TOURING "GREAT ROADS" OF HUMAN ACTIVITY: USING GEOGRAPHIC VISUALIZATION TO EXPLORE HISTORICAL LANDSCAPES

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ABSTRACT

Geographic visualization is being used to enhance learning and stimulate student research in introductory history courses at Samford University. A combination of natural and man-made feature data layers provides a geographic tableau that illuminates human-environment interactions and their influence on settlement. Given virtual environments for selected historic corridors, students research locations and events associated with historical actions that occurred within these corridors. The ability to visually explore spatial contexts associated with past events excites student interest and promotes insight into historical eras. Spatial data visualization in GIS is a natural fit for the "Great Roads" approach, which teaches regional history in microcosm. Using geographic visualization to teach history and stimulate student research makes such survey classes more interactive and engaging for students. Here is evidence that GIS is transforming not only the way historians use maps, but also the way they teach. GIS project development of these "Great Roads" experiences for history education is supported by the Academic Excellence and Geographic Information Systems (AEGIS) Project. This three-year project (funded by the U.S. National Science Foundation) is training Samford University faculty from a variety of disciplines (history, political science, classics, chemistry, biology) to use GIS with students in lower-division courses.

INTRODUCTION

The computer revolution has changed the way history is researched, written, and taught. There undoubtedly remain islands within the profession not immersed in the digital tide, but they are rapidly disappearing. Search engines such as JSTOR now routinely provide users full access to digital copies of academic journal articles, eliminating the need for interlibrary loan or photocopying expense. Contemporary routines such as e-mail communications between colleagues for research project development and the sharing of data and information across vast telecommunications networks are forming a new digital infrastructure that is transforming management of the scholarly experience. None of this replaces basic historical skills such as locating valuable primary sources or intelligently balancing arguments based on evidence, but computer systems are dramatically improving access to most of those sources and arguments.

This computer revolution has likewise transformed the way historians use maps. Historians have traditionally used two-dimensional maps – whether on a classroom wall or a page in a book – displayed at fixed scale, static and voiceless. The use of map data in Geographic Information Systems (GIS) software revolutionizes this experience by enabling dynamic interaction with historical landscapes in three geographic dimensions (as well as, of course, a temporal fourth dimension). Layers of geographic data associated with these historical landscapes can be shuffled and manipulated, as if they were a stack of printed transparencies. Historical attributes associated with point, line, and area features can be developed and easily accessed by any user. Such geographic visualization provides an exciting means for communicating spatial contexts associated with important historical events, and offers an effective tool for stimulating student research. This paper will explore the use of geographic visualization as it is evolving in an introductory history course at the authors' university in the United States.

BACKSTORY ON "GREAT ROADS" APPROACH FOR LEARNING HISTORY WITH GIS

During the freshman year at Samford University, aspects of western heritage (philosophy, history, literature, art, and music) are the subject of a two-semester course sequence – UCCP 101 & 102 *Cultural Perspectives* – taught in the freshman year. The non-western world is fairly well ignored, and even the modern history of Europe gets short shrift, so great are the interdisciplinary pressures that all fields be represented. So when it comes to the History Department's sophomore-level Humanities general education option – HIST 200 *The West in Global Perspective* – an instructor has but a single semester to communicate the essence of world history in the past five hundred years.

Virtually all universities in the United States offer such a world history class that claims to introduce the history of the whole world since 1500 or some similar date. It is an ambitious yet vitally important undertaking, considering all that American students fail to know about the modern world, and that this may be their total collegiate exposure to world history. Of all the problems involved in mounting such a course, three may be most basic:

- The first challenge for a university history professor is to emphasize *world* history in such courses, since they have only recently evolved out of a "Western Civilization" survey class tradition. Many so-called world history courses (and their associated textbooks) in U.S. universities clearly still offer what is basically a traditional western civilization approach with a few poorly integrated add-ons from the non-western world.
- A second difficulty is how to deal with great population units, ideologies, and movements and still keep things on a human scale. Unless students can relate to the experiences of other human beings on a personal level, history does not usually come alive for them.
- A third problem is the matter of how to get students actively engaged in reading and research. Lifelong independent learning habits are essential for effective critical thinking and problem solving in a world where globalization has dramatically increased international interactions.

