Service Learning in the U. S. Virgin Islands National Park: A Virtual Preservation Project

Karen J. Horton, Constance Holden, Ken Wild
University of Maine/National Park Service

Abstract

In the spring term of 2004 twelve students and two faculty members at the University of Maine (UM) participated in a service learning project for the U. S. Virgin Islands National Park (the Park) on St. John. The Park archeologist sought to virtually preserve decaying sugar plantation buildings using three dimensional computer-aided design (3D CAD) models with photographic skins. The challenges included fast turn-around time, student project management, and unforeseen technical requirements. The interdisciplinary service learning team was able to demonstrate the feasibility of the virtual preservation concept. The project resulted in benefits for the students, the faculty members, and the institutions. One student summarized her experience: "There were no textbooks or directions telling us what to do, what to measure, where to store our information or how to analyze it….The greatest part of this project: knowing we're making a difference."[1]

Introduction

A brief phone conversation between Karen Horton and Ken Wild in July 2003 started twelve students and two faculty members at the University of Maine (UM) on an enviable service learning odyssey. Horton is an Associate Professor of Mechanical Engineering Technology (MET) at UM. Wild is the Archeologist and Cultural Resource Manager for the National Park Service at the Virgin Islands National Park (the Park) on St. John. He is faced with managing hundreds of crumbling stone buildings built in the seventeenth through nineteenth centuries by enslaved people from Africa under sugar plantation owners who were subject to the Danish crown. Funding is inadequate to stabilize the deteriorating structures. Wild's goal is to create three-dimensional computer models with photographic images of the most important and threatened structures. He envisions a web site in which the three-dimensional images of the models can be manipulated so that viewers can "walk through" realistic-looking structures. The structures would be placed on a model of the terrain of St. John to demonstrate their locations. This vision will be referred to as virtual preservation.

Wild was interested in hiring student interns with technical backgrounds to use MicroStation (Bentley Systems, Inc.) to model specific structures.[2] A water-drawing windmill facing imminent collapse is located at the Leinster Bay sugar factory site. He sought students who could clear jungle at the site, measure the windmill and other structures, photograph them, model them, apply the photographs to the models, take survey and global positioning system (GPS) measurements of the terrain and structure locations, and develop a model of the site terrain with the structural models applied. He hoped an image of the resulting model could be exported to a web site for public viewing.

MET students at UM learn to create three-dimensional models in MicroStation, but they are not skilled in all the areas Wild required. He was clearly seeking an interdisciplinary group. Faculty technical and management support would be needed to complete such a project. His proposal would require significant resources.

Constance Holden, Instructor of Spatial Information Science and Engineering (SIE), was eager to participate. Holden had worked at an archeological site, but neither she nor Horton had been to St. John or had experience with the envisioned virtual preservation process. Holden reviewed the relevant literature and found that the techniques and processes are only now under development. A service learning project to virtually preserve an historic site would be challenging.

Supporting Wild's goals offered potential benefits for the students, the faculty members, and the institutions involved. Students from UM would travel to a stunning location in the Virgin Islands to perform important preservation work for the National Park System. The students would apply technology to an unusual social issue: preservation of structures that were built by enslaved people to provide sugar and rum to Europe under a brutal colonial system. Participants would have a chance to work with others in different disciplines. The challenges of the applied technical tasks could motivate strong learning outcomes. The work had the potential to bring significant publicity to the institutions and to offer publication opportunities for the professionals. If successful, the Park would have a 3D CAD model to virtually preserve at least one structure, and a report describing techniques to use in the future.

Project Funding and Administration

This project was performed on a short lead-time. During the fall term of 2003 Horton, Holden, and Wild obtained three primary sources of funding to carry out a virtual preservation pilot project for the Park during the spring term of 2004.

