

Life Size: Environmental Knowing Through Full-Scale Installations

MARK CABRINHA

California Polytechnic State University, San Luis Obispo

"The problem of method in forming habits of reflective thought is the problem of establishing conditions that will arouse and guide curiosity; of setting up the connections in things experienced that will on later occasions promote the flow of suggestions, create problems and purposes that will favor consecutiveness in the succession of ideas."

John Dewey, *How We Think*

INTRODUCTION

The installation plays a liminal role in architectural education. As liminal, the installation acts as a *threshold* between design as intellectually conceived and perceptually experienced. As liminal, the installations presented here *transition* back and forth from design as an individual activity and design as a social process. As liminal, installations exploit the *transitions* between messy and precise design processes, not as oppositions, but rather as ends along a continuum. The argument here is that design *as an activity* and *as an experience* is most effective when spread across these thresholds and transitions. The liminal role of the installation reinforces that design process and design product are reciprocal experiences.

The installations presented here developed at three different design schools, in Fall 2006, Winter 2007, and Spring 2008. Looking across all three studio installations over an extended period of time gives these life size pedagogical experiences a longer look - an impression on architectural education that lasts considerably longer than the short duration of the installation itself. There is no pretense that these are permanent structures. The strength of these installations is their impermanence - light, temporary, fleeting - giving the studio a willingness

to experiment and the tools to test it out. Rather than a permanent structure, what I hope is lasting is the perceptual shift in the design student. Working at life size through the installation establishes the conditions to test ideas out in a way that working at one's desk never could.

Situated in the contemporary context of digital fabrication, my intentions are to shift from a focal to a peripheral awareness of these technologies, while upholding the opportunity they bring to the studio. These tools continue to foster a dominant image of technological novelty created by a focal attention on technology. In putting the technology at the periphery, my motivation in pursuing these pedagogical exercises was to understand how they might enable a wider spectrum of design experience, what Michael Speaks has coined 'design intelligence.' Design intelligence is a form of thinking-as-doing focusing on innovation through speculative testing and prototyping (Speaks 2005). This view inverts the higher authority of theory and instead focuses on the active 'intelligence' of workshop practices in which "the intelligence of practices allows us to manipulate the conditions under which designs and buildings are produced in search of opportunities that can be exploited. Practices, in other words, allow for a great degree of innovation because they encourage opportunism and risk-taking rather than problem solving" (Speaks 2002). Speaks specifically identifies how CNC technologies are enabling workshop practices to speculate through the full scale prototype and in so doing, the prototype "becomes a tool of innovation and not just a version of the final design" (Speaks 2005).

In academia, if these technologies are used as expedient means to output final designs, as is too

often the case, then the potential of these technologies to extend and enable design intelligence is marginalized, if not worse. This paper, then, seeks to place the technology in the margin, to probe how working at life size, through the installation, challenges a wider spectrum of design intelligence.

Through the careful attention to what students say as well as what they do, their commentary helps to understand the place of precision in a digitally mediated design process. Furthermore, mirroring the larger social implications of digital media, these studio installations suggest a kind of collective-intelligence: progress by way of differentiation, integration, competition, and collaboration. This challenges the notion of authorship of the singular hand, even if extended through digital prosthetics, suggesting a more collective, discursive, and experimental 'think-tank' bound through the installation and enabled by the precision and scalar shifts of digital fabrication tools. In testing design as full-size installations, judgment shifts from the designer's 'intent' to the authenticity of experience.

LIFE SIZE: ENVIRONMENTAL KNOWING

"We install ourselves in modes of apprehending nature that at first are strange to us" (Dewey 1934: 348).

The goal of these installations is not simply the finished product, but the life size environmental knowing they provide. Environmental knowing implies a wider embodied, or kinesthetic, approach that reaches beyond the merely visual. The screen as primary visual interface to the laptop only reifies the cognitivist attitudes of early artificial intelligence research. The cognitivist approach emphasizes thinking as a solitary activity and that plans are first mentally visualized and only then acted out after the fact. Now some decades later, and despite considerable critique against this position, at times the laptop-as-design-studio seems to extend this untenable position. This is hardly a nostalgic and tired rant against "the machine", but rather to suggest that digital media are just now revealing their potential to connect intuitive material inputs with articulated material output.

