A Case Study in Using Student Service Learning as a Tool to Acquire an AISC Structural Steel Teaching Sculpture

John Schmidt
Ferris State University
Big Rapids, MI

Student service learning has been receiving much attention. Universities have used many different methods to engage students in this activity. From mandatory to voluntary, community service to university service, several methods to engage students in the concept of service without financial gain have been presented. This paper describes the case in which student service learning became the vehicle through which a construction management program built their own Structural Steel Teaching Sculpture—a teaching tool promoted by the American Institute of Steel Construction. As an incentive and guide to others who may wish to attempt a similar project, an example of the application of student learning to the project, details of the process, potential obstacles, associated costs, and recommendations are presented.

Key Words: AISC, Steel Teaching Aid, Structural Steel Teaching Sculpture, Service Learning

Introduction

Depending on the type of program, to varying degrees construction students receive basic training in statics and structures. Unlike engineering programs, they also receive instruction in plan reading. While engineering students receive much more detail of structural steel design, construction students, with their limited design exposure, will be required to visualize these details and make them into reality.

It was recognized that construction students could benefit from a model showing structural steel elements and related connections as they learn about the basic concepts of steel design and construction. The American Institute of Steel Construction (AISC) promotes such a model in the form of a Structural Steel Teaching Sculpture (hereafter referred to as the *SSTS* or simply, *the structure*). Such a model, usually donated by an industry partner, was not available to this institution due to a lack of interested fabricators.

Figure 1: (left to right) SSTS in final location. Welding students at work.

How does one obtain one of these models with no fabricator and limited funds? Make it a service learning project and involve as many students as possible from across campus. How does one convince a potentially reluctant university administration of the merits of such an approach? Get students, faculty, and staff from across campus, as well as the local community, involved in the process.

The following describes the use of the collaborative nature of Student Service Learning as a basis by one university to become the first to fabricate their own SSTS, placing it in a prominent position on campus in affirmation of the efforts of all those involved, and providing an additional tool for the effective teaching of structural concepts.

Student Service Learning

Just what is meant by *service learning*? Furthermore, what is different about *student service* learning versus other service learning? Perhaps this needs no explanation. However, the term has become quite popular of late among academics. What is it that has caught the collective eye of these academics?

A review of the available literature contains a multitude of resources describing the topic and offering advice. Choosing one web resource for discussion, *The Big Dummy's Guide to Service-Learning* (Cooper, 2006) provides a basic overview of the goals of such activities. This particular resource allows readers to submit suggestions for goals. At the time of this writing, the website listed nineteen goals. Eliminating redundancy and entries irrelevant to the project at hand leaves the following ten goals (provided verbatim):

1. To enhance student learning by joining theory with experience and thought with action.
2. To fill unmet needs in the community through direct service which is meaningful and necessary.
3. To enable students to help others, give of themselves, and enter into caring relationships with others.
4. To assist students to see the relevance of the academic subject to the real world.
5. To enhance the self-esteem and self-confidence of your students.
6. To develop an environment of collegial participation among students, faculty, and the community.
7. To develop a richer context for student learning.
8. To better prepare students for their careers / continuing education.
9. To help students know how to get things done.
10. To do something. Anything.

The process described herein supports all of these goals, and more. In particular, while it may seem trite, the last item in the list says so much more. From the standpoint of the faculty and students that wish to see the outcome, when faced with limited funds and a lack of sponsorship, doing *something* is a much better way to channel frustration. In addition, doing *something* is an opportunity to engage students.

Learn and Serve America is a program of the *Corporation for National and Community Service*, an independent federal agency. Their website states "*Service-learning engages students in the educational process, using what they learn in the classroom to solve real-life problems."* It continues, *"Service-learning can be applied across all subjects and grade levels; it can involve a single student or group of students, a classroom or an entire school. Students build character and become active participants as they work with others in their school and community to create service projects in areas like education, public safety, and the environment."* (Learn and Serve America, 2006)

These goals and ideals of student service learning always directed the project development.

