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Teaching Concrete Masonry Unit Construction

Andreas Luescher, *Bowling Green State University - Main Campus*

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LUESCHER, ANDREAS[1]

ABSTRACT:
The Architectural Materials and Systems course at the Bowling Green State University in Ohio pursues the integration of a design/build exercise, which focuses on the creative opportunities that come with the application of concrete masonry units. The exercise with CMU's causes interesting interplay interaction, interpretation, and integration, providing students the opportunity to break away from compartmentalization and offering a unique forum for testing pedagogies about making. Students are encouraged and expected to exploit the endless possibilities of expression through spontaneous, coherent and innovative incorporation of CMU's. Collaboration among students gives them a valuable occasion to realize a design in built form as mock-ups that cannot be duplicated in any other format. The project shown here explains how concrete masonry units support and contribute to an architectural concept.

Keywords: *Concrete Masonry Units, Design/Build, Mock-ups, Experiential Pedagogy*

1 INTRODUCTION

Having been tutored in the Swiss pedagogical system, I know the value to students of courses that combine professional and scholastic training. Toward that end I have made a point of developing classroom assignments which incorporate 'real' world collaborations. This kind of exposure to professionals from other disciplines, especially in design, engineering, procurement and construction, is invaluable to a student's development. This is true not only with regard to professional standards, but also, and more importantly, to his/her human (and humane) approach to work which is often highly technical and overly intellectualized.

The purpose of this paper is to describe the pedagogy behind a design/build exercise emphasizing Concrete Masonry Units (CMU's). The real world project was organized around three interrelated objectives: appreciation by students of materials (CMU's) and processes as integral components of design thinking; questioning by students of divisions which present themselves in both architectural practice and education (the mind's share vs. the body's share in the experience of architecture; making vs. theory; individual vs. team work); and recapitulation, in compressed form, of the semester's focus on the constituent process and languages of architecture.

The design/build project challenges the assumptions embedded in terms like 'manual' and 'design'. Rooted in the belief that architecture education should reflect the complete life of the building process and, further, that nothing can replace the function of the body (particularly the hand) in the early stages of design, the design/build model reduces artificial boundaries between learning and doing. It does so by presenting physical properties and methods of building construction, technologies, and

[1)] Professor, Bowling Green State University, Ohio, Department of Architecture and Environmental Design, aluesch@bgsu.edu

materials as fundamental components of the design process, not as 'functional' and 'technical' concerns to be worked out later. Specifically this design/build exercise emphasizes Concrete Masonry Units, which creates an approach very different from the typical design/build point of view because of its single focus on a specific material. In other words, without the opportunity to learn through the hands, the world remains abstract and distant, and the passions for learning will not be as fruitful.

2 EXPANDING DIMENSIONS OF PRACTICE AND EDUCATION

"Architecture starts when you carefully lay two bricks together. There it begins." Mies van der Rohe. [1]

Mies continued during his inaugural speech as Director of the Illinois Institute of Technology in Chicago to tell the audience how much we can learn from a single brick. He appreciates its small handy shape, its useful for every purpose, the logic provided by its bonding, pattern and texture, and the richness it generates in even the simplest wall surface. Mies was convinced that bricks teach us a certain discipline due to the exactness and meticulousness implied in working with them. The implication of this is that a certain mathematical and design thinking organizes how the bricks are laid in order to realize their beauty and structure (Figure 1) [2].

Figure 1. The Lemke house in Berlin (1932) was the last house designed by Mies van der Rohe before he emigrated to the United States to head the Armour Institute (today known as IIT).

Mies had extraordinary insights into building material, as exemplified in his masterful handling of brickwork in the Brick Country House (unbuilt, 1924), as well as in the Karl Liebknecht and Rosa Luxemburg Monument (Berlin, 1926). He also embraced and demonstrated his mastery of new materials through his teaching at the Illinois Institute of Technology in Chicago. In his courses in architectural design, students where taught design skills based on the intended use of the building, the materials of which it is designed, and the structural principles derived from the characteristics of these materials. His students learned building construction by working out the structural details based on material selection. His design sensibility and teaching philosophy centred around the use of the physical properties such as wood-frame, brick or stone masonry, steel frame, and reinforced concrete skeleton construction. Naturally, one of the first assignments given was the planning of a small one-story, "wall-bearing" brick house [3].

