

Using Model Building as a Means to Introduce High School Students to Engineering
F. Andrew Wolfe, Ph.D., P.E.

INTRODUCTION

During the summer of 2000, four Union College students and eight Schenectady High School students built models for an exhibit about the Erie Canal. The models were built from original engineering drawings of the structure and were built to scale. The Schenectady High School students were all part of the Science and Technology Entry Program for minority and disadvantaged students. The four college students were each in charge of one model and several of the STEP students. The model building began with scale drawings of each model taken from copies of the original Erie Canal Structure drawings. This work took 3 weeks to complete and showed the STEP students how to read plans, use a scale and draw plans. The next seven weeks were used to build the models. Three models, a double chamber lock, an aqueduct, and a change bridge, were built constructed out of wood and one, a lift bridge, was constructed from metal. Each model was carefully constructed and detailed. The illusion of stone work was created using spray paint and felt tip markers. The students worked together through the entire process, learning how the structures themselves were built, and learning how the models needed to be constructed to mimic the actual structure. The models are currently on exhibit in the Nott Memorial as part of Union College's exhibit on the Erie Canal. Although no future home has been determined for the models, the State Museum of New York is interested in using the models for future exhibits. At the end of the summer the STEP students had learned about engineering and had each help complete a museum quality model of a structure of the Erie Canal.

BACKGROUND

The 175th anniversary of the opening of the Erie Canal was celebrated at Union College in the Fall of 2000. The celebration included rare original drawings of the canal structures, painting, memorabilia, and maps of the Canal. An integral part of the exhibit was the four scale models built by Union College and Schenectady High School students during the summer of 2000.

These models represented four important structures associated with the Canal: double chambered lock, aqueduct, change bridge, lift bridge. These models had to be built to exact specifications and appear to be museum quality for the exhibit to accept them.

CHRONOLOGY

This project was started in the Fall of 1999 as an offshoot of the proposed Erie Canal exhibit planned at Union College. At that point discussions were held to determine what should be in the exhibit and the idea of using models was put forth. From the initial meeting, it was decided that Union College students would build the models with assistance from students in the Science and Technology Entry Program (STEP) at Schenectady High School. The STEP students are bright, motivated students who are either economically disadvantaged or a minority. The STEP program gives the students a chance to learn about engineering and the sciences before entering college. The model building was broken into two major parts. The first part consisted of determining which structures to model and finding original structure drawing which could be used to build the models. The second part was to build the models from the drawings provided. In the Spring of 2000 Professor Wolfe and two STEP students visited the New York State Archives, where the Erie Canal structure drawing are kept, several times during the Spring of 2000. They looked at many drawings to determine which ones could be used as the basis for designing a scale model. It was determined during these sessions that the structures to be modeled would be a double chamber lock (similar to Lock 23 of the Enlarged Erie Canal located in Rotterdam, NY), an aqueduct (Seneca River Aqueduct), a Whipple change bridge (Alling, NY), and a Whipple lift bridge (Utica NY). This work benefited the STEP students in that they were able to see how old engineering drawings were done and the differences between old drawings and modern drawings of structures.

The Erie Canal exhibit was scheduled to open on Labor Day 2000. This gave the team a total construction time for the project of ten weeks with three weeks for design and seven weeks for construction. The final products delivered to the exhibit needed to be museum quality models in a diorama and enclosed in a Lexan case. The construction of the scale models began June 26, upon completion of both Union College's and Schenectady High School's academic year. Eight

STEP students and 4 Union College students participated in the construction of the models. They were supervised by three engineering faculty with a fourth faculty member acting as a fabricator for the project. The construction was broken into several parts. First, a full size drawing of each scale model was completed. This involved determining the size of the model based on the original dimensions of the structure and the space available in the exhibition hall. Both the STEP students and the Union College students began learning new skills during this part of the process. The STEP students learned about scales and the design process. Since several of the structures were very long and narrow, an appropriate scale needed to be found which would allow enough detail of the structure while keeping the model within its maximum dimensions. For the aqueduct this meant taking 600 feet out of the middle of the aqueduct so that it would be sized correctly to provide detail and still fit within an eight foot space. Both groups learned how to work off of a set of incomplete plans. They were forced to make decisions based on what they knew and what was available to them from the archival drawings. The Union College students also learned project leadership skills. As much as possible, the students were left on their own to complete the projects. The faculty team was available for questions but was not on site at all times. This forced the Union College students to act as leaders for the STEP students. They had to keep the students interested, on target and working. In addition, the Union College students were in charge of getting the STEP students lunch each day and providing outside activities.

With the drawings complete, the next step in the process was determining the materials required to build the project. For the lock and the aqueduct this meant choosing between wood and some form of mortar for the structure. In both cases wood was chosen as the construction medium. For the lift bridge wood, plastic and metal were all looked at as possible construction materials. It was finally decided that the lift bridge structure would be made from brass rods with wood used for the bridge deck and fishing line for the tension rods. The Whipple change bridge uses wooden dowels and metal channels to form the structure with wood used for the bridge deck and fishing line used for the tension rods. In the cases of the bridges, several materials were tested before the final materials were chosen. The STEP students worked along side the Union College students in determining the materials to be used in constructing the models. This allowed the STEP students to see the bases used to select materials for projects.

Using the full size drawings of the models, each group began the process of constructing their model. Materials were ordered, shop drawings were made and pieces began to be cut to shape. For both the lock and the aqueduct, Professor John Serth provided his wood working shop for the fabrication of pieces of the models. He required that a drawing of the piece be supplied before he would make the piece. As construction progressed additional problems surfaced which needed to be solved. These included: how to make the wood look like stone blocks, how to join the brass pieces together, the correct placement of the trough for the aqueduct, and others. These were solved by the group or groups after discussion of different alternatives and trials of the alternatives.

As work progressed the students developed skills and were able to use these skills on their projects. Some of the students were good at putting the pieces together while others painted, or worked on the dioramas which would house the models. There were also STEP students who became very talented line drawers for simulating the stone blocks. They were able to draw over 1000 blocks onto the wood surface. They were able to determine where the blocks would be seen so that the amount of work could be minimized.

During the last week of the project, the dioramas were constructed and finished. The dioramas placed the models into their proper settings. The lift bridge was placed in a downtown setting with a factory and houses, the aqueduct crossed a river, and the change bridge was in a field. The lock was too big to have much scenery, but a flag and locktender gave the model scale.

CONCLUSION

The Erie Canal exhibit at Union College attracted more than 10,000 people over a six week period. During that time numerous positive comments about the models were overheard. To recognize the effort by the students and faculty in construction of the models, a banquet was held where the Union College students and faculty and STEP students were recognized by Union College. Later that night a symposium on the engineering of the Erie Canal was held in the exhibit hall among the Erie Canal models and the students were again recognized for their accomplishment. In addition, the local newspaper ran a story on the model builders and the models were shown on local television.

This project provided ten minority or economically disadvantaged students a chance to learn about engineering. The project taught the Union College students leadership skills and people skills which they would not have received in their courses. The STEP students learned engineering skills - basic design, construction skills, alternative testing, the ability to change approaches to better handle construction problems, and interpersonal skills. Each student was proud of their accomplishment and the fact that the models were on display and will travel as part of an Erie Canal Exhibit.