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I, Richard Huizenga, hereby submit this original work as part of the requirements for the degree of Master of Architecture in Architecture.

It is entitled:

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I design. I build. Sometimes in that order: An argument for construction-centered design process

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Master of Architecture, in the School of Architecture of the College of Design, Architecture, Art and Planning

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Figure A. DAAP MetroLab design-build studio community exhibition. Summer 2014.
Abstract

There exists a chasm between the world of design and the world of construction and fabrication. In contemporary practice and studio education it has had a significant impact on the way architects work, and by extension, the way architects think. Architects are not involved in the actual construction process, and contractors are not involved in the design process. This has yielded a cultural arrogance within the profession as well as academia that views architects as being on a higher level than construction professionals and accepts selective disregard or ignorance of construction realities as an acceptable status quo that begins at the foundational education level. With the significant widening of this designer vs. builder gap over the past decades following the modern era, the notion of the architect filling a “hands-off” role in the building process has become widely institutionalized and thus has created a near industry wide culture that views fabrication knowledge and craft as optional items that would make up an individual designer’s unique skill set, rather than cornerstones of a professional lexicon.

This divided condition has also proven through the years to be self-propagating; it reinforces a professional landscape that punishes multidisciplinary collaboration, and rewards an over-specialized, largely office-dominated work environment. In our world of contractors, subcontractors, technical experts, and consultants of all varieties, architects are in most instances coordinators more so than they are designers, leaving the necessity for material engagement at any level even more irrelevant. In a very real way, E-mail has replaced much of the craft and skill that was once hallmark of the “master builder.”

With a return to being builders first, architects can gain back a world of design potentiality and control of final outcomes, not to mention professional regard. By possessing intimate and intuitive understanding of construction and fabrication through a hands-on design approach, architecture no longer needs to be rectified with construction, but is instead borne of construction whose elements becomes richer parts of their designed whole. Ultimately this is a matter of capitalizing upon design opportunities through a shift in mindset.

2 Carpenter, Learning by Building, x.
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Figure 2.7 Accessed January 22, 2016. http://mlsarchitects.ca/ghost9.htm. Ghost Lab Horse Barn
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Figure 3.1  Jordan, Trevor P. Diagram Illustrating Cyclical Process of Digital and Analog Craft: Combining Imagination and Technique. March 27, 2012.

Figure 3.2  “Inception - Dream World Cafe Scene (2/5) (HD).” YouTube. Accessed April 28, 2015. https://www.youtube.com/watch?v=_bsGUOVTA84.


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Figure 6.1  Accessed March 14, 2016. https://menoistorija.files.wordpress.com/2015/09/image10.jpg.

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Figure 1.1
Ghost Lab 8. Summer 2006
Introduction

As a young undergraduate student, my school’s design-build professor once told me “Architects don’t think in form, they think in material.” If a design is realized solely in abstract concepts such as form, and space, there eventually comes a threshold whereby the ideas must be translated into a built form composed of boards, bricks, and nails. The design which was conceived of the abstract, must be executed in the concrete. There comes a point where we ask ourselves “so how does this actually get built?”

This widely practiced approach proves to be problematic in that it only engages the amount of construction reality that the designer can anticipate in advance of the physical construction process. Or worse, it doesn’t engage construction realities at all. It does not allow for very much, if any, design work to happen as a product of the construction process itself; The building process is strictly a vehicle for the design, rather than being a vehicle and a driver. When a design is rectified with it’s construction as opposed to being borne of it, there is a tendency to water down the design; the construction reality itself detracts from the purity of the gesture and the two are pitted against eachother. The less construction realities are consulted with and explored during the early design, the more pronounced this “neutered by it’s construction” effect becomes.

A solution to this canundrum is to allow construction to become a generative element in design development. By thinking and working in material as a native mental language, there is no transition from design to building. There is no distance between abstract and concrete, the two become indistinguishable from eachother and the design gesture is relieved of the responsability to defeat it’s own fabrication. The design process extends all the way through the construction process, feeding off of exigencies that arise and providing flexibility to capitalize upon design opportunities that may have gone unforseen in earlier stages of the project. This work flow and mentality provides new potential for a more appropriate, more contextualized, and richer architectural expression than it’s conventional counterpart.

Figure 1.2 (left)
Traditional building delivery diagram of operations.

Figure 1.3
Design-Build building delivery diagram of operations.

Brian MacKay-Lyons founded the “Ghost Lab” in coastal Nova Scotia which has evolved over the years into an educational retreat of sorts for designers and building professionals to reinforce these ideas through experiential learning.

“In much contemporary architecture, the form is all that matters, and it remains largely unchanged by the process of being built. Today architects both design and compose construction documents in the virtual space of the computer, leaving the entire process literally untouched by human hands.”

His stance is to capture the latent possibilities for design development and direction that lie often untapped within the construction process.

MacKay-Lyons cites four key questions within the Ghost projects, that direct the transformation of the initially pure geometric form:

1. How to imagine building it at all?
2. How should it be built?
3. How can it be built?
4. How was it built?

These four questions encapsulate a process of transformation based on fabrication and construction. They provide steps that re-shape the abstract parti or concept into a finished work that capitalizes on these investigations to become a more appropriate response to its forces.

