MOVING THE APPALACHIAN TRAIL: INVENTORY, ANALYSIS, MODELS, AND MAPS

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ABSTRACT

Rutgers University's Landscape Architecture students employed GIS in a variety of ways for a project to redesign an historic portion of the Appalachian Trail (AT) at Bear Mountain State Park in New York. The undergraduate students used ArcGIS and ModelBuilder to conduct a comprehensive study that included:

- inventorying the site
- analyzing conditions
- identifying potential trail routes
- exploring the routes with 3D visualization
- communicating features of the final design

Working in partnership with the New York-New Jersey Trail Conference, the project will establish permanent, sustainable routes for the portion of the trail that runs through Bear Mountain State Park. Other project partners included the National Park Service and the Palisades Interstate Park Commission.

This paper/presentation reports on the entire project which featured advanced GIS applications, public participatory methods, and a remarkably interdisciplinary study of one of the AT's most notable sites.

BACKGROUND

The 2,100 mile long Appalachian Trail (AT) is considered by many to be America's premier long trail, stretching from Maine to Georgia. While the full length of the trail has been completed by more than 8,000 hikers, millions of visitors have walked some segment of this storied trail. As a National Scenic Trail, the AT enjoys the protection and oversight of the National Park Service, while virtually all of its maintenance is performed by non-profit trail and hiking organizations who cherish this national treasure. Based on the vision of planner Benton MacKaye (1921), the original path of the AT was built in just 14 years. Today it is identified with its widely recognized logo (Figure 1).

The first segment of the Appalachian Trail was built in 1923 by the newly formed New York-New Jersey Trail Conference (NYNJTC) at Bear Mountain in New York. This segment is now within a short drive of New York City and sits within the heavily used Bear Mountain State Park, making it a heavily trafficked stretch of trail. This heavy use has come at a great cost, as the trail has resulted in over use and degradation, despite several relocations and continual refurbishment of eroded portions.

In an effort to create a more sustainable solution to this problem, the NYNJTC (tasked with the continuous maintenance of the AT through the states of New York and New Jersey) contacted the Landscape Architecture Department at Rutgers seeking assistance in planning and designing a 5 mile route across Bear Mountain. The 29 students enrolled in Landscape Architecture 331 (Intermediate Landscape Architecture I) dedicated themselves to this extended project and engaged in an enormous amount of work to see it through to its completion.

Figure 1 – The Appalachian Trail has had over 8,000 hikers complete its entire length.

Within the traditions of landscape architecture, regional design work like this is not unusual, although many of the specifics of the project set it apart. Landscape architectural educators have long included fairly advanced examples of landscape assessment and regional design in their studio work (as represented in McHarg 1969, Lewis 1996, and Steintiz 1993a, 1993b, 1993c). There are also some reasonable texts for guiding such work such as the one used in this class, The Living Landscape (Steiner 2000).

Despite the comfortable fit within the traditions of landscape architecture, the work is still difficult for students who are placed in a position of constantly learning new concepts and skills while producing materials that are of sufficient quality for public consumption. The students in the studio began with quite limited practical exposure to GIS. The first several weeks of the semester were used to advance their knowledge and abilities with GIS as far as possible. Still, each phase of the project created opportunities for learning additional material, and many elements of the project were still limited by the nascent GIS abilities of these students. The overall success of the project was reinforced by the interest in the community (e.g., Androvitch 2004; Cannon 2004; Hujber 2004; Malwitz 2004a, 2004b).

PROJECT DESCRIPTION

Inventorying the site

The project began with a comprehensive study of the characteristics and issues on site: the 5,000 acre Bear Mountain State Park, which is about 800 miles from the northern terminus of the trail at Mount Katahdin, ME. Initially, a broad study was undertaken collecting all readily available information, both analog and digital, that reliably described any known characteristics of the site. Over time these materials were assembled systematically into a thorough inventory of both the physical and the social landscapes.

The project team gathered information and data during visits to the area (Figure 2) and acquired existing data from the many project partners to map and analyze with ArcGIS. According to Lauren Weitz, a student in the class, “GIS enabled us to access a lot of data about the site in a small amount of time, which was crucial for us to be able to complete our project under such tight deadlines.”

Figure 2 – A New York-New Jersey Trail Conference volunteer leads students in an initial exploration of the Appalachian Trail at Bear Mountain State Park.

