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Learning & Teaching: moving neophyte into expert

by Carmina Sánchez-del-Valle and Sean Creque

Teaching 3D modeling in a rich modeling environment, such as the one offered by **form•Z**, is a challenge. The inevitable question, when first confronted with it, is where to start. This short essay came about when an experienced teacher and a new one got together to critique their approach to introducing three dimensional modeling in the architecture design studio. During the course of the conversation we found ourselves agreeing on many points, even though we belong to different generations, and have had different academic experiences. One of us has taught with **form•Z** for almost fifteen years, and the other has had two years of intensive study in **form•Z**. The questions we considered are probably typical: how to start, and how to evolve initial understanding so that students can compose their own protocols for modeling. The most critical learning occurs at the start, because it provides the student with the tools to continue learning, and makes visible the structure of the working environment. We agree with David Matthews' statement in the **form•Z** Journal 15 "that the conceptual foundation allows students to build their own understanding of the relationship between the virtual and the physical processes of designing." Also, as with a musical instrument, the time spent practicing advances knowledge and skill.

We agree that students find it easier to navigate a new modeling environment when they have had experience working in another. For example, basic operations such as selecting objects for manipulation are standard in any program. However, each software imposes its own conditions, and ways of defining building order. Moving from a known system to an unfamiliar one can be disorienting. For example, while in simple modelers only one tool is active at a time, in **form•Z** several tools may work in conjunction, each one offering a variety of settings that may affect the behavior of the other active tools. We debated how useful having prior knowledge of other programs facilitated, or speeded up learning to model in **form•Z**, and eventually agreed that knowing how to build physical models was essential. In **form•Z**, particularly at the beginning when one is learning, it is easier to construct the model as if one was cutting and sculpting material. This requires seeing the model as perforated surfaces and sculpted solids. It is the kind of model where space is defined by elements composed from the plan, elevations, and sections (working on the XY, XZ, and YZ Cartesian planes).

To start modeling in **form•Z** it is fundamental to understand object selection, knowing which tools are for drawing, and how tools interact. In the beginning the objects to be modeled need to make the most use of this basic knowledge. Nancy Cheng has written how in the context of learning through play "constrained geometry fosters an understanding of basic elements and operations." The new teacher recalls that when he was first learning **form•Z** the class was asked to model a chair, a stapler, etc. as a way to present tools and operations to build complex form. Yet, later he found it difficult to translate this understanding into building an architectural model. In his article published in the 2005-2006 **form•Z** Joint Study Report, David Steiner observes that to construct 3D models students need to have the ability to disassemble complex forms into parts, understand their geometry, and strategize the process needed to build it step by step. Although we concur, one important point is missing: it is crucial to also define a working context with discrete links to the assembly of buildings. Cheng among others has also written on the opportunities and mishaps posed by the translation from the physical to the digital.

form•Z, and similar modeling environments, requires the student to know a lot about the building—detailed design information—that the student has not yet figured out. We have found that a direct entry into digital study models is to build starting with a 2D plan, section, and elevation. This approach to modeling allows students to see conflict areas while designing. Plans are drawn and used to build walls and other components. If the model has varying horizontal sections, then one builds with the elevations or the sections. Yet, when modeling by mimicking other media one can lose sight of new ways of building, new procedures that lead to new forms. A direct translation from traditional media tends to hide the attributes of the digital. In some programs one "draws" the model by drawing the outline of components including holes to extrude. The model starts as planes of infinite thinness, and magically grows into volume and material. Modelers such as **form•Z** offer other possibilities for building. In these the working environment can be populated with objects of several types: 2D drawing objects, templates of unknown thickness, complex surfaces, and constructed volumes.

In studio the model is an analytical, representational, and communication tool. Here we will focus on the analytical aspect, arguing it is a way to advance modeling skills. An essential operation before building any part is to understand the project to then formulate a strategy for building its model. The most challenging projects are those that have transformable geometries. Transformation usually requires that shifts operate on a surface changing its general form, and assemblies made of rigid components change their configuration while maintaining the initial connections. These modeling projects are less dependent on 2D templates to be extruded, because they require most of the building to happen in space. Creque tested this proposition building models of the Hylite Wall, Muscle Room, and Muscle Body by ONL/Oosterhuis, in collaboration with students at TU Delft. All of these projects use the Festo muscle as the actuator inflecting form change. Creque had only photographs and written descriptions to reconstruct the projects and imagine their movement. His goal was to understand how they were built, and how they changed form as they moved. **form•Z** was not intended to be the setting for movement simulation.