Didactically speaking, an architectural idea must become real in order to fully experience it as a human and share that experience with others. Enduring architecture comes from a process that

explores design at varying scales simultaneously. This process must go beyond generating a form to figuring out how to build it. In similar form, Mies' thinking was applied in the BGSU Architectural Materials and Systems class. Students went beyond the conceptualization of a design and the reality of architecture's visual qualities to embrace a physiology synthesizing touch, sound, and movement. The underlying unity of phenomena is implied by stressing the transience of the context where things are mined, produced, fabricated, and installed.

Specifically, students were encouraged and expected to exploit the endless possibilities of expression through intuitive, rational and innovative integrations of CMU's. Besides the possible combinations of placing concrete blocks adjacent to another material, the visual ecology of the site created an interesting challenge to find a meaningful and poetic interpretation (Figure 2). But equally important: how can CMUs influence form, affect space, challenge perception and elicit experience that support and contribute to an architectural scheme?

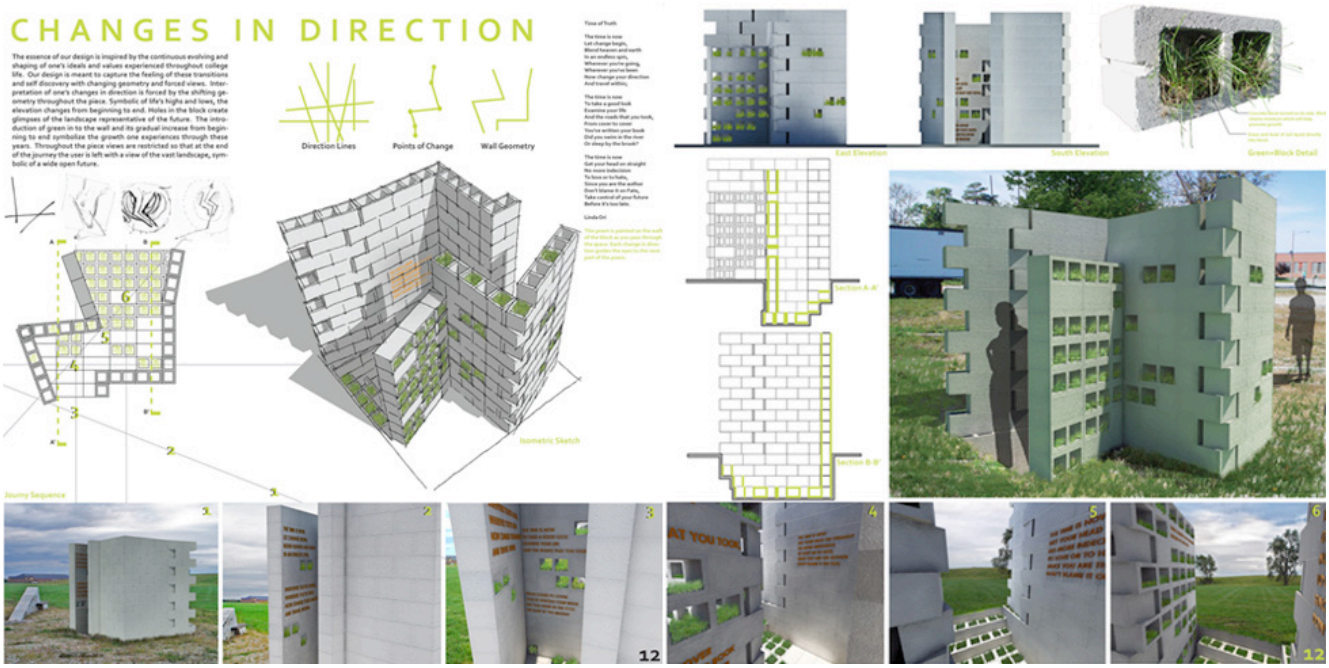

Figure 2. BGSU Architecture Student Design Submission shows the confidence and knowledge necessary to describe the visual appeal of concrete masonry units including: overall appearance; use of colour, shape, and texture; and integration with the surrounding landscape graphically in a variety of styles.

