An Evidence-Based Design approach for function, usability, emotion, and pleasure in studio redesign.

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Abstract

Studio-based design education is changing to include multidisciplinary design teams, geographically distributed teams, information technology, and new work styles. In this paper, we present the research findings from a graduate studio redesign using an Evidence-Based Design approach with measures and outcomes for function, pleasure, and the emotional needs of users. Located in a design school at a research university in the United States, we conducted four types of pre- and post-occupancy measures: observations, interviews, surveys, and diary studies. Six issues informed studio redesign: Aesthetics, Acoustics, Collaboration, Faculty Interaction, Sociability, and Stewardship. We transformed a single room design studio into four interconnected spaces: an area with individual workspaces, collaborative spaces, a kitchen and social cafe area, and a classroom with distance learning technology. Student satisfaction significantly improved in the new studio according to survey results. Some participants' open-ended survey comments suggest that functional needs were met, but some pleasure-related and emotional needs linked to habitation were problematic. Claiming of individual workspaces and limited social norms were linked to mixed positive and negative responses on aesthetics and acoustics. Collaborative and social spaces, where there is no expectation of ownership, had uniformly positive results in both closed- and open-ended survey results.

Keywords
design studio education; learning environments; design research; Evidence-Based Design

Design studio education is rapidly changing to keep current with and push design practice. Common trends include multidisciplinary teamwork, increased use of information technology, geographically distributed collaborations, and flexibility in work environments.

The design studio in universities is a physical place, a cultural place, and a social place. Activities are characterized by five factors: co-location, learning-by-doing, continuous access, integrative learning, and mimicking practice (Lawson & Dorst, 2009). A studio-based education ecological framework includes observable components, or "tools", and pedagogical approaches used to construct design knowledge (Brandt, Cennamo, Douglas, Vernon, McGrath, & Reimer, 2011). The studio environment supports a learning-by-doing pedagogy where guided instruction helps students acquire design knowledge and skills. Design instructors rely on professional experience, awareness, and talent (e.g., Goldschmidt, Hochman, & Dafni, 2010).

Studio education has a three parts: studio pedagogy, social dynamics, and ideals and expectations (Groat, & Ahrentzen, 1996). Studios are more than the design functions supported, the research and design methodologies taught, and declared rules.

Interactions between studio dwellers, faculty, staff, and administration shape social dynamics. Each person immersed in a studio culture brings his or her ideals, values, and expectations. Furthermore, global student populations in studio environments require cultural sensitivity.
Studio critiques and conversations help students navigate the complexities of designing, and the configuration of the studio where critiques occur in turn may influence interactions and outcomes. Design critiques in studio education vary along three dimensions: from number of people (one-on-one, small group, whole class), public/private, and formal/informal (Oh, Ishizaki, Gross, & Yi-Luen Do, 2013).

Design and architecture schools are shifting from solely individual projects to team projects (Koch, Schewennsen, Dutton, & Smith, 2002). Increasingly, design studio environments need to support individual work and teamwork, through individual and collaborative workspaces.

Universities are rethinking their design studios. For example, the d.school at Stanford University chronicles their design space transformations in the book, Make Space (Doorley & Witthoft, 2012). The Human-Computer Interaction Design program at Indiana University created a new studio with a broad range of types of space, from limited individual desks for doctoral students to collaborative workspaces and project rooms for master’s students. Faculty offices and students are collocated to increase interaction opportunities. The studio is also a departmental showcase (Callison, 2011).

Research of university studio redesign projects varies from the anecdotal to rigorous studies. Evidence-Based Design (EBD) rigorously links credible evidence validated by research and design decisions. EBD originated in healthcare facility design, as a method to achieve excellence in medical staff and patient experience, including safety, the reduction of medical errors, hospital acquired infection, and staff injuries (Ulrich, Zimring, Zhu, DuBose, Choi, Quan, & Joseph, 2008). Increasingly, EBD is used in other domains such as learning environments, retail space, and workplaces (Hamilton & Watkins, 2009). Textbooks detail EBD approaches for elementary and secondary school learning environments (Lippman, 2010; Hamilton & Watkins, 2009). One perceived limitation to EBD is the focus on easily measurable functional outcomes.