“That's, how, in the act of building, the purity of the form was modified by requirements of suitability to function and clarity of construction. In the end, form, function, and construction were balanced through a series of decisions that had to do with appropriateness. In this it is intriguing to recall that Kahn once said, “All I teach in the university is appropriateness.”

When aspects of construction reality are engaged as a generative component of the design’s maturity, the construction reality just as in the Ghost Project, is being interrogated on a constant basis. In this case the very parts and pieces of a construction that once were merely necessary for the building to stand, become the very elements of a meaningful architecture.

6 Mackay-Lyons, Ghost: building an architectural vision, 207.
7 Mackay-Lyons, Ghost: building an architectural vision, 207.
8 Mackay-Lyons, Ghost: building an architectural vision, 208.
Figure 1.4
Shobac Farm, Nova Scotia. Ghost Lab site.

Figure 1.5 (left)
Ghost Lab 8 Joinery Sketches by apprentice

Figure 1.6
Ghost Lab 8 studio building sketches.

Figure 1.7 (left)
Ghost Lab 8 studio building design phase

Figure 1.8
Ghost Lab 8 Framing

Figure 1.9 (left)
Ghost Lab 8 internal steel components in process.

Figure 1.10
Ghost Lab 8 Interior steel components finished.
The construction strategy, and scale of individual ISS modules was directed primarily by the space shuttle payload bay dimensions and weight capacity.
Limitations and Design

It has been said that the definition of design, in an abstract sense, is simply the management of limitations. This simple definition is quite telling of what designers from any profession actually do. In this light, the act of designing an orbital space station is quite a similar activity as designing a single family residence sited in suburban America. Limitations tie architectural intentions together and give them purpose. Without limitations there would be no good design.

A major problem with this fact however, is that very few understand it expressly for what it is. While the majority of designers and educators understand this concept under the term “forces,” the terms are not necessarily similar in what they imply. The term “force” in an architectural sense calls to mind site conditions, cultural values, and other theorized architectural issues, that designers love talking about. “Limitations” on the other hand, call to mind budgetary restraints, zoning and political issues, as well as other negatively charged aspects of a design project. The term “limitations” encompasses “forces” and implies so much more. Architects and students will often base an intention upon relevant forces but in reality, designs are composed of limits. While they mean essentially the same thing, the connotative meaning gets in the way of a critical understanding and appreciation for the fact that limits are the life blood of design, and provide the potential for innovation.

In his 1989 thesis work under MIT social science professor Donald Schon, architect Glenn Wiggins defines this dilemma in detail. In Wiggins’ thesis “Methodology in Architectural Design” he explores explicit ways that designers operate and sheds light on mental structures that are used in the act of designing. This is in response to the largely tacit volume of information that architects and designers possess, creating a dilemma of justification.

Architects typically learn to design without acquiring a language that can describe their design actions. While a designer may have a good tacit justification for his or her design work, finding the words to express the justification may be very difficult. As a result designers are often considered artists, guided by a muse and incapable of explaining their design work.

This is very poignant in that it teases at the issue of how much information designers are aware that they are standing upon. In the text Wiggins cites that often the most important parts of a design process remain elusively cloaked in mystery of implied understanding and
that the parts of the process that the designer is able to articulate may actually be of the least importance.

Including, or omitting the act of making and fabrication to the design process has very significant effects toward the imposition of limitations. The Ghost Labs documentary text, founded by Brian MacKay-Lyons articulates the nature of limitations upon the designer and design process aptly:

One of the characteristics of the Ghost Lab—as well as all great works of architecture—is the severity of the limitations within which the makers are required to operate. In the case of the Ghost project, the limitations are of both material and time, as the structure must be designed and built within only two weeks, using locally milled wood. This goes directly against what is typical of most contemporary architecture, which prides itself on an appearance of being born without limitations, and against what occurs in many schools, where issues of economy are ignored. This approach avoids the realities of a world of ever-decreasing resources and the fundamental responsibility of the architect to act in the best interests of the community. There is a misguided understanding that accepting limitations will somehow curtail the freedom of expression of the student, and that excessive budgets have often led to so-called inventions in architecture. Igor Stravinsky, the Russian composer, writes; “only within strict limitations is freedom possible,” pointing out the fundamental truth that without limitations, there can be no freedom.12

As a corollary to this line of reasoning, Psychologist Barry Schwartz, in his 2006 TED talk titled “The Paradox of Choice” explained his research demonstrating that infinite choice is paralyzing, and exhausting to the human psyche.13 He goes on to elaborate that excessive volume of available options, through comparison of endless opportunity costs, also reduces the level of satisfaction gained from what is ultimately chosen. This research harmonizes with MacKay-Lyons in beginning to explicitly define the role that limits and constraints play within a design process. It also corroborates Wiggins’ position that to command design process, one must be able to understand and articulate the necessity for the ironically constructive role that limitations play within design innovation.

