Making Constructive Discoveries

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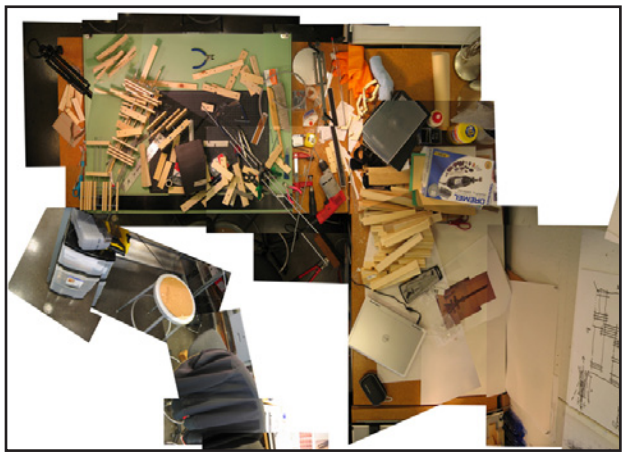

Figure 1: Collection of work on student's desk

INTRODUCTION

This paper focuses on a pedagogical framework that assigns specific attention to making as an integral experience of design. This critical reflection on curricular and teaching examples focuses primarily on educational instances when acts of making are combined with early processes of conceptualization. Significant stages of student development, from early introductory design studio, to a vertically integrated seminar, to an advanced, comprehensive, capstone studio, involve making as an integral mode of design investigation, experimentation, and research. At the core of this pedagogical impetus is an emphasis on an essential tenet of craftsmanship, "the skill of making things well,"[1] as a means to exploring questions, problem solving and discovering sensibilities at the convergence of making and thinking.

"CONSTRUCTION"

My early teaching experience in the area of building construction began, like most new instructors, as a section leader for a core architecture construction course, aptly titled 'Construction.' This course covered fundamental principles of construction practices, materials, methods and technologies, and presented a majority of the content material to students through case studies of well documented and researched buildings. Students were asked to perform the requisite analytical orthographic and paraline re-drawings of a select group of case studies in an attempt to gain an understanding of the organization and integration of building systems, components and details. At this time, and because of the organization of the school's curriculum, the course was distinctly separate from the core architectural design studio sequence. In a significant way, this initial experience teaching construction left an indelible impression on my own teaching methods and ideas about how the topic should be better integrated in an architecture curriculum.

As the only moment in a curriculum when a student is exposed to principles, technical information, and skill sets of construction, the comprehension of the subject can potentially result as a set of isolated lessons engendering a mindset that is based on a linear, sequential process – *design it first, then devise how to build it.* This is not to suggest that construction courses in architecture schools should be eliminated or diminished in relevance; on the contrary, they should be raised to a level of priority interdependent with core design studios. More integrative and iterative lessons involving construc-

tion as part of the initial conceptual design process would enable learning experiences based on discovery and not solely based the confirmation of factual information. Involving students (especially beginning design students) early on in experiences of making introduces them to "construction" – *or the act of building* – as an inextricably heuristic part of designing. The underlying pedagogical concept is to take students from concrete experiences through to abstract thinking.[2]

Generally speaking, architectural design studios begin with investigations of a conceptual nature and end with a building design project; initial analyses of sites – whether actual building sites or abstract frameworks – setup a "before-and-after" condition whereby the "idea" or "concept" for a project is ultimately confirmed by the creation of an artifact or representation of a building. Some argue that this process is actually reversed from the order it should have.[3] In *Teaching Students to Think Critically*, Chet Meyers points out that the generally accepted sequence of beginning with abstract lessons and concluding with concrete experiences may result in a "stultifying" classroom environment. Meyers writes:

> By presenting abstractions first, teachers rob students of the pleasures of discovery, Kinney (1980) calls the teaching of abstractions in an artificial context, devoid of any association with the world as students know it, "disembedded learning."[4]

Meyers argues for a learning environment that involves students in problem-solving and motivates an investigative and exploratory mindset which in turn promotes a "discovery of abstract thinking." [5]

