Premise & Process:
The Pedagogical Implications of Computing in Design

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Abstract: Form is capable of communicating a profound idea only when it is linked to a more essential metaphorical intention. The design studio is a forum for addressing this relationship of idea and the means of expression. Computing offers the potential to enhance the design enquiry, but issues of how and when to integrate computer applications in the studio have significant pedagogical implications. It not only has an impact on the size, complexity and number of design projects, but also on whether architectural ideas or computer technology is the content of the studio. It is important to distinguish between the computer image and the process used to achieve the final result. Many computer-based studios focus on the final product which encourages technology to drive design. This paper addresses how design issues can determine the use of technology so that design ideas and computing can reinforce each other, rather than be competing issues. It examines how the unique strengths of computer modeling and animation is used to explore the relationship between visual expression and intention via the issues of metaphor, tectonic color, context and kinetics in several of my graduate and upper-level undergraduate computer-based design studios in the School of Architecture at the University of Illinois at Urbana-Champaign (UI-UC). The studio topics are diverse in nature and include Normative Studio: Prototype as Formgiver; Urban Issues: Context, Color & Kinetics; and Virtual Metaphors: Literature as Formgiver.

Signified & significance: design & the computer

Form is capable of communicating a profound idea only when it is linked to a more essential metaphorical intention. The design studio is a forum for addressing this relationship of idea and the means of expression. Computing offers the potential to enhance the design enquiry, but issues of how and when to integrate computer applications in the studio have significant pedagogical implications. It is crucial that design ideas and computing reinforce each other, rather than be competing issues. The time required to learn how to use a computer effectively has an impact on the size, complexity and number of design projects in a computer-based studio. It is also important to distinguish between the computer image and the process used to achieve the final result if architectural ideas, rather than computer technology, is to be the content of the studio.

The primary method of integrating computing in the architecture curriculum is through beginning skills or computer courses which introduce the basic procedures of using a computer. The emphasis in these courses varies. Some are very specific and focus on learning how to use a particular software program. Others focus on issues such as design communication or representational skills and introduce computer applications as a design media in relation to specific issues or types of drawing skills. The goal is to enable students to use the computer in their other classes, regardless of whether the professor teaching the course knows how to use the computer programs. Although these courses are a valuable means of introducing basic issues to a large number of students, they are not an effective means of dealing with computing in the design studio.

The rate at which new programs are developed and existing programs are upgraded, often means that the material in an introductory sophomore course is out-of-date by the time a student needs to use it in a design studio a year later. As a result, only the most "computer-interested" students will continue to learn new applications on their own time, especially the more complex CADD and multimedia programs that are the most useful for design. Unless using a computer program is a required component of a studio, the majority of students will use traditional media for design and limit their use of the computer to the simpler applications such as e-mail, word processing and spread sheet applications.

Another factor is that introductory courses, regardless of the subject matter, deal with large numbers of students and cover a great deal of information in a limited time frame. In addition, introductory computer courses are usually taught

in labs, which also has an impact on the type and scale of work that can be covered. Assignments are often rudimentary not only due to the inherent nature of an intro course, but also due to the limited availability of computer equipment and time for each student to do the projects. [Heye97] As with every introductory course in the curriculum, the information must be revisited in other courses and at a more sophisticated level in order for understanding to take place.

Too often the criticism of studio projects done on the computer is that students spend too much time struggling with the program instead of design issues or let what they already know about a program determine the design. It is one thing to learn how to use the basic tools of a computer application to create a simple building form, it is another to know which tool or application to use to accomplish a task that arises out of developing a complex design project. The latter requires more than an introductory knowledge of a computer program and limited access to equipment if architectural ideas, rather than computer technology, is to be the driving force of the design. This does not mean that introductory computer skills classes are not useful; they just do not adequately address the issue of design computing. It does means that faculty teaching computer-based studios must be familiar with the programs used in the course; not only how to use the programs, but also the pedagogical implications of computing and design.

