Tamkang University
Tanshui, Taiwan

# The Processes of Setting Out

by Chen-Cheng Chen

In his book "Digital Gehry,"[1] Bruce Lindsey compares the canoe lofting process with the digital manufacturing process and discusses the relationship between drawing, modeling, and setting out. In the following design centered discussions, I probe into the role that digital tools can play in different setting out processes.

Our department has a requirement that the first semester design studio freshmen get acquainted with basic drawing skills, model making, and the fundamentals of object proportions and construction. We generally start with an assignment titled "Object Enlargement." The students are asked to choose an object from their daily life, measure it, and then make a hand drawing of it at a larger scale. After this is done, the drawing is transferred onto foam boards and cut into series of sectional profiles. These cutouts are then assembled together into a 3D model. Figure 1 illustrates the models of an enlarged hammer and an enlarged toothbrush, both done by students.

***Figure 1:*** Models for enlarged hammer and toothbrush by Hsin-Yi Huang and Yen-Chen Lu.

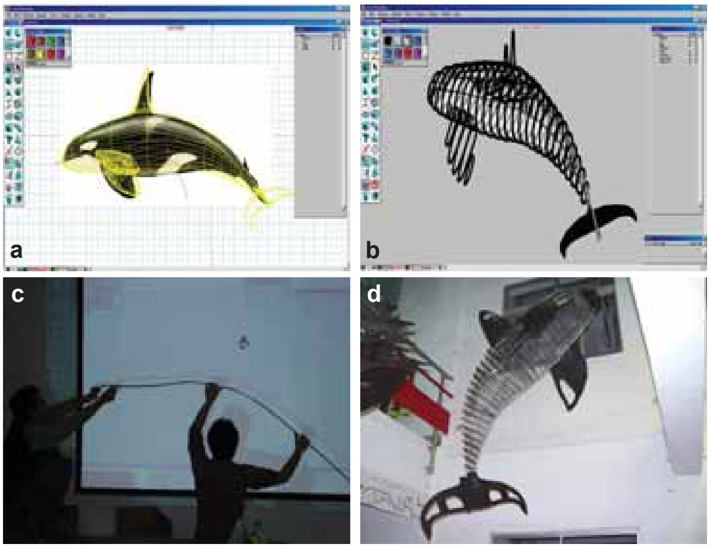


***Figure 2:*** The process for making a killer whale model by Chi-Fu Shiaw and Chi-Li Chang.

A few years ago, in order to acquaint students with the setting out process in a computer environment, we had graduate students make models of ocean fish as an assignment for the Computer Applications in Architecture class. Students had the option to select the material for their models. Some of them selected a computer model of a killer whale from the available 3D resources (Figure 2(a)). They produced a series of cross sectional profiles of the whale using the Contours tool in **form•Z** (Figure 2(b)). In those days, our department had no digital fabrication machines. The students had to paste the cross sectional profiles on plastic corrugated cardboards and to cut out the profiles manually, one at a time. To create a bendable bridge that kept the profiles together, wires were strung through plastic tubes. This appeared to be a metaphor for the longitudinal direction of the skeleton of a whale. Assembling these pieces together was not a straightforward process. The students had to project an image of the whale on the wall (Figure 2(c)) and use it as a guideline when configuring the profiles together. They also used the projected image when bending the wires inside the plastic tubes (Figure 2(d)).

This past summer, the United Ship Design and Development Center asked our Interior Design Department to design the guest rooms of their 50-meter long yacht. In addition to the overall design, the assignment also required a decomposable model. The 1:50 yacht model was about 1 meter long. Making the hull of the yacht presented a real challenge for us and, after some discussions, we decided to use the canoe lofting method in **form•Z**.

First, we used the Nurbz tool in **form•Z** to construct a digital model for the body of the yacht. Next, we brought in fiberboards and piled them up until they matched the height of the 1:50 yacht model. Then we used the CNC Miller to carve out the body of the yacht. Because the CNC Miller we used only had three axles, we divided the process into two parts and built the yacht separately. First, we carved out the shape of the yacht (Figure 3(a)) and left some supporting pieces to connect with the fiberboard block. Then we turned the piled fiberboard block over in the exact same location (Figure 3(b)) and milled out the middle part of the fiberboard block. This part of the process was similar to the canoe making process. After this was finished (Figure 3(c)), we turned over the fiberboard block again, and carved out the supporting pieces. The yacht hull was now complete.

The furniture making process was much easier; we used the digital laser cutter to cut out the acrylic panel. To get the profile pieces, we designed and piled them up together. The finished model images are shown in Figures 3(d), (e), and (f). The main purpose of the model was to allow a potential buyer to understand the interior design of the yacht during the exhibition. There were four interior design choices for each room. A buyer could replace the original design with the one he liked. Even though what we built was only a scale model, we still gained an idea of how much labor is required by a yacht designer to build a real yacht.