If one were to more closely examine the lessons learned through construction drawing exercises, one could conclude that the assignment focuses a student's attention more intently on effective methods of architectural representation rather than on the application of purposeful, exploratory constructional methods. The resultant re-drawings are impressive accomplishments from the standpoint of composition, line work, and information management, but do not necessarily support the development of a nascent understanding of constructional logic and manipulations made due to material properties and performance. The set of analytical re-presentations of the assigned case study construction documents – a provisional proxy for the actual building – result in an illusory "site" of investigation. This pedagogical tactic is focused more intently on the graphic disassembly and re-assembly of the construction document as a precursor to the physical engagement of actual building materials and attempts to momentarily suspend the need to understand the effects of gravity on dimensional characteristics and tectonic stabilities. Actually, in a more direct way, the hand-eye coordination imbedded in penmanship exercises taught in early education are more purposeful lessons with regard to developing a constructional logic in that they help a student learn how to coordinate a set of physical relationships influenced by gravity, friction, pressure, and speed to affect material. Eye to hand and back to eye harmonization is repeatedly reinforced to establish the shape of a letter and then improve the physical control of joining one symbol seamlessly to another to form a word; these are exercises that purposely focus mental attention on physical action and stress the mechanics of writing not the syntax or meaning of a letter, word or sentence. Robin Evans makes a strong argument for the limited role of drawing and the search for new ways of working. He writes:

Figure 2: Studio work session

> The drawing has intrinsic limitations of reference. Not all things architectural can be arrived at through drawing. There must also be a penumbra of qualities that might only be seen darkly and with great difficulty through it. If judgment is that these qualities in an around the shadow line are more interesting than those laid forth clearly in drawing, then such drawing should be abandoned, and another way of working instituted.[6]

Evans writes of a process steeped in acts of discovery not procedures structured to confirm a set

of "references." A more meaningful understanding of what is architectural can be better achieved through a four-dimensional, constructional act involving space, form, materials, and time. Engaging materials and their inherent properties along with employing methods of assembly provide a student with the necessary resistances and problem-solving challenges. This introduces the potential for a dialectical learning process involving formal, spatial, tectonic, material – as well as conceptual – transformational operations.

MAKING

Making is a means to inventing design discoveries. These discoveries are simultaneously intentional and serendipitous; they can be focused or distracted, fortuitous or frustrating and should be allowed to occur as an emerging sensibility of an evolving design methodology. This is primarily intended to help students realize a set of possible connections between ideas (and artifacts) emerging out of a process of making or ones generated from a speculative, representational enterprise[7] – both are informed and guided by thoughtful and rigorous working methods. This provocative thought by John Rajchman is particularly applicable to the challenges faced during beginning design instruction and the integration of making as an equally important component of abstract processes:

> Werk [. . .] is rather [. . .] a singular, irregular construction built from many circumstances; … often it knows no other logic of development than the crises it goes through. It therefore has a loose, unfinished plan before it acquires a recognizable 'form' or 'represents' anything …[8]

It is at this initial stage of learning how to reconcile generative methods of making with abstract generative processes of thinking that an integrated approach to teaching design studio is opportune and necessary. The conventional approach emphasizes a more linear process defined by an absolute relationship between abstract concept first *then* physical construct, *idea then building*. This segregated, linear process is often a byproduct of the way the design problem is structured; the re-organization of the very structure and chronology of expectations in a design problem is essential for allowing a questioning of the design process to be part of a student's initial set of experiences. Chet Meyers identifies the "learning cycle approach" as an effective technique developed by Robert Karplus[9] and how Karplus "experimented with ways to apply Piaget's concept of movement from concrete to abstract levels of thought in [their] classroom activities."[10] Karplus and his associates developed a three-stage "learning cycle" that "incorporated exploration of materials and the introduction of new concepts."[11] The framework included three stages defined by the exploration of materials, the invention of concepts, and the application of concepts.