Holden and Horton successfully proposed a three-credit service learning course to the Division of Lifelong Learning at UM to be offered as a Continuing Education (CED) course during the spring 2004 term. CED courses are open to all students. The course was numbered MET220 and titled CAD Modeling of Archeological Structures. CED courses must be offered after 4:00 pm. The course was scheduled in a computer laboratory four hours per week, Monday and Thursday from 4:30 to 6:30. A three-credit CED course supports the faculty member overload with eight percent additional salary; by team teaching the course in addition to their regular classes Horton and Holden each earned an additional four percent salary.

Wild successfully sought a grant from the Friends of the Virgin Islands National Park (the Friends) for eight student interns to travel to the Park to work during the two week 2004 spring break. Each intern earned seven dollars per hour for two forty hour work weeks plus a two hundred dollar travel stipend, for a total labor cost of $6080. In addition, the Friends supplied camping equipment and tenting sites for the interns to camp for free at the Cinnamon Bay Campground.

Horton successfully sought a UM Faculty Research Funds grant to fund faculty travel to the Park including housing, meals and jeep rental, in order to manage student interns and provide technical support. This funding totaled $7800.

Holden and Horton have teaching (non-research) appointments. Both were teaching their full loads during the planning period in the fall 2003 term, plus teaching MET220 as an overload during the spring 2004 term. Holden and Horton volunteered time to the Park seeking funding, selecting student interns and helping to coordinate their interactions with the Park, managing the project before and after the trip, supervising interns taking data at the Park, performing technical tasks to support student outcomes, and compiling the report.

Project Organization

By mid-December 2003 Holden and Horton had solicited applications for the internships and had recommended to Wild eight of fourteen applicants to intern at the Park. Six of the interns were registered for MET220. Four students not traveling to the Park also registered for MET220.

During January and February the ten students in MET220 learned about the water-drawing windmill from site drawings that had been completed a number of years before. They practiced using MicroStation to model the windmill and to apply photographic materials to the model. They also practiced related geographic information system (GIS) database development. By practicing the modeling tasks prior to taking data, students were able to consider the data they would need to take in the Park to complete the modeling upon their return.

During the first two weeks of March the eight student interns, Holden and Horton traveled independently to the Park to gather the required data. The team performed the tasks at the Leinster Bay site that Wild had set out: they cut and dragged half an acre of brush away from several stone structures, measured the structures, photographed them, surveyed the site and buildings, and took GPS measurements of the terrain. The photographs of Figure 1 show the team members working at Leinster Bay. Interns also began modeling the structures and applying photographs using computers located at the archeology building at Cinnamon Bay Campground. The students were able to obtain a pilot model with some photographs applied before they left the Park. Wild arranged for Park officials, representatives from the Friends, and members of the press to visit the site and speak with students near the end of the data collection period.

After the interns returned to UM with data, students in MET220 continued to model the windmill, other buildings, and the terrain. All students contributed to a final report for the Park by describing the tasks they completed.