Professor Brown's approach to this learning experience includes an initial focus on understanding how Europe and Europeanized powers developed hitherto unknown technological power and even more interesting powers of social mobilization that enabled them to explore and then dominate the rest of the world. He then explores how the non-European world fought back against colonialism to regain independence, in part by learning the secrets of those same European tools and ideas that had enabled their subjugation.

Professor Brown has been teaching this course for more than thirty years. In the current version of the course, he begins with a quick survey of European technological developments from maritime improvements ca. A.D. 1300-1500, to intellectual breakthroughs in the Scientific Revolution 1500-1700, and to the military implications of the Industrial Revolution after 1780. Most of this lecture track, however, is devoted to the less tangible but arguably more important theme of new European ideas of social mobilization – political nationalism as invented in the Enlightenment and worked out most spectacularly in the French Revolution; cultural nationalism as invented in early Romantic thought and worked out most notably in modern German history; socialism (particularly in its Marxist variety) as invented in nineteenth-century central European social science and developed most comprehensively in modern Russian history. Thus he introduces the major political ideologies of the modern world, assuming American students already have some familiarity with classical Liberalism. (He also assumes, rightly or wrongly, that he can expect his students to be familiar with U.S. history and to a lesser extent with British history.) In addition to exploring the powers tapped by these three greatest of all modern ideologies, it is also intended to give students some chronological framework of modern European events from the French Revolution and the Congress of Vienna on through the Cold War to use as a background for understanding European impact on non-European regions. Hopefully it provides students with some idea of how Europeans and Europeanized countries so quickly explored and then came to dominate the rest of the world. But this is not the theme of the course that makes particular use of geographic visualization.

Visualization comes into play when students use interactive mapping experiences to explore how the rest of the world, region by region, fought back against European intrusion, in part by borrowing some of those same European physical and intellectual inventions, especially nationalism and socialism. Working with GIS data layers, the instructor takes one key transportation corridor in each of six non-European regions of the world, to use to teach the history of that region in microcosm. These are not famous cross-cultural roads or journeys such as the Silk Road, the route of the Orient Express, the Pan-American Highway, and such, but transportation corridors limited to regions or even single nations:

1. the Veracruz-to-Mexico City corridor, to represent Latin American history since 1500
2. the Durban-to-Johannesburg corridor, to represent modern African history
3. the road network from Damascus south to the Gulf of Aqaba and the Nile Delta, to represent the Mideast
4. the Grand Trunk Road from India's Calcutta to Pakistan's Lahore, to represent South Asia
5. the main road from Jakarta to Surabaya on Java, to represent Southeast Asia
6. Japan's Tokaido from Kyoto to Tokyo, to represent East Asia

The assumption here is that most every development of consequence in any region shows up along its most important transportation corridor, and can be illustrated with examples on a human scale instead of with a nameless, faceless summary that might be valuable for the scholar but be deadly dull for the survey history student. The hacienda, for example, was a control institution that evolved in New Spain about eighty years after the original Spanish conquest and that faded away in the Mexican Revolution of the 1910s and the land reforms of the 1920s and 1930s. Introducing students to two specific haciendas along the Veracruz-to-Mexico Corridor – El Lencero (owned for a time by Santa Anna, occupied by Winfield Scott, lived in for awhile by Gabriela Mistral and now beautifully preserved as a museum of 19th century furniture) and San Pedro Coxtocan (created in 1602 and bought, with the worst of timing, by an American-British couple in 1906), gives introductory history students specific names and faces to work with, yet leaves a lasting image of the rise and fall of the whole institution.

For each corridor the instructor requires that an associated book be read – some political autobiography, such as *Long Walk to Freedom* (Mandela 1994) and *This Side of Peace* (Ashrawi 1994); some eyewitness travel/adventure, such as Bernal Díaz's *Conquest of New Spain*; some historical fiction, such as Rudyard Kipling's *Kim* and C. J. Koch's *Year of Living Dangerously*; some a combination of all the above, such as *Japanese Inn* (Statler 1961). In all cases the paths of the chief personae of the books, fictional or historical, intersect or run along the main corridors that serve to represent the region. Objective daily quizzes on these readings usually start out viewed as onerous by most of the class, but are soon welcomed almost as a sort of entertainment. Lectures on history as seen along these regional corridors build up to the subjects of books that come late in history (for example, Palestinians and Israelis in the late 20th century, as in Ashrawi's autobiography) and build on top of the subject of books that come earlier in history (for example, Bernal Díaz's eyewitness account of Cortés' conquest of Mexico from 1519-1521).

