Where do Ideas Come From?: a Hands-on Strategy for Designing and Building Architecture

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1. Establishing an Attitude Towards "Craft"

Many schools are instituting design/build programs to explore the value of learning by doing.[2] Some argue that there is inherent architectural value in that: "…a rethinking of maker and means inevitably involves a rethinking of what architecture ought to be."[3]

In orthodox studios, students work primarily in paper and pencil, cardboard and glue, making representations that stand for other things—typically a building—to be fabricated by others, in another frame of time, at a different scale than the representation. In the studios discussed in this paper, students develop projects using real materials for a real purpose, in real time at full scale. Students build and rebuild their projects for critical review and group discussion.

A project example

Consider the following project statement from a recent studio:

> ***Make a vessel out of concrete that will hold and pour a gallon of water. Critique, revise and repeat.***

Embedded in this seemingly simple statement are numerous key principles: the idea that the student uses her own hands, drawing on her own skills and resources, to fashion something out of raw material; the idea that the thing has a typological correspondence to things already existing in the world; the idea that the thing is made with a pre-defined material, with its own behavior, history, technical requirements, body of research, and cultural memory; the idea that the thing has some kind of use that is ultimately testable; the idea that the thing has a haptic relationship with a human being; the idea that the thing is of an approximate size, capable of being picked up, examined, and passed around; the idea that the student is reflective and self-critical; and the idea that the project has numerous cycles of repetition. There is a complex set of aesthetic, technological, economic, functional, and ergonomic issues in this assignment that a student must consider when carrying it out. By approaching it in a repetitious cycle, the student engages in a long conversation with the subject, and comes to know it intimately. By the end of the term, the students had made dozens of vessels, each with its own special qualities and characteristics.

The word "craft" should be considered very broadly, meaning *any* human transformation of raw material into another object. This making can happen by hand, with the assistance of machine tools, or through the agency of automated manufacturing equipment. Every human or machine-made artifact that exists in the world has been made by craft. One important opportunity to develop a critical attitude towards craft and a critical awareness of agency occurs as students design and make.

David Pye was an English woodworker and design teacher who originally trained as an architect.[4] His book *The Nature and Art of Workmanship* gives us an important and useful set of principles regarding craft and workmanship. Pye uses the terms “workmanship of risk,” and “workmanship of certainty” to describe two different approaches to making that are distinguished by whether the result is predetermined and unalterable once production begins. “An operative, applying the workmanship of certainty, cannot spoil the job. A workman using the workmanship of risk, assisted by no matter what machine-tools and jigs, can do so at almost any minute.”[5] There is a qualitative difference in the objects made by the two methods, however most things that exist in the world are made with varying proportions of both types of workmanship.

Consider the veracity and implications of "risk" and "certainty" in this case: Imagine joining two wooden boards together in a 90-degree angle. You could use a pocket-knife to whittle the boards at the requisite angles, and then join them with some sort of fastener. This would be a "risky" technique because any slip of the hand would "spoil the job". Alternately, using a power mitre-saw with pre-machined detents set to prearranged angles involves a workmanship of certainty making the result "predetermined and unalterable once production begins."[6] Imagine other techniques which exist between the two examples given: for instance, how a hand saw, free-cutting a pencil line, falls between a work of risk and a work of certainty. There is no perfect certainty nor perfect risk, merely a sliding balance between the two.

Now consider the potential qualitative difference between the two techniques. Imagine the whittled joint, perfectly executed, so that it could not be distinguished from the machined joint; it would be a notable feat if a person could pull that off. If the two joints were compared side-by-side, and we were told how they were made, then we would probably hold the whittled joint in higher esteem. Thus, we see the qualitative difference between artifacts made with certainty and risk. "There is something about the workmanship of risk…which has been long and widely valued."[7] The artisan-made, hand-thrown, ceramic coffee cup tends to be more highly valued than a machine-produced cup, because of an appreciation of the "risk" embodied in the former. Furthermore, there is a sense of the hand of the maker and evidence such as fingerprints, wobbles, and scratches of the risk that went into it: an immensely various range of qualities, “without which the art of design becomes arid and impoverished.”[8] In this way, objects have quality whether precisely predetermined or evidently crafted. In some cases, from a design standpoint, precision is highly desirable, in other cases, it might not be. A designer could propose an artifact that has a sort of looseness to it. For example, rough, rubble masonry would be “spoiled” by executing it with too much precision. Pye defines good workmanship as “that which carries out or improves upon the intended design. Bad workmanship is what fails to do so and thwarts the design.”[9]

This is a critical point. Architects often imagine a pristine ideal of straight lines and square corners generated by drafted lines on paper: "In a designer's drawing all joints fit perfectly."[10]

Even in a computerized, highly-technologized world all things, from handmade to industrially-produced, from small handicraft to big building, are made with degrees of certainty and risk, of roughness and precision.