These installation-based studios were conceived to challenge this cognitivist emphasis through a shift

toward embodied cognition. Guided by about three decades of research into embodied cognition, in *Philosophy in the Flesh*, Mark Johnson and George Lakoff propose that reason is 'piggy-backed' onto perception and action, thus inverting the presupposed higher order of reason. Furthermore, they suggest that technology offers an enlargement of perception through the increased manipulation of objects, and thus technology has the potential to enlarge our capacity for reason. This follows from the pioneering work of developmental psychologist JJ Gibson, who made a central tenet of embodied cognition: *perception is active*. Visual acuity is directly linked to our sensori-motor system, such that perception is embodied, or kinesthetic. Tools, as an extension of the body, afford the possibility to actively explore the environment, and therefore develop perception and what we reason about, to follow Lakoff and Johnson. For JJ Gibson, this developed into his theory of affordances, popularized by Don Norman's *Design of Everyday Things*. My preliminary understandings of the affordances of digital fabrication in design education have been previously presented (Cabrinha 2007).

Scaffolding is presented as a third chain to active perception and the theory of affordances. Scaffolding shifts the perception of tools and technologies from a focal awareness, emphasized in a digitally saturated design culture, to a peripheral awareness (Clark 1998). Scaffolding supports actions, which would otherwise be impossible or unthought-of of, without such scaffolding. Rather than focusing on the novelty of technology, the concern here is how these tools productively become absorbed into the design process, and the potential to extend design intelligence. In suggesting that these digital fabrication tools are part of the scaffolding of the contemporary design studio, the intent is to place these tools at the periphery of discussion, instead focusing on the material, social, and environmental knowledge they support.

The argument is not that design should follow embodied cognition, but quite conversely, when design process is spread across a wider perceptual spectrum, as the installation encourages, design intelligence exemplifies embodied cognition. With the installation as vehicle, understanding how the installation provokes the design studio offers insights into the depths of design intelligence.

RESEARCH DESIGN: PHENOMENOLOGY OF DESIGN PRACTICES

Donald Schön's understanding of design 'artistry' as reflection-in-action is further characterized as a "conversation with the materials of a situation" (Schön 1987). However, Schön's observations were based on a stereotypical 'coach and student' model centered around the sketch. How does a change in the "materials of the situation" change this conversation and who takes part in the conversation? This is not to downplay the ability to 'think it out' through the sketch, but to ask: how does this "conversation with the materials of the situation" change when working with real materials at full scale in a digitally mediated studio?

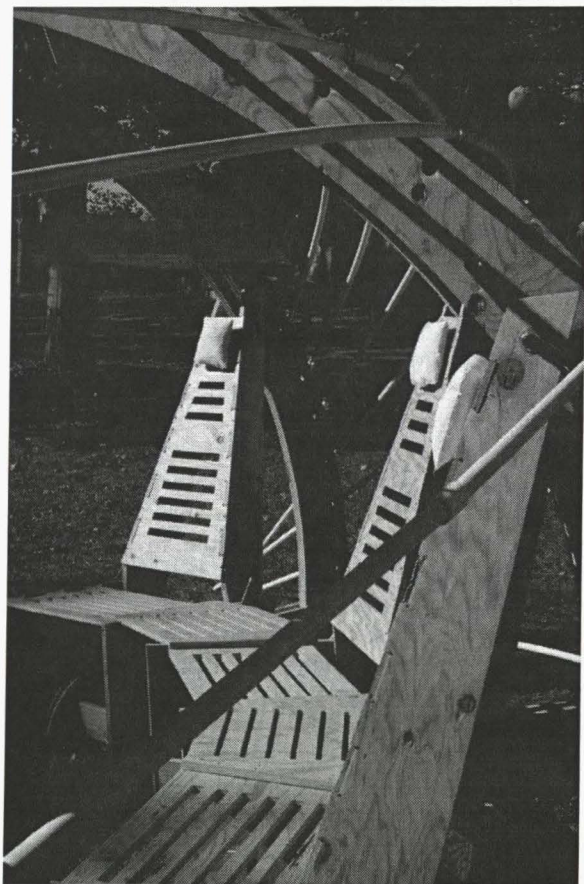


Figure 1. Fall 2006, Rensselaer Polytechnic Institute. The installation was to provide an ergonomic sitting surface for the situated and static observing body integrated with an enclosure for the kinesthetic and dynamic body moving through space in time.