The instructor has gradually evolved a practice of grouping students into five or six small discussion groups from the second day of class, one for each non-European region of the course. They take daily reading quizzes first as individuals, and then as members of their small group, and get the total of the two grades. This serves as a nice springboard towards general class discussion, and second, it helps them quickly get to know group members, which is important in that there is some group dimension to their research papers at the end of the semester. In class the small groups are thereafter collectively referred to as "Mexicans," "South Africans," "Japanese," etc. Individual research projects for the course must be chosen in the history of a student's particular region, and be on a topic that shows up as either movement or pattern on the chosen corridor. At semester's end the instructor gets a traditional research paper in history, while the class gets a presentation on the same material using hyperlinked data layers (created by the students) in GIS to convey a sense of place associated with important historical events.

This "Great Roads" approach yields a broad cultural history. History as a humanities discipline (as with virtually every social science discipline) has independently developed a "telescoping-of-time" technique for quickly getting a handle on a given region. A quick and successive look at geology and climate, soils, native vegetation, native zoology, prehistory, history, political balance of forces in the present leads to educated guesses at the near future. Perhaps the most famous work of history among historians worldwide (in the past century) was *Le Méditerranée et le Monde Méditerranéan à l'Epoque de Philippe II* (Braudel 1949). Only by page nine hundred or so of this twelve hundred page blockbuster did Fernand Braudel get to specific political and military chronology, but it was all the richer for the geology-to-prehistory look at what came before. In the field of Geography, Carl O. Sauer's *The Early Spanish Main* is a better look at the clash of Spanish and Carribean culture than any historian has written, primarily because of his use of that same geology-based approach (Sauer 1966). Ian McHarg, a Scottish scholar who wound up at the University of Pennsylvania as head of the department of Landscape Architecture, used a regional planning approach based on this geology-to-the-future pattern. On his faculty were geologists, geomorphologists, botanists and zoologists, anthropologists/folklorists, historians, and political scientists. They would descend on a community and each study a particular angle, bring them all together in that telescoping-of-time pattern, and then say to the community: projecting these curves of land use, social behavior, etc., here is what you will look like in fifty years; conversely, tell us what you would like to look like in fifty years and we'll tell you which of these curves you have to change. From this, of course, came *Design With Nature* (McHarg 1969), which with its stacked transparency technique of solving current planning problems prefigured and influenced GIS.

EARLY TERRAIN MODELS FOR "GREAT ROADS" HISTORY LESSONS

Trying to set his history subjects in the framework of such a geology-to-future planning sweep, Professor Brown (for each of the six regional corridors listed above) began by developing three-dimensional classroom terrain map models, approximately 30" x 18" in length and width, some 5 or 6" high when completed. The basic idea was that once students got a feel for the ups and downs of the land, determined mainly by geology, and also the variations of climate and vegetation there, they had a very visual setting for the historical events that played out there – a very visual geographical set on which the teacher could then stage the history. He experimented with these static 3D terrain models and found that they engaged students in a limited way, and were difficult and bulky to store.

He then developed and patented a way to use a limited number of quarter-inch-thick contour map "motherboards" – usually four or five – in which the same contour lines were cut on regular intervals but staggered from board to board. This yielded color-coded contour "rings" that students could stack atop one another and enabled the building of a map model of thirty or more layers, for example, from four motherboards that all stored in a one-inch thickness. As a teaching device it proved to be considerably more engaging than two-dimensional maps or even static three-dimensional ones. While students constructed the model layer by layer, building up the terrain from sea-level (or from 400 meters below sea-level, in the case of the Jordan Rift Valley map), he could talk to them of the changes in climate, vegetation and scenery that came with changes in altitude, or of the rain shadows relating to mountain ranges and prevailing winds. For those corridors he had personally "worked" with camera, in the company of area experts and translators (Veracruz-to-Mexico City, twice; Damascus south, twice), he was able to show PowerPoint slides and relate them to the 3D classroom models. Students in small groups were then challenged to guess the main historical road(s) along this terrain, by deciding where to drape light-pull chains on the map model to represent the road. The professor, with other chains, then provided actual historical solution(s) to the question, explaining where students got parts of it right, when they had not and why not. Such models disassembled for storage in a couple of minutes at the end of class, ready for use with another class. At the time, students were given individual copies of two-dimensional black-and-white maps of the corridor to help them remember the original and from which they could learn specific cities and terrain features.