The three projects we discussed so far have dealt with the issues of enlarging and reducing the size of objects. We shall next deal with the issue of structural strength. Figure 4 shows a wooden ellipsoid frame with a diameter of 2, 3, and 5 meters, which was also built by our students.  We picked an ellipsoid shape because it has two centers and X, Y axes of different lengths. Its curvature also varies at different locations of its perimeter. As it deviates from a conventional orthogonal structure, it offers an additional challenge when practicing construction. The size of the ellipsoid was determined by the size of the working space. We wanted to allow one or two persons to be able to work within it. The inner space of the ellipsoid is intended for individual students to exhibit their work. There are wheels underneath the ellipsoid, which allow it to be moved around. Due to budget limitations, the main body of the ellipsoid was built with 18mm thick plywood, connected by glue and joints.

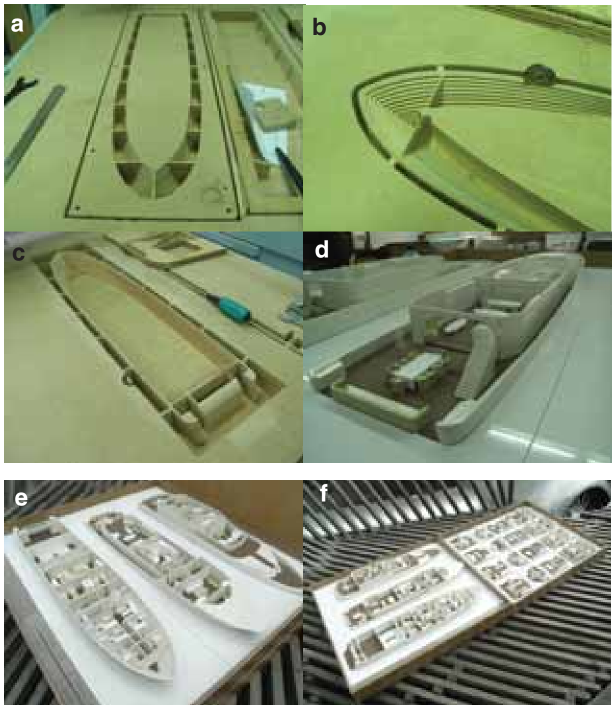


***Figure 3:*** 1:50 yacht model by Hong-Ming Chen, Yi-Shan Chen and Chen-Chia Lee.

The ellipsoid consists of five distinct parts, three of which have been completed. Each was done using a different elliptical topology. The first part is located at the center of the ellipsoid and is rather symmetrical. For the second part we tried different construction methods and was made as a non-orthogonal structure. The third part is located at the end of the ellipsoid and is made of pentagon and hexagon frames joined together. After the ellipsoid is completely finished, different finishing materials on the surface will be tried. While the ellipsoid should not be considered a complicated structure to make, we also need to recognize that, without the help of CAD/CAM software such as **form•Z** and VISI-CAM, it would be notably hard to complete a 550-piece ellipsoid within such a short time by a single person.

The monumental fish sculpture by Frank O. Gehry and the enlarged sculpture by Cales Oldenburg helped us realize that, nowadays, it is possible to copy nature's creatures and artificial objects and turn them into works of art at a much larger or smaller scale. CAD/CAM facilitates scaling up and down and helps turn the ordinary into something extraordinary. We can now integrate different materials together in accordance with their different functionalities. Setting out is a process that requires elaborate thought. Digital tools make it possible to engage with precise "construction" experiences in the real setting out process.[2] Mathematically, constructing a 3D model in CAD through 2D supplementary lines or curves is similar to "integration" in calculus, and setting out a real model in CAM is similar to "differentiation" in calculus[3]. As we know, differentiation


***Figure 4:*** A wooden ellipsoid frame by Lee-Peng Chen.

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and integration are complementary to each other, helping students to better understand calculus. Consequently, design and construction become a mutual interactive process for design studies through the CAD/CAM manipulations.

## References

[1] Lindsey, Bruce, "Digital Gehry: Material Resistance Digital Construction", p.14, Birkhauser, Basel, Switzerland, 2001.

[2] Hovestadt, Ludger and Mueller, Dennis, "ESG Pavilion – Digital Technologies in Design and Production", "Microarchitecture", "DETAIL" (Chinese Edition), CN 21-1488, p.94-97, Liaoning, PRC, April, 2005.

[3] Emmer, Michele, "Mathland: from Flatland to Hypersurfaces", Birkhauser, Basel, Switzerland, 2004.

**Chen-Cheng Chen** is an associate professor and coordinator for computer studies in the Department of Architecture at Tamkang University, Taiwan. He teaches undergraduate and graduate digital design studios, and courses for computer applications in architecture. His current research interests are focused on information technologies in architecture and the integration of computer-aided design and manufacturing for construction. He is the editor for the Chinese edition of "IT in Architecture" series. He received his B.A. from Tamkang University, M.S. from Carnegie-Mellon University, and Doctor of Technical Science from Swiss Federal Institute of Technology (Eidgenossische Technische Hochschule, Zurich, ETH-Z). Email: 097016@mail.tku.edu.tw.