The New York design firm Lewis Tsurumaki Lewis, provides a model precedent-in-practice for this research as well as for the investigation and embracing of limitations within design problems to generate innovation. The firm’s first book *Opportunistic Architecture* outlines their stance of seizing upon latent design opportunities that exist within the given restrictions and forces of projects.

12 Mackay-Lyons, *Ghost: building an architectural vision*, 204.
Figure 2.2
TED talk “The Paradox of Choice” presented by Barry Schwartz
One of the principal tactics that underlies the work in this volume is the inverting of the value of constraints, by recasting the limitations of a project as the trigger for design invention. By maneuvering imaginatively within operational boundaries, the latent potentials of the project can be teased out of the very restrictions that would seem to weigh it down. In this sense, the seed for the most radical solution can always be found within the items that initially pose the greatest resistance. Rather than avoiding these obstacles through formal or logistical gymnastics, the tactic of catalyzing constraints generates an impassioned inquiry into the unavoidable limits of architectural production.14

The key advantage a process of construction and fabrication provides to this end, far above any other process of design development, is that the limits it presents are real and incontrovertible. They cannot be ignored or mitigated through varying viewpoints or theoretical positions and from this reality create a unifying effect to design teams. Elvin George in “The Parkstadt Workshop: Integrating Design and Construction in Architectural Education” summarizes this effect:

This method weaves design and construction into a continuous, unified building process—one with several advantages over the traditional way of designing at the drafting board and handing the drawings over to a contractor for execution. Design takes place on-site, where we feel the wind, see the way the light falls, and experience the view through the columns to the open field. This takes us away from the once-removed world of the office to the site, and engages our body as well as our mind in the design process. It also gives us a more sharable language of design. In the course of working in this way, I have seen time after time how many arguments about specific design issues that can go unresolved in the office or classroom can be resolved quickly once we get together on-site and test things directly. This happens naturally because, when we talk about an object abstractly, we each have a slightly different view of the thing. But when we stand in front of it, and experience it as built reality, we are dealing with the thing itself, and this eliminates some of the confusion that inevitably results from discussions based on drawings and explanations once-removed from the real thing.15

Besides the design implications, the fact that the clear constraints presented by construction reality are being related to team dynamics is very telling about the way architects work in contemporary practice, the manner in which architects are seen from outside the profession, as well as the way architects are trained. There very much exists the idea of the architect as the lone hero, or the tortured artist, when in reality building and design does not happen in a vacuum but through collaboration of teams of individuals and through community. Being able to handle and coordinate all these various involved parties is an unsung skill that the best designers possess.
Figure 2.3
The narrow space for Dash Dogs became a primary driver for the spatial organization and architectural strategies.

Figure 2.4
Dash Dogs

Figure 2.5 (left)
Steel floor and ceiling with embedded lighting fixtures

Figure 2.6
Laminated Ply-boo standing counter.
This would seem logical given the studio culture that is invariably developed in every architectural school through long nights and tough reviews. Still though, the necessity for this community to move forward is a lesson that by and large is lost and thus requires explicit definition.

The two towers also showed how designing and constructing something can build community. The handing up or holding down of lumber, the looking after each other up on the scaffolding, the calling out for or giving of assistance, the odd conversations had high in the air while waiting for the next task to arrive all created an incredible camaraderie among the participants. Up on the two towers, among people who mostly did not know each other two weeks earlier, a real bond developed. Even in our age of distance and distraction, communities of people can still spontaneously arise.

Within the understanding of construction and design through building, there are several key elements that must be understood for good design to happen. These are foundational elements of what makes up material fluency and understanding of fabrication. These things contribute to actionable knowledge to be applied to design ideas. 16

16 Mackay-Lyons, *Ghost: building an architectural vision*, 129.
Figure 2.7
Ghost Lab Project Horse Barn.

Figure 2.8
Ghost Lab participants.
Figure 3.1
Recursive flow between the hands and the mind; between production and generation.
Harnessing Discovery

Is architecture created? Or is it discovered? Does an architect create a brilliant idea? Or do they arrive at one? The Christopher Nolan film *Inception* provides a very poignant image of this dynamic in the scene where, sitting in a Paris café, Cobb explains to Ariadne the nature of designing dreams:

**Cobb:** They say we only use a fraction of our brain’s true potential. That’s when we’re awake. When we’re asleep, our mind can do almost anything.

**Ariadne:** Such as?

**Cobb:** Well, imagine you’re designing a building. You consciously create each aspect. But sometimes it feels like it’s almost “creating itself”, if you know what I mean.

**Ariadne:** Yeah, like I’m discovering it.

**Cobb:** Genuine inspiration, right? Now, in a dream, our mind continuously does this. We create and perceive our world simultaneously, and our mind does this so well that we don’t even know it’s happening. That allows us to get right in the middle of that process.  

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As designers, this analogy of dreams is very emblematic of what we do with design process. Physically, the nature and order of our design does not yet exist, therefore we are faced with the paradox of working to create it and to discover the ramifications of its elements. What we are ultimately doing is trying to shape and understand the unknown. In designing, we simultaneously create and discover.