3 RE-ENGAGING BODIES AND MINDS

"The concrete block? The cheapest (and ugliest) thing in the building world ... Why not see what could be done with that gutter-rat?" Frank Lloyd Wright [4]

The first molded concrete block appeared in 1882, but mass production of concrete blocks did not develop until Harmon Palmer patented a cast-iron hollow block machine in 1900 [5]. The aesthetic and structural potential of the concrete block attracted Wright again and again throughout his career. Initially built in brick, stucco and stone, Wright's Prairie Style was later built in concrete block. In the 1920s Wright had developed Knit Blocks, with which he built four Textile Block homes (Figure 3) [6].

Figure 3. Wright's famous Millard House in Pasadena, California (1932), a textile block house using Wright's intention was to blend the house with the colour and form of the trees and hillside.

In 1936, Wright developed the Usonian Houses, many of which were fabricated in concrete block. In the 1950s, the Usonian Houses inspired the Usonian Automatic do-it-yourself kit house. Wright's Usonian automatic house was conceived as a style of home which could be affordably produced and bring style to the masses. Over a 15-year period, he built about a hundred of these homes. He used the word Usonia as an abbreviation for United States of North America [7].

With a grant from the National Concrete Masonry Association Foundation (NCMAF, Herndon, Virginia), we were fortunate enough to have the time and materials to follow Mies' and Wright's lead and investigate the creative possibilities of the concrete masonry block in our Architectural Materials and Systems class [8]. Juniors and seniors in a pre-professional architecture program were instructed to explore the theme of additive and subtractive design based on the CMU. An additive composition is one in which units or parts combine to make a unified whole. A subtractive composition, on the other hand, is one in which bits appear to have been removed from a monolithic block, similar to a sculptor chipping away until the final sculpture is visible. The goal of the competition was to excite students about the endless possibilities of additive and subtractive composition using the basic building block.

Students were quickly drawn to more contemporary and famous Swiss architect Mario Botta, who built his career based on the manipulation and interpretation of concrete blocks. Botta seems comfortable working with a sense of material 'poverty'. His interest in working with the manipulation of a small element at the scale of a brick or block (concrete or stone) has remained a constant. His limited material palette arose, he explains, in response to the projects' circumstances, notably financial constraints.

In 1973 Botta's office completed a single-family house overlooking Lake Lugano, just outside Riva San Vitale in the Italian speaking section of Switzerland. At the time, this project was profound in various ways, including its completion, the many ways it positioned itself in relation to topography, its organization and its application of CMU. The single family house boldly embraces the modern look but, being made of concrete blocks, it establishes an equivalence with the native stone which can be seen as a simple yet powerful variation on the local vernacular. Over time, it has become more

enveloped by trees, yet the encroaching wood does not diminish the building's strong physical presence, and its original intention has remained mercifully intact [9].

Following Riva San Vitale's house, Botta started to use bands of colored stripes that began with the Ligornetto house (1975-76) and have continued ever since on a wide range of domestic, public and institutional works. The Ligornetto house is emphatically striped in a veneer of pink and grey cement blocks, organized into horizontal bands each three courses high that cover the building from top to bottom (Figure 4). The stripes are distributed equally over the façade (except for a double height pink band that forms the parapet) and articulated with raked mortar beds that produce fine shadows between the bands of colour for additional emphasis.

Figure 4. Botta's expressive use of stripes that contribute to the monumental presence of the single-family house in Ligornetto (Images by Ashley Paine, Queensland University, Australia, 2012).

In Botta's own words, he described the Ligornetto house's banded concrete block pattern in contrast to nature, thereby reinforcing the artificiality of architecture, and drawing attention to the built boundary marked by the house at the limits of the town. He writes: "The will to create a clear relation between the new building zone and the remaining countryside has determined the project. The treatment of the façade with horizontal stripes wants to underline the "designed" aspect of the new artefact as a contrast to the nature around. This theme of façade—"design" is found again in the local building tradition: it is a sign of care, attention and love for one's own habitat in a constructive tradition […]. It is a sign of the "richness" of the poor" [10].