Imagine, once again, joining two boards together at a 90-degree angle. There are a number of possibilities to choose from: a 45-degree miter, a 90-degree butt joint, a half-lap joint, an overlapping joint, a dove-tail joint; you could lash them with rope or use a variety of fasteners. Each of these options has implied precision and roughness. Available tools, skills and materials influence critical decisions about plausible outcomes. For instance, the 45-degree miter is capable of making a highly precise joint but is relatively difficult to achieve without supplementary jigs, clamps and tools. It has a tight dimensional tolerance; miss by a fraction of an inch, or a few degrees in angle, and the appearance, strength, and integrity of the joint can be ruined. There are big differences between it and, for instance, the lashed joint, which is less dependent on dimensional accuracy. Instead, it is dependent on a different set of skills such as knot-tying and assessment of rope quality. From a craft standpoint, they are very different propositions, as they may be from a strength standpoint. The differences in character are also likely to be very pronounced. In this simple example, there are implications in making a (seemingly) simple design decision: implications about workmanship, resources, strength, time, skill, character, cost and so on. The critical designer takes these into account while making decisions.

In a third-year undergraduate design studio in 1999, students designed and constructed a park in a small town in Mississippi that included an arbor, benches, stage and a retaining wall.[11] None of the students was an expert craftsman and it was essential for us to find a way whereby students could design park elements that they would be able to build. No one in the group could construct to the tolerances imagined (naively) on paper and in models when originally working in the isolation of the studio. Material experimentation, coupled with critical discussion of notions of workmanship, led to development of a tectonic strategy that did not depend on extreme precision for success.

The arbor is the best element to demonstrate how this way of working determined the construction language of the park. The arbor is a 10' x 70' steel frame structure that supports wisteria plants for shading the space beneath. It consists of seven 10'x10' bays with 1/2" steel bars bent into “groin” vaults over each bay. Through a series of mock-ups, fabrication experiments, and critical discussions, the students decided to make the arbor's columns out of 1-inch thick steel re-bar.

Each column is made of three bars "lashed" together with 1/2-inch round steel rod. Steel is heated with an oxygen-acetylene torch and, as it is softened by the heat, it is wrapped smoothly around the vertical bars in a fluid fashion. There is a high degree of risk in the wrapping of the steel; it depends on good timing by the worker holding the torch and the person doing the wrapping. It was not clear at the outset what the language of the wraps should be: Should they be tight or loose? How many turns should they make? Should they be made with smooth bar or reinforcing bar? Students made mockups of a range of wrap-types and determined through consensus, based on actual results, the final design and fabrication of the columns. With practice gained in experimentation through repetition, the arbor team developed the skill necessary to wrap the steel with consistency. In other words, they achieved good workmanship: a good fit between design intention and outcome.

The columns were fabricated at the school and then placed on site-cast foundations. A system to ensure "certainty" was required so that the columns would fit on the cast-in anchor bolts in the correct orientation. Jigs and fixtures were developed to position the column legs accurately while wrapping, and then to locate the steel baseplate in its proper orientation. This method brought a desirable degree of certainty to the fabrication process. Once the columns were on-site, leveling nuts on the foundation anchor bolts permitted the columns to be plumbed vertically.

The groin vaults were fabricated and installed in a similar fashion: the basic profile of the vaults was defined by panels built on jigs (for certainty), while the smaller members were installed "by eye" with a high degree of risk. The tectonic language of the vault is based on an approximately 12-inch overlap of the horizontal, perpendicular members. Since this spacing does not require a high level of precision, the overlaps could be off by even a few inches. The character of the final arbor is that of a vegetated and vegetative steel structure, a unique artifact constructed with equal measures of risk and certainty, executed by novice builders. Critical discussions about theories of workmanship allowed the students to develop the character of the final built work through experimentation and making. This degree of innovation, I believe, could not have developed on paper nearly as well as it did with a program of experimentation with real materials that included a critical approach to workmanship. Furthermore, it was realized as a group activity, with much give and take, and with a spirit of camaraderie, invention, discovery and adventure. It demonstrated an attitude of work as *serious play.*