Vitruvius stressed that architectural design involves both practice and theory based on the premise that "architects who have aimed at acquiring manual skill without scholarship have never been able to reach a position of authority to correspond to their pains, while those who relied only upon theories and scholarship were obviously hunting the shadow, not the substance... In all matters, but particularly in architecture, there are these two points: the thing signified, and that which gives it its significance." [Vitr60:5] The Vitruvian model of observation and experience as the underlying premise of developing the ability to distinguish "know how" from "know why" is an effective model for integrating computer technology in architectural design. In this way, signified and significance are integrated in the design studio to provide a "forum" for understanding the "relationship" of the disparate aspects of an architectural project in different contexts and with different constraints.

Iteration: a premise of linkage

The relationship of design studio and academic courses in a curriculum is crucial in linking practice and theory. The linear model prevalent in most architecture programs, in which academic and studio courses are two isolated and often competing traditions, does not encourage or facilitate making connections between coursework. [Brad96] Design is not done in a vacuum. An iterative approach which uses design issues and computer applications to create investigative studies that are immediately revisited and reinforced in a more complex design project encourages greater understanding of both design development and computing. In order to facilitate this type of linkage in my studios, the projects during the first half of the semester are ideation and analysis studies that relate to a final design project: interpretations of a poem, an analysis of a building, 2D and 3D tectonic color and connections studies.

Linking the focus and content of these initial studies to issues that relate to the final project has an impact on the quality of design. Although these investigations are similar to the type and scale of projects in an introductory course on design media or theory, the distinction is that the content of the ideation and analysis studies is determined by the final studio project. I have found that covering this information in a separate course is not as successful as incorporating the investigations in the studio for several reasons. Students are usually not as motivated to learn either computer applications or design theory when it is taught in isolation from the studio if they do not see, or understand, the immediate use of an issue to their design projects. Also, perhaps due to the workload inherent in architecture programs, the majority of students do not have the time to include additional material from other courses in their design projects. Integrating these studies into the studio provides a common knowledge base for both the development and evaluation of the studio projects and reinforces an iterative process that results in more meaningful design.

While the architecture curriculum at UI-UC is based on the traditional linear structure of unrelated studio and lecture classes, the upper-level studio format does offer an opportunity to challenge this model. Teaching a graduate or senior-level undergraduate studio is a full-time appointment because these studios meet for 15 hours a week, instead of the typical 9-12 hours a week in many architecture programs. The additional time allows me to integrate a seminar and computer instruction with the design process in the studio, instead of teaching the material in separate unrelated courses. The topics of the studios are diverse in nature and include Normative Studio: Prototype as Formgiver; Urban Issues:

Context, Color & Kinetics; and Virtual Metaphors: Literature as Formgiver.

The seminar component for all of the studios include readings on perception and color. In addition, the Urban and Normative Studios include readings on cultural geography and urban/suburban issues, while the Virtual Metaphor studio includes readings on ideation/poetics and discussions on the architectural implications in the literary texts used to generate design concepts. The computer component includes demos on computer applications in 3D modeling, 2D graphics, desktop publishing, digital photography and animation. The projects are done on PowerMACs using ArchiCAD, FormZ, Photoshop, Pagemaker and Playback. The computer-based studios include a series of smaller individual studies and a final group project. Computers are in the studio, not in a lab. There is one computer for every three students in the course which determines the number and scope of the projects. Seminar discussions occur once a week and computer demos are given twice a week during the first half of the semester; both components focus on a series of investigative studies germane to the studio.
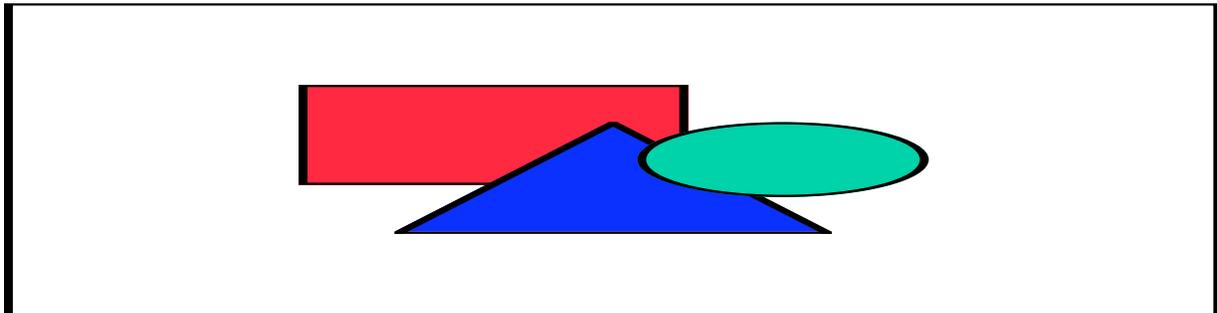