4 TEST DRIVE

In summary, the interrelationships between the inside and outside of the natural surroundings, which appears in Mies', Wright's and Botta's work, are fundamental to whole design and its continuous cycle as part of nature. Specifically, the students faced the challenge of understanding the creative opportunities Mario Botta found in concrete blocks. His design skill of laying brick in a variety of patterns that creates a two-tone effect, while recessing the mortar joints behind the front line of the bricks (which are thus highlighted by shadow) gives the wall a powerful, solid appearance. After carefully analyzing Botta's inspirational architectural approach to CMU, students took a field trip to watch the production of blocks at a local fabricator. Then, groups of three or four students read the

design challenge, did brainstorming sessions and created mock-up models of their designs in order to understand the various interactions within volumetric shapes [11].

A jury composed of representatives of the CMU industry, professional architects, and construction managers selected four designs out of eight based on formal and spatial composition and with a focus on the geometric pattern to be fabricated in the field. The chosen designs were re-formed as full-size mock-ups, considered to be an essential part of the design process. Not only do they serve as a useful model for assessing performance tolerances balancing practicality with design aspirations, but, more critically, the mock-ups provide the opportunity to truly experience the nature and quality of a space that is never adequately sensed in any other medium.

This in-between step also describes the materiality of CMU's and explores the potential they have of communicating something beyond their spatial properties and qualities of form. The dialogue between detailed construction drawings and the full-scale mock-up is an important testing ground to help students to identify failures and questionable construction methods (Figure 5).

Figure 5. BGSU Architecture Students compared and discussed their design and discoveries made in the mock-up stage as a guide for the final design/build implementation.

Exemplifying this approach is Russian designer El Lissitzky's approach: under his direction, architecture students designed on an experimental scale. Instead of using a scale of 1:10 on paper, they 'drew' in solid materials on a scale of 1:1 [12]. This experiment in making drawings fully dimensional was intended to force students to feel their way, quite literally, through space, marking it out as they went. Like mock-ups, this process provides invaluable insight about the installation of a component or a combination of components to demonstrate the constructability and installed appearance of the work.

An outstanding innovative sample would be the 12BLOCKS by loomstudio, a collaborative practice of design and architecture, that developed a series of 12 shapes of a block without challenging the normative 8 x 8 x 16 block size nor the pragmatic virtues of running bond. Their research was based on three fundamental strategies for re-proportioning a typical 8 x 16 face concrete block, yielded blocks with greater dynamic presence and multiple possibilities for organization in running bond, as well as an underlying set of regulating mathematical intervals. The results are twelve animating faces: 1) socket block, 2) chisel block, 3) fold block, 4) bracket block (Figure 6), 5) awning block, 6) shim block, 7) spade block, 8) pachinko block, 9) tornado block, 10) sine block, 11) ripple block and 12)

egg block [13]. This design research confirms endless possibilities of expression through inherent, practical and reinterpreted usage of blocks and their response to the transformative potential of dynamic natural forces.