Figure 3: Studio work session in woodshop

BETWEEN A AND C[12]

The following design problem taught in an introductory undergraduate design studio utilizes the "learning cycle" as part of iterative, exploratory process beginning with concrete materials[13] and analogous artifacts and cycles back and forth between manipulating materials and developing a conceptual basis for new applications of materials, tectonics, and overall formal and spatial strategies. The principle[14] explored through the design problem is that of interpreting the act of *surrounding* as an invention of enclosure and asks the student to question and describe through constructs the essential act of surrounding – *or enclosing* – as a simultaneous act of unification and separation.

The principle is initially explained, as an action that separates the inside from the outside while simultaneously giving definition to what is between. The student is encouraged to argue that the act of enclosing can also perform as an extension of that which it surrounds and, in turn, maintains or compromises its identity. Through this project, the student is asked to analyze and fabricate a series of interpretive formal and spatial studies of knots. In the context of this design project, the knot – *or most importantly the physical act of tying a knot* – is a means of revealing, discovering, and instrumentalizing spatial concepts of between, surrounding, and enclosing. The educational purpose of the investigation is for the student to explore and develop a series of strategies of defining space by involving the use of topological configurations, three-dimensional composition, multiple materials, assembly methods, and fabrication techniques. In so doing, the project challenges the student to define and manage relationships and ordering of a set of principal elements of space-making and form-making: volume, mass, frame, and surface.

The parameters of the investigation account for the general performance criteria for the design of constructs in terms of how materials – formed in specific shapes and configurations – define space explicitly or implicitly. The construct is used to define (identify) a location in space by delineating an area (or areas) of space and emphasize experiential (visual) thresholds into and out of space. How the construct affects natural or artificial light and how it implies space outside of the physical limitations of the artifact are important additional aspects addressed.

From the outset of the project, the student is asked to employ materials effectively and as part of a process that is sustainable; they are asked to carefully consider a logical assembly system and sequence and manage the scale of fasteners, components, parts, and sub-assemblies. This project allows for an introductory, albeit cursory, investigation of effective structural strategies; gravity is part of the resistance of the project and is a constant test of the viability of the overall assembly. Tolerances are discussed to underscore the importance of precision and accuracy of craft and how the role friction-fit connections may play a central role in the overall design of the construct.

The overarching objectives[15] of the design problem is for the student to begin to understand architecture as a four-dimensional, constructional act involving space, form, materials, and time; to develop an understanding of material properties and systems of assembly; to understand the potential of transformational operations; to recognize the performance-based attributes of materials; and to be critical of the purpose of the construct, in terms of how it works, how it is assembled, and how it affects space. Moreover, as one of the first design problems, it lays the groundwork for future investigations that may serve more conventional architectural design problems where program may be emphasized to a larger extent.

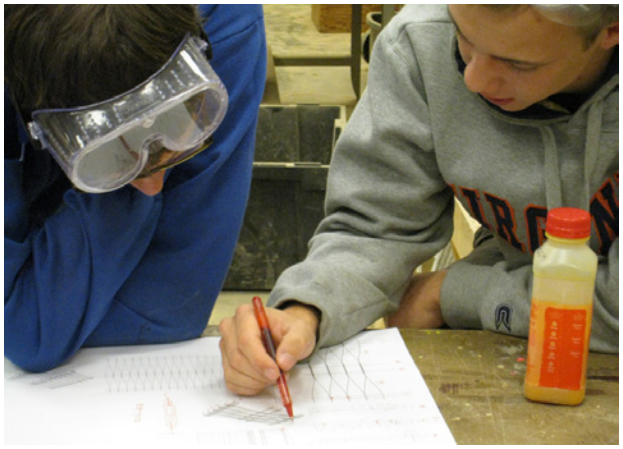

Figure 4: Translating drawings

"HOW WOULD YOU BUILD IT?"