Figure 1. Normative Studio: tectonic color-connections

Computer modeling and animation are integrated into the design process to encourage "becoming aware" of the implications of a design and to facilitate a critical review of the creative process. Desktop publishing is used throughout the term to present projects not only as constructs but also to convey architectural concepts and experience. Computing is used as a means to explore the implications of a design as a part of ideation and development; to enable the tangible reality of tectonic color, light, and material to generate architectural ideas as form; and to develop, as well as present, a project based on an understanding of the human experience. The role of the computer in the studio is to enable the designer to generate meaningful architectural proposals that would not be as readily created using conventional methods.

Since relying on previous computer experience also incorporates preconceptions and ingrained habits that may work against the objective of using computing as a creative design media, students do not need to know how to use a computer or any of the applications to take the studio. The choice of software and instruction is carefully orchestrated to reinforce the design investigation so that design issues are the driving force of the studio. I give computer demos (3D modeling, 2D graphics, digital photography, video and computer animation) as a part of the design process in the studio to generate, develop, and present a project as concept, construct and experience. As a result dissimilar, or even the lack of, computer skills are not a negative factor. The focus is not to learn all of the "bells and whistles" of a specific program, but to learn what to use in a variety of programs to address particular design issues. The design project and process determine when and what tools and programs are taught on a "need-to-know" basis in order to address the issue at hand. This approach enables design, not technology, to be the content of the studio.

Ideation: a process of discovery

The design of architecture is concerned with the expression of ideas through culturally significant and relevant form, issues which involve the ability to understand the relationships and implications of disparate issues as a part of the larger context. This requires the ability to distinguish "know how" from "know why" to understand the relationship of

the parts to the whole, from different points of view and in different contexts - the process of "what if" that is integral to meaningful design. As John Dewey notes, in Art as Experience, the relationship of idea and the means of expression is essential to the creative process:

> "What most of us lack...is not the inceptive emotion, nor yet merely technical skill in execution. It is [the] capacity to work a vague idea and emotion over into terms of some definite medium...between conception and bringing to birth there lies a long period of gestation. During this period the inner material of emotion and idea is as much transformed through acting and being acted upon by objective material as the latter undergoes modification when it becomes a medium of expression...the physical process develops imagination, while imagination is conceived in terms of concrete material." [Dewe34:75]
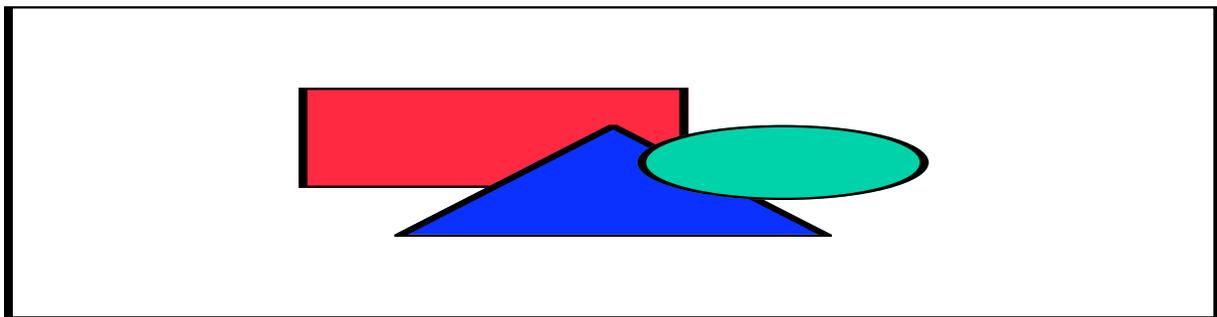