Some aspects of this were gradually made easier and more accurate by the introduction of Geographic Information Systems at Samford University, courtesy of the Department of Geography. After training on the use of GIS software, Professor Brown was able to import digital terrain data for conversion into contour lines at specified elevation intervals, apply hypsometric color shading, and add cities, rivers, railroads, roads and other data as appropriate. Resulting contour lines were then converted into a physical model using a computer-controlled laser cutter on a 40" by 80" bed, and printed maps glued to motherboards were cut quite precisely into those contour rings to be stacked atop one another as described above (Brown and Sullivan-Gonzalez 2002).

EXPANDING THE REACH OF GIS AT SAMFORD UNIVERSITY

Four years ago Professor Baber was hired by the Samford University Department of Geography to serve teaching and related needs associated with the mapping sciences. Professors Brown and Baber were initially introduced through the university's "new faculty" mentoring program. During this time Brown began to learn more about the potential for use of GIS in developing hands-on, interactive student experiences – at first simply exploring how he might create maps for students, but later wondering if students might be actively involved in the process. Baber in turn became increasingly interested in the dissemination of GIS throughout the undergraduate curriculum, and eventually led a grant-writing team to submit a proposal to the National Science Foundation (NSF) supporting the integration of GIS experiences into lower division courses across the Arts and Sciences. The resulting grant-writing team included two social science faculty from Geography (with Baber as Principle Investigator), two physical science faculty from Biology, and Brown as the sole Humanities representative. The National Science Foundation subsequently awarded funding for *"Academic Excellence and Geographic Information Systems (AEGIS): Guided Multidisciplinary Integration of Spatial Technologies in Higher Education"* in September 2003 (DUE-0310935). The AEGIS Project, as it is known at Samford, is a multidisciplinary effort to introduce students in a variety of lower division Arts & Sciences courses to methods of GIS data gathering, exploration, analysis, and representation

Integration of GIS across a university's curriculum was pioneered at schools such as the University of Wisconsin-Milwaukee, in response to growing demands for the technology in Geography, Urban and Regional Planning, and Biological Sciences (Huxhold 1994). Today, many prominent universities (including the University of Georgia, Florida State University, the University of Oregon, the University of Arizona, the University of North Carolina, the University of Tennessee, Syracuse University, Rutgers University, Pennsylvania State University, the University of Maryland, Clark University, and the University of Delaware, to name but a few) have developed extensive multidisciplinary GIS programs. The time is right to extend the use of spatial technology in multidisciplinary education at smaller liberal arts schools such as Samford University.

GIS is an exciting, multidisciplinary technology that offers problem-based learning opportunities for undergraduate research. Computerized map database software is the engine that moves GIS, and it is now widely used for the analysis and management of spatial data. A broad spectrum of professional fields employ GIS, including Business (retail location, real estate, site selection), Engineering (transportation planning, site development), Urban and Regional Planning (demographic analysis, resource allocation), Biology (habitat analysis, change detection), Meteorology (weather systems, storm modeling), Agriculture (precision farming), Public Safety (geographic profiling, crime mapping), Political Science (election analysis, political systems), and Sociology (socioeconomic studies, criminology). The AEGIS Project is extending student education and research experience into many of these areas.

The implementation strategy for this project was based on the success of Problem-Based Learning (PBL) throughout the university. Samford is a nationally-recognized leader in implementing PBL in the undergraduate curriculum. In 1998 Samford was awarded a $1 million grant from the Pew Charitable Trusts. The strategy for adding PBL to the curriculum was based on intense faculty development and training, summer release time, and peer exposure and review of PBL course modules. Since 1998 PBL has been adopted in over 50 classes across various disciplines and by over 75 professors and instructors. In October 2000 Samford hosted a highly successful PBL conference (attended by more than 600 educators and administrators), and was awarded a second grant from Pew establishing a national center for the peer review of PBL course portfolios. In 2001 the university was awarded a Trans-Atlantic Cooperation (TAC) grant, payed for by the Fund for the Improvement of Post-Secondary Education (FIPSE) in cooperation with a mirror grant funded by the European Commission of the EU to facilitate scholarly partnerships between Samford and the University of Maastricht in the Netherlands.