The AISC SSTS

Perhaps more familiar to schools of structural engineering, the AISC's SSTS has been around since 1986. The original design by Dr. Duane Ellifritt, a University of Florida Professor of Structural Design at that time, was intended to help students visualize the three-dimensional reality of a two-dimensional drawing. It was later adopted by the AISC as part of their university programs. The intent of the program is to partner a steel fabricator with an interested university, having the fabricator donate the completed structure to the school for final placement. To date, the structure is located or being placed at 135 schools throughout the United States and Mexico. AISC also provides universities many other tools and opportunities to assist in the teaching and understanding of the use of steel in construction. To view the complete list of these schools and available materials, visit the AISC website at *http://www.aisc.org*, click on *Learning Opportunities*, then *University Programs* (American Institute of Steel Construction, 2006).

Basic Approach

The desire to acquire the structure was first met with resistance in lower level administration. Concerns centered on need, cost, and placement. The program was not an engineering program. Funds for such an effort were not available. If acquired, where would it be placed? Little discussion took place for one year while efforts to gain a fabrication sponsor moved slowly.

In the meantime, a series of changes in all levels of university administration opened the door for new initiatives. A casual conversation in July between a Construction Management professor and a Welding Engineering Technology professor ignited a slow flame. The idea of having students fabricate, assemble, and erect the structure themselves was born. The next six months were spent submitting requests and negotiating with university administration.

The basic approach was to have Sigma Lambda Chi (SLC), the construction honor students, carry out the role of project managers while a group of welding students completed the fabrication of the steel components as one of the class projects in the two-year welding technology capstone lab.

Who Else Can Be Included?

There is much more to placing a SSTS on a campus than merely cutting and welding some steel. It is understood—perhaps universally known—that little is done in most academic institutions without involving some campus politics. Anticipating potential reactions encouraged a review of the goals of student service learning. To enhance the service learning aspects of the project a concerted effort to involve as many people as possible from across campus was sustained.

To increase the number of students involved and incorporate a cross-college experience, a landscape design competition of the SSTS's foundation setting was introduced. The design competition was presented as a request for proposals (RFP). Teams were to be composed of one student each from SLC, Architectural Technology, and Ornamental Horticulture. Since the number of Ornamental Horticulture students was significantly smaller than those of the other two programs, these students were allowed to serve on more than one team. The students submitting the winning entry would receive $100 each and would provide the construction management oversight of the foundation and landscape construction. The contest provided approximately one month for completion of proposals.

Once again, with an eye on campus-wide acceptance and the goals of service learning, a panel of judges was assembled. Professors from the Colleges of Technology, Arts and Sciences, and Business—representing diverse programs in Architectural Technology and Facility Management, Humanities, Biology, and Music Industry Management—joined the Dean of the College of Technology to serve as judges. Final award for the selected design would follow approval of the faculty of Construction Management. Ultimately, implementation of the design would be coordinated with the University's Superintendent of Grounds.

Four of the seven teams submitted their proposals for review. Each team provided a formal presentation with a question and answer period. The union of differing views provided by three students with such diverse backgrounds was quite evident and encouraging. The most interesting observation was the unique and completely different perspectives offered by the panel of judges—extending the service learning aspects to this room of professionals. In closed deliberations, the judges declared a tie and students from both teams received awards. It was decided that, with the guidance of the Superintendent of Grounds, the two proposals would be combined—a fusion of their best features.

Fabrication

As a final component of the two-year degree program in Welding Engineering Technology, students complete a project of their choice. Everything from kennels to wood burning stoves can be seen at various stages of completion on their shop floor. From this class of students, four volunteered to work on the fabrication of the SSTS.

SLC members shared the responsibility of visiting the welding students during their nine lab-hours per week, answering questions and interpreting drawings. For the construction students, the relationship emphasized the importance of providing clear construction documents, developing simple instructions, problem solving, critical thinking, and dealing with issues related to the welding trades. The welding students experienced much the same, as well as exercising a depth of plan reading skills that exceeded their normal instruction. Most importantly, the learning took place between and among the students, with guidance from their professors.