Within the process of designing, there is a constant back and forth cycle of “guess and check” in search of those elusive “ah-ha!” moment. The instant where we stumble upon that one missing piece that gives us new eyes and reshapes our assumptions about the design problem. When this happens, we ask ourselves “did I create this or did I discover it?” Really the answer is both, we put the pieces into place, and then discovered their resulting conditions. Recursive design process is what we are talking about, and as a result, serendipitous discovery.

Throughout a typical design process, we may experience only a handful of design revelations however; if one were able to somehow cram 10,000 “ah-ha!” moments into a single design process, we could imagine that the resulting architecture would be incredibly rich and innovative. While consciously chasing after these serendipitous occasions proves to be futile we can however, consciously engage in activities that we know to increase the likelihood for moments of inspiration and discovery; We can’t actively make ourselves arrive at revelation; we have to work indirectly and engage in an activity that yields it. Going back to the scene from Inception, we must create in order to perceive.

There is a fundamental shift in thinking process that takes place once ideas are committed to materiality, the hands control the mind just as much as the mind controls the hands. Production is therefore a critical element in any form of inspiration and discovery. Ultimately the act of production, in any medium is an effort to supply your intellect with some form of input information from which to draw revelation and conclusion. In reference to Wiggins’ research into design methodology, in essence design process is not a “see-move-see” method, but really a “move-see-move-see-move-see…” cycle. In this case the question is which came first: the chicken or the egg? Which came first: the design conjecture or the design revelation?
Figure 3.4
Map of the recursive creative process created by the Dubberly Design Office.
Free Lab by Christine Macy enumerates this succinctly. The book documents many student design and construction projects from Dalhousie University. Within is commentary of the design-build process in general:

“‘Building’ is a verb as well as a noun, and every architect knows that to make a good building is a long process that involves many steps and many participants along the way. These labs focus on the design process, taking students on an adventure of discovery – one that reveals design less as parti and more as a methodical and layered work. Some of these labs involve multiple stages of work like a scientific experiment, where suppositions are developed and tested. Others establish a field of action for student invention. Still others set up a pedagogical framework where each step a student makes takes them to a position where they can make the next one. Design development is the lesson here.”¹⁸

This studio approaches discovery as a foundational element of the design process and structures it’s pedagogy around this position. It is emblematic of the notion of fostering serendipity in design. This is accomplished through the close integration of physical construction throughout the design process. Not every building or design project can be delivered through the design-build method, the take away is that we must strive always to make them so in our studio environment. In the absence of a full scale construction site, the simple act of making and working physically in material form as a mental exercise, is critical to sound design work.

In the text Design Build Studio, a book covering several notable design-build educational programs within architectural schools nationwide, Steve Badanes, an architect and professor from The University of Washington, advocates in his essay “The Architect as Builder” for the design-build process both as a vehicle for building delivery as well as an educational model. He makes many points in reference to the validity of this as a design method that cover multiple aspects of architecture. Most notable of these are his remarks in concern to the way problems are solved within design-build methods.

“With this expanded role, the design process is extended into the site, and we are able to avoid the locked-in mindset that governs most building projects once they are committed to paper. Throughout the construction process, we can adapt the design to whatever exigencies arise. The architect/builder becomes part of the drama that unfolds as the structure grows and comes alive and the three-dimensional reality provides inspiration and suggests solutions to problems that are elusive or simply impossible to detect at the drawing board or computer screen.”¹⁹

This position of flexibility allows great nimbleness and leaves many design decisions until later in the process whereby elements of the site will have been prepared and the

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architectural project will have been implemented enough to direct the solution to many problems that otherwise would be vexing if handled at the schematic or design development phase. It also characterizes the understanding that there will be unforeseen issues and problems that arise as the construction unfolds; It represents the willingness to fully embrace knowing that you do not know everything and further that much of the needed information for such actions isn’t available until you are at the point where the decisions must be implemented. On a deeper level this focus relies on a sense of discovery allowing solutions to present themselves as pieces are put into place. Badanes goes on to write about the benefit personal hands-on involvement in a project’s construction has for a designer, creating many opportunities for improvisation and richness.

“Personal involvement in the construction process results in an architecture that evolves much like a piece of sculpture or a new invention whose creator constantly reviews, reconsiders, and adjusts to meet new insights and conditions. When you make something yourself, you can improvise in a significantly different way than mere drawing allows. This leads to structures with an intensely personal character. The work becomes more idiosyncratic and spontaneous, reflecting the immediacy of the decision-making process. In the end, the design/build process has increased potential to result in a far more appropriate product.”

In this instance however, what Badanes is referring to is not just a series of design conjectures, but rather conjectures committed to construction. Construction itself existing as a generative exercise rather than simply an execution. Using this approach the architecture is grown grassroots style in a bottom-up direction rather than a more typical top-down approach allowing for a much more responsive feedback loop of information cycling back and forth from the designer to the building construction. The designer evaluates, makes a design move, and then receives feedback that shapes the next set of conjectures. In this case however, the building construction phase and the design phase are happening simultaneously therefore these conjectures are directly related to the actual materiality of the finished building. This serves to directly connect construction activities and building physicality with recursive design processes.