Figure 2. Normative Studio: Prototype Analysis & Final Project

Geoffrey Vickers, in his essay "Rationality and Intuition," describes this symbiotic relationship as "...two functions which in practice are never wholly separated but which are, nonetheless, logically distinct as two reciprocating phases in a recurrent process of mental activity." [Vick78:157] The recognition of ideas and the potential for transferring that essence through the use of metaphor is found within intuition. The modification and working out of ideas in the material world of form is found within the rational mode. Both act in unison. One is generative while the other is formative. One is creative while the other is critical. [Vick78:147] This simultaneous emergence of both essence and form is the premise of the ideation process that I use to integrate teaching computer applications in conjunction with design. This approach turns what is potentially a detrimental issue into a positive one. It breaks the learning curve of dealing with computer technology into discreet and more manageable components. Also, by focusing on design issues instead of technology, computing is a means of expression not the end result.

Each studio topic suggests a set of issues that are important formgivers. These issues, instead of a focus on the final product, determine the process and the use of technology in the studio. The unique strengths of computer animation and modeling are used, not simply as a means to produce walkthroughs or photorendered images, but to explore the relationship between visual expression and intention via metaphor, tectonic color, context and kinetics. These issues are explored in a series of computer-based ideation and analysis studies which introduce the students to an iterative design process. The studies serve several purposes: to generate and visualize an idea as form and represent form as experience; to promote observation of the built environment; to facilitate teaching the computer applications; to explore design issues and to establish a visual vocabulary for the final architectural project.

Tectonic color is an important aspect in all of the studios. Tectonics deals with the constructive arts; the relationship of the parts to the whole via composition (elements and relationships), structure (formal and physical), and space (field and volume). Color, material and forms are the physical manifestations that inform our perception and concurrent understanding of a work of architecture. Tectonic color in architecture incorporates the compositional, structural, and spatial aspects of color theory with its material expression to construct our visual experience. The tectonic implications

of color expand the expressive dimensions of material and form which links "construct" and "content." Monochromatic color (single color) emphasizes the "uniformity" of the parts of a composition; analogous (related colors on the color wheel - e.g. red and red-orange) express a kindred "similarity"; complements (opposite colors on the color wheel) generate a "distinction" of opposing forces; and single-color extension (one discernible color against a field of visually achromatic hues) "isolates" an element of hierarchical importance. [Brad92]

Digital cameras, photo editing, page layout and computer modeling applications are the means for introducing the design issues of tectonic color theory and perception. The studios start with a series of ideation and analysis studies that link tectonic color theory with design issues as formgivers for the final project. This iterative process provides a basis for design decisions and enables the students to be comfortable with computing by the time they start the final project. Each studio topic has inherent issues that impact on the premise and process of the design investigation.
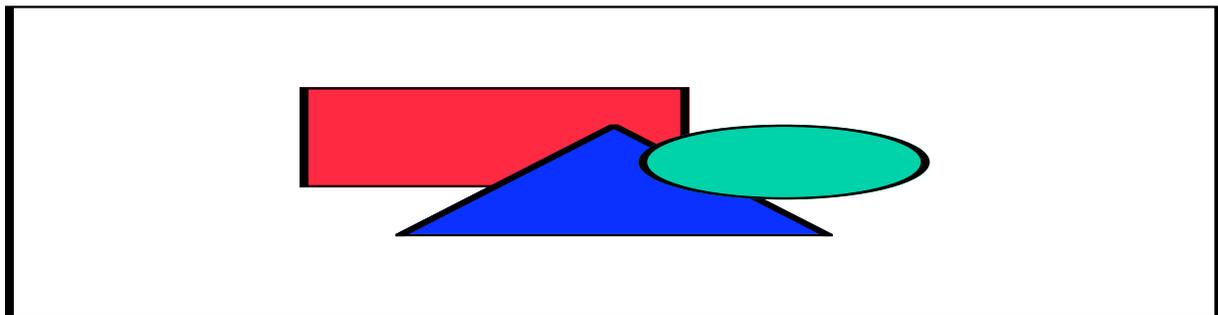