Problem-Based Learning and GIS are a natural fit. Using the PBL strategy, students and teachers draw on current events and community issues (including environmental matters) to analyze GIS data with real-world relevance (Audet and Ludwig 2000). GIS technology supports a variety of spatial decision-making applications and there are numerous reports of GIS used for general education in a project-oriented, problem-solving environment (Audet and Paris 1997, Chen 1998, White and Simms 1993). Geographic Information Science encompasses the use of GIS in scientific research and spatial analysis, along with the study of fundamental issues arising from the creation, management and use of spatial information (Longley et al 2001).

GIS is nothing less than a technological revolution in the mapping sciences, and the benefits extend beyond cartography and remote sensing to a host of disciplines where spatial data analysis is important (such as environmental resource management and regional planning). GIS databases provide the means to input, store, manage, display, and analyze spatial information in a medium where many current challenges (environmental protection and natural resource conservation, for example) can be more efficiently explored (Chou 1997). Workplace technology for many contemporary occupations increasingly involves GIS, and students must be prepared for such technical work environments in order to remain competitive. GIS is employed within numerous professional fields, including geology, ecology, hydrology, archaeology, forestry, demography, public safety, transportation planning, and business logistics (Davis 2001, Longley et al 2001). Throughout the United States the number of persons using GIS as part of their jobs is estimated at more than half a million, a number projected to grow at a rate of 15 percent per year adding a demand for roughly 75,000 new GIS employees each year (Phoenix 2000). The U.S. Department of Labor has identified geotechnology as one of three important emerging technological career fields (along with biotechnology and nanotechnology), and economic growth in the worldwide GIS market is projected by some to more than quadruple annually for the near term future (Gewin 2004). Samford University is working to help meet this growing demand.

SCIENCE, TECHNOLOGY, AND THE LIBERAL ARTS

Institutions of higher education must provide both scientific leaders and a society that can intelligently evaluate the alternatives that science presents to them. Samford University is a traditional "liberal arts" college committed to developing within its students an appreciation for the value of scientific and technological endeavors as well as their abiding importance to everyday life in the United States. Daniel Sullivan, President of Allegheny College, has noted, "the nation's liberal arts colleges . . . are fertile soil for innovation and experimentation" (Sullivan 1994).

Samford University, the largest private university in Alabama, offers learning experiences and nurturing relationships with faculty so that each student may develop personal empowerment, academic and career competency, social and civic responsibility, and ethical and spiritual strength. This 160 year old university is one of the oldest educational institutions in Alabama and embraces its mission and responsibility of stewardship to the 4,500 men and women enrolled from 41 states and 21 nations throughout the world.

The Department of Geography offers majors in Geography and an interdisciplinary concentration in Environmental Science/Geographic Information Systems (initiated in 1995 in partnership with the Department of Biology), as well as a recently developed Certificate in Geographic Information Science. The GIS program in Geography began in 1990 with a grant from RUST International, Inc. In 1991 Samford University reached agreement with Environmental Systems Research Institute, Inc. (ESRI) to establish a Regional Training Center for ESRI GIS software.

The Department of Biology offers majors in Biology, Environmental Science, and the aforementioned Environmental Science/Geographic Information Systems (offered jointly with the Department of Geography), each leading to a Bachelor of Science degree. The EGIS program trains environmental science students, giving them extensive knowledge in GIS, GPS and mapping.

Samford is poised to play an important role in environmental quality and global sustainability. In Fall 2001, the Vulcan Materials Company Foundation awarded Samford University a US $310,000 grant to establish the Vulcan Materials Center for Environmental Stewardship and Education (VMC). This partnership between Vulcan Materials Company and Samford University encompasses three areas of strategic importance: education, environmental stewardship and innovative environmental management. Located in Samford's recently built science building, the Center brings all of Samford University's environmental academic programs within a single conceptual framework.

Samford faculty work cooperatively to develop innovative, interdisciplinary educational experiences. Samford University is an institution that places great emphasis on both teaching and research. Samford faculty view learning and discovery as truly inseparable processes, and both lie at the heart of the mission of our university. We also know that the 21st century society will require skills such as solving complex problems, dealing with uncertainty, and probing the unknown that are best acquired through discovery based learning experiences. Committing to the integration of research and education will help secure our nation's future by asserting a traditional strength of our great universities.