While the design investigations of the installations are a form of design research, the critical evaluation of the installation process is a form of researching design (Glanville 1999). Schön calls this reflection on reflection-in-action the phenomenology of practices in which "students do not so much attend these events but live in them" (Schön 1987: 311). To evaluate this lived experience, focus needs to be placed not only on the artifacts, what is done, but also what is said thus giving voice to the students' reflections and observations. The methods of ethnography, primarily participant-observation and reflective interviews, are an interpretive effort "to rescue the 'said' of such discourse from its perishing occasion and fix it in perusable terms" (Geertz 1973:20-21). Critical evaluation was established through my own ethnographic documentation of

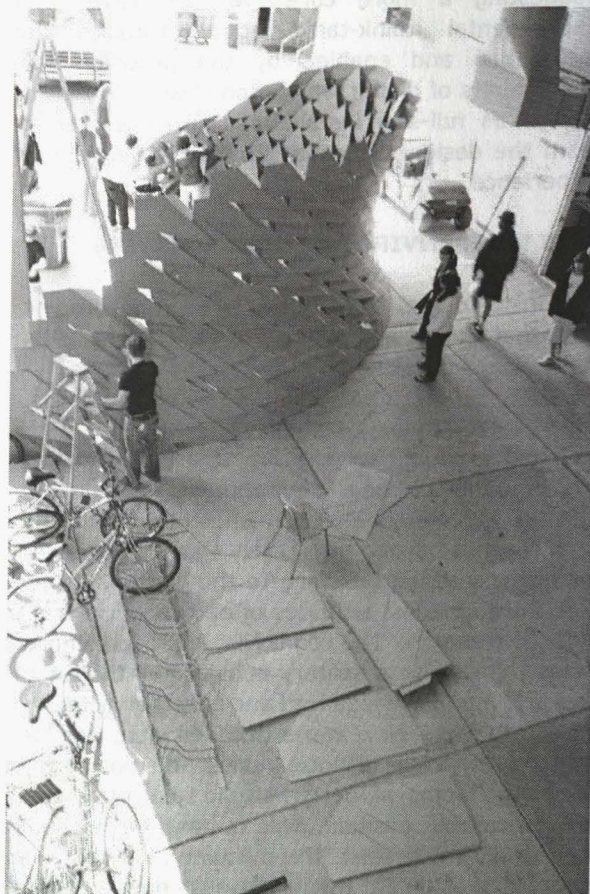


Figure 2. Winter 2007, University of Oregon. A technique of expanding pattern was given with the expressed intention to do more with less. As an interior architecture studio, the technique was employed to create a screen and a series of ceiling ribbons to direct circulation through an entry foyer.



Figure 3. Spring 2008, Cal Poly, SLO.

The studio was to develop a zero waste material system, that could quickly be assembled to house an exquisite meal.

the studio process, primarily daily note taking at the end of studio, the student's required studio blogs, student generated "post-occupancy evaluations" of the installations, through recorded installation debriefing discussions and finally, exit interviews. In employing ethnographic methods, the intent is not to simply describe what happened, but to test the underlying conception of design intelligence through the lens of digital fabrication and the implications of building 'life size'.

DESIGN (SUB)CULTURE(S)

The studio-based installations presented here were developed over a period of a year and a half at three different schools, each with unique design sub-cultures. In the first studio, in Fall Semester of 2006 at Rensselaer Polytechnic Institute, the studio was broken down into four teams, to develop an ergonomic landscape pavilion over four weeks (Figure 1). In the second studio, in Winter Quarter of 2007 at the University of Oregon, a technique of expanding pattern was given to create an interior installation over two weeks (Figure 2). In the third

studio, in Spring Quarter of 2008 at Cal Poly, San Luis Obispo, the studio was to create a material system that eliminated waste and could be quickly assembled to host a moveable feast (Figure 3). The intent is not to polarize, critique, or isolate any one school, but rather, to suggest that they each emphasize discrete aspects, digital acumen, social and ecological awareness, and material intuition, that are part and parcel of one healthy design culture.