Figure 3. Urban Issues Studio: Tectonic Color - 2D/3D

STUDIO TOPIC	SIGNIFIED RATIONAL/MEANS	SIGNIFICANCE INTUITIVE/ISSUES
Normative	Ideation	Tectonic Connections
	Analysis	Prototype Studies: Circulation, Structure, Mass, Space, Articulation, Content, Materiality & Function
Urban	Ideation	Tectonic Color: 2D & 3D Studies
	Analysis	Grid Studies: Window, Masonry, Elements
Metaphor	Ideation	Poetics: Coleridge Poem
	Analysis	Stair Studies: Type, Material, View

In order to make the transition from architectonic constructs to an architectural proposal, the issues introduced in the ideation and analysis projects are reinforced in the development and presentation of the final design projects. Animations and 3D modeling are used throughout the design process to explore the experiential aspect of architectural design. In the Normative Studio, the architectural connections of adjacency, contiguity, tangency, overlay, intersection, and juxtaposition are the vehicles for linking the content of color theory and form. The analysis projects use the same computer programs and the form relationships in the connections studies to analyze the structure, circulation, mass,

shape, articulation, content, materiality and function of a building prototype. The premise of this studio is that architects, as participants in society as well as professionals, have a stake in the design of common, or normative, buildings. The proliferation of building prototypes as national icons has filled our world with vernacular buildings for which the primary context is a sea of asphalt. The sheer quantity and the too-often lack of quality of the normative prototypes being built today have a great impact on our lives. No longer can architects ignore, as did Pevsner, the equivalent of the 'bicycle shed' in our society in the belief that it is well served by the tradition of vernacular building.[Pevs63:15] To address these issues, each student selects an intermediate-size institutional or commercial building prototype to document and analyze. The final project is a new design informed by the prototype studies. The success of the final project is the extent to which it incorporates the strengths and overcomes the weaknesses of the existing prototype. The final evaluation is not only if it could be built, but if it should be built. To what degree is the new design an improvement on the existing prototype? To what degree does it add to the quality of life?
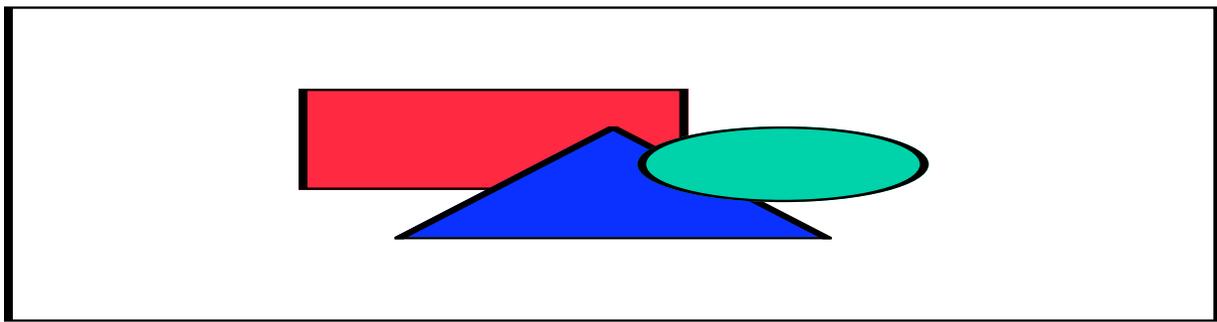