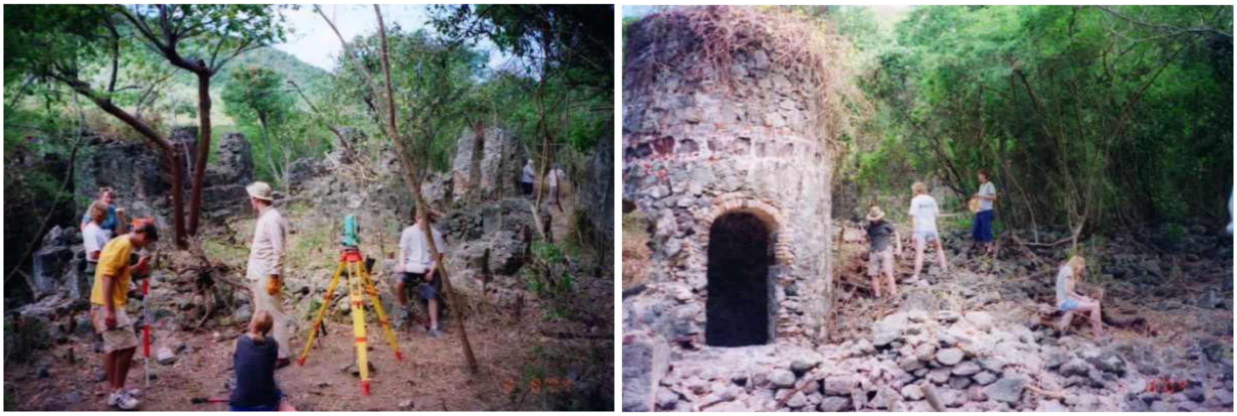

Figure 1. Interns and professionals take survey measurements, physical measurements, and photographs at the Leinster Bay site in the Park.

Interdisciplinary Aspects

A diverse group of students and interns from UM and other institutions worked as a team to complete this project. The participants included eight women and eight men with backgrounds in archeology, art education, civil engineering, electrical engineering, electrical engineering technology, forestry, mechanical engineering, mechanical engineering technology, science education, spatial information science and engineering, and theater. Two of the eight UM students traveling to the Park were women, and four of the ten students in MET220 were women, including one African-American. The UM interns working at the Park lived and worked with four archeology interns from other institutions, all women, who were working for Wild on this project and other projects.

Developing MicroStation lessons for the diverse students in MET220 was challenging. Several of the students were already fairly proficient in MicroStation while others had no experience with engineering graphics or the software. Learning objectives focused on specific 3D CAD modeling techniques to be applied to the Leinster Bay site stone structures for which drawings and some photographic data were available. Students often worked in pairs so the more proficient students could help those without any background. The lessons were as self-directed as possible to encourage individual achievement at an appropriate level for each student.

The interns hired by the Park to apply their technical skills also learned about history and cultural preservation. Wild tasked them to read about Caribbean sugar production and the slave system that resulted in the stone structures to be preserved. He brought the interns to a stabilized historic sugar production site and discussed the labor the enslaved people were forced to perform to build the stone structures and produce sugar. With this new knowledge, interns found working at Leinster Bay while thinking about the conditions of the enslaved people sobering.

The diversity of the interns' backgrounds and of the tasks performed allowed each to learn and practice new skills on site and provide leadership in at least one task. The students successfully formed fluid work teams at daily organizational meetings. One group including art, archeology, and engineering interns photographed the structures and documented the locations from which photographs were taken. A group of engineering students measured and sketched the structures for later modeling. Groups including forestry, engineering, and archeology interns surveyed and performed GPS measurements. After the initial data collection, several engineering interns worked on modeling, and some interns who had been taking photographs developed photographic skins for the models using Adobe Photoshop.[3] Each group carefully organized and documented the data they had taken and the modeling they had performed. At some points Horton or Holden supported the project management by assigning students with specific skills to be responsible for managing related tasks or for organizing and documenting related data.

When the interns returned with data from the Park, MET220 students were able to use their diverse strengths to complete the feasibility demonstration and document their work. Again students selected those parts of the project they found interesting and that fit their backgrounds. The theater student had stage managing experience and she and the science education major obtained and edited the students' contributions to the report. The art education major and the electrical engineering technology major researched several different methods of stitching the photographs to create a photographic skin for the model of the windmill. The engineering majors focused on the modeling tasks. The forestry major worked on the terrain model from GPS and survey data. The spatial information science major who served as a park intern was enrolled in a database course with Holden. She assigned him to develop a database for the photographs as a project.

Challenges

The short lead-time was inadequate to obtain funding for faculty release time, so Holden and Horton both performed the project on an overload and volunteer basis. This limited the outcomes to what the students themselves could accomplish.