Many prominent universities are incorporating design-build programs into their pedagogy. This is very poignant in the fact that design-build is a paradigm built around the flow of information and discovery to the designer as they make design decisions. This thus provides a very ready vehicle for education. It follows therefore, that being a good designer, in many ways, is synonymous with being a good student.

Figure 4.1
Ghost Lab joinery details.
The Assembly

Perhaps the one of the largest and most important of things to master in today’s architectural practice is use of the building component, and the assembly. Hallmark of many formalists and digital parametric practitioners alike is the emphasis of homogeneous and monolithic design forms. This is problematic to the education of a matured and skilled designer, as well as the development of architectural designs in that nothing in reality, man-made or nature-made exists in this manner. Everything is composed of many smaller components that all have relationships with each other and all have assembly logics and systems. This is the nature of building construction. Everything has fasteners and boards and sheets, everything is composed of many smaller constituent parts. Even things that we would consider to be homogeneous such as cast in place concrete are not actually so. Their construction involves an elaborate formwork system that is built out of many smaller form components. So while the building material itself may be monolithic, its construction process is not. Logic of assembly is understood widely under the umbrella term of “detailing.”

Peggy Deamer, in Building (in) the Future: Recasting Labor in Architecture explains the development and evolution of the architectural detail through recent history, as well as its significance following the modern movement in design. A primary work she references is the comprehensive survey of modern detail provided by Ed Ford in his “The Details of Modern Architecture.”

As Ford described it, the modernist detail was the nondetail, which is to say, it did not aim to express the technique of construction, but rather, to promote the effect of plastic composition that did not seek to distract with attention-grabbing detail. Modernism’s concern for an architecture both monolithic and heroic in its compositional unity and weightless in its machinelike disengagement from the ground yielded an aesthetic of effortlessness. Detail, always the conveyor of difference (not of monolithic uniformity) and support (not of weightlessness), was put into the service of not looking like it existed, of not looking like labor was required.21

Carlo Scarpa’s work takes the opposing stance to the dilemma of detailing provided by modernist ideas. Not only does Scarpa embrace the character and potentiality of the architectural assembly, but also he leverages it as a generative element to larger design outcomes. In Studies in Tectonic Culture Kenneth Frampton examines Scarpa’s work and methodology in the chapter titled “Carlo Scarpa and the Adoration of the Joint.” To Scarpa, the joint bore such value as an architectonic element that much of his work was devoted to

mastering and manipulation of this design feature alone. In the text Marco Frascari is cited in reference to Scarpa’s work:

In Scarpa’s work everything turns on the joint to such an extent that, to paraphrase Le Corbusier, the joint is the generator rather than the plan, not only in respect of the whole but also with regard to alternative solutions lying latent, as it were, within any particular part. These alternatives arise spontaneously from Scarpa’s method, his habit of drawing in relief, wherein an initial charcoal sketch on card, one of his famous cartoni, becomes progressively elaborated and overlaid by traces, washes, and even white-out to be followed by further delineations, entering into a cyclical process of erasure and redesign respect of a given junction, without ever fully abandoning the first incarnation of the solution. In this way, as Marco Frascari has remarked, Scarpa’s cartoni serve as an archaeology of the project: “In Scarpa’s architectural production relationships between the whole and the part, and the relationship between craftsmanship and draftsmanship, allow a direct substantiation in corpore vili of the identity of the process of perception and production, that is, the union of the construction and the construing.22

In a direct sense, Scarpa has captured the essence of design conjecture with his handling of detail and joinery. The layers of investigative sketches about one detail reveal an entire lineage of design decisions, experiments and ultimately discoveries. The drawings represent a clear example of how one can “draw their mind around” every turn and corner of a project or detail in this instance.

The moral of this story comes down to understanding the deployment of building components, systemized elements that are designed to function within a particular building system. It is vital that students and practitioners alike possess understanding and value for assembly and component construction through physical exploration to arrive at detailing resolution of their own contrivance that bears architectural significance and exists as part of their design intentions, rather than in opposition to it.

Figure 4.2
Contemporary modern detailing aesthetics.

Figure 4.3 (left)
Carlo Scarpa cartoni sketches.

Figure 4.4
Carlo Scarpa cartoni sketches.

Figure 4.5
Scarpa-designed celebrated detail aesthetics.
Figure 5.1
Robot Fabrication facility, RMIT.
The Tool

It is an interesting experience walking down the tool aisle of the local hardware store. Looking at the power and hand tools in all their varieties, you can notice each one is designed specifically for a different purpose. Each one has strengths, and weaknesses. Each one performs some tasks brilliantly, and other things terribly. The tool aisle is nothing short of a monument to construction process. Tools are developed as products to meet specific job needs of the craftsman, they are physical embodiment of and response to a construction process.