Figure 4. Urban Issues Studio: Final Projects

The Urban Studio examines the issues of context, architectonic color and kinetics for the streetscape and architectural renewal of an urban business district. In this studio, on-site observations and analysis of architectural patterns are used to break habits of perception that rely on color shorthand (i.e. the sky is blue, grass is green). Students document six patterns in the built environment: 2 grid patterns in windows; 2 grid patterns in masonry, concrete masonry unit (cmu) or stone; and 2 hierarchical patterns in architectural elements. These patterns are templates for tectonic color studies which interpret each composition as two-dimensional and three-dimensional constructs based on monochromatic, single-color extension, analogous, complements, and complement-split color harmonies. The Tectonic Color Studies accomplish several things. The 2D studies incorporate a wide range of color harmonies as content for designing different constructs for each pattern. It also introduces the students to the compositional implications of color and encourages them to look at the world around them for inspiration, not via mimicry but through a process of analysis and interpretation which links construct and content. The 3D studies reveal the impact of a single color harmony as content for different constructs and extend the tectonic properties and perception of color in two-dimensional composition to the three-dimensional realm of architecture. This helps students understand the relationship of the parts to the whole, from different points of view and in different contexts that is integral to meaningful design. The color studies are the basis for the final projects. Each student uses principles of tectonic color to upgrade two facades for Northside, a designated historic business district in Cincinnati, Ohio; one as a minor intervention and the other as a major intervention. This is followed by a group project, in which a facade upgrade is revisited and developed further as an adaptive reuse project. The success of the final projects is determined by the dynamics of urban revitalization and the constraints of working in a designated historic district governing the degree of intervention and whether to replicate, emulate or interpret the historic context.

The Metaphor Studio focuses on the issue of content, or essential idea, in which literature is the formgiver for architecture. The ideation studies use tectonic color theory and connections to interpret Samuel Coleridge's poem on imagination, as a reconciliation of opposite or discordant qualities, to generate concepts that have architectural implications. These poetic studies introduce the students to an ideational process of design which uses traditional and

digital media to link the content of words and form. The stair project is a combination of video and computer animation exercises that address the perceptual implications of architectural sequence. Some of the insights gained from this exercise are the importance of view, detail, color and light. For the final project, the students choose a work of literature as the starting point for generating concepts with architectural implications. Using the same process as the poetic studies, each architectural proposal identifies and develops these concepts as formgivers to address and focus the design. One of the stipulations of the studio is that the projects must incorporate animations as a part of the design process as a vehicle to generate, develop and present the project. Perhaps as a result of this stipulation and the influence of the initial stair studies, the path is a strong element in developing the concept and architecture of each project. The final projects in this studio are evaluated by the degree to which they evoke, rather than illustrate, the literary concepts architecturally.

The symbiotic relationship of rationality and intuition links the means of expression and the potency of ideas. Computing in these design studios provides a "means" to signify the experience and understanding of architecture that encourages the discovery of "what" gives architecture its significance.
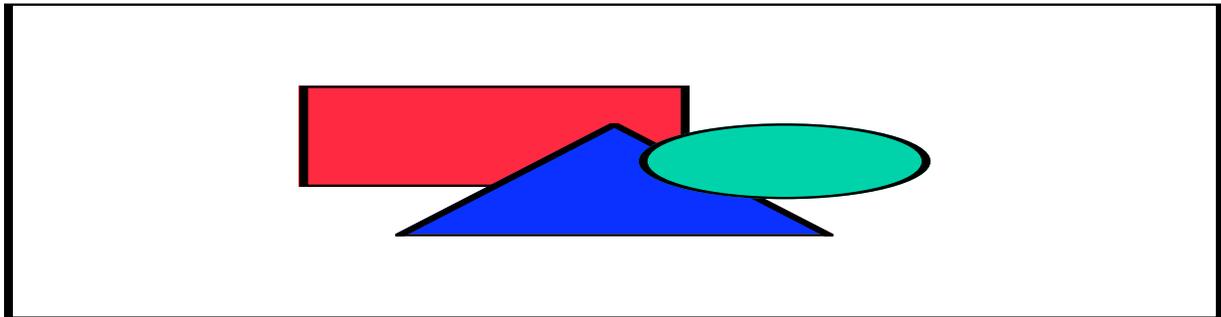