The short lead-time also resulted in limited planning for the data collection. Interns arrived at the Park without training in the specific equipment available, without standardized data sheets or plans for collecting data, and without scheduled and scoped tasks. The interns had to develop work strategies, technical skills, and data organization on site. With the professionals facilitating, they organized their work each morning and reviewed their progress each afternoon. Horton, Holden, and Wild were each familiar with only a limited set of the total skills required, and not all were on site during the entire trip. Interns had to be able to manage and complete some tasks independently. These challenges resulted in specific problem areas.

The surveying and GPS measurements were problematic. Three locations served as the hubs (datums) for all other measurements made with the total station (surveying equipment). The real world coordinates for these hubs was to be obtained with the GPS unit. Student interns began surveying prior to taking GPS measurements. Due to the mountainous terrain, GPS data could be obtained for only a single hub. Holden and the forestry student required significant time to resolve this problem after the trip.

Certain aspects of the photography were technically limiting. In order to apply digital photographs to orthogonal models, the photographs need to be stitched (multiple photographs joined). During the second half of MET220 students determined that PTGui, a graphical user interface for Panorama Tools, was the best software available at UM to create the photographic skins.[4] Optimally, photographs should be taken from known distances with known camera angles with established control points (flags or marks) and visible measurement devices in the photos. While interns thoroughly documented the buildings with photographs, they didn't record these precise measurements. The photographs that were taken can be stitched, but the accuracy of the resulting photographic skins for the 3D CAD model is limited.

MET220 students learned how time-consuming project management is. Students were expected to report weekly on their goals and their progress toward completing their goals. Not all students were as productive in a self-regulated classroom setting as they might have been in a more hierarchically managed setting.

Wild feels having the virtual preservation available for public viewing would motivate the private donors he typically relies on to support future virtual preservation. Students attempted but didn't successfully export a model with photographic skins.

Student Learning Outcomes

In order to successfully complete MET220 all students demonstrated specific learning outcomes using MicroStation and ArcView, a geographic information system software package[5]. All students also demonstrated technical writing skills. In addition, each student demonstrated competency in an area relevant to the specific project tasks she or he was assigned to perform.

Student outcomes related to MicroStation were assessed through classroom exercises, homework, and quizzes. Students imported as raster images architectural drawings of plantation buildings at the correct scale, and measured scaled lengths from the raster images. They then used the measurements to size two-dimensional shapes and three-dimensional primitives to model buildings. They used Boolean tools to create voids and to add details to the models. From photographs of buildings they created material files and applied the materials to the models.

Student outcomes related to ArcView were assessed through classroom exercises and projects. Students demonstrated knowledge of the basic techniques of data visualization and attribute management. They performed both spatial and attribute queries. They developed a database from which they hyperlinked images, documents and web pages.

Students then demonstrated learning outcomes specific to their individual tasks and were required to document the outcomes for the final report to the Park. The mechanical engineering technology and mechanical engineering majors all chose to develop their

MicroStation modeling techniques. One of these students also integrated all the upgrades to the well model. For example, one student modeled the bricks in the arch, another created the void left by the rocks that had fallen out of the structure, and a third modeled the supporting crown of rocks at the top of the windmill. These changes were integrated into a single model. The art education and electrical engineering technology students used PhotoShop and PTGui to develop the photographic skins to apply to the models. The forestry student developed the model of the terrain from the survey and GPS data. Outcomes were assessed relative to the project goals through a review of the final products and their written documentation.

The travel and internship in the Park were not part of MET220, so no related learning outcomes were assessed.

Student Perceptions

Comments reflecting student perceptions regarding the benefits of the project are taken from a letter, course evaluations, and an interview for an article.