While tools vary widely in their capabilities and technological sophistication, ultimately they all bear striking similarities in that all of them are unintelligent machines and can not function without the interface of a human using them. From the simple chisel to the cordless drill, to the 6-axis industrial robotic arm, they all are merely tools to an end that is only as good as the person using them. Even the most sophisticated CNC Machining centers still themselves are dumb machines possessing zero agency.

With the rise in popularity of the use of digital fabrication methods and computerized fabrication techniques and tools, there has been great debate about the sophistication level of digital fabrication tools and their position relative to traditional ideas of craft. This has come to be known as “digital craft” however, in many ways the distinction is unimportant, it’s still a tool that performs an operation. It is still a device that ultimately is concerned with a portion of construction process. While physically they are executing some of the tasks of the matter, they are not in fact any different from a screwdriver, hammer, power drill, or pencil. They are merely tools.

David Pye articulated this aptly in his definition of “workmanship of certainty” and “workmanship of risk.” In his essay titled “Imagining Risk” Scott Marble summarized the essential viewpoint of Pye’s position:

He identified craft with the “workmanship of risk”- where the result of working with a material is “not predetermined, but depends on the judgment, dexterity and care” of the maker. “(T)he quality of the result is continually at risk during the process of making.” but the payoff is a singular object that serves the broader cultural purpose of sustaining diversity and variation. By contrast, he associated the “workmanship of certainty” with industrialization, and in particular, with mass production and automation, where the refinement of the process assures a predetermined result.  

With this mindset, one can take that same stroll down the hardware store tool aisle and have a completely new image of the tool varieties and how they work. While a chisel provides great “risk” to the craftsman and the CNC operated six-axis robot arm provides great “certainty,” they both can be leveraged in similar and meaningful ways toward architectural ends. Inevitably the choice of tools depends widely upon the desired outcome, and the point in the design developmental process. At an early state, tools providing great uncertainty might be desired in order to capitalize upon “emergent” results and unexpected effects to generative ends. While later in the process a more sophisticated digital fabrication tool requiring many hours of programming might be more advantageous for highly cyclic production operation.

Everything any architect will ever construct will be the product of the capabilities of tools in current use at the particular time. As architects knowledge of how things become as they are, and what steps they took to get there cannot be under valued. Just as a keen understanding of the sequence of historical styles and precedents is pivotal to any well rooted and appropriate design, an understanding of physically how raw materials will become finished materials, and how these will integrate to become a constructed design is mandatory. Christopher Alexander echoed this position regarding tools and the necessity to understand their use and construction as a whole:

Quite apart from my desire to work as a builder, quite apart from my desire to see buildings with this quality built, and quite apart from my belief that architects should be builders, there is just the simple, plain, ordinary fact of the necessity for having first-hand acquaintance with building and making things. And it seems ridiculous to have to mention it except for the fact that most architects today do not understand this. In a woodworking shop, one of the distinctions between somebody who understands working with tools and somebody who does not is to realize that the process of sharpening or sweeping up are absolutely fundamental to the activity of making something.²⁴

This provides a simple example into the dynamics often overlooked when considering fabrication and construction. These dynamics can often be the difference that creates a meaningful and appropriate architecture.

While working in the fabrication shop both in my undergraduate and graduate experiences, I spent a great amount of my time assisting students with their models and construction projects for various classes. I cannot count the amount of times I was approached by students who had egregious fabrication requests relative to their design.

²⁴ Carpenter, Learning by Building, 23.
Figure 5.2
Power Tools

Figure 5.3
Hand Tools.

Figure 5.4
CNC Router designed and built by author.
intention and I had to tell them that there was no tool or device in existence to create what they wanted. It ultimately became an exercise of educating them on the means available to them so that their design could be developed in order to take advantage of these means as vehicles for their gestural intentions. These experiences became indicative to me of the learning process and importance of understanding the reality that limitations and capabilities of current tools and technology provides upon a designer. Further it highlighted the importance of not only understanding the limitations and uses of the tool, but leveraging these qualities as design drivers.

Another aspect to the nature of tools, which many overlook, is their response to the value system that created them. For example, consider a modern cordless drill. Great developmental lengths on the part of the manufacturer have been gone to do provide the most advanced and competitive tool product possible. Technological advancement however, is not the end unto itself; it serves at the pleasure of the value systems of the manufacturer’s potential customers. Perhaps the drill has an advanced lithium ion battery with a new brushless motor in addition to improved software and control, to the tradesman considering buying this drill, these things are unimportant except that they represent higher performance, longer work times, faster application speeds, and less time lost to changing batteries. Essentially this tool’s design would allow them to do more in a day’s work. Thus with keen consideration, the design of the ubiquitous cordless drill represents design factors relating to construction such as the realities of time, money, materials, and skill. All of these things directly correlate to architectural considerations.