Figure 5. Metaphor Studio: Ideation - Reconciliation of Opposites

Illustrations

Figure 1. Normative Studio: Tectonic Color - Connections
Arch 371 / Fa '96 - Studies by Alvin Ho
Adjacency, Tangency, Overlay, Intersection Studies

Figure 2. Normative Studio: Prototype Analysis & Final Project
Arch 371 / Fa '96 - Projects by Alvin Ho
Circulation Analysis & Functionality Model
"Student Center" Old Observatory Adaptive Reuse Project

Figure 3. Urban Issues Studio: Tectonic Color - 2D / 3D
Arch 372 / Sp '98 - Studies by Daniel J. Karas
Black Line, Single-Color Extension, Monochromatic, Analogous,
Complements and Complement-Split Color Harmony

Figure 4. Urban Issues Studio: Final Projects
Arch 372 / Sp '98 - Project by Stephen Dillon, Daniel Karas, Scott Sherry
"Big Sky Bread Company" Adaptive Reuse Project

Figure 5. Metaphor Studio: Ideation - Reconciliation of Opposites
Arch 374 / Sp '97 - Project by Brian Dell, Faiza Malik, Kwok Kei Yan
Ideograms & Ideational Models

Figure 6. Metaphor Studio: Final Projects
Arch 374 / Sp '97 - Project by Brian Dell, Faiza Malik, Kwok Kei Yan
"Despina" Inspired by Italio Calvino's Invisible Cities

References

[Brad92] For further discussion of these issues see: BRADY, Darlene A. and ENGLISH, Mark M., Architectonic Color: Composition, Structure and Space, in: *Structurist* 31/32 (1991/92): 89-95; Color, in: *Inland Architect* 37/2 (March/April 1993): 42-45.

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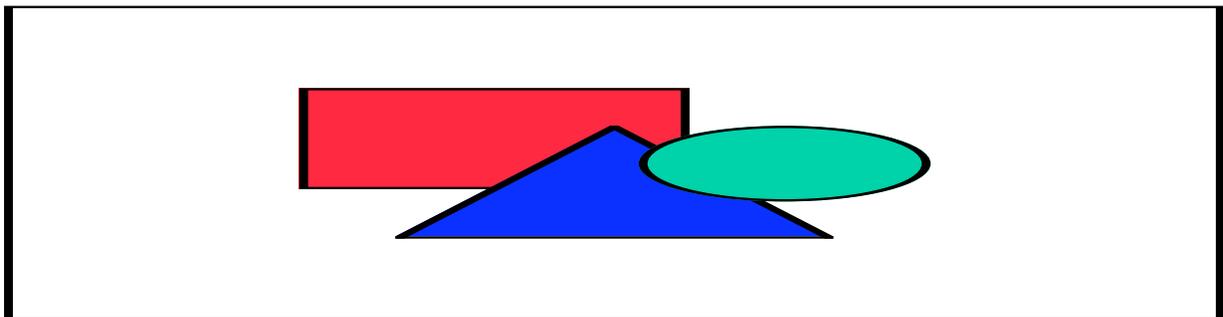[Vitr60] VITRUVIUS, *The Ten Books On Architecture*, translated by Morris Hicky Morgan, 1960, Dover, New York.

Figure 6. Metaphor Studio: Final Projects