One MET220 student who did not work as an intern found student management and learning the technical skills a valuable experience:

> *"The class was beneficial in many respects and I sincerely enjoyed it. We were given a goal to achieve, given the tools to do it and then we realized our objective as a team. The structure of the class, and the atmosphere within it, was centered around teamwork; it was a perfect complement to the project management class... For me, this alone was well worth the time and money spent. To add to this, I came away from MET220 with some very valuable technical skills.*
>
> *The technical content included basic GIS functions using ArcView software5, and CAD modeling using MicroStation. Not having had any exposure CAD, cutting my teeth on this powerful software was an exercise in patience and determination. But given the direction of future technology, I bet my new CAD skills will serve me well after I graduate."*

Another student commented on both the time penalty and the benefit of student management:

> *"Though it was difficult due to the nature of the class to determine what needed to be done all the time, more could have been done before classes rather than during them to establish the tasks to be done.....*
>
> *Trusted students to accomplish things on their own and was incredibly open to student ideas and input."*

Two students who did not intern in the park commented on the level of student ownership:

"...did very well in letting the students take hold of the project and really make it their own."
"…very open to the students controlling aspects of the project….both instructors were very flexible."

One also suggested that in the future participants video tape site work for students who don't intern, and that faculty members make sure everyone has a checklist of exactly what they need to do (in other words, strengthen faculty management).

Another intern recognized the difficulty of managing a task with so many unknowns:

"Topics at the beginning of the course were helpful in preparing for the USVI [U.S. Virgin Islands] work, but did not entirely prepare the student to be able [to] actively contribute to the project…. did an excellent job in preparing us for work in the USVI with the resources she had. Going in blind, she was able to predict some of the skills and applications we would need."

An MET student in the class who interned would have liked more technical preparation:

"When covering the basics spend more time so when it comes down to do the final project more people will be able to do more stuff."

Another MET220 student who interned was interviewed for an article in a UM based publication several months after the trip.

"But most important, we had come to do a job – an endeavor bigger than any of us anticipated. I wasn't prepared for the difficulties of measuring ruins that, from the photographs, seemed such a simple task back in Maine. Little did I know we were pioneers.

There were no textbooks or directions telling us what to do, what to measure, where to store our information or how to analyze it….

The greatest part of this project: knowing we're making a difference."[1]

Benefits to the Faculty Members and Their Institutions

Holden and Horton felt the time they volunteered to the Park was well spent. Like the students they were enthusiastic supporters of the project. The project offered interesting opportunities for public service, scholarly work and publication.

Since Wild had invited the press to observe the interns working at the Leinster Bay site, several newspaper articles about the project, including an Associated Press article, were published in local Virgin Islands, Maine web-based, and national newspapers.[6, 7, 8] In addition, the University of Maine found the work interesting enough to publish an article describing the project in its public news magazine.[1] Based on a proposal to continue investigating the virtual preservation process, Horton was granted a paid spring term 2005 sabbatical. To augment the service learning project, Holden began to develop a GIS database to document the Leinster Bay site. The project offers her unique publication opportunities.

Both faculty members hope the outcomes of the project will lead to additional funding opportunities to continue the virtual preservation project at the Park.

Benefits to the Park

In spite of the challenges and limitations, students did demonstrate the feasibility of virtual preservation with a model of the water-drawing windmill displayed in Figure 2. Student interns also took physical measurements of several structures at the Leinster Bay site that can be used in future modeling efforts. They photographed the windmill and other buildings on the site extensively. This work can help identify changes in the structure over time should funding for stabilizing the structure become available.

Figure 2. Compare a photograph of the water-drawing windmill at Leinster Bay and an image of the 3D CAD model with a photographic skin.

In addition to the model with the photographic skin, students developed a model with some structural elements embedded. Structural details can be important to the preservation record; for example, bricks of different materials in the same structure can have historical significance. Students also created a basic terrain model from GIS data Holden provided based on topographical maps and measurements. The structural model was successfully placed on the terrain model.

Students documented the project by reporting on their specific activities. Horton edited a report to the Park to describe the scope of the work performed and to provide suggestions for future work. The body of the report describes the administrative aspects of the project, the goals, a general description of the techniques applied to achieve the goals, and the outcomes. The detailed descriptions of the technical aspects are contained in extensive appendices.