2) Develop achievable expectations through hands-on experimentation

EXPERIENCE AND LEARNING THROUGH SERIOUS PLAY

Exploration with materially-based projects, crafted by hand, promotes the development of a critical discourse between maker and object, and between maker and critics/colleagues. Students discover ideas about form and tectonics by expanding their recognition of material possibilities. Students interacting directly with materials learn a host of things. The bodily senses understand mass, texture, smell, resistance to deformation, sound, and color; the subtle interplay of these things with each other, and with other materials and processes. Direct experience promotes learning that is fundamentally different than, but not necessarily more important than, indirect experience.[12] This educational approach fits into what might be called the “process” tradition of thinkers and philosophers such as William James, Charles Sanders Peirce, George Herbert Mead and John Dewey.[13] In the early twentieth century, Dewey suggested that contact with any new material "…must inevitably be of the trial and error sort. An individual must actually try, in play or work, to do something with material in carrying out his own impulsive activity, and then note the interaction of his energy and that of the material employed…." He championed direct experience to improve children's education where "…it is found, even with comparatively indifferent modes of instruction, that children's inquiries are spontaneous and numerous, and the proposals of solution advanced, varied and ingenious."[13] Dewey argues that learning comes from thinking, and that direct experience forces to students to think about the subject in more complex ways than with the "peculiar artificiality (that) attaches to much of what is learned in schools."[14]

Design is a specialized form of learning, in the sense that, as one designs, one learns increasingly more about what it is that is being designed. There is a complex relationship between designer and designed: one learns about the object itself, about one's intentions for the object, and about others' reactions to the object through the act of design. Design itself is a form of argument, creating a "persuasive argument that comes to life whenever a user considers or uses a product as a means to some end."[15] Richard Buchanan argues that there are three important elements to a design argument: technological reasoning, character and emotion. Technological reasoning engages the functionality of the thing; character deals with qualities such as "good sense, apparent virtue, and goodwill toward the audience;" emotion evokes things like aesthetics, and the degree to which a user is "persuaded that it is emotionally desirable and valuable in their lives."[16] Thus, there is an inherent complexity of argument in design, embedded in, and communicated by the actual things we design. Craft embeds these arguments in material objects.

Reversal theory—a general approach in psychology dealing with motivation, emotion and personality—provides a way to think about play in two phenomenologically opposite states: *Telic* play, the "serious" state of play (from the ancient Greek ,'telos', meaning a goal or purpose) and *paratelic* play, the looser, more frivolous state (incorporating the ancient Greek word, 'para', meaning alongside).[17] Different benefits accrue out of each type of play, and we pursue each type for different reasons. They are not oppositional; they are reciprocal. Each cycle feeds the other. Consider, for instance, a dancer simply enjoying the pulse of the music, swaying to its rhythm, (paratelic play) and “discovering” a certain movement that has some emotional or physical resonance, and which ends up being transformed into serious choreography for a public performance (telic play). The telic mode of play allows one to achieve purpose, accomplish goals, satisfy a competitive need, and the like. The paratelic mode of play permits one to operate in a protected zone of psychological safety, because the stakes are entirely different. In telic play, one might say that the end justifies the means, in paratelic play, the end *is* the means.

When an architecture student plays with concrete (or any other material) they might approach it telically, or paratelically, depending on his or her purpose. Ideally, there should be a cycle of learning from paratelic to telic to paratelic, and back again, starting with a period of loose experimentation within the protected, paratelic frame, then a purposeful application of lessons learned, and then a looser experimentation again, on a slightly different trajectory, in a continuing cycle of experimentation, discovery and learning. “…(W)here thinking is not controlled by the tyranny of some exigent and overriding goal, it can more easily take new paths which can lead to discoveries.”[18]