The inventory process for this site was not a trivial matter. While the physical characteristics of the area have been captured moderately well, data compatibility and availability complicated matters greatly. The study area is at the intersection of four counties, each with different data quantity and quality. And the site is also close to several areas of significance for homeland security and threatened and endangered species, each limiting the data available for the project.

Right from the start, the social and cultural elements of the inventory were much more difficult. The site is important historically for students of pre-settlement populations, Revolutionary War battles and movement, the Hudson River, the State Parks movement, and World War II, as well as the AT itself. Many of these histories are presented today primarily as vague written descriptions with limited spatial representations. However, the histories are both part of the appeal for visitors and a potential threat to siting the trail. Additionally, the inventory worked to incorporate information about approaching development as New York City's suburbs creep ever closer, and the park's very diverse user population.

One major form of assistance in the data collection process came from across campus. The students were granted access to existing data from the New York-New Jersey Highlands Regional Study through the Grant Walton Center for Remote Sensing and Spatial Analyses (CRSSA) at Rutgers. David Tulloch, a co-instructor of the course, was a co-investigator of that study, which was directed by the USDA Forest Service. These data present an integrated representation of existing land use and vegetation, streams, other trail locations and certain cultural aspects of the site.

The final product of the inventory process was a complex and thorough description (both graphic and textual) of the entire site and the larger study area. This was critically important for the next step: analysis of the site.

Analyzing conditions

The analysis and synthesis of the inventory materials served as a turning point of the project. Having amassed and organized an overwhelming amount of information, the project team was challenged to analyze it in ways that would reduce the information down to a comprehensible set of issues and problems and a systemized database that would support future work.

While new to the students, much of the analyses conducted were not so much innovative as they were fundamental. While the relatively simple task of converting a DEM into a usable set of slope and aspect maps can seem daunting to many new users, the project team worked to transform the inventory into an issue-oriented description of the site, often relying on multiple analytical approaches to the problem (Figure 3). For example, an aesthetics team worked with on-site photos as well as viewshed analysis to systematically identify areas deserving more attention as well as problem areas.

The goal of the analysis phase was to produce materials that could guide a participatory session, which was conducted as part of a 2-day charette (Figure 4). Participants at the charette included hikers, volunteers, topic experts and employees of many of the involved organizations. The charette provided the project team an opportunity to present their entire inventory and analysis and receive responses regarding any perceptions of its appropriateness or inappropriateness in describing this most unique landscape. The culminating session of the charette required the participants to digest the materials presented (as well as the content of other discussion sessions) and provide the project team with both a list of priorities and a list of different design approaches to explore. The first two phases of the project were considered a great success and have been awarded a planning award by the New Jersey chapter of the American Society of Landscape Architects.

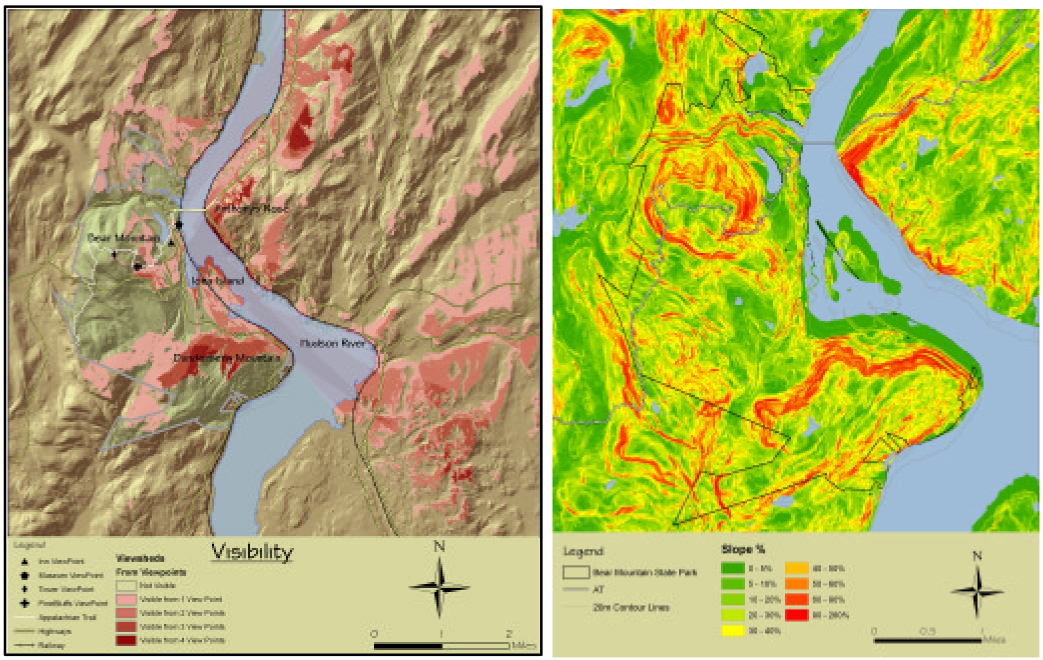

Figure 3 – Visibility and slope were among the many characteristics that were studied using the analytical capabilities of ArcGIS.