Fabrication began with the winter semester, culminating with the structure's unveiling 15 weeks later on the last day of classes. The original set of drawings was obtained from the AISC's Director of University Relations, Mr. Fromy Rosenberg. After the start of fabrication, a CAD file was found in the *Teaching Aids* section of the AISC website (American Institute of Steel Construction, 2006). After downloading and reviewing the file, it was discovered that the file contained some significant changes to the design that would have voided some of the work already accomplished. It was decided to move forward using the original set of drawings.

Figure 2: Welding students fabricating and erecting the SSTS.

Landscaping

The landscape competition was discussed earlier. As the project progressed into the spring, efforts to acquire donations of materials got underway. National home improvement retailers and local landscape professionals were contacted to assist the anticipated student labor force by providing in-kind materials and equipment. However, as paperwork and contacts were being processed, the location changed—effectively eliminating the need for any landscape preparation.

Steel Preparation and Painting

Questions regarding the sequence of priming, finish coat painting, and sandblasting arose early in the project. Several options existed.

1. Question of Assembly and Placement versus Erection: Perform final assembly of the structure prior to placement on-site versus erecting the structure on the foundation. The former allows controlled conditions for all steps through assembly but risks damage to the coating during placement. The latter avoids some of the anticipated damage involved in moving the entire structure and, regardless of order of painting processes, requires final coating of connection bolts and welds.

2. Question of Process: Individually sandblast, prime coat and final coat each piece, then assemble and touch up the whole structure.
   This provides the protection of a controlled environment during all painting.
3. Question of Process: Individually sandblast and prime coat each piece then assemble and final coat the whole structure.
   This provides the protection of a controlled environment through priming and, if done off-site, through final coat. It also avoids potential damage to the final coat during assembly.
4. Question of Process: Completely assemble the structure, then sandblast, prime, and final coat the entire assembly.
   The reduced time and simplicity of this suggestion was very compelling. The argument was made that mill scale between pieces would be sealed by the paint, sealing the joints from water infiltration and potential rust stains.

Industrial coatings sales representatives provided conflicting opinions. After careful deliberation of the fourth option, the potential for paint cracks developing at the joints and around connections due to thermal movement seemed great. The concern for a lifetime of rust stain maintenance removed the option from consideration.

Original plans called for the use of the Auto Body program's facility and student labor for sandblasting and painting. It became obvious that the program's equipment was inadequate for structural steel. Efforts to locate a sufficiently large paint booth and a satisfactory sandblasting unit required two locations. Combined with time constraints, student labor was ruled out. Arrangements were made to use the paint booth and technician of the Heavy Equipment Technology department. Sandblasting services, necessary to remove mill scale and clean the steel surfaces prior to prime coating, was to be donated by a nearby manufacturer.

The limited size of this paint booth, the need to move the structure off-site for sandblasting, and the desire to obtain the best possible prime coat lead to the selection of the third option, and the decision to erect the structure on its foundation. Therefore, to protect the final painting process from the April elements, a temporary enclosure needed to be built around the erected structure.

Students disassembled the structure, transported the pieces to the sandblasting facility, and returned the prepared pieces to the Heavy Equipment program's painting booth across campus for priming by the program's technician and university painters using air sprayers. In the meantime, students prefabricated plastic-sheeted stud panels for the on-site paint booth. Following prime painting, the pieces were moved to the foundation and erected, the paint booth was assembled around the SSTS, and final painting performed by university painters.

The selected paint system, donated by a national industrial coatings manufacturer, was a fast-dry, single coat, polyurethane formulated for accelerated maintenance painting of bridges. The use of an air sprayer with this fast-dry paint inside the enclosure caused a swirling effect difficult for the painters to control—drying on the backside of pieces and resulting in an unintended but visually interesting dimpled surface texture. This may have been avoided by using an airless sprayer.

Figure 3: Footing form, erection, placement of painting enclosure, and applying final coating.

Foundation

The SSTS plans do not provide direction for foundation design. Foundation design is dependent upon actual location and exposure to wind or seismic conditions. Other loads that must be considered are not necessarily obvious to a typical engineer. However, to a professor, such loads may seem ordinary. Consider, for example, the number of bodies that may be stacked upon one arm of the structure or a chain wrapped around the structure's base with the other end attached to a pickup truck. Such unforeseen loadings may be significant.