THE SUCCESS OF FAILURE

The telic/paratelic cycle in these material investigations is dependent on the reality of the situation. This is because some series of critical judgments needs to be made to advance the work. A thing made can be evaluated by the maker and by others for what it actually is, not for what a representation merely purports it to be. It stands there (or it doesn't), it looks good (or it doesn't), it meets expectations (or it doesn't). The maker is not dependent on the authority of an outside critic to predict the future success or failure of the thing made. At a fundamental level, the thing is its own best critic. It is self-confirming for the maker in a way that lies outside of the realm of mere opinion. When a maker knows he has truly succeeded (certainly in his own eyes, and perhaps in the eyes of outside critics, but most importantly by the silent testimony of the object made), it breeds a feeling of self-confidence that can fuel production of future work (both made and represented). When a maker knows that she has failed, the failure tells her that she has found the edge, that she can return to the point of failure, and make good on it in future revisions. It is important to appreciate the breadth of notions of “success” and “failure”: to succeed in one of these projects is to develop a critical discourse with it; to establish "mastery" over it, to meet one's expectations, to learn—and abstract—lessons from it. It is possible to succeed in the project even if on its face the project didn’t turn out as originally intended. Knowing one has failed is useful, positive knowledge. In a paradoxical way, failure also builds self-confidence, in the sense that it helps the maker understand the idea of limits: the maker’s limits, the limits of materials, techniques, plausibilities. Understanding the limits of one's knowledge is an oft-cited definition of wisdom. The important thing is to provide the right time for failure to happen: the paratelic play cycle is where failure wants to happen so that it can still become part of the knowledge base (ready for deployment when it really counts), but while inside of the protected frame.

As an example, as students work on the concrete vessels they go through these paratelic/telic cycles, they (ideally) make progress; they innovate. In cycle one perhaps they come up with an "interesting" mix of concrete; in cycle two, they might discover that the mix flows well into small cracks; in cycle three they might discover that the cracks sponsor a beautiful texture of ridges on the surface; in cycle four they might develop a way to optimize the mix for intensifying the texture, in cycle five they might discover that the addition of color intensifies the texture, and so forth. With each iteration, the student develops design ideas and, just as importantly, develops the craft skills, techniques, and procedures for carrying out the work.

A small project recently assigned to third-year undergraduates illustrates these notions of telic and paratelic play.[20] In this particular assignment, the students drew a slip of paper from each of two hats. One slip named a nominally-rigid material, the other a nominally-flexible material. They were asked to begin the project by making three joints: an "overlapping" joint, an "abutted" joint and a "separated" joint. Though some of the materials were orthodox construction materials (wood, concrete, brick, building felt), others were not (lace, insect screen, bubble wrap). And the combination of the two was likely to be highly unorthodox (brick and lace). An iterative design process over the course of two weeks led each student to develop 1) numerous joints—the ostensible purpose of the project as assigned; and, 2) an abstract understanding of the problem and its solutions—the actual purpose of the project which came out in class discussions, and which is transferable to other design projects.

For instance, one student, confronted with the task of joining brick and lace, after a frustrating struggle with the apparent dissimilarity between these materials (when considering them at “full” scale), finally found a solution when she broke the brick apart, zoomed in to the micro scale, and acknowledged small fissures in it that were highly compatible with the delicate lace tendrils. Reflecting on the lessons learned in the project, she writes,

> *During the extrusion processes that formed the clay into its block shape, larger particles are scraped across the soft surface. The striations left in the clay are evidence of the path which the particles have traced….A hierarchy of structure to the lace was identified, allowing the top layer of threads to be unwoven from the underlying structure….By looking to the striations, enormously more precise and efficient connections could be made. Each thread fitted neatly behind a particle which had scraped across the surface. Continuing to pull at the particle in the prior direction of force allowed the thread to act as a hook when set in place…*[21]

On unfamiliar turf, this student, in “playing” with the materials over the course of two weeks, gained an intimacy with them that revealed their hidden structures to her. Dissecting the lace allowed her to understand the hierarchy in the lace sample she chose (a consequence of its construction). Breaking the brick apart, and examining it at a micro scale, gave her insight into the brick’s extruded manufacturing process. By playing paratelically, she discovered a compatibility between the materials that led to a more purposeful and meaningful joining of them.

3) discover design solutions that couldn’t plausibly emerge in the absence of such experimentation.

By the end of the process, the student has designed and built an object that couldn't exist in the absence of this process. The work didn't happen exclusively in the space of the mind. It happened in real space, real time and with real materials, in a process of architectural design driven by serious play, described by Mark West as, “an abiding faith in chance, the free fall of imagination, and its emotional pulse; a solemn study of 'natural law;' and an embrace of what can be called a 'builder's sensibility.' These lines are entwined and knotted through the discipline of architecture in a search for new forms and approaches to architectural design.”[22] The critical feedback from the reciprocal cycles of telic and paratelic play join together in a synergistic way to propel the work forward. Play leads to innovation, discovery, and the development of new ideas, forms and techniques in architecture.