Each tool, with it’s various developments and marketing strategies of the different manufacturers is indicative of value systems that exist within construction methods. They represent the value systems that relate to the physical process how a piece of architecture becomes realized. In just the same manner, architecture is a response to the conditions and value systems that created it, it is the architects responsibility however, to ensure that the value systems that have to do with the reality of real world fabrication are not at odds with the value systems of theoretical positioning and aesthetic considerations. To accomplish this, the architect must first understand the tool.
Figure 5.5
Tool design as reflection of value systems and fabrication attitudes.
The Material

One of the greatest problems with material deployment in today’s practice is that so much of the knowledge that once was possessed by the architect in regard to material culture, its use, and capabilities has fragmented. What once was the purview of the designer, now is handled by the specialist or consultant. Given that so much of the components that are used to construct buildings now are commercially developed products, the business of designing a building has less to do with deploying materials in innovative ways, but rather knowing what building products exist and specifying the right ones to suit your needs. While this is the reality of our modernized society, as well as the nature of contemporary practice, it does not exonerate the designer from the necessity of a full and working understanding of material. Further the manner in which our current architectural material culture is not built upon materiality, but rather what materiality something looks like has had very large and negative effect on the way buildings are designed.

But it can be argued that materials knowledge is the key to creating meaningful design, because when a deep understanding of the materials accompanies a structure’s design, a structure resonates with and communicates itself through the care that went into its creation.25

Building materials in the architectural sense possess two characteristic traits, performative aspects, and qualitative aspects.26

Performative qualities pertain to what the material does. In many instances this falls into the purview of engineering however, it applies to every aspect of the manner in which a material performs on a functional level. For instance, steel acts as a tensile and compressive load bearing material. Concrete and stone masonry are known for their robust durability and compressive load bearing capabilities as well as their permanence. Wood is similarly used widely for its structural properties in medium scale projects, as well as its affordability. Tile and glass are widely used in bathrooms and residential kitchens because of their waterproof qualities. Rubber absorbs vibrations and sound, fiberglass insulates, and copper conducts electricity. All of these are performative aspects of these materials that define their nature in common use.

Qualitative aspects on the other hand, pertain more so to a material's experiential relationship to the human element. It is a term referring to the phenomenological quality that can be achieved through material deployment. Qualitative employment of material is a very large part of what conveys aesthetic intention within building. While ideas and definitions of what is aesthetically pleasing and innovative have changed over time, the relationship of the material to senses of beauty and aesthetics has not.

Because so much of what architecture is about relates to the human aspects of building, and because our building design and construction industries are so centralized upon product-based items and systems, there has been great effort to “product-ize” and package material properties. These products, at their varying levels of quality and function present advances, as well as dilemmas. While material advances in synthetic and composite materials can greatly advance the performative nature of materials over their traditional counterparts, the issue of their qualitative properties presents problems. Often artificial materials that do not possess the desired aesthetic or qualitative properties are given a façade or veneer in order to make them more appealing and present them outwardly as their traditional counterpart. This can be easily seen in the multiplicity of engineered wood flooring solutions that all are given a veneer to make them look like rough sawmill lumber. At face value one might say, “well they look just the same so what’s the difference?” and the question is valid however, in this instance a successful product has been developed at the cost of the industries material culture. Extrapolate this example across an entire building industry where most everything in a building is a product based component and it results in a situation where aesthetics and intention are not conveyed through material innovation and development by the designer/architect, but chosen from a catalog of popular options provided as products.

This in and of itself is not the worst thing ever, ultimately buildings are constructed differently today than they were a hundred years ago with far more technologically advanced materials and this is unavoidable however, this condition leads to very real issues with the training and indoctrination of future designers with regard to material culture. When someone is brought up to think that materials that look the same must be the same, and they stop thinking about material qualities as parts of the designers repertoire, a great amount of expressive power is thus sacrificed on the altar of construction product development.
Figure 6.2
Comparison of flooring material options, all of which having wood-like aesthetics.

Figure 6.3
Architectural Products magazine, highlighting the product driven nature of contemporary architecture.
Figure 7.1
Project neighborhood: Over the Rhine, Cincinnati, Ohio.
Thesis Design Project

To address the issues presented within this research, this thesis proposes a new and different type of design education facility. It features studio spaces that are set up as shop/fabrication spaces throughout. This is in contrast to the current model of design studios adjacent to a single shared workshop that is more prevalent within design schools in North America.

This approach will serve to show the nature and activity of design in new light. Rather than considering fabrication and building as something that is done in another part of the building off somewhere else, it will be seen as central and essential to the design process on a fundamental level. In this way the architectural quality of the structure, and programmatic assembly will interface with the pedagogical attitude from which the architecture was conceived. It will serve as a showcase as well as a facilitator of construction based design.
Figure 7.2
Project Location, Cincinnati, Ohio.

Figure 7.3
Site massing and topography.
Site

The Over the Rhine neighborhood of Cincinnati, Ohio was chosen for the location of this design project due to its state of repair and current comeback in development interest. After decades of neglect and decline, the neighborhood has hundreds of derelict historic buildings and vacant lots offering great opportunities for real estate development and investment. For this reason the neighborhood will be treated as a design-build laboratory for architectural investigation. In addition, having local fabrication assets in the neighborhood will strengthen community engagement with the redevelopment process and stimulate local economic growth.