DEVELOPMENT OF "GREAT ROADS" VISUALIZATIONS

Over the past two years the AEGIS Project has transformed the "Great Roads" classroom experience. In addition to providing participating faculty members with training in GIS, the grant funded installation of ArcGIS software on all computers in every student computer laboratory on campus as well as on office computers of any faculty member who requested it. Now everything from introduction to each corridor to final class presentation is performed in GIS format, with a current goal to enable students to "fly" through historical landscapes using ArcGIS 3D Analyst, ArcScene, and/or ArcGlobe.

In order to produce suitable geographic visualizations, Professor Brown as History instructor required elevation data on a general regional scale (as opposed to maps with a tighter focus such as a specific battlefield or city). He wanted to begin his experiment with Mexico, move on to South Africa, and then through four additional regional "Great Roads." Appropriate free data was available on the web from the U.S. National Imagery and Mapping Agency's (NIMA) Geospatial Engine. This GIS data portal allows a user to zoom in to an appropriate part of the world on the opening map, select "NIMA coverage" and expect to find DTED Level 0 elevation coverage virtually worldwide. This site allows a user to define an area of interest by selecting an upper-left point and a lower-right point to define a rectangle. If the user is using ArcGIS software, the data can be downloaded and translated into ArcInfo Grid format for use in ArcMAP. Symbology for this digital terrain model can then be classified in regular elevation intervals of the user's choice – in Brown's case, 100 meter intervals – and hypsometrically tinted in a great variety of ways – in Brown's case, in colors rather typical of a traditional atlas. This digital elevation model (DEM) can be used to create a "hillshade" layer (as if a light source were shining from some particular point of the compass and some particular angle in the sky, creating realistic shadows on this digital recreation of the earth's surface, upon which the hypsometrically scaled DEM can be draped for enhanced terrain representation.

To this basic elevation and hillshade map Professor Brown added other layers of data – modern cities, railroads, rivers and such. Once located, such complementary data files for the area of interest were imported into this base map, and trimmed ("clipped" as the software labels the process) to fit the area of interest. These features were extracted from a larger dataset bundled with the ArcGIS program media. The most useful data files included city centers (points) and large urban zones (areas), current railroads, current roads, rivers (all lines) and/or floodplains (areas), and even a gazetteer (points) of populated places. All these complementary files are in vector form (presented, that is, in the form of points, lines and areas/polygons). The elevation data is in raster form, and works fairly well until one zooms in to a field less than 20 km x 20 km or so (when the square geometric pattern of the raster grid's pixels becomes too coarse for effective viewing). The data is deeper than the initial map shows. Using the information tool and clicking on a given stretch of railroad, for example, yields a pop-up table of attributes that among other things identifies it as either single- or double-track. City attribute tables give population, at least in ranges. A single random point clicked on the map reveals attributes that tell a user, depending on which layers are uppermost in the legend of the map, which administrative area it is in, its exact elevation, and much more. For more detailed maps, a massive amount of digital data is commercially available ranging from very reasonable prices to extravagantly unreasonable rates. Professor Brown intends to eventually develop high resolution visualizations of localized events, including battlefields, cityscapes, and other such areas requiring closer spatial focus.

STIMULATING UNDERGRADUATE HISTORY RESEARCH WITH GEO-VISUALIZATION

One trick at this point is to make sure the course remains a history class and does not become a GIS class. So far Professor Brown has done this to reasonable satisfaction, and (judging by student course evaluations) to the satisfaction of almost all the students. At this point in the evolution of the course, he takes four single hours from his course, spread fairly evenly across the semester, to introduce the different regional terrains – while at the same time introducing students to GIS use in a slow and graduated way. In general they are taught manipulation of data already in layer form in GIS, and not very much about finding such data in cyberspace or other sources and importing same into GIS. The hope is that those intrigued enough by the process to want to do the latter will go take the introductory GIS sequence offered by the Geography Department.