Understanding the complex relationship between ideas of craft, workmanship, play, discovery and innovation is not a uniquely contemporary problem. It may be exacerbated by the accelerating nature of our industrial culture to introduce expanded and precise ways to fabricate, and faster and more accurate ways to draw. In the end, the evidence of these inputs (intentions, representations, materials, workmanship) will be apparent in the resultant physical artifact. It is important to recognize that these change very slowly compared to the apparent

speed of the culture. Play is a fundamental human trait, and its creative potential can be brought to bear on the problems of architecture and construction, as well as other problems in life, as evidenced by Galileo's thoughts on the subject: "But if by digressions, we can reach new truth, what harm is there in making one now, so that we may not lose this knowledge, remembering also that we are not tied down to a fixed and brief method but that we meet solely for our own entertainment? Indeed, who knows but that we may thus frequently discover something more interesting and beautiful than the
solution originally sought?"[23]

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[1] Susan Piedmont-Palladino and Mark Alden Branch, Devil's Workshop : 25 Years of Jersey Devil Architecture. (New York: Princeton Architectural Press, 1997) p. 14.

[2] See Mark Robbins and Jason Pearson, eds., *University-Community Design Partnerships: Innovations in Practice.* (New York: Princeton Architectural Press, 2002).

[3] Piedmont-Palladino and Branch, p. 14.

[4] Pye received an architectural education at the Architectural Association (AA) in London, then spent three years practicing as an architect, until World War II intervened. After a stint in the Navy, Pye first started teaching at the AA, then the Royal College of Art, where he was Professor of Furniture Design until his retirement in 1974. From: *David Pye: Woodcarver and Turner,* (London: Crafts Council, 1986) p. 13.

[5] David Pye, *The Nature and Art of Workmanship* (Cambridge: Cambridge University Press, 1968) pp. 22

[6] Ibid.

[7] Ibid. See also: Walter Benjamin, "The Work of Art in the Age of Mechanical Reproduction," in *Illuminations,* (New York: Schocken Books, 1968) p. 217; and Robert B. Gordon, "Who Turned the Mechanical Ideal into Mechanical Reality?" in *Technology and Culture,* Vol. 29, #4, p. 244.

[8] Pye, *Nature and Art,* p. 30

[9] Ibid.

[10] Ibid., p. 31. Or now, on a cathode ray tube where all joints fit perfectly to a one-thousandth of an inch tolerance.

[11] The studio was taught by Nils Gore and Shannon Criss at the Mississippi State University School of Architecture.

[12] It's important to promote indirect experience in these projects as well. For instance, library research into the scientific properties of concrete.

[13] Maxine Greene, "Philosophy and Teaching," in Merlin C. Wittrock, ed., *Handbook of Research on Teaching* (Washington, DC: American Educational Research Association, 1986) p. 491.

[14] John Dewey, "Thinking in Education," reprinted in Louis B. Barnes, ed. *Teaching and the Case Method*, (Boston: Harvard Business School Press, 1994) p. 10-11.

[15] Ibid., p. 13.

[16] Richard Buchanan, “Declaration by Design: Rhetoric, Argument, and Demonstration in Design Practice,” in Victor Margolin, ed., *Design Discourse,* (Chicago: University of Chicago Press, 1989) p. 96.

[17] Ibid., p. 101-103.

[18] Michael J. Apter and John H. Kerr, "The Nature, Function and Value of Play," in *Adult Play,* p. 15.

[19] Ibid. p. 169-171.

[20] Partial credit for the idea of an assignment about joining incompatible materials is due to Rachel McCann and David Lewis, at Mississippi State University.

[21] Julia Ng, (unpublished class writing assignment.) 2003. Having students write reflectively about lessons learned at the conclusion of a project is beneficial for both them and me.

[22] Mark West, “Construction-Research-Design-Invention: Elastic Behavior in a Moist Environment,” *JAE*, Volume 54:4, May 2001, p. 251.

[23] Galilei, Galileo, *Dialogues Concerning Two New Sciences,* Translated by Henry Crew and Alfonso deSalvio. (General Publishing Co. Ltd., Dover Paperback edition, Toronto, 1954) pp. 7-8.