While functionality and usability are critical in design studio environments, multiple factors shape learning. Human factors researchers have argued that pleasure with products – and by extension, environments – moves beyond mere usability (Green & Jordan, 2002). Four types of pleasure benefits are linked to design: physio-pleasures, socio-pleasures, psycho-pleasures, and ideo-pleasures (Jordan, 2000). Users derive physio-pleasures through design qualities that alter user physiological states (e.g., calming colours that reduce arousal). Socio-pleasures enable people to be more comfortable in their relationships with others (e.g., feeling socially accepted). Psycho-pleasures are delivered through design that makes unpleasant tasks easier by reducing frustration (e.g., online one click shopping). ideo-pleasures pertain to people’s moral values and personal aspirations, and how people want to see themselves and want to be seen by others.

Studio experiences are coloured by emotional responses that operate on three levels: visceral, behavioural, and reflective (Norman, 2004). Pleasure and emotional design are linked in a holistic assessment of user experience (van Gorp & Adams, 2012). Visceral design concerns appearances (e.g., colours, aesthetics), relates to physio-pleasures and provides hedonic benefits. Behavioural design relates to effectiveness of use (e.g., functionality, usability), links to psycho-pleasures and relates to practical benefits. Reflective design considers interpretation and understanding over time (e.g., experience, personal story), concerns ideo-pleasures and socio-pleasures and relates to emotional benefits.

In the sections that follow, we describe a redesign project for a studio that houses graduate students in a university setting. The design studio was transformed through renovation from a single room to a suite of connected spaces to better support the range
of activities required of graduate students engaged in individual and collaborative team work. First, we discuss the design strategy used in the redesign of the studio. Second, we describe the research methods used to study the former graduate studio and the remodelled studio. Third, we present the results. Fourth, we discuss the research findings. Last, we summarize the research presented in this paper.

**Design Strategy**

The studios before and after renovation house approximately 40 graduate students in two-year design programs. To discover the main challenges presented by the pre-renovation graduate design studio, we collected baseline measures using observations, interviews, an online survey, and a diary study documenting where students did their work in and outside of the studio. Six key findings from the pre-renovation research informed the design of the new studio:

1. **Aesthetics.** Students rated furniture, paint colour, carpeting, and upkeep of the studio very poorly. Students complained about the overall greyness of the studio, unaesthetic quality of furniture, and the need for regular maintenance. Student ratings relate to visceral-design and physio-pleasures.

2. **Acoustics.** Students identified conflict between individual work requiring quiet concentration and teamwork demanding group discussion, in the shared, multi-function studio space. Student ratings relate to behavioural-design and psycho-pleasures.

3. **Collaboration.** Students were dissatisfied with the amount and quality of space dedicated to collaborative activities, based on the needed balance of individual and teamwork in graduate education. Student ratings relate to reflective design, ideo-pleasures, and socio-pleasures.

4. **Faculty Interactions.** The studio housed both first and second year graduate students engaged in course and thesis work. Most interaction with faculty occurred in classrooms and faculty offices distributed throughout the school. Limited faculty interactions likely relate to reflective design, ideo-pleasures, and socio-pleasures.

5. **Sociability.** Students had limited space to congregate over food and socialize; furthermore, teams often occupied the social space for non-social purposes. Student ratings relate to reflective design, ideo-pleasures, and socio-pleasures.

6. **Stewardship.** Students lacked agency over their studio environment and complained about studio conditions and upkeep. Lack of stewardship and agency likely relates to reflective design, ideo-pleasures, and socio-pleasures.