In the first GIS lab of the course students in pairs (working together to help boost their confidence with this at first mysterious and largely unknown GIS process) are issued a CD-ROM with an ArcGIS map document file of the Veracruz-to-Mexico City corridor (including all associated data layer files). Students are taught how to (a) display existing layers (beginning with hillshading), (b) manipulate an elevations layer for hypsometric tinting and partial transparency for draping the classified elevation layer over the hillshade layer, (c) modify symbolization for roads, railroads, rivers, flood plains and urban areas as appropriate, and (d) use basic tools such as zoom, pan, measure, information, etc. The last step of this first exercise is instruction for them to switch from Data to Layout View, and give their map a title, north arrow, scale bar and authorship. Students then to export a graphic image (.jpeg) file of their completed map and send it to the instructor's e-mail address. He in turn runs off two color copies of each for distribution at next class, and at the same time makes use of these maps in the currently on-going Mexican history lectures.

By the second GIS lab students are required to bring 256MB flashdrives (a U.S. $40 addition to materials required for the course, but an item with multiple future uses for students after this course) and are set to work individually with an ArcGIS map document file of the Durban-to-South Africa corridor. Many of the tools they will need in their final presentation of their research project in the course are introduced here: (a) how to create new point, line, and area features representing routes, territories, and events gleaned from historical research, (b) how to hyperlink graphic images they have located from their research for use in illustrating what they have learned in presentations to the class, and (c) how to label different features that they have added to their interactive map projects.

From the very beginnings of this terrain-map-and-history project – in fact from years and years ago when he saw a computerized fly-by produced by the Jet Propulsion Laboratory of the general Los Angeles area – Professor Brown has aspired to integrate that kind of visual terrain map technology in his history class. Now ArcGIS 3D Analyst, ArcScene, and ArcGlobe have put these aspirations within reach.

Last year, on a trip to South Africa to "work" the Durban-to-Johannesburg corridor with camera and notebook, the author learned that he could purchase the entire 1:50,000 scale topo maps of South Africa, in digital form as a set of seventeen CDs, for less than $100 U.S. From the Republic of South Africa's Land Affairs Department, Chief Directorate, Surveys and Mapping (Van Der Sterr Bldg, Rhodes Avenue, Mowbray; tel: +27 21 658 4300; website: http://w#sli.wcape.gov.za ; e-mail: cdsm@sli.wcape.gov.za ; email map sales: sales@sli.wcape.gov.za). He promptly ordered same, and was delighted to find that the whole Isandhlwana – Rorke's Drift battlefields area fit on the same 25 km x 25 km (approx.15 mi. x 15 mi.) tile, which made importing it into his existing ArcGIS map document file very convenient.

Isandhlwana was the most spectacular battle in the whole sixty years of the Zulu heyday, a January 1879 Zulu-British analogue of the1876 Custer's Last Stand between the Sioux and the U.S. Army (as the author tells his mostly American history students). Here a British unit armed with rockets, cannon and state-of-the-art Martini-Henry rifles was surprised by a Zulu force of some 40,000 and almost totally wiped out; there were 55 survivors, they were all mounted, and they all probably left the battlefield early. And like the Sioux victory, it simply meant that the defeated European power was now obliged to bring in overwhelming force and break all opposition: the Zulus were finally crushed as an independent entity by the British within six months after Isandhlwana. Not only is Isandhlwana a crucial turning point in South African history, it is one of the most dramatic settings for a battle in all of world history. The British camp was at the base of a quarter-mile-long hill shaped remarkably like the Egyptian sphinx, a landmark visible from miles and miles away. The three-mile-long ridge that the main Zulu army suddenly stood up along, and the rolling plain on which the subsequent battle developed, spread out clearly before a modern-day observer standing at the base of the sphinx. Only seven miles west is Oskarberg, the mountain across the Buffalo River (the border then between British Natal and independent Zululand) at the base of which was Rorke's Drift, garrisoned by a very small and sickly British force, where fugitives ran and where the subsequent battle progressed.

To make a long story shorter, the contour lines of this tile can be converted to a terrain model in GIS, over which an instructor can drape modern roads and historic battlefield movements. Using contemporary visualization tools available in ArcGIS, self-controlled student fly-bys of the Isandhlwana – Fugitive's Drift – Rorke's Drift path of the battle are now possible, from the mistaken excursion east of the main British force under Lord Chelmsford in search of the main Zulu army that was not there, to the discovery by a handful of British cavalry of 40,000 Zulu warriors sitting quietly regiment by regiment in a nearby gorge, to the dying away of attacks on Rorke's Drift a day later. It brings the whole campaign to life in a way Professor Brown has never achieved before.