At the level of a comprehensive, capstone architectural studio and advanced seminar in fabrication, involving students in a design problem that effectively integrates constructional investigations along with conceptual explorations is equally important; but this serves a set of different purposes. In this context, some of the content and principles covered in construction courses can be folded into the design development of a project making more immediate, instructional links possible. Research and development can now be applied more rigorously to more phases of the design process. The fundamental pedagogical goal for this advanced, 4th year architecture design studio problem is to focus the student's attention on a real, current, and culturally relevant design investigation. The ques-

tion *"How would you build it?"* is treated seriously at every juncture where concept and construction need to be synthesized; this question helps a student working collaboratively with others to focus on the importance of developing a sound design-build or build-design strategy that emerges out of the careful consideration of performance guidelines set by the instructor and influenced by the client, budget, timeline, and end user group. Other factors that help define the design problem and provide a set of critical resistances include institutional organization and interdisciplinary collaboration. The question *"How would you build it?"* is used to leverage a set of ideas out from a purely abstract initial conceptual state into an applied, translational set of constructions informed by material and tectonic performance. These provisional constructions, which take the form of templates, mockups, and prototypes, introduce the student to exploratory practices of fabrication which focus on technical and manual skill development. Although technique is not the end goal, it is used as means of gaining a familiarization with the resistances of materials when cut, ground, heated, shaped and re-formed to produce a desired configuration and assembly. These developmental, skill-building experiences associated with manual techniques helps inform a base, tacit knowledge as well as abstract constructs - i.e. systems and organizational schema of the overall building; these complimentary forms of learning about building are used as modes of communicating important principles of construction. The feedback a student receives from material properties and the fundamental physics of workmanship is highlighted as an important lesson of construction *and* design. The manner in which one building element is fabricated and joined to*, or held apart from*, another element and made part of a hierarchy of integrated subassemblies and systems of building is at the core of these exercises. The goal is to amalgamate multiple states-of-mind and ways-of-working that what would otherwise be artificially separated into discrete occurrences and ultimately result in a design *then* build mentality.

THE EDUCATION OF AN ARCHITECT

In his writings on the education of the architect, Vitruvius calls for a form of knowledge "that is the child of practice and theory," he emphasizes that "practice is the continuous and regular exercise of employment where manual work is done with any necessary materials according to the design of a drawing."[16] This describes a linear process from drawing to construction, and a hierarchical order from higher level conceptualization (theory) down to lower-level, manual effort. Vitruvius only accounts for a portion of the process and implies a unidirectional sequence from ideation to materialization and does not describe the potential of a reversed process of learning from materials and construction to the conception of ideas.[17]

Alberti's influence on the separation between design and building is widely known and has been undeniably part of the architectural profession's decree for centuries. In his book *On the Art of Building in Ten Books*, Alberti goes to great length to define the appropriate parameters for the education of an architect and the critical hierarchies to be maintained as part of the professional conduct of architectural practice. Alberti distinguishes between buildings that are "convenient for use" and can be realized by "workman" from those edifices that require a "perfect and complete" process of preconception, determination, and judgment; these buildings could only be designed by those individuals in the profession.[18]

Alberti also describes a phenomenon he himself experiences when developing the design of a building from concept to drawing and finally to a representational model; he recalls:

> I have often conceived of projects in the mind that seemed quite commendable at the time; but when I translated them into drawings, I found several errors in the very parts that delighted me most, and quite serious ones; again, when I return to drawings, and measure the dimensions, I recognize and lament my carelessness; finally, when I pass from drawings to the model, I sometimes notice further mistakes in the individual parts, even over the numbers.[19]

In this self-critique, Alberti focuses on what he calls "errors" or "mistakes" that point to an incorrectness of dimensional properties, proportions, and size. The miscalculation, or perhaps *misrepresentation*, occurs during the process of translating concept into drawing and drawing into model. One could reasonably assume that a similar set of inaccuracies might then occur from model to construction of the actual building. One is also left to wonder how these faults may have had an effect on subsequent iterations of concepts, drawings, and models.