The new studio suite increased from 167m$^2$ in a single room (figure 1) to a 400m$^2$ suite formed by four interconnected spaces to support multiple work preferences: an area with individual workspaces for 40 students, collaborative space with an enclosed team room, a kitchen and social cafe area and a distance-learning capable classroom (figures 2,3,4,5). Additional features included wall-to-wall whiteboards, six 50-inch video monitors, dynamic screen-sharing technologies, and teleconference abilities. Furnishings were specified through collaboration with Steelcase learning environments.
The following are key features of the studio redesign.

1. To ensure aesthetic appeal in the graduate studio an architecture and interior design firm was hired to coordinate the space, furniture, and fixtures in a collaborative design process with faculty members and staff from the school and university. Most of the furniture in the studio was sourced from Steelcase.

2. To reduce acoustic interference, individual workspaces were separated from the collaborative work areas. The studio floors were carpeted to reduce noise. Acoustic ceiling materials were hung in the individual work areas and the collaborative space.

3. The collaborative area was more than doubled to 85 m$^2$ to include multiple types of collaborative spaces, and an enclosed team room for video conferencing.

4. Increased contact between students and faculty in the studio was achieved by connecting a 76m$^2$ distance-learning capable classroom to the collaborative area of the studio suite. A large glass garage door located between the classroom and the collaborative area can flexibly transform the space from contiguous studio space to secluded classroom.

5. The social area was significantly increased to 61m$^2$, accommodating four tables, four lounge chairs, a standing height bar with stools, dishwasher, espresso coffee machine, full sized refrigerator, microwave, and toaster oven.

6. Student stewardship of the studio was encouraged through a rotation system of self-assigned upkeep tasks such as vacuuming, use of the dishwasher, and cleaning whiteboards, kitchen counters, and tables. A student representative was asked to act as an intermediary to voice student concerns directly to the head of the school and a student advisory committee.

Figure 1. Floorplans of old studio (left) and of the remodelled studio suite (right). In the remodelled studio, the collaboration space and learning lab replaced the former one-room studio. The laboratory and offices in the old configuration became a large room with desks for individual work. The classroom across the hall from the old studio became the kitchen and social area in the remodelled studio. Architectural and interior design by Edge Studio.
Figure 2. Images from the old studio: (far left) individual desk area; (center left) kitchen area; (center right) social space; (far right) teamwork area.

Figure 3. Panoramic 360° photograph of the graduate design studio before remodelling: (left) team table; (center) view onto individual desks; (right) kitchen corner and social area.

Figure 4. Images from the remodelled studio: (far-left) individual desk area; (center-left) kitchen area; (center-right) tables in social space; (far-right) team tables near classroom.

Figure 5. Panoramic 360° photograph of the remodelled graduate design: (left) view into kitchen and social area; (center) view into classroom; (right) view into collaborative spaces.

Research Methods
We conducted four types of pre- and post-occupancy measures: online surveys, field observations, interviews, and smartphone diary studies on preferred work locations. All methods informed the redesign strategy; however, we focus here on the online survey, for pre- and post-measure comparisons with supporting information from field observations. While interviews and diary studies were generally informative, there was a large imbalance of participants pre- and post-renovation, providing limited data for comparison.

The online survey had 12 questions with 112 sub-questions with Likert scale responses, and nine open-ended comment boxes. We conducted the survey twice, pre-renovation in April 2012, and post-renovation in November 2012. Participants were solicited via email to the graduate student mailing list. The questions described below are grouped according to the six key themes for design: Aesthetics, Acoustics, Collaboration, Faculty Interaction, Sociability, and Stewardship.
1. *Aesthetic* measures included questions about satisfaction with individual and collaborative spaces, asking for assessments of aesthetic appearance; colour and quality of finishes (surfaces, walls, carpets); table surface quantity, quality, and layout; file storage quantity; and chair.

