation into the application of the principles and processes of design/build to ensure student work that is both imaginative and technically sound.

Notes

1 In 2011 the International Federation of Interior Architects/Designers (IFI) developed the IFI Interiors Declaration as a foundation and description of the practice of interior architects/designers worldwide. The Declaration provides "…clear goals for and affect the fundamental understanding and shaping of our practice, its education and research…" (Caan, 2011).

2 The Department of Architecture, University of Pretoria, presents the undergraduate degree as a Bachelor of Science in Interior Architecture (BSc(Int)). The Department views 'Interior architecture' as a category of the broader discipline known as 'Interior design'. Interior design refers to all work concerned with the design of interior space within built environment enclosures, ranging from interior fit-out to the adaptive re-use of existing buildings (including additions). For the sake of clarity, this article will make use of the widely understood term 'interior design'.

3 Groups were pre-selected by the studio lectures to encourage heterogeneity in the teams (in design ability and background). Russ & Dickinson (1999), when discussing collaborative design in the interior design studio, mention that although heterogeneity can make teamwork more difficult it holds a number of distinct benefits. They also state that a professional team's composition is typically dictated by management and that employees rarely choose who they would like to work with. The studio simulates the design office and as such pre-selection was deemed relevant.

4 Juhani Pallasmaa is a Finish architect, educator and critic. His seminal work "The Eyes of the Skin: Architecture and the Senses" published in 2005 points the way to creating architecture that engages multiple senses. The interaction between the human body and design is further explored in the 2009 publication "The Thinking Hand - Existential and Embodied Wisdom in Architecture."

5 Paper-based materials, such as corrugated cardboard, are easy to handle and pose a low safety risk. Manufacturing can be completed by hand and students do not necessarily require experience or prior knowledge of tools and techniques to test and implement ideas. In addition, paper-based materials can simulate other traditional building materials, for example: corrugated cardboard (flat sheet of stock material) can simulate plywood or other board materials.

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