Each installation developed over a matter of weeks as an introductory project in the design studio. While the installations were certainly a culminating event, they were not the culmination of the studio. Rather, the intention was for the installations to influence their final studio projects.

Through the critical examination of all three installations over an extended period of time, the students' reflections shaped several themes. Their reflections, primarily drawn from recorded conversations at the completion of the installation, reach beyond the specificity of their particular

situation into the very nature of design intelligence and at times, a critical awareness of the culture of design education.¹ In placing both the finished installations and the 'novelty of technology' at the periphery, their comments help to position three central themes. First, to understand the transitions between the messy and the precise, and in so doing, help to identify the place of precision in a digitally saturated design culture. Second, the ability to work across scales, including full scale, quickly and with precision made risk manageable and thereby supported a culture of experimentation. Finally, in working on a common problem that is literally larger than themselves, their comments reveal a larger social transformation of design culture from an emphasis on individual 'creativity' to critical collaboration.

MATERIAL PLAY

"The playful attitude becomes interest in the transformation of material to serve the purpose of a developing experience" (Dewey 1934: 291).

Each installation began with a form of material play (Figure 4). Rather than begin with an overarching 'idea,' material play gave the studio tools and techniques to manipulate material, while simultaneously focusing and enlarging their perception about what that material can do. Through these three successive installations, I became aware not only of the rules of the play (how-to), but was able to establish the objectives of the play (what-for). "Material play" is not just a warm-up exercise that can be discarded, but material play opens the door to experimentation. In the second installation, they had to transpose their approaches, changing their pattern, scale and orientation, based on material thickness, even as subtly as the change from copy paper to card stock:

"I think it was interesting how we learned to manipulate material. It doesn't just apply to paper, or cardboard, you can do it with anything. You can make a lot of different things out of one thing. Just changing the way you do one thing can have a totally different impact." *Susan, graduate student*

The technique of expanding pattern in this studio was effective as it gave structure to their play. While patterns can vary and with unique effect, the principle of alternating staggered lines is constant. Some understood this within the first hour of play, for others it was frustrating that "it doesn't

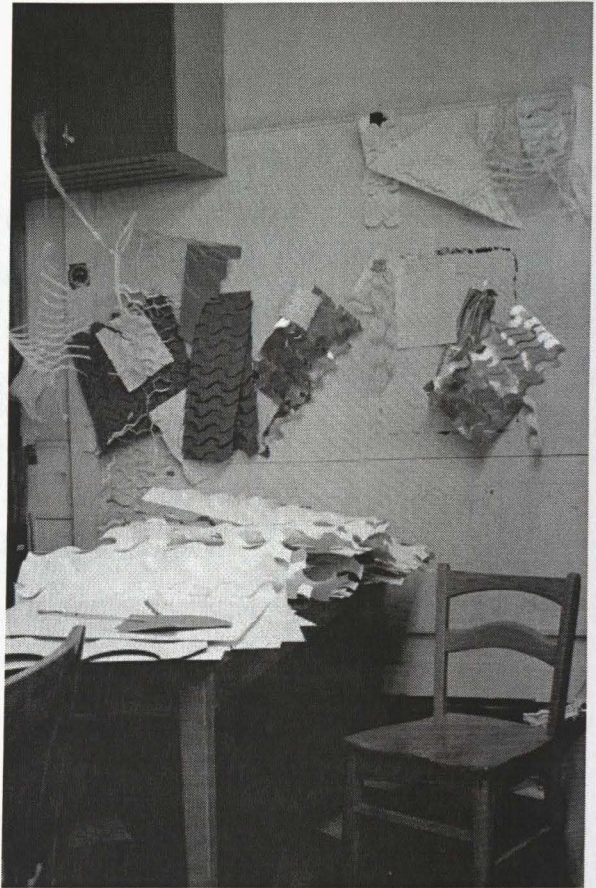


Figure 4. Material play in the first week of studio, Collaborative Patterns Studio, Winter 2007 UoO.

work." However, the fact that something "worked" focused the play - there was an objective in the technique which could be tested and evaluated. In one student, there was a satisfying 'a-ha' moment, in which she blurted out in studio "it works!" She later recalls:

"I learned so much about how to manipulate materials. Because I was frustrated at the very beginning and you knew I was because I didn't understand how this could work. And then I finally got it. Then you score it here, and it stretches, and it stretches a little bit more, creating that more lacy like look." *Linda, undergraduate student*