2. *Acoustic* measures included questions about acoustic interference in both the individual and collaborative work environments, asking for satisfaction ratings on amount of noise from other people’s conversations, amount of background noise (i.e. not speech), level of privacy, frequency of distractions from other people, and distance between people.

3. *Collaboration* measures included questions about collaboration in both individual workplaces and collaborative group spaces. Participants were first asked for satisfaction ratings of the primary location for individual work in the graduate design studio suite, including meeting space within individual work locations, and space to accommodate work, materials, and visitors. Participants were then asked how they would evaluate the following features of the graduate studio suite: tools and technology in meeting areas, arrangement and furnishing of meeting areas, and variety of places for collaborative work.

4. *Faculty interaction* with students was determined based on interviews pre-renovation, and using field observations in the new studio. In the fall of 2012, the classroom was not yet being used to teach, whereas in the spring semester of 2013 the classroom was being used for multiple classes. Observations were collected four times each day on weekdays and on one day over the weekend between September 2012 and April 2013.

5. *Sociability* measures were taken using the online survey, asking for evaluations of the kitchen and social areas. We averaged the two questions since the social areas and the eating area were a single space prior to remodelling.

6. *Stewardship* was assessed with one survey question pre- and post-occupancy, asking for a rating of satisfaction on ability to alter the space.

We conducted an ANOVA comparison between the pre and post survey responses. While no control group was available, there was no overlap between the pre and post renovation groups in this study.

The field observations were conducted at four time points daily. Researchers noted where people were in the studio on a schematic floor plan. The observations were tallied in a spreadsheet. Photographs of artefacts and student activities were taken and annotated in a field notebook and then transcribed in a shared online document.

**Results**

In this section, we describe the results from the online survey and field observations. The design of the new studio suite was very successful, with students rating the new studio suite over all significantly better than the old one. Forty-three respondents completed the survey, eighteen pre-renovation, and twenty-five post-renovation. All survey responses are reported on a seven point Likert scale. We present results according to the six design themes: *Aesthetics, Acoustics, Collaboration, Faculty Interaction, Sociability,* and *Stewardship.*

*Aesthetics.* Aesthetic appearance and satisfaction with both the individual and collaborative areas was significantly higher in the redesigned studio, including
assessments of overall appearance, and satisfaction with colours, finishes, quality and quantity of surfaces, file storage, and workstation chairs (see table 1).

We interpret open-ended survey responses to signify that the quality of the aesthetic choices was appreciated overall; however, some students were dissatisfied with aspects both before and after renovations, but for remarkably different reasons. For example, comments on the old studio focused on the greyness and lack of aesthetic appeal:

“At the moment the walls, tables and floor are all grey. So even when we get stuff tacked up here and there, the overwhelming feeling is grey grey grey.”

Whereas comments on the remodelled studio focused on the pristine condition of the new space:

“So pristine, it's hard to feel totally comfortable. (Although that may be good for a shared space.)”

“Not sure what I would actually do, but something to make it a bit more playful, less dauntingly pristine.”

“Everything is white and sterile looking, any amount of "lived in" quality dramatically takes away from the aesthetic. This is especially true in the kitchen.”

We interpret the survey questions to mean that the function, quality, and aesthetics of the remodelled studio significantly improved after remodelling. The negative overtones of the open-ended responses may indicate that some participants didn't quite feel at ease in the new studio.