Embedded in our history of architectural education and practice is the reinforcement of this procedural segregation of thinking *then* making which is extended into a professional framework where roles and responsibilities are delineated by hierarchies and legal boundaries. As Alberti points out, buildings of utilitarian use need not even be considered by the profession and can be sufficiently built by others outside of the profession – further distinguishing and separating the roles of professional architects from builders and craftsmen. This is not to suggest that specializations defined by a body of technical knowledge, know-how, and expertise in the profession should be subsumed into an overarching generalists mindset and practice. Instead the argument is that a preparation, from general to highly specialized knowledge, would stand to benefit further from an education which reinforces a dialectical interdependence between ideas emergent out of processes of making with ones generated from highly abstract generative constructs. The instructional approach in design studio courses should emphasize an inter-reliant relationship between concepts and constructions and strive to form equilibriums between abstract representations and full-scale, material constructs; a *construct* can be equally effective when emphasized as theoretical framework and a physical artifact.

At this juncture it is important to identify the potential for translational connections in the form of technique (manual skill), workmanship, and craftsmanship[20] as influential precursors to abstract thinking. These translational connections can allow for a constructive cycle, a reflection-in-action[21], or an *action-then-reflection* between material experimentation, then conceptualization and back to manual manipulation. Hand, eye, and mind coordination works to reinforce how material effects can affect the direction of an idea. Manual dexterity and mental flexibility are exercised in unison in a concerted iterative process comprised of actual fabrication (manual and computer numerically controlled), three-dimensional modeling (analog and digital), and two-dimensional drawings (hand and computer aided design) to exercise mutually supporting roles between construction and concept. A critical teaching tactic involves avoiding privileging one mode of working and thinking over another; technique (the development of manual skill) is employed as part of an investigation and a concept is questioned as a further development of a skill

Figure 5: Full scale testing and evaluating

set – one is not made prominent over the other. Throughout this process, it is important to explain the reciprocities and focus the student's attention on the relevant coordination between technique, workmanship, and craftsmanship and overall relationship to conceptual, abstract thinking. For example, creating (or making) an edge while cutting a material requires a student to account for the effectiveness of the technique (manual proficiency) used to cut. The workmanship of the cut and its effects of an edge (or multiple edges) of a plane, in turn, affect the overall craftsmanship (balancing of all factors and qualities) and leads to a potential awareness of a symbiosis between construct and concept.

The separation or the order of a linear sequence between designing and making extends into philosophical and pragmatic debates over the relationships between design and workmanship. David Pye takes an ardent position in his book *The Nature and Art of Workmanship* and reverses the linear relationship between design and workmanship. Pye explains that it is the inventiveness of the workman that has historically enabled the existence of the designer:

> Our environment in its visible aspect owes far more to workmanship than we realize. There is in the manmade world a whole domain of quality which is not the result of design and owes little to the designer. On the contrary, indeed, the designer is deep in its debt, for every card in his hand was put there originally by the workman.[22]

Pye goes on to underscore this point by further differentiating the non-physical act of design and the physical actions of workmanship by distinguishing design as rhetorical endeavor explicable through "words and drawing" while workmanship, in the practical sense, accounts for everything else in our physical world.[23]

In his book *A Theory of Craft: Function and Aesthetic Expression*, Howard Risatti makes a clear distinction between ideation and construction as a "kind of Cartesian dualism" [24] and explains that designing as an activity takes the form of an "abstract notation" and thusly can "never be the same as the thing intended to be made from it." [25] Risatti makes an interesting point as he further distinguishes a two-part process of the making of an object into a "design-man-ship" and "workmanship"[26] and argues one can "judge the quality of the design conception separately from the quality of the finished product."[27]

Richard Sennett, on the other hand, describes a *dialogue* that can be achieved between making and thinking as an indicator of reaching a level of craftsmanship. He writes:

> Every good craftsman conducts a dialogue between concrete practices and thinking; this dialogue evolves into sustaining habits, and these habits establish a rhythm between problem solving and problem finding. [28]

This argument strives to close the gap between efforts of the mind and those of making; similar gaps can be narrowed in architectural education by helping a student reframe the relationship between concept and construction and emphasizing the equal importance and dialectical interdependency of "design-man-ship" and "workmanship." These pedagogical strategies foreground experience as a central act to learning about *how* to manipulate the material world; this concept of *experience* described by Sennett as a two-part German term – *erlebnis* and *erfahrung* highlights the importance of cultivating an interdependency between human response to the physical world in the form of an emotion (and a thought) and, in turn, the reaction to the physical world through an act of manipulation requiring some degree of skill. [29]

This form of *experience* does not privilege singular techniques or skills, but balances a set of interdependent actions to support a process of discovering one's sensibilities toward the built environment. It is a potential, however ephemeral, means of exploring design at the moment of convergence of physical actions in making and abstract discoveries through thinking.