Conclusions

A diverse group of enthusiastic students at the University of Maine participated in a service learning project to demonstrate the feasibility of virtually preserving decaying stone structures in the Virgin Islands National Park. The project was undertaken on a short lead-time with limited funding. Students learned skills they needed, managed the complex tasks asked of them, applied the skills to demonstrate a previously untried concept, and documented their work.

Several groups benefited from the project. The Virgin Islands National Park received a 3D CAD model and a report detailing the methods used to attain it. The University of Maine and the Park received excellent press at the local and national levels. UM also identified the work performed as appropriate for its own publication. The Mechanical Engineering Technology program and the Spatial Information Science and Engineering department benefited from the publicity and from student interest in the project. The faculty members involved benefited from the fascinating opportunity for professional development through such a unique challenge. With appropriate future funding, further development and refinement of the techniques could offer similar benefits to all parties as other threatened sites are virtually preserved.

The most important beneficiaries of the service learning project are the students. They served the National Park System by supporting the preservation of a unique and threatened cultural structure at the Leinster Bay sugar production site. They learned about the brutal historical context that resulted in sugar being grown and produced by enslaved workers in the Virgin Islands and the importance of cultural preservation to understanding that system. Students worked with an interdisciplinary team. They developed and practiced technical, project management, and communication skills by learning as they served. They collected data at the endangered site using photographic, surveying, and global positioning system techniques. They used the data to develop three-dimensional computer aided design models of the terrain and of a water-drawing windmill facing imminent collapse. They applied photogrammetry software to stitch the photos together to apply to the windmill model. They documented the work they performed. This was a truly unforgettable experience.

Acknowledgements

The Faculty Research Funds Committee, University of Maine, The Friends of the Virgin Islands National Park, and the Continuing Education Division, University of Maine funded this project.

Thank you to students in MET220 for the comments included in this paper and to Murray Callaway, a Lecturer in English at UM who provided a logical framework for reporting on the outcomes of the project.

1. Nick Houtman, Reengineering the Past, UMaine Today, January/February 2005, University of Maine System, 2005.
2. MicroStation, Bentley Systems, Inc. 2005. 3 Jan. 2005. < http://www.bentley.com/en-US/Products/MicroStation/ >.

3. Adobe Photoshop, Adobe Systems Incorporated 2004. 3 Jan. 2005. <http://www.adobe.com/products/photoshop/main.html>.
4. PTGui, New House Internet Service, B.V. 2004. 3 Jan. 2005. <http://www.PTGui.com/>.
5. ArcView, ESRI 14 Dec. 2004. 3 Jan. 2005. <http://www.esri.com/software/arcgis/arcview/>.
6. Lohr, Lynda. "St. Johns Ruins Being Preserved by Technology," *St. John Source* 10 Mar. 2004. 1 Jan. 2005. <http://www.onepaper.com/stjohnvi/?v=d&i=&s=News:Local&p=1075612934>.
7. Probasco, Mat, Associated Press. "Maine students digitally model Virgin Islands plantation," *Maine News from the AP Wire* 16 Mar. 2004. 1 Jan. 2005. < http://news.mainetoday.com/apwire/D81BEOLG1-75.shtml>.
8. . Probasco, Mat, Associated Press. "Maine students digitally model Virgin Islands plantation," *USA Today* 16 Mar. 2004. 25 May 2004. <http://www.usatoday.com/tech/news/2004-03-16-digitized-caribbean_x.htm>.

KAREN J. HORTON, Associate Professor of Mechanical Engineering Technology, University of Maine.

CONSTANCE HOLDEN, Instructor, Spatial Information Science and Engineering, University of Maine, and Associate Professor of Developmental Mathematics, University of Maine at Augusta.

KEN WILD, National Park Service Archeologist and Cultural Resource Manager, Virgin Islands National Park, St. John.