<table>
<thead>
<tr>
<th>Measure</th>
<th>DF</th>
<th>F</th>
<th>Sig.</th>
<th>Mean Pre</th>
<th>Mean Post</th>
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<td>(a) Aesthetics</td>
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<td>201.06</td>
<td>.0005</td>
<td>1.89 (SD .94)</td>
<td>6.04 (SD 0.94)</td>
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<tr>
<td>(b) Colour</td>
<td>1.42</td>
<td>64.23</td>
<td>.0005</td>
<td>2.16 (SD 1.64)</td>
<td>5.72 (SD 1.31)</td>
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<td>(c) Quality finish</td>
<td>1.42</td>
<td>93.90</td>
<td>.0005</td>
<td>2.21 (SD 1.72)</td>
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<td>(d) Work surface</td>
<td>1.42</td>
<td>11.09</td>
<td>.002</td>
<td>3.74 (SD 1.91)</td>
<td>5.40 (SD 1.78)</td>
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<td>(e) File</td>
<td>1.42</td>
<td>5.07</td>
<td>.03</td>
<td>3.95 (SD 2.37)</td>
<td>5.32 (SD 1.68)</td>
</tr>
<tr>
<td>(f) Chair</td>
<td>1.42</td>
<td>52.01</td>
<td>.0005</td>
<td>3.21 (SD 1.65)</td>
<td>6.12 (SD 1.01)</td>
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Table 1. Measures on aesthetics of environment and satisfaction with personal work- places (n = 43: pre n = 18, post n = 25). Responses on a seven point Likert scale (1 = very unsatisfied, 7 = very satisfied).

Acoustics survey measures suggest significant decreases in acoustic interference around individual workstations and the studio in general, with significant increases in satisfaction based on reduced interference from other people's conversations and background noise, frequency of distractions, distance between people, and privacy for conversations (see table 2).
Open-ended survey responses suggest that acoustic interference is still a concern for some students. In the old studio acoustics were mentioned as problematic:

“The main complaint with the studio is that there is not enough quiet space to do focused individual work like writing, reading or synthesis.”

In the remodelled studio, creating a quiet area separate from the collaborative areas for individual work with sound absorbing ceiling treatments and carpet helped with acoustics. However, establishing social rules about making noise in a quiet space continued to present challenges.

“It is still a fight to find quiet space where I won't be disturbed. I wish there were quiet chambers where I could lock myself into something or if there were a door that I could close to indicate that I don't want to be disturbed. I do try to write and read at my desk using my studio headphones but depending on who is around, I will still get interrupted and asked questions. That's just the nature of being in a social environment. There are no quiet rules in the back green-chair area. To get real peace and quiet I still have to go home to work.”

The open-ended comments suggest that acoustics are comprised of both technical and social issues.

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<tr>
<th>Measure</th>
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<th>Sig</th>
<th>Mean pre</th>
<th>Mean post</th>
</tr>
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<tbody>
<tr>
<td>(a) Individual Noise Interference</td>
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<td>5.02</td>
<td>.031</td>
<td>2.94 (SD 1.89)</td>
<td>4.16 (SD 1.65)</td>
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<tr>
<td>(b) Background Noise</td>
<td>1.42</td>
<td>13.66</td>
<td>.001</td>
<td>3.06 (SD 1.79)</td>
<td>4.16 (SD 1.89)</td>
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<td>(c) Distractions</td>
<td>1.42</td>
<td>21.50</td>
<td>.0005</td>
<td>2.44 (SD 1.46)</td>
<td>4.56 (SD 1.5)</td>
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<tr>
<td>(d) Crowding</td>
<td>1.42</td>
<td>13.60</td>
<td>.001</td>
<td>3.68 (SD 2.19)</td>
<td>5.48 (SD 1.36)</td>
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<tr>
<td>(e) Conversation Privacy</td>
<td>1.42</td>
<td>19.42</td>
<td>.0005</td>
<td>2.63 (SD 1.57)</td>
<td>4.64 (SD 1.44)</td>
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Table 2. Acoustic interference survey measures before and after remodelling n = 43 (pre n = 18, post n = 25). Responses on a seven point Likert scale (1 = very unsatisfied, 7 = very satisfied).

Collaboration measures indicated significantly higher student satisfaction in the remodelled studio, including assessments of meeting space within individual work locations, space to accommodate work, materials, and visitors around workstations, tools and technology in meeting areas, quality, arrangement and furnishing of meeting areas, and variety of places for collaborative work (see table 3).

