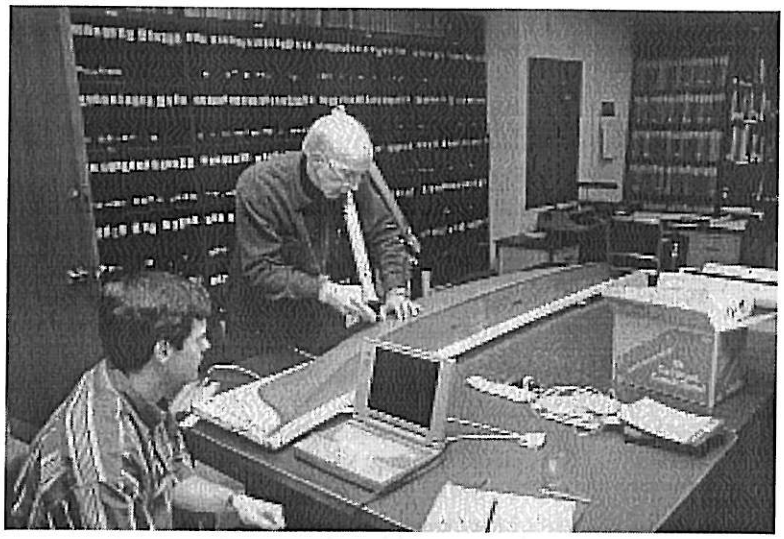

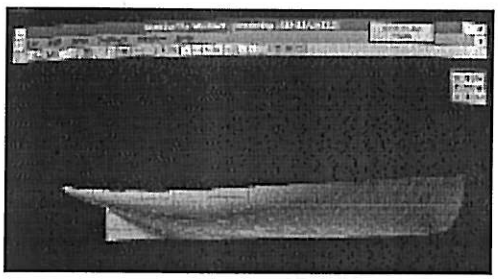

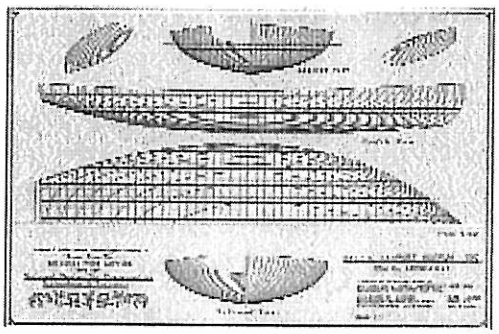

Faro arm measuring a model at the Smithsonian Institute.

Rendered view of the model surface with the planer sections cut through the model visible.

Photos and illustrations courtesy Mystic Seaport, Mystic, CT.

that could be used to measure and draw the more than 1,600 models in their collections. It appeared as though one solution could come from the application of both new computer technology and modern measurement practices to the problem. The National Center for Preservation Technology and Training awarded the group with a grant to purchase the equipment and to train both staff and volunteers in its use. After receiving the grant, we ordered both the equipment and the software and began the project.

We decided to measure the models with an arm type coordinate measuring machine, often used by machinists to check new components or to reverse engineer older parts. This type of measuring machine allows for a wide range of flexibility in the measurement of complicated hull forms. The arm itself moves much as a human arm does. Its six joints allow the point probe at the end of the arm to reach out and around the objects to be measured. The software keeps track of the rotation at each joint in the arm, and knowing the length of each section, does the trigonometry necessary to locate the tip of the arm in space. To collect three dimensional coordinate points, the operator places the tip on the point of interest and presses a button to record that point. Alternately, the probe can collect up to 30,000 points an hour in a stream mode if the button is held down as the probe moves through space. Planer cross sections can be lifted from the object by using a software feature that locks onto a defined imaginary plane. The arm will then collect only points that lie on the plane as the arm passes back and forth across it. In measurements taken on models at Mystic, the machine has had a repeatable accuracy of approximately six thousandths of an inch over the length of the model. The typical electronic model of a half-hull usually contains six to eight hundred measured points, although very detailed models may have thousands of measurements taken. All of the coordinate data taken is stored directly on a laptop computer that runs the system.

After the three-dimensional coordinates have been gathered, they are converted into lines plans. This is done through the use of a naval architecture package by AeroHydro, Inc. called MultiSurf. This software allows for the creation of an electronic surface model of the wooden half-hull. Like the wooden object, the electronic surface can be sliced through with planes to reveal any cross section desired, such as those typically found in a set of lines plans for a vessel. To create this digital surface, electronic battens are run through sectional points and major boundary curves, such as the sheer, the rabbet line, the keel profile, and the transom outline. These battens, or splines, are then used as a skeleton over which the skin, or surface, is stretched. From there the computer is instructed to cut the surface into stations, waterlines, and buttocks (all of the cross-sectional cuts typically used to define a ship's hull form) for a set of lines. The process is similar to the way in which vessels are drawn by hand, except that the electronic model is in three dimensions. Any changes made to the hull in one view, such as the fairing up of the sheer, is automatically handled in the other two views, thereby saving the operator from constantly redrawing the changes. After dragging a point to a new location, the entire model is instantly updated to reflect the change.

Although we have used the machine primarily to measure hull forms, the machine can be used to measure any type of object. The arm comes in a variety of lengths, and can be leap-frogged down and around an object, linking all of the measurements into one unified coordinate system. Using this system, we hope to better document the half-hulls in existence both in museums and in private collections. This system also provides an accurate curatorial record of three-dimensional artifacts should some disaster strike.

For more information on this project, please contact Mark Starr, Shipyard Documentation Shop, Mystic Seaport Museum, Inc., 75 Greenmanville Ave., Mystic CT 06355-0990; 860-572-0711, ext. 5092; email: <marks@mysticseaport.org>.