Educational Art

A Sculpture That Teaches!

By Duane Ellifritt, Ph.D., P.E.

There are probably 40 or 50 ways to join two pieces of steel together. Some are more economical than others and, while students are not expected to graduate with the knowledge possessed by fabricators and engineers with years of experience, they should have a rudimentary knowledge of the most common kinds of connections. Thus, my job each semester was to try to teach them how to design a few simple connections. Unfortunately, the exercise often ended in frustration.

Beginning steel design is basically two-dimensional; members are reduced to lines that intersect other members at points, or nodes. Even in 3-dimensional analysis, members are still lines meeting at points. After determining the forces in all those lines, actual members can be selected that can efficiently resist those forces. Students rarely have a problem with this; well, the good ones, anyway.

But it is those points – connecting one member to another – that give most students trouble. Connections are graphically 3-dimensional in nature, even in a two-dimensional analysis. Given two orthogonal views with all the bolts and welds, one should be able visualize them – or so I always thought.

How could I help students see a 3-D connection when looking at 2-D diagrams on a page? Field trips are always helpful, if you happen to be lucky enough to have a steel-framed building going up nearby, in a stage where the steel is still exposed. In a small town like Gainesville, that is not always the case. And even if you can find an appropriate structure, you have to transport the students there, coordinate with the contractor, have the students sign "no liability" forms, get hard hats and safety glasses and arrange the time for a tour. Add to this the owner's reluctance to allow students to climb over a structure that presents all kinds of physical hazards and potential liability and it becomes a real chore to organize and carry out a field trip.

My next idea was to build models of various connections and bring them into the classroom. I didn't get very far with this because, at full scale and with real steel, they would be too heavy to carry around. Okay, we can mount them on wheels, I thought, and roll them into class at the right time. But where to keep them when they were not in use? The logistics of this scheme were not realistic.

In the spring of 1985, I had an epiphany: I would create a sculpture for the campus that would do double duty as a work of art and serve as a teaching tool. It would feature all kinds of steel members and the most common kinds of connections. That would solve all the problems inherent in my other solutions. It would be right outside the Civil Engineering building (no transportation involved) and students could examine it at their own convenience. Since it would be rooted to one site, there would be no storage problem. It was a perfect solution! But how could I sell such an idea to the University administration? The Chairman of Civil Engineering and the Dean of the Engineering College both gave it their blessing, but I also had to convince the University Facilities Planning Committee.

I spent several months designing what I believed to be an optimum arrangement of pieces and connections, all radiating outward from a central free-standing column. I then made four elevation views of the structure, and a color isometric rendering that would mean something to a Committee of non-engineering types. I included a light sketch of the Civil Engineering building in the background, showing my idea of where the sculpture could be located in a prominent spot.

Dr. Ellifritt pointing out the various connections on his sculpture to students. Courtesy of Ron Franklin of Engineering Publications.

The original steel teaching sculpture, erected at the University of Florida in 1986. Courtesy of Jeff Post.

After I made my presentation to the Committee, there were a lot of questions, some about whether this could be considered "art" or not, but mostly about safety and the University's liability. After much discussion, the Assembly agreed to allow me to erect the sculpture, but in an alternate location on the south side of Weil Hall behind an electrical substation, virtually hidden from public view. I wasn't happy, but at least I had approval to build it.

I had developed, over my years in industry, some contacts with steel fabricators, so I approached one of them, Steel Fabricators, Inc. in Ft. Lauderdale, about making my sculpture. They agreed, but needed some fabrication drawings which I did not have. I had only my conceptual drawings of how I had envisioned the finished product would look. In order to fabricate, a separate drawing is required for each piece, showing where holes are to be punched, tabs to be welded, angles to be attached, etc. Fortunately, an engineering firm who was on our Board of Visitors, Kun-Young Chui and Associates from Valdosta, Georgia agreed to make the shop drawings for me.

The next hurdle was the foundation. Building a foundation meant digging a hole, but one just doesn't go out and start digging on a University campus! I had to apply for a "dig permit" from the Building and Grounds department and have the underground utilities located. Then I could set some stakes and

University of Western Ontario. Courtesy of Duane Ellifritt.

get students to help with the digging, placing reinforcing, and pouring concrete.

The fabrication of the sculpture was completed in October. Steel Fab loaded it onto a flat-bed trailer and transported it to the campus, where they engaged a mobile crane to lift the piece from their trailer and set it on the anchor bolts. I had set the bolts myself, so was a little tense during this operation, but the base plate slipped over the bolts quite easily.

Shortly after the installation, I gave a brief discussion of my creation at a national steel meeting and several professors approached me and asked if I was willing to share the plans with them. I was frankly flattered to be asked and made them available to anyone who wanted them. A few universities, like the U. of Toronto and the U. of Houston built a copy and sent me pictures.

A few years later, the American Institute of Steel Construction heard of this and thought it was a great teaching tool and would be a good device for establishing relations between engineering schools and steel fabricators. I was approached by Fromy Rosenberg, AISC's Director of Education, about their taking over the plans and promoting it as a teaching tool. I gave permission to use my idea and AISC took the plans, scaled the structure down to around eight feet high (my sculpture was 14 feet high), changed some of the connections, and began a vigorous campaign to get more of them built on college campuses.

This effort has been hugely successful, and as of this date (early 2010) there are 135 of these sculptures on campuses within the United States, with an additional 18 in Canada, 5 in Mexico and one in India.▪

Virginia Tech. Courtesy of Dr. Thomas M. Murray.

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