Open-ended responses in the pre-survey suggested that some participants had concerns with the collaborative spaces. In the old studio, students lamented the limited amount of collaborative spaces.

“For a lot of the core classes, several groups are always meeting at once. It can get crowded quickly, especially with the lack of counter space in the kitchen area. Meetings often trickle into the social dining areas.”

The collaborative space in the remodelled space received praises.
In contrast to mixed positive and negative survey responses on aesthetics and acoustics, the closed- and open-ended responses on collaborative spaces were uniformly positive.

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<tr>
<th>Measure</th>
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<th>Mean pre</th>
<th>Mean post</th>
</tr>
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<tbody>
<tr>
<td>(a) Individual meeting areas</td>
<td>1,42</td>
<td>16.95</td>
<td>.0005</td>
<td>3.11 (SD 2.07)</td>
<td>5.32 (SD 1.49)</td>
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<tr>
<td>(b) Accommodate self and visitors</td>
<td>1,42</td>
<td>10.57</td>
<td>.002</td>
<td>3.68 (SD 2.08)</td>
<td>5.48 (SD 1.58)</td>
</tr>
<tr>
<td>(c) Collaboration tools and technology</td>
<td>1,42</td>
<td>109.53</td>
<td>.0005</td>
<td>2.72 (SD 1.02)</td>
<td>6.27 (SD 1.15)</td>
</tr>
<tr>
<td>(d) Arrangement meeting places</td>
<td>1,42</td>
<td>76.50</td>
<td>.0005</td>
<td>3.35 (SD 1.53)</td>
<td>6.38 (SD 1.71)</td>
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<td>(e) Shared meeting areas</td>
<td>1,42</td>
<td>74.78</td>
<td>.0005</td>
<td>3.16 (SD 1.39)</td>
<td>6.16 (SD 0.91)</td>
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<tr>
<td>(f) Variety collaboration spaces</td>
<td>1,42</td>
<td>165.99</td>
<td>.0005</td>
<td>2.95 (SD 1.04)</td>
<td>6.50 (SD 0.80)</td>
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Table 3. Collaborative meeting space survey measures before and after remodelling n = 43 (pre n = 18, post n = 25). Responses on a seven point Likert scale (1= very unsatisfied, 7= very satisfied).

Faculty interactions were limited in the studio prior to remodelling. Both graduate students and faculty mentioned that faculty rarely entered the graduate studio room. Faculty perceived the graduate studio as student territory and went there only if invited or otherwise necessary. The new classroom integrated within the redesigned graduate studio suite was commissioned for classes starting in the spring semester of 2013. On average, faculty members represented 3% of the people counted in the remodeled studio. On average, faculty members were counted in the studio in two of the four daily observations.

Sociability. On average participants were significantly more satisfied with the social and kitchen space going from 3.25 (SD 1.68) before remodelling to 6.83 (SD .28) after remodelling [F(1,42) = 100.23, p= 0.0005].

Some of the open-ended survey responses before remodelling highlighted the main concerns with the kitchen and social space.

“Kitchen does not have enough features. We need a larger refrigerator, and a better dish-washing system. People get too lazy to wash dishes because the sink is too small and it takes too much effort.”

After remodelling, some minor concerns remained with regard to kitchen details.

“I wish we had storage tubs for the shelves to hide the items on the shelves. Maybe one for each student? If we bring our own in, they won’t match the decor and may still end up looking messy and low class.”

“I think there should be more “floor” in the kitchen to avoid hard (carpet) clean ups.”
Stewardship and student agency on average significantly improved going from 2.94 (SD 1.47) before remodelling to 4.80 (SD 1.61) after remodelling [F(1,42) = 14.931, p= 0.0005]. While a significant improvement, 4.8 on a seven-point scale falls between 4 “neutral” and 5 “somewhat satisfied.” Some open-ended survey responses suggest that while agency significantly improved in the remodellied studio, improvements are still necessary.