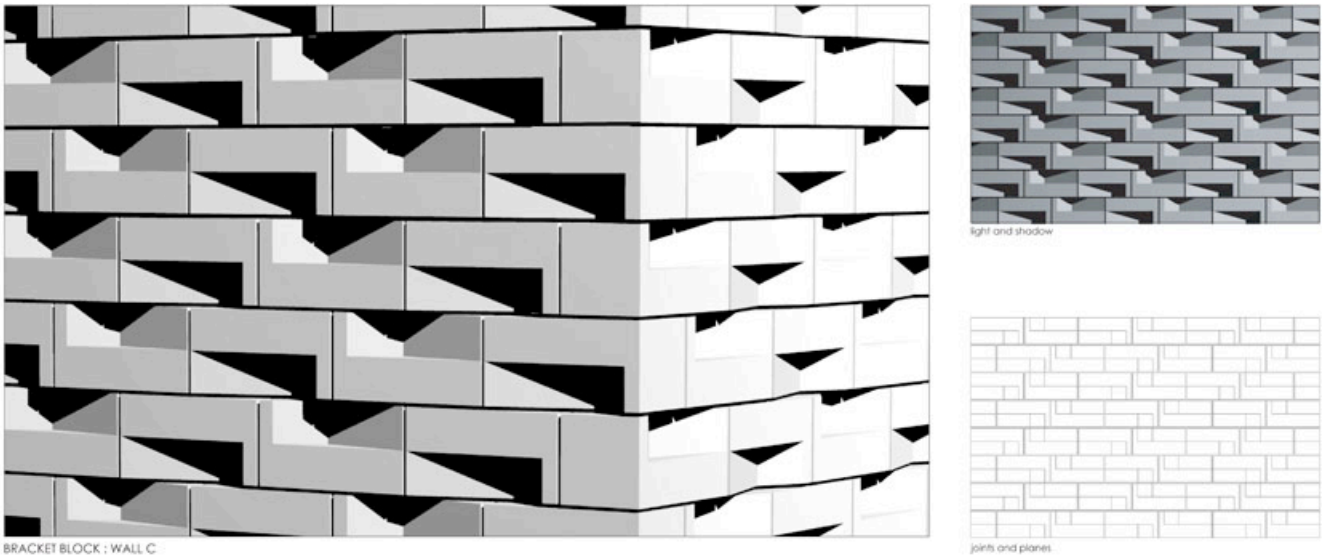

Figure 6. loomstudio's proposed design of a bracket block wall using a running bond based on an 8 x 16 face of a typical concrete block (Rendering by loomstudio, 2013). In 2008 their invention won honourable mention at the 54th Annual Design Review by the ID Magazine.

Pedagogically, I consider the value of the full-scale mock equally important to practice in drawing. This exercise tries to restore the use of bodily activity to the assembly of industrially produced masonry units that is often lost in considering contemporary architecture practice and education. [14] The embodied tasks of building walls were the basis of four criteria for the evaluation of a successful execution.

1) Aesthetic Concept (the visual appeal of the design, including: overall appearance; the use of colour, shape, and texture; and integration with the surrounding landscape)

2) Innovative Use of Concrete Masonry (novel use of standard concrete masonry products)

3) Functional Use of Concrete Masonry (how well the design utilizes the various capabilities of traditional concrete masonry units as a building material)

4) Constructability (how well the design takes into consideration its ability to be actually built)

Students learned those built structures are a form of mock-up that provided them with a better sense of the design that they could not have known from digital renderings and toylike models. For example, no rendering can ever really simulate the way sunlight bounces off the concrete blocks and leaves behind a remarkable shadow. Capitalizing on the hands-on experiences of the built mock-ups provided us with a testing ground of constructional capabilities and allowed us to gauge visual result. The mock-ups also showed the juniors and seniors the dreams, limitations, compromises, realizations, and afterthoughts of working with concrete masonry blocks (Figure 7).

Figure 7. Public reception of the mock-ups allowed students to see the history of their projects and to talk about the unique participation they have experienced and learned from. Obviously, the children were entertained and ready to test the strength of the structures.

The numerous lessons of this design/build exercise have a direct bearing on my position as a teacher with regard to the demands of architectural education.

- To understand that construction methods and materials must inform design.
- To understand that design assignments which fail to make this connection are incomplete and insufficient.
- To understand the importance of investigating and communicating ideas to knowing how buildings are made.
- To understand that the design studio is energized by democratic experimentalism, one in which association (of scope, method, character) is not merely a means to pre-defined goals, but rather the process for the ongoing revision of these goals as well as of the methods for attaining them.

Two practical imperatives complement this major aim. The first is the promotion and endorsement of design/building methodology by the organizations which govern architecture and construction education. The second is to work for space in education for the recombining of groups of people and their specialized jobs. In the United States most architecture programs structure their curriculum

within guidelines established by the Association Collegiate Schools of Architecture (ACSA) and the National Architectural Accrediting Board (NAAB), which reviews the curriculum. Most construction management programs establish their curriculum guidelines within standards set by the American Council of Construction Education (ACCE). We must work together to establish some dialogue between the two boards with the goal of fostering changes in curriculum formats that merge construction technology with design. "Designers, theoreticians, and technologists must listen to one another to experience the value of what Niels Bohr called 'complementarity': the capacity to extend beyond any particular way of thinking. We develop the capacity for design by a tolerance for, or insistence on, multiple ways to conceptualize, represent, and test our ideas" [15].

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