CONCLUSION

From introductory courses to advanced architectural design studios, integrating lessons of making and conceptualizing are an essential part of a sound architectural design education. Critical to integrative instructions are frequent constructive opportunities for a student to act on "images of matter"[30] and experience the real and the imaginary as reciprocal sensations of the hand and the mind. The separation of these experiences creates an artificial divide between constructing and designing, a divergence detrimental to the potential for discovering one's own innate sensibility and awareness of imagined and built environments – making is an essential means to experiencing these discoveries.

ENDNOTES

1. Richard Sennett, *The Craftsman,* (New Haven, Yale University Press, 2008) p.9 In this book, Sennett writes about the concept and practice of "craftsmanship" in society and makes this point, among many, about the importance of craftsmanship. "'Craftsmanship' may suggest a way of life that waned with the advent of industrial society – but this is misleading. Craftsmanship names an enduring, basic human impulse, the desire to do a job well for its own sake. Craftsmanship cuts a far wider swath than skilled manual labor; it serves the computer programmer, the doctor, and the artist; parenting improves when it is practiced as a skilled craft, as does citizenship. In all these domains, craftsmanship focuses on objective standards, on the thing in itself."
2. Chet Meyers, *Teaching Students to Think Critically,* (San Francisco, Jossey-Bass, 1986) p. 29 "The key to the movement from concrete to abstract is the order of this movement: concrete experience first, then abstraction."
3. Ibid., p.29, "This idea [of going from concrete experiences to abstract ones] may seem like mere common sense – but it stands in direct opposition to traditional teaching methods, which introduce abstractions first and then seek to have students confirm those abstractions through some concrete method of