“Another frustration is that although there are changes we have asked for such as different garbage cans for the kitchen, all the money has been spent. I don't understand how this space is supposed to be a work in progress or a prototype to iterate on when there is no money to make such changes.”

“It bothers me a bit that people don't erase their work on white boards and that we are all doing our own chores by volunteering. It seems that there should be a better system where we can all clean at the same time.”

“I would prefer if our seats in the studio changed every month or so. This would give me a chance to talk to people I never get to talk to.”

Discussion
The data in this paper raises many questions about what the studio is in design education. We discuss the main findings in terms of the established six design themes: Aesthetics, Acoustics, Collaboration, Faculty Interaction, Sociability, and Stewardship.

Aesthetics. The old studio clearly was in need of repair, with deteriorated aesthetics and limited functionality compared to the renovated design studio (Figures 1,2,3,4,5). Our interpretation of the survey results is unequivocal in determining that the new studio is significantly more satisfying from an aesthetic perspective. However, the survey results are qualified by certain open-ended responses. The presence of both positive and negative measures in the data suggests that on some levels the remodelling of the studio significantly improved student satisfaction, and on others the renovated studio presented aspects of discontent.

We speculate that the patterns observed replicate what philosopher Odo Marquard termed a typical inversion of negativity. The solution to a problem is first perceived positively, then with indifference, and finally the solution becomes a new problem (Marquard, 1990). In this instance, the high quality of the remodellied studio is the solution to the problems identified in the old studio, yet at the same time the high quality in the remodellied studio becomes the problem of the new studio.

We had not anticipated that a high quality design solution could be both positive and at the same time problematic for students. However, the differences between closed- and open-ended survey comments suggest that there are multiple layers to the problem of aesthetics as perceived by occupants. The contrasting opinions suggest individual differences in visceral and physio-pleasure responses to colours and aesthetics.

Acoustics. As described earlier, the closed-ended survey revealed significant improvement with respect to acoustic interference in the renovated studio, coupled with negative comments in the open-ended questions on the same topic. The closed-ended survey questions capture the functional improvements: individual work areas are separate from group work areas, there are multiple places where groups can work, and the surface area more than doubled for the same number of people. At the individual level, acoustics relates to behavioural-design and psycho-pleasures.
The negative comments in the open-ended survey questions suggest a lack of social rules about how to interact with others in the quiet individual work areas. The tension around acoustics may be evidence of a missing socio-pleasure. To solve the acoustics problem it is not enough to install sound absorbent acoustic materials; social rules need to be enacted by the studio occupants as well.

**Collaboration.** The collaborative space received positive marks on both the closed- and open-ended survey results in the remodelled studio. Why is there no inversion for collaborative space as there was for aesthetics and acoustics? One possible explanation may be that collaborative work in a shared space is by its nature temporary. Students had no expectation to inhabit the space and own it past the duration of the team meeting. As such, perhaps students perceived collaborative space as a temporary space, and not as a primary territory to inhabit for a long time (Brown, 1987). The collaboration spaces may have supported reflective teamwork, delivered psycho-pleasures by making typically unsupported team tasks less frustrating, and increased socio-pleasures by making team members feel more comfortable in their relationships with others.

**Faculty interactions.** Two findings relate to faculty presence in the graduate studio. First, we noted that faculty members were observed more frequently in the graduate studio after the renovation in general meeting with students. Second, teaching classes in the classroom connected to graduate studio was associated with the most faculty sightings. Third, the kitchen and social space provided a public space for interactions with faculty. Through design critiques faculty members question student work to increase reflection. Increased interaction between faculty and students likely afforded (a) psycho-pleasures on difficult design tasks by encouraging students and providing design tips, and (b) socio-pleasures, derived from students and faculty working together on design projects.