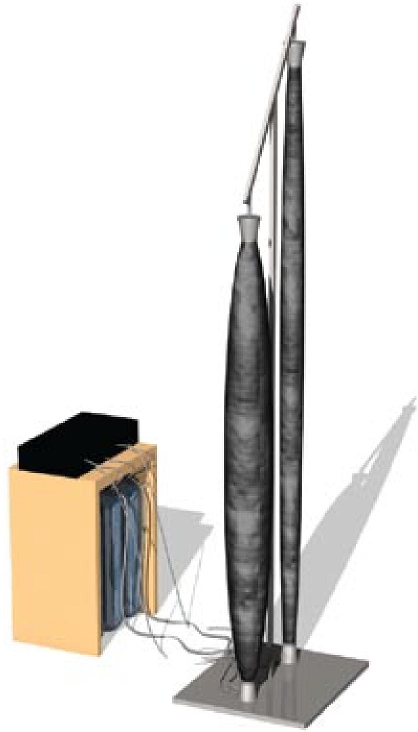

Figure 1: Festo System Diagram.

Figure 2: Hylite wall detail.

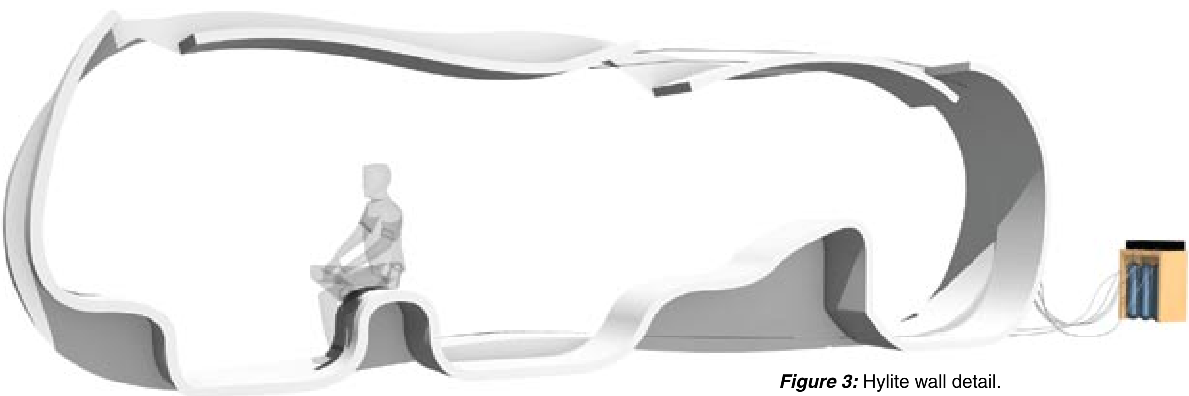

Figure 3: Hylite wall detail.

Creque also wanted to build directly from measurements, rather than from 2D templates.

The Hylite Wall is a system composed by self-supporting panels assembled in a continuous strip. The panel element can perform as floor, wall, ceiling, openings, and furniture. It has actuators that compress or stretch the panel form to assume various configurations. Changes in the panels impact the volume of space they define. To build the model of the wall it was broken down into types of volumes, number of parts and types, materiality for rendering, and relationships (connections). This process involves both reverse engineering, a process discussed by Prichard-Schmitzberger among others, and re-engineering to put it back together in a digital form. To build different states of this panel Creque had to manipulate some of the panel components, including the Festo actuator for it to decrease or increase its length. The digital model of the continuous wall strip shown here is a simplification of the system. To build it accurately Creque would have had to manually manipulate each panel, and adjust it to the position of the ones attached to it, to show the wall transforming as a whole.

The Muscle Room is a system made of wood frame panels with moving parts connected by hinges (joints). Running through the frames are Festo muscles, the actuators that contract or stretch to place frame parts in predefined locations. For the Muscle Room a model of the pieces that would remain in place was first built, and then those that changed position were added in. Modeling the various states of the room walls is easier than in the Hylite project because all it takes is to manually rotate and move the parts into new positions, while maintaining the connections between them. However, this is a time consuming process.

Figure 4: Muscle body section elevation.

The last project, the Muscle Body, is a structure made of translucent and transparent Lycra that forms a conglomerate of quasi-spherical balloons or bubbles. Air pressure is used to expand the space, and Festo muscles to contract, or squeeze the air out. It operates like a shaped toy balloon, where the twists in the balloon are equivalent to the Festo muscle. Modeling the body presented many challenges, in particular aligning the muscles precisely on the Lycra surface curvature. The muscles are located on the seams where the bubbles connect. In this case, the **form•Z** tutorials were helpful. Another challenge was to create the Lycra bubble shells. After many tests, a procedure involving “sweep” seemed simple and obvious. Finally, the last obstacle to having a model matching the object in the photographs was to show the varying translucencies of the Lycra surface. After much searching, modeling this condition also proved to be simple, resolved by applying Booleans operations accurately.

A productive initiation into modeling in **form•Z** is better supported by having some experience building physical models. Models of architectural objects with known parameters and basic geometry are best at this stage. Graduating into 3D complexity can be encouraged through the reverse engineering and reconstruction of an architectural project with complex geometries. The analytical model, rather than the design study model is the best context for exploration and learning at this point. In any case, a creative eye is critical for strategizing the process of making.