Figure 4 – A NYNJTC volunteer works with students at the first charette to understand the inventory and analysis materials.

Identifying potential trail routes

As a large and diverse project team, the many different students brought a variety of skills and interests. Several individuals were particularly motivated to explore the technology and advanced applications, like route selection.

While many members of the project team employed a more traditional approach to trail design in which they used trace paper overlays on top of the inventory and analysis materials, another approach emerged. Starting with a spatially explicit list of trail design criteria – including slope, land cover, and notable viewpoints – the designers used ModelBuilder and ArcGIS' analytical capabilities to assign "costs" across the surface of the mountain. Then, by identifying the least cost path the students had effectively identified several different potential routes up the mountain and then several more down.

While the trail experts participating in the process were initially hesitant about this approach, they quickly warmed to it as they bushwhacked their way along an approximation of the best of the computer-generated routes. As with any of the student-designed trail proposals, on-site exploration (or, perhaps, groundtruthing) revealed many details not shown in the data.

As a final step in this portion of the process, all of the proposed trail designs were digitized (Figure 5) to allow basic comparisons between the routes and the landscape (both general terrain and specific features). These trail designs were presented at a second charette where participants then helped develop a final design and strategy for the project (Figure 6).

Figure 5 – A comparison of the different trail alternative scenarios leading from the Bear Mountain Bridge (upper right) to the existing Appalachian Trail (lower left).

Figure 6 – Participants in the second charette used stickers and markers to mark their favorite, and least favorite, of each of the alternative designs.

Exploring alternatives with 3D visualization

Using the previously described data and ArcScene, the project team created 3-dimensional images and videos of the site as a means of communicating the basic characteristics and features of the site as well as exploring the alternative trail designs. Based on the number of students engaged in the creation and editing of the videos, the technology has clearly crossed a threshold regarding usability.

Exploring and understanding the site and cognizing the implications of different trail alignments fits within a larger process of exploring planning and design proposals (Figure 7). "Two dimensional maps can only take you so far; ArcMap helped us create detailed trail systems, taking into consideration all the geologic and topographic features on site," said Almodovar. The 3-dimensional element also aided the group further in their credibility with the audience. It was one more, very dynamic element that the project team could provide that other participating groups did not yet have.