**Social space.** Satisfaction with social space and the kitchen area was significantly improved with studio remodelling, as suggested by closed-ended survey questions and open-ended comments. The open-ended comments that are critical point out functional problems and not issues of emotional response or ownership. We believe this is the case because the kitchen and social spaces are perceived to be shared spaces. Sociability likely increased opportunities for reflection, socio-pleasures (e.g., belonging), and ideo-pleasures (e.g., opportunities to be seen within a social group in a particular manner).

**Stewardship.** Students were encouraged to take ownership of the graduate design studio suite as a group and to be responsible for the care of it. The closed-ended survey questions and the open-ended comments suggest that there are several levels to student agency in the studio suite. The closed-ended questions captured that students felt much greater agency in the remodelled studio. Encouraging stewardship in the studio environment provides opportunities for self-reflection and collective reflection on upkeep and agency. Both ideo-pleasures (e.g., how one wants to be seen) and socio-pleasures (e.g., belonging to a group) are likely linked to stewardship.

The open-ended comments indicate that the imposed rotation system for self-assigned upkeep tasks such as vacuuming and cleaning whiteboards and kitchen counters was met with resistance. Students expressed the desire to create their own system. Other comments suggest that some students were confused as to the process and budget available to make changes, and who can make aesthetic decisions in the studio. The school should decide how much to encourage student studio self-organization, and how much to guide processes for studio stewardship. Future work will examine alternatives of how to encourage student agency and studio upkeep.
The apparent contradictions between closed- and open-ended survey results require multiple explanations. One explanation is that designed artefacts have multiple meanings that go beyond aesthetics and functional features; for example, meanings attributed to designer intent or user interpretations in context; solutions to human needs, business or technical opportunities; and sensory user experiences, and emotional response (Gagliardi, 1992).

User research informed the graduate studio suite redesign. Perhaps, the studio system designers addressed functional student needs but missed some deeper pleasure or emotional needs. As inhabitants of a studio environment, design students are acutely aware and are critical of its features. Behaviours are influenced both by functional attributes of the studio environment and policy. Since there is a cyclical movement through the studio with graduating students and new students entering each year, culture, including social norms, needs to be first established and then communicated to new members. The challenge to expected behaviours and gradual establishment of new social norms in studio culture could arguably be presented as a case of second-order or double-loop learning (Argyris & Schöon, 1978).

Rhetoric offers other insights into designed artefacts. Rhetoric is defined as the available means of persuasion for a dialogue between designed artefact and audience (Buchanan, 1995). Rhetorically, artefacts have their own logic (logos); engender emotional response in the audience (pathos); and have their own character (ethos). The closed-ended survey responses may indicate that from a students’ perspective the “logic” of the design studio suite was successful from a functional and aesthetic perspective.

The “pathos” or emotional responses in the open-ended comments tell a different story. From an emotional perspective the redesign aesthetics did not resonate with all students. Some mentioned not feeling at ease, or being afraid to ruin the clean white space by occupying and working in it.

From an “ethos” perspective, once something is designed it in turn designs the world (Fry, 2009). Acoustic interference in the studio is shaped by acoustic material qualities, functional localization choices, social protocols, and noise sources. The acoustic ethos is shaped by the interplay of such factors.

**Conclusion**

The pre and post occupancy measures delineate a complex story of how participant needs in the studio environment are aesthetic, functional, emotional, behavioural, social, and institutional. Clearly, to design studios researchers should consider these multiple levels and their interactions. One limitation of the Evidence Based Design approach is the focus on easily measurable functional needs. While closed-ended survey responses indicated that students were significantly more satisfied with their new studio in functional terms, open-ended survey comments suggested that pleasure-related and emotional needs linked to habitation were problematic for some students. Moving forward, the analysis of survey data will be triangulated with qualitative methods, including observational studies, diaries and contextual tours, and attempts to parse out sub factors in depth, such as identity, agency, and stewardship.

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