In the third installation, the implicit objective to do more with less, became the explicit goal, ideally eliminating waste altogether. Building upon the previous installation, where it lacked attention to joint and assembly, an additional objective was to create a material system that could easily be as-

sembled and disassembled. Rather than one technique they had to use, as in the previous studio, I gave them three techniques: folding, expanding pattern, and pattern tessellation. With these clearer objectives, they had to test and evaluate - to experiment - which techniques they wanted to employ and why. What was understood as techniques for "material manipulation" in the second installation became "experimentation" in the third studio. Importantly, with these shared objectives, play becomes social:

"I think we were all just willing to experiment too. All of the things we were working on had the potential to work with and experiment with. We were all just willing to do that." *Ruth, undergraduate student*

Further asking what about the project gave that willingness to experiment:

"Its playful. We were making something and working together." *Ruth, undergraduate student*

Through previous experiences, I could anticipate their frustration as they realize the slightest change in material thickness affects the design outcome. What I had not anticipated, was how working into design constraints, enabled their willingness to experiment:

"It [starting with cardboard] would have cramped the imagination. To start with cardboard it is not as flexible, but paper gave us the feeling that we could experiment with anything. And then from there we could take the cardboard and modify it instead of just throwing it out." *Mary, undergraduate student*

As these students attest, material play is an essential ingredient in opening up the imagination. Rather than impose rigid material constraints from the outset, working into material constraints fosters curiosity and risk-taking, and paired with clear objectives, a willingness to experiment.

PHYSICAL SKETCH MODELS

Like the hand sketch alluded to in Schön's one on one conversation between student and teacher, all three studios reinforce the importance of physical sketch models in the collaborative design process. These rough, improvised sketch models acted as social artifacts in which design discussions were literally worked out with many hands. Rather than

arguing over design solutions, the loose quality of the sketch model gave access to multiple voices without need of rhetorical persuasion, nor digital, sketching, nor modeling skills.

In the second installation, challenged by how to draw these expressive material studies, the studio discussed what could be done rather than working it out. For a moment, that discussion led to frustration and argument, which was a stark change of character for the eagerness the studio had previously with material manipulation. Spontaneously, I began to sketch model, "you mean like this?", and the messy improvisation began with several students alternatively stepping in to both suggest and work out their ideas. While there never was a final sketch model, it was 'just enough' to unite the studio. In the end, we were all surprised how much the final installation resembled that improvised sketch model.

Similar to the second installation, the third installation was basically entirely worked out in physical models, alternating between rough sketch models to more refined larger models to full-scale prototypes. In other words, every idea was worked out in the open. In the first installation, the presence and absence of sketch models was most revealing. With the two teams that worked primarily digitally, their design was constantly in flux with no physical record to trace their design intentions. Perhaps not in-coincidentally, the two teams that relied on their digital models had the most team tensions. I had asked for a digital master model, with the intention that each team member would contribute to it. In actuality, there was a single individual who modeled the majority of the project, essentially controlling its development.

Perhaps obvious, and yet easily overlooked, the crucial role of sketch models in these studios is not simply to represent ideas, but to get them out. As sketches, and without concern for craft and precision, the improvisation of these models opened the "conversation" to the entire group. While material play may foster curiosity, and physical sketch models support design collaboration, they certainly aren't particular to full scale installations. What is particular to installations, are the implications of scale itself.

SCALAR SHIFTS

Most noticeable in the first installations is how these students worked across scales, enabled by easy access to laser cutters and a CNC router (Figure 5). Perhaps the most significant aspect of digital

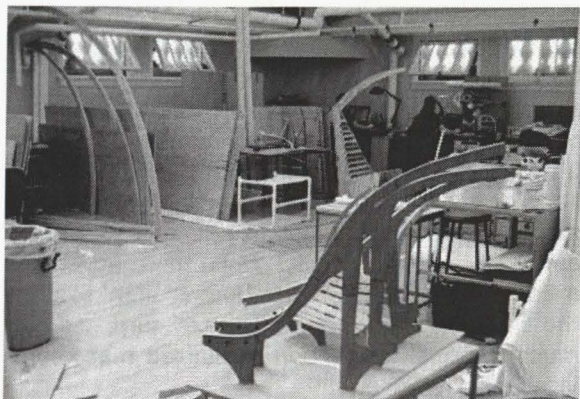


Figure 5. Working across scales in the Tangible Bits Workshop, Fall 2006 RPI.