In the future the authors are eager integrate such contour maps of major battlefields on all of the identified regional corridors – Cerro Gordo or Puebla in Mexico, Napoleon before Acco in Palestine, in fact a long, long list of crucial battles fought along these six world-class corridors in the past half-millennium.

CONCLUSIONS

Part of the success of this "Great Roads" geographic visualization teaching approach is that it lets the instructor deal with huge institutions and movements (the *hacienda* as a Spanish colonial control device that emerged about 1600 in New Spain, for example) while still keeping history on a personal level (the particular history and images of the Hacienda El Lencero near Xalapa, to continue the example, for a time the key hacienda of Santa Anna and now lovingly restored as a museum of nineteenth-century furniture, or of San Pedro Coxtocan, a hacienda created in Huejotzingo in 1602 and bought, with the worst of timing, by an American-British couple in 1906, just before the Mexican Revolution in the land reforms of which they lost both hacienda and their lives). Another factor is that once students can visualize the lay and texture of the land, they have a mental stage on which the history can be played out.

Student presentations of historical research via GIS have been enormously successful. Small groups know from early in the course that they must come to an agreed basic terrain map they will share, though each have their own points, lines and areas layers to use as well as hyperlinked images of their own. Limiting research topics to subjects that show up as movement or pattern along the chosen regional corridor has freed students to focus on the spatial influence of terrain on important historical eras and events. The movements of armies, goods and persons, the pattern of religious shrines or pilgrimages, the changing patterns of agriculture – these are all represented, as expected, quite well. But even the use of geographic visualization to illustrate literary history has proven successful. Over the past two semesters "South African" group students have done very interesting comparisons of the lives of authors and their fictional characters as they related to the Durban-to-Johannesburg corridor. One project visualized the experiences of H. Rider Haggard as a circuit-riding judge in Natal compared with his fictional hunter in *King Solomon's Mines* (Alan Quartermain, who headed inland from Durban to confront the fictional Kukuana), who shared a good many traits Haggard saw in the nearby very non-fictional Zulus. Another explored Nadine Gordimer's early years in a grim mining town not far from Johannesburg, versus the flight of the "liberal" white couple she so vividly created in *July's People*.

In summary, Professor Brown attempts to give his university history students lasting insights into important patterns of six non-western regions of the modern world by using geographic visualization to enhance student learning. Student exploration of these historical tableaus using GIS is constrained only by the bounds of their intellectual curiosity. As a final example, in one of these six corridors – South African history – he aspires to present everything from where San rock art was produce in prehistoric times to the Gauteng invasion of the coast on a modern summer holiday. Under the extreme time pressure of a world history survey course, he tries to do this in microcosm by focusing on the Durban-to-Johannesburg corridor, arguing that this is the single most historically representative corridor of southern Africa. Regardless of designated "Great Roads" corridor, his attempts to integrate GIS mapping into the student educational experience as they study important historical regions are providing a highly visual platform for those students and their own research.

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TOURING "GREAT ROADS" OF HUMAN ACTIVITY: USING GEOGRAPHIC VISUALIZATION TO EXPLORE HISTORICAL LANDSCAPES

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Encounter Human Geography Google Earth Activities provide rich, interactive Google Earth explorations of human geography concepts, helping students visualize and explore human landscapes around the world. All Explorations include corresponding Google Earth KMZ media files. Improve student results: When you teach with Mastering, student performance often improves.Â Connect global concepts to local geographies using geospatial technology tools. Place-based Learning empowers students to explore the real world with links to online Google Mapsâ„¢ that connect students to dynamic web maps supported by community-contributed photos and introduce them to Volunteered Geographic Information (VGI). Graph drawing techniques for geographic visualization (P. Rodgers). Exploratory visualization with multiple linked views (J.C. Roberts). Visualizing, querying and summarizing individual spatio-temporal behaviour (D. Mountain).Â Sophisticated interactive maps are increasingly used to explore information - guiding us through data landscapes to provide information and prompt insight and understanding. Geovisualization is an emerging domain that draws upon disciplines such as computer science, human-computer interaction design, cognitive sciences, graphical statistics, data visualization, information visualization, geographic information science and cartography to discuss, develop and evaluate interactive cartography.