References

1. Cheng, Nancy Yen-wen. “Linking the Virtual to Reality: CAD and Physical Modeling.” In CAAD Futures Digital Proceedings, 1995. p.303-311.

2. “Playing with Digital Media: Enlivening Computer Graphics Teaching.” In ACADIA’99 Conference Proceedings. p.102-155.

3. David Matthews. “Integration of the Actual and the Digital: Folding Modeling into Beginning Design Learning.” In “Digital Intentions, Explorations, and Accidents,” Andrzej Zarzycki (guest editor), 2006-2007 **form•Z** Joint Study Journal: Partnerships in Learning 15. p 92-97.

4. Prichard-Schmitzberger, Axel. “Team-Working and Reverse Engineering: Teaching Methods for Complex Architecture.” In 3rd International ASCAAD Conference on Embodying Virtual Architecture Proceedings, 2007.

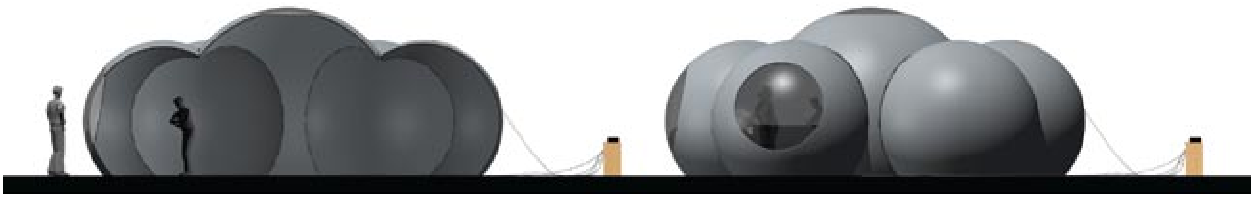

Figure 5: Muscle room detail.

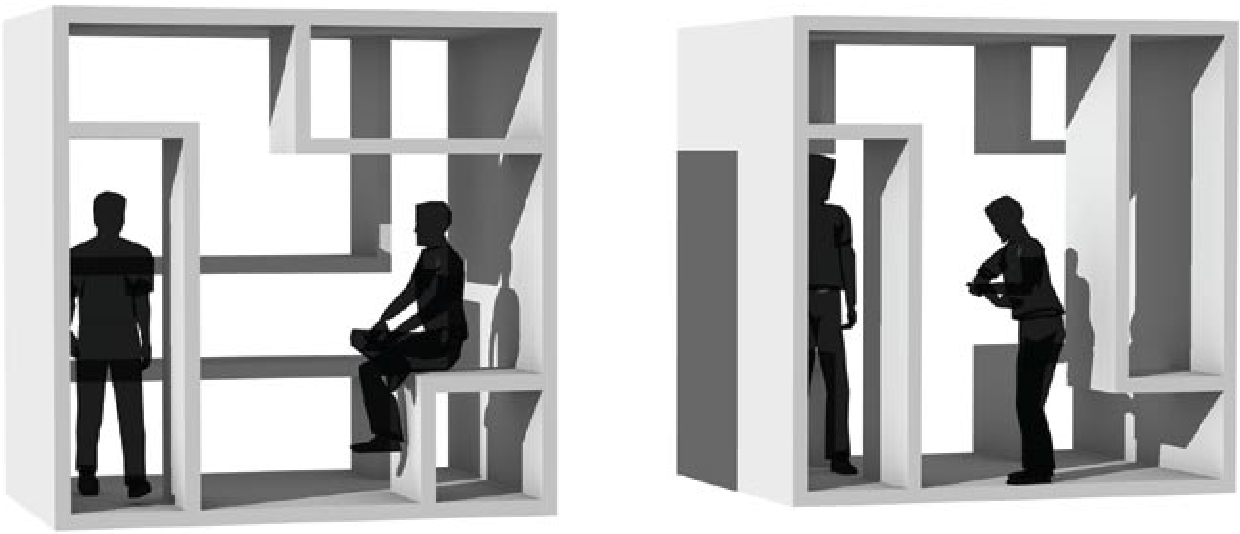

Figure 6: Muscle room states.

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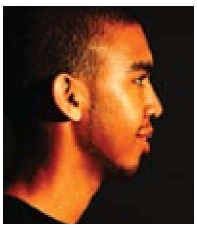

Sean Creque is a M. Arch student at Hampton University's Department of Architecture. His thesis challenges traditional ideas about what walls are and what they can contribute to a space. The research tools have been 3D physical and **form•Z** models exploring the relationships between walls, space, forms, and uses. He plans to pursue a postgraduate degree in Structural Engineering to have a deeper understanding of structures, so that his architectural work can become more expressive. He is particularly interested in tensile structures to create lighter more flexible systems.