fabrication tools on the design process is their scalability. One can work with the model as a scaled working prototype and test it out at full scale as a proof of concept with minimal effort. This proved to be problematic as well, as the lack of full scale testing in the earliest installations, with one case in particular, meant the project was essentially a full-scale sketch model. Nonetheless, the presence of at least three scales, from small sketch models, to larger prototype models, to full scale proof of concept, is an encouraging reminder of the human dimension of built work, even while working at smaller scales.

A well recognized consequence of working at full scale, and working within the constraints of machine tools and material sizes is designing for assembly. Rather than impose a kit of parts approach, or learn the implications of materials and methods, the students quickly come to this realization in building their own work. Furthermore, working under the weight of full scale, places emphasis both on constructability of the joint and its structural capacity (or lack thereof). Failure, while at first disheartening, is an important realization of the limits of materials and the necessity of testing ideas.

In the 2nd installation the accumulative effects of the complete installation were not understood until it was done. One student commented on assembly and testing joining:

"We should have numbered every panel, and built a prototype of the thing." *Donna, graduate student*

The fact that they never really tested the joints meant they had to hole punch countless holes through thick card stock was a firm, if humorous, reminder to test connections:

"Had we known the connections, we would have saved our hands." *Barbara, undergraduate student*

The students hadn't tested the joints because they did not see the relevance until feeling the weight of it:

"It didn't come together until it became really big. Because I think with the connections we were working at the smaller scale. So when it is big, and all over the place, it is like wow." *Lisa, undergraduate student*

"I think the size was very limiting to us. We couldn't test what it was going to do. You can't take a smaller model of this, and have the same results as the life size thing." *Susan, graduate student*

In the end, the final installation was the prototype and the test:

"We understood how it worked because we put them together." *Susan, graduate student*

What is most compelling is a word not often heard when working at smaller scales: "test". This was reiterated in the third studio as well:

"You can't learn by doing these little tiny models, because once you get it at this full scale, well, a lot of us were saying, it takes on a life of its own.... In the end, we all had to collaborate to figure out exactly what we were doing." *Mary, undergraduate student*

While there are important pedagogical lessons working at full scale, there is also the very significant implication on a young designer's developing identity to inhabit their own work, to literally install themselves:

"It got me excited about the project just because of the scale and because of the fact that you could see yourself in the space. Then also not just seeing the

system work, but seeing how well if it is like this, what if we do this, what if we do this. The fact that we cut a whole out of it and said, well it is nice to see through, but that is not the right solution. It just developed from there, and seeing it full scale was really exciting." *Sharon, undergraduate student*

PEER REVIEW AND PUBLIC ACCEPTANCE

As public work, not only do students install themselves, the publicness of the first two installations were powerful reminders of the social experience and acceptance of architecture, outside the familiar confines of the architecture gallery. In the first installation, a student in the studio came across a LiveJournal blog entry praising these "ridiculously awesome" installations. In the second installation, the studio selected a site that was the entry foyer between the architecture department and the art department as an explicit attempt to bridge these two programs. As one student puts:

"We left our little teeny tiny classroom where nobody ever sees us, and we had to take over the school and expose ourselves." *Donna, graduate student*

And while the third installation ended up being a very temporal and private event, one student humorously captures the importance of getting out of the gallery:

"Can you imagine if we set this thing up in Berg [the gallery], set up the halogen lights, invited people over to critique it and eat minnie muffins? That would suck. It would totally ruin it. Because you are so much more forgiving when you are just enjoying it and not like trying to turn it into this art piece." *Amanda, undergraduate student*

The humor in this last comment also has sharp teeth. While certainly this installation is not above critique, in fact was continually critiqued along the way, the opportunity to install themselves in their work allowed them to evaluate the experience of their work rather than distance themselves through a defensive position common at the end of almost every studio. Working at full scale flattened critique, enabling a considered evaluation, by students and professor alike, in what was right in front of us.