Basic foundation design became a class problem. It was then beefed up to mitigate affects of unforeseen forces. After removing a select area of paving stones from the site, an electrical contractor bored a 30-inch diameter hole beyond the frost depth of 48 inches. This approach achieved penetration through glacial till that included very large boulders while minimizing disturbance to the pre-landscaped area. A standard forming tube was used to support the hole and provide a 6-inch above-grade reveal to protect the structure from the blade of snow clearing equipment. Longitudinal and hoop reinforcement was fabricated by construction students using ingenious methods for jigs and bending of the No. 3 reinforcing bars. Anchorage was provided with ¾-inch galvanized threaded bars extending a minimum of 3-feet into the foundation. As an added teaching feature, the leveling nuts were left exposed after erection of the SSTS.

Assembly

Assembly was done twice. The first occurred in the welding lab while being fabricated and was performed by welding students. Final assembly took place on the foundation, prior to final painting, and about five days prior to the unveiling. The process joined the construction and welding students with university grounds personnel and their backhoe to assist in placement. This gave the welding students the opportunity to supervise the careful erection of their work while construction students learned a little more about steel construction and related tools.

Location, Location, Location

The original proposal for the project was submitted in late summer. Approval from the highest levels of administration came in the form of an acceptance of concept. But, being a new administration, the exact method of approval was yet to be determined.

It is important to note that there are really two pieces to the approval being sought for a project of this nature. The first piece of this approval is the permission to locate the structure on campus. Throughout this project, there were no less than five times that approval was considered final by the project team. Obviously, frustration mounted with each resurrection of the proposal. It would be difficult to explain the hierarchy of those that provided final approval. In fact, many of those involved in the approval of the project and its location are unknown to the project team.

The second piece of this approval is the agreement on the specific location. It is this second piece that is the most difficult. Three separate approvals were received—each thought to be final—each identifying the chosen location. No indication of any problem with the selection of the site was made evident to the project team. Two weeks prior to site work, the administration began second-guessing their location decision—resulting in six more iterations of the approval process. As the time came to break ground, and with no commitment on a site for modification to the winning landscape designs, the approved and final location was identified.

The location chosen by the administration was within 100 yards of all of the other locations. Surprisingly, it placed the structure in the most prominent of all locations, as the centerpiece of the adjacent quad. Since this location was already landscaped and required minimal effort for foundation construction, the pressure to break ground was relieved. The student landscape design competition became a mute point, albeit a learning experience for the students who competed.

A Rose by Any Other Name . . .

What is in a name? The title block of Dr. Ellifritt's plans contain the phrase, *Structural Steel Teaching Sculpture*. Indeed, these four words have been combined in various ways to name like structures at other universities. Some schools have a *Steel Structure* or a *Teaching Sculpture*, while others have a *Structural Teaching Tool*.

After the fine arts community of this campus took exception to the use of the word *sculpture* in the title of the structure, it was discovered to be a common problem on many campuses. Objection was so strong that invitations to the representative of that community to participate on the panel of judges for the landscape design competition were rejected. In respect to Dr. Ellifritt's original design, the name of the structure was not modified. However, it is now referred to as *the structure* or, more affectionately, the *SSTS*.

A Union Shop or Not?

Throughout this report, students, faculty administrators, staff, and university personnel are referred to often. This university is, in fact, a union environment. Understanding that the SSTS was to be a service-learning adventure, the unions enthusiastically embraced the project and engaged the students—working side-by-side with the students and faculty where needed. Their dedication to the university's teaching mission was extraordinary.

The Unveiling

Having all site construction, painting, and erection completed within the 12 days leading up to the unveiling ceremony was indeed cutting it close. The ceremony occurred on the last day of classes, taking advantage of concurrent advisory board meetings, student awards banquet, Sigma Lambda Chi inductions, and an alumni golf outing. A cross-section of the entire campus was on hand to witness the students uncovering their work (of art) with great pride.

Show Me the Money!