verification. In traditional science courses, for example, the theoretical aspects of the subjects are almost always presented in lectures or textbooks before students reenact or confirm the theories in a laboratory."
4. Ibid., p.30
5. Ibid., p.30
6. Robin Evans, *Translations from Drawing to Building and Other Essays,* (Cambridge, MIT Press, 1998) p.159
7. Howard Risatti*, A Theory of Craft: Function and Aesthetic Expression*, (Chapel Hill, University of North Carolina Press, 2007) p.166 "The modern conception of design, in which the designer's creations only exist in the form of abstraction until they are given materials form reflects a kind of Cartesian dualism separating mind and matter. It makes explicit what had previously only been implicit – the division between mental conception and physical execution." Howard Risatti*, A Theory of Craft: Function and Aesthetic Expression*, p. 166
8. John Rajchman*, Constructions,* (Cambridge, MIT Press, 1997) p.7
9. Robert Karplus, a former dean of the graduate school at the University of California at Berkeley, based this on Piaget's learning theory and early childhood development physics experiments which focused on mental operations focused on the reversibility of order.
10. Meyers, op. cit., p. 31
11. Ibid., p.31
12. Jean Piaget from *The Child's Conception of Space*
13. Meyers*,* op. cit., p.32, "The first stage involves the *explorations of materials*. Before any exploration begins, the teacher must identify clearly the key concepts or principles to be taught. The teacher then carefully selects materials that relate to those concepts and are relatively familiar to students. Students begin working with these materials, discussing their explorations with other students and the teacher. The most important aspect of this part of the learning cycle is the creation of an atmosphere in which probing, puzzling, and raising questions provide a natural challenge to the students' present, mental structures, thereby creating the disequilibrium necessary for change. During the exploration phase, the teacher's roles are primarily those of catalyst and facilitator – raising additional questions, offering encouragement, and making sure that exploration begins to lead in the direction of the abstractions he or she intends to teach."
14. Meyers*,* op. cit., p.32, "In the second stage, invention of concepts, the teacher helps the students use their interactions with materials and the questions arising from those interactions as a point of departure for introducing generalizations, principles, or concepts that will make sense of the original explorations. Through this process, students are gently led to understand abstractions in a meaningful context. If necessary, teachers may introduce additional experiences or information to aid in the formulation of new mental structures. This part of the learning cycle is usually the most challenging to teachers. They must not rush to draw conclusions for students but rather let students struggle with the trial and error and the discomfort involved in developing new ways of thinking."
15. Meyers*,* op. cit., p.32-33, "In the final phase of the learning cycle, *application of concepts*, students apply the concepts, principles, or generalization they have just formulated to work with new but related set of materials. The purpose of this phase is to reinforce the newly developed mental structures. The teacher here assumes the role of mentor. He or she supports students as they test their abilities to apply newly developed abstractions to new situations."
16. Marcus Vitruvius Pollio, *The Ten Books on Architecture*, (New York, Dover, 1960) p. 5
17. Vitruvius also goes on to explain that the highest level of theory associated with concepts can even be shared between disciplines, but the training and techniques specific to each endeavor cannot of course be shared for reasons having to do with technique and skill. He writes "the arts are each composed of two things, the actual work and the theory of it. One of these, the doing of the work, is proper to men trained in the individual subject, while the other, the theory, is common to all scholars: for example, to physicians and musicians the rhythmical beat of the pulse and its metrical movement. But if there is a wound to be healed or a sick man to be saved from danger, the musician will not call, for the business will be appropriate to the physician. So in the case of musical instrument, not a physician but the musician will be the man to tune it so that the ears may find their due pleasure in its strains." Vitruvius, op.cit.
18. Leon Battista Alberti, *On the Art of Building in Ten Books*, (Cambridge, MIT Press, 1988) p.315, "To make something that appears to be convenient for use, and that can without doubt be afforded and built as projected, is the job not of the architect so much as the workman. But to preconceive and to determine in the mind and with judgment something that will be perfect and complete in its every part is the achievement of such a mind as we seek."
19. Ibid., p.317
20. Although the three terms *technique* (as an indicator of manual skill), *workmanship* and *craftsmanship* are listed in sequence, this does not suggest that they are synonymous with each other. As potential precursors to abstract thinking, these skills and mindsets have varying degrees of influence on the process of translating idea into
21. Donald Schön, *The Design Studio, An Exploration of its Traditions and Potentials*, (London, RIBA Publications Limited, 1985) p.23, "Our spontaneous responses to the phenomena of the everyday life do not always work. Sometime our spontaneous knowing-in-action yields unexpected outcomes and we react to the surprise by a kind of thinking what we are doing while we are doing it, a process I call *reflection-in-action*."
22. David Pye, *The Nature and Art of Workmanship*, (London, The Herbert Press, 1995) p.17
23. Ibid, p .17, "Design is what, for practical purposes, can be conveyed in words and by drawing: workmanship is what, for practical purposes, can not."
24. Risatti, op. cit., p.166, "[…] modern conception of design, in which the designer's creations only exist in the form of abstractions until they are given material form, reflect[ing] a kind of Cartesian dualism separating mind and matter. It makes explicit what had previously only been implicit – the division between mental conception and physical execution."
25. Ibid., p.162-163, "As an activity, design is the conceiving and creating of a plan or instruction in the

form of an illustration, drawing, ideogram or some other abstract notation with the intent that it be realized as some thing. Regardless of the notation used, a design is always an abstraction; never is it the same as the thing intended to be made from it."
26. Ibid., p.166
27. Ibid., p.166
28. Sennett, op. cit., p.9
29. Ibid., p.288, "the first names an event or relationship that makes an emotional inner impress, the second an event, action, or relationship that turns one outward and requires skill rather than sensitivity."
30. Etienne Gilson reflecting on the work of Gaston Bachelard in *The Poetics of Space*, (Boston, Beacon Press, 1969) p. ix