UNDERSTANDING THE PLACE OF PRECISION

Remarking on her first experience with digital fabrication tools, one student observed that the

ability to shift from small scale to test it out at full scale made risk manageable. In *The Nature and Art of Workmanship*, David Pye wrote about the workmanship of risk and the workmanship of certainty, noting that certainty is built upon risk. Through this, he critiques the false opposition between the hand and the machine, and instead suggests that it is about precision, when precision is warranted. The students' comments seem to confirm Pye's description of risk and certainty, and help to identify the place of precision in the design studio.

Despite their limited exposure to digital tools and digital fabrication, in asking the students in the second installation what the laser cutter enabled them to do, they understood the basic affordances of digital fabrication: "production," "precision and consistency," "speed," and "with the computer, variation, it allowed us to basically do the same thing, but allow it to be different."

While this is accurate, what was revealing was what followed:

"It also allowed us to not be afraid to take risks. Because if every time we experimented we had to do it by hand, I don't think we would want to. We would find one mediocre one that would work, and do it." *Melissa, undergraduate*

"You have to do it and test it. But if we were doing it all by hand, we would have sat there and said, 'oh this works. It took us this long to get this version, it works, lets just use it.'" *Susan, graduate student*

While the basic affordances of these tools such as precision and speed appear very mundane, these students' comments articulate the affordances of these affordances: the ability to experiment, take risks and test ideas out.

In defining the place of precision, this conversation continued to help to understand the role of the hand:

"I don't think you could have understood how it really works unless you had done it by hand....A lot of it is trial and error....[with the laser cutter] you still have to go and print them out, but you are not understanding which point in the process that was the faulty part. But when you are doing it by hand, its working, its working, and all of a sudden that made it not work anymore." *Barbara, undergraduate*

Summarized by the same student who was frustrated at first that she couldn't get her expanding pattern to expand:

"You are able to distinguish which elements are working." *Linda, undergraduate student*

Over a year later, at yet a different design school, the third installation studio confirms, with some nuance, the previous students comments. In this case, the precision of digital fabrication allowed them to evaluate their design as a kind of test or proof of concept:

"When you have the CNC router, you don't doubt your craft.....if you have it done with the CNC router and it fails, you go back and think about your design, instead of second guessing if the craft was perfect." *Patricia, undergraduate student*

"If we had done [it by hand] and then our thing fell, we would be thinking, 'man, if we had just cut it better.' Or if we had had more time and been more precise. But now we can just purely look at it objectively as design, and we can say, oh it is the design of the leg." *Amanda, undergraduate student*

In a previous studio discussion, one student commented that because of the digital production, her relationship to the work was different. Asked again what she meant by that:

"Yes because then you end up with a group of worker bees, basically. You end up with a group of laborers and a group of people with the whips. With this, none of us had to do that. We design it, we think about it, it is more intellectual I guess, and less labor, and you feel like you're are doing something unique." *Amanda, undergraduate student*

This shifts the place of precision from managing risk and testing, identifying an unanticipated role of production: to liberate the studio by removing the "worker bees". These students' design investigations were cut and explored by hand, but the ability to quickly, and precisely produce at quantity gave them the opportunity to evaluate their design ideas empirically and qualitatively at full scale through the installation experience.

CONCLUSION

Looking across all three installations over an extended period of time, my pedagogical influence evolved from a more explicit method oriented 'how-to' in the first installations to a proposition

oriented 'what-for'. Shocked by the lack of craft and material waste in the first installations, craft became understood to be more than the result of skills, but based on crafting curiosity through a solid proposition, in which developing material economies became that proposition: "more process, less material." In addition to the effects on design process, the proposition here is that these tools, and through establishing the right conditions, can have a powerful affect on design culture. In working at full scale, enabled by the scalar shifts of these tools, the installation bound the studio in working something out that was literally larger than themselves, shifting studio from a collection of individuals, to a cooperative, integrated, and collaborative community.

ENDNOTES

1. Students are identified with pseudonyms. The issue of gendered learning styles has been brought to my attention. While gender is not covered in this paper, an awareness of the culture of design education and different learning styles associated with gender, such as collaboration, may be read into this paper. Enrollment by gender in the first studio was 3 males and 11 females, the second studio, in interior architecture, happened to be entirely female, and the third studio was 6 males and 11 females.

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