Original plans to acquire 100% material donations were modified by the uncertainty and timing of approvals. Outstanding support from the Dean provided a cushion of funding to see the project through. With two departments handling the process, the flow of money was somewhat buffered. Materials came in a combination of donated, wholesale, and retail pricing. Most services provided by other than students or faculty were graciously absorbed by various university administrative departments or provided in-kind by outside vendors. As the project neared completion, a grant was secured through the university's Foundation to offset most of the costs incurred by the department and college. Table 1 provides a brief summary of the associated costs, materials, and labor.

Table 1

Brief summary of associated costs, materials, and labor

Item	Cost
Steel and Miscellaneous Pieces	$3,000
Student Awards	500
Miscellaneous Equipment and Supplies Related to Onsite Construction and Erection	600
Copies and Postage: Plans and Invitations	150
Unveiling Ceremony	500
Brass Plaque and Signage (estimated)	1,000
Total	**$5,750**

In-Kind Donations of Materials, Equipment, and Labor:

- University union painters, Heavy Equipment department technician, and grounds personnel assisting with foundation drilling and steel erection, backhoe, and painting equipment.
- Industry facility, blasting sand, sandblaster, and operator.
- Industrial coatings (primer and paint).

Materials Re-Used by Construction Department:

- Temporary painting enclosure: wood framing and plastic sheeting ($400)

Hours: (not including hours yet to be devoted for web design and introductory material)

- Welding students: approximately 550 hours
- Other students: approximately 450 hours
- Faculty, staff, and industry partners: untabulated

Recommendations

The following provides advice for those who may wish to duplicate such an effort.

1. Receive, in writing, a description of the approval process prior to committing resources or involving others. This does not guarantee there will not be changes. But it does provide the roadmap excluding detours.
2. Do not fast-track the planning and fabrication. Take a semester to secure the donations of materials and services. Perhaps overlap this effort with the semester necessary for university approval. While students completed the fabrication in three months, it took the university nine months for approvals.

3. Consider the union environment. Get union agreements in place early.
4. Budget for all of the items discussed, then modify it for the program's unique approach.
5. Consider the set of drawings to be used. While this project used the original hand-drawn set, a very detailed CAD file exists that provides bills of materials and the ability to more easily produce prints. It differs from the original. Select one and stick with it.
6. Do it. While it would be difficult for a school that has no welding program, the students' pride will last for generations. At the unveiling, proud students voiced their desire to bring their yet unborn children back to campus in the decades ahead. For those lacking welding expertise, partner with a local vocational school or find another institution if needed. Across the spectrum of participants—students, faculty staff, and local industrial partners—a general sense of accomplishment and understanding was shared.

Conclusion

This paper described many of the obstacles and presented suggestions in an effort to assist those who may consider a university-based project of this size and impact. It suggested the use of student serve learning as a vehicle to that end.

Since the unveiling, a few touch-ups, signage, and minor tasks still remain. A web-based photo journal is under development. Of course, it is expected that one or more students in the College of Business and the College of Arts and Sciences will assist in this effort. The SSTS serves the campus community as a teaching tool for Architectural Technology and Construction Management students, a model for art students to use for sketching, a conversation piece for community members walking their dogs, and a point of pride for more than 1,000 student hours of service learning.

While the acquisition of a SSTS was the goal, student service learning provided an effective vehicle and the focus for the project. This paper described one program's experience in that effort. However, it is not limited only to the acquisition of a SSTS. Student service learning offers valuable hands-on exposure to project management, collaborative decision-making, crisis management, team work, and many other valuable traits desired by construction managers while providing a means of achieving any desired outcome. A program's desire to reach any goal and a commitment to involve students in that effort are all that is necessary to get the ball rolling.

References

Cooper, M., Volunteer Action Center at Florida International University (undated). *The big dummy's guide to service-learning*, http://www.fiu.edu/%7Etime4chg/Library/bigdummy.html (31 Dec 2006).

Learn and Serve America (2006). *Learnandserve.org*. http://www.learnandserve.org/about/service_learning/index.asp (31 Dec 2006).

American Institute of Steel Construction (2006). *Aisc.org*. http://www.aisc.org/Content/NavigationMenu/Learning_Opportunities/University_Programs/University_Programs_Intro_Text.htm (31 Dec 2006).