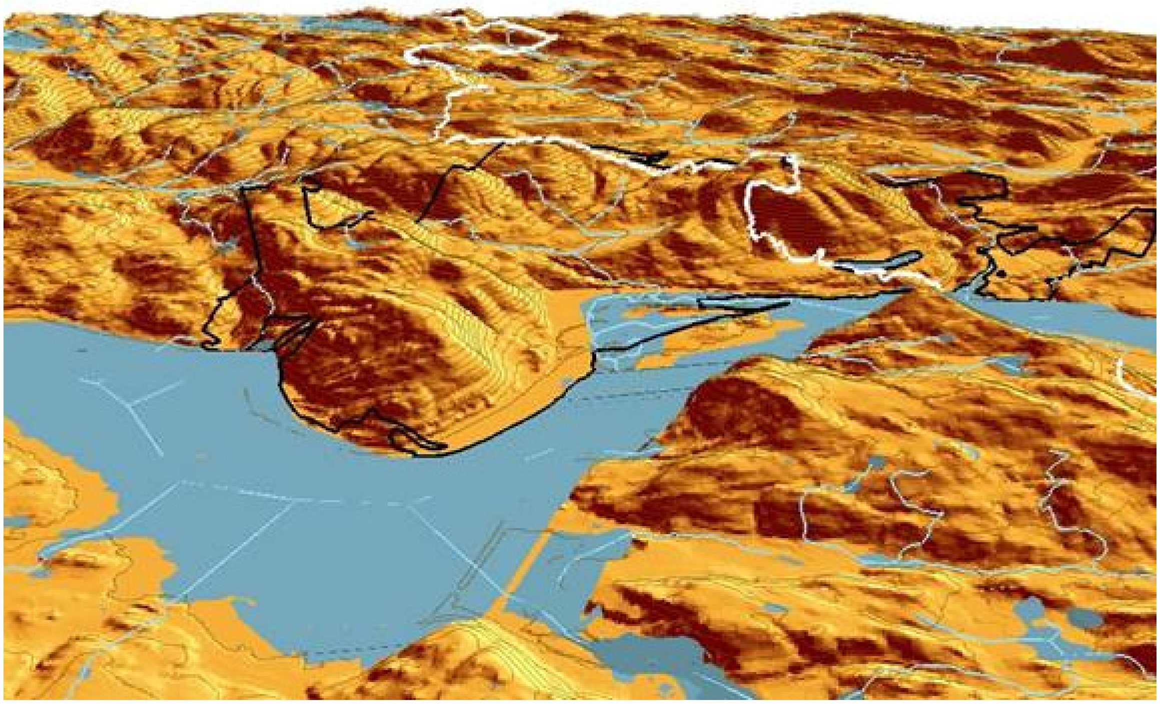

Figure 7 -- ArcScene allowed the students to illustrate how the Appalachian Trail (in white) snakes across the landscapes of the Hudson Highlands.

Communicating features of the final design

A major challenge of the project was finding ways to communicate the design concepts and specific outcomes envisioned by the project team. Much of the sophisticated analysis mentioned earlier was less important to some participants than textual descriptions and simple hand-drawn sketches. The 3-D fly over video clearly helped the students establish their technological credibility with the audience, but it is less clear that it truly communicated complicated issues as well as simple maps.

Instead of treating this as a problem, the undergraduates creatively sought many different alternative techniques ranging from analog to digital and virtually everything in between (Figure 8). Some of these included creative manipulations and alterations of ArcGIS products in other programs. One team explored printing map materials, marking and rendering them by hand, rescanning that modified product, and further editing the imagery in photo-editing software. The practical experience of watching participants – real experts on the site -- interact with their maps and drawings is an irreplaceable learning experience. Even when some elements never reached their intended level of sophistication.

Figure 8 – Students used a wide variety of graphic techniques to communicate various aspects of their design work.

LESSONS LEARNED

The project described in this paper was part of an important learning experience for all parties involved: students, faculty, and charette participants. Aside from the final design (portrayed online at http://hahawall.rutgers.edu/jrstudio/BearMt/Final/), the project's most important element was the new ground forged for the many involved parties. These new experiences, often somewhat experimental in nature, were important "lessons learned."

Clearly, a studio project like this can't succeed without some significant technology applications. The integration of the technology into the class is important because it helps make such a large project possible. Students are better prepared to understand GI science issues, like data incompatibility and the importance of metadata, after confronting them on a real project. Site visits, especially to such a compelling site, also make the learning experience deeper (Figure 9).

The project also introduced issues of institutional complexity. The students worked in partnership with the New York-New Jersey Trail Conference. But the project also involved the National Park Service, the Palisades Interstate Park Commission, the Appalachian Trail Conservancy, and the New York State Office of Parks, Recreation and Historic Preservation. The students had to synthesize information from these different organizations while also trying to develop a vision that could satisfy their needs.

Students rarely get to move from so little experience (having worked through a few ArcGIS exercises) to such advanced applications (e.g., trail routing algorithms and 3-D animations). Instead of being a daunting problem, most of the students responded positively to this learning environment. It was easier for them to cognize the complex issues -- ranging from coordinate systems to classification to complex cartography – in a stressful but rewarding project environment, than in abstract exercises.

Finally, the faculty and professional participants witnessed creative approaches and solutions that would not have resulted within the traditional trail design environment. While, ultimately, at least 80% of the presented design work was thrown away before the end of the second charette, the impact that these exploratory approaches had was important to the overall success of the project. Thanks to these expressive materials, virtually every participant reached a new level of understanding about this wonderful old mountain and this historic trail.

Figure 9 – Two landscape architecture students study a heavily used portion of the Appalachian Trail at Bear Mountain State Park in New York. The Hudson River is seen in the background.

ACKNOWLEDGMENTS

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The most important contribution came from the entire class of 29 students in Landscape Architecture 331 -- Intermediate Landscape Architecture I. Their late nights and eagerness to invest themselves in the project was critically important to the overall success of the process.

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