Figure 7.4
Existing site conditions. The derelict warehouse building currently on the site is to be demolished (theoretically.)
**Figure 7.5**
High Bay allows direct connection of indoor fabrication spaces and loading dock.

**Figure 7.6**
Mezzanine studio spaces link lower level fabrication areas with upper level studio space within the high bay.

**Figure 7.7**
High Bay organized building scheme.
High Bay Organized Scheme

The primary architectural gesture for this design is in the form of a multi-level high bay fabrication space, and outdoor yard. These spaces each, are served with industrial gantry cranes that connect multiple levels of the building with open fabrication space, and loading dock areas. The indoor high bay serves to facilitate heavy duty construction and prototyping in all weather conditions, as well as facilitate movement of material in and out of both the workshops and second level studio spaces of the building.
Figure 7.9
Key Lower level thresholds: Indoor bay to outdoor bay. Workshops to indoor bay. Workshops to sidewalk.

Figure 7.10
Key Second Level thresholds: Administrative spaces to high bay studio spaces. Second level studios to southern facing exposure and city views.

Figure 7.11
Upper Level thresholds: Studio to high bay. Studio to southern facing exposure and city views.
Threshold Conditions

Key threshold conditions are identified as architectural devices defining relationships between major spaces.

By engaging wall assembly, variable spatial relationships can be facilitated that will provide function and showcase architectural intentions of highlighting the importance of assembly, and material usage.

Primary walls that define programmatic space will be fixed while secondary wall systems such as offices and meeting spaces will be composed of temporary wall systems allowing great flexibility within the structure.

Figure 7.12
Section diagram of key boundary conditions within the building design.
Figure 7.13
Lower Level workshop spaces contain the majority of heavy duty, fixed fabrication assets.

Figure 7.14
Second Level studios primarily served by medium and light fabrication assets and facilities.

Figure 7.15
Third Level studios primarily served by medium and light fabrication assets and facilities.
Centralized / Distributed Fabrication Assets

One major research goal of this thesis is investigation of the inclusion of fabrication assets to traditional studio environments. This has been tested through the use of a desktop CNC Router within the thesis studio. From these experiences, a strategy of categorically staged distribution was adopted. At lower levels, the heaviest and most hazardous fabrication assets are kept while as one progresses higher in level through the building, the spaces are designed to be more conducive to lighter and smaller scale fabrication activities. This design alleviates workshop spaces from being inundated with students using small tools that could be put to better use outside of the enclosed workshop.

Figure 7.16
Heavy fabrication assets concentrated at lower levels of building.
Figure 7.17
Lower level consists of fixed spaces spilling out into flexible open spaces.

Figure 7.18
Second Level studio serving semi-flexible needs of studio as well as flexible high bay space needs.

Figure 7.19
Third Floor Studio semi-flexible design strategy.
Flexibility / Fixed Spaces

Flexibility of space is of key concern in that heavy fabrication and shop equipment needs to be mounted securely to a floor slab. For this purpose, key areas are designed to serve as highly structured, and fixed fabrication facilities that are adjoined to open, highly flexible fabrication and lay up spaces. Within this strategy studio spaces are considered mid-flexible spaces in that they are served by furniture and exhibition systems that create a different type of use pattern not entirely related to fabrication. This aspect of the design is very closely related to the treatment of centralized and distributed fabrication assets and shapes an overall attitude of greater engagement of fabrication and building within the design studio.

Figure 7.20
Studio Spaces and workshops consist of fixed use spaces that adjoin open areas of flexible use spaces.
Figure 7.21
Main noisy/dusty generating tools and processes contained to lower level spaces.

Figure 7.22
Second Level studio space treated as a mid-level fabrication space.

Figure 7.23
Upper level, enclosed studio space set aside for light fabrication and cleaner design work.
Noisy / Quiet

Noise and hazard containment was handled in similar fashion to the centralized vs. distributed fabrication assets. This allows the building design to define the relationship between noisy, heavy fabrication areas with quieter areas that will be better suited for smaller and lighter scale work. It is also reflected in the amount of enclosure particular spaces receive; upper level studios are completely enclosed and separated from lower level studios and fabrication areas as well as the high bay.
Figure 7.25
Hatching pattern developed through consideration of efficient CNC machine operation patterns and available brush tip pen options.
Presentation Strategy

Using the CNC router designed and developed by the author, presentation materials were developed making use of the machine as a drawing tool rather than simply printing design boards. In this way the design presentation will be treated in similar fashion to a fabrication process relative to tool capabilities and predilections as well as material characteristics from a quantitative and qualitative standpoint. Every part of the presentation strategy was created using catalyzed limitations presented by the nature of the tools and materials available. Paper size was chosen such that would fit on the bed of the machine, with borders allowing time efficient production. A black and white hatched pattern was developed using Grasshopper and Rhinoceros to represent images with depth and varying qualities depending upon the viewing distance. In this manner, the presentation of the project becomes indicative and a demonstration of the ideas explored in this thesis.
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