**3D Simulation: A Project for a Scholarly Community**

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# Abstract

Projects involving multiple disciplines cross traditional departmental boundaries and fuse various divisions in advancing scholarship. Seemingly, unrelated disciplines such as Art, Engineering, Geospatial Technology, Computer Science, and Archaeology can be unified in creating 3D computer simulations representing topics of scholarly research. A simulation such as "Rome Reborn" is beyond the scope of a small community college. The technology and skills used for a virtual reality project could, however, be adapted to a more modest undertaking by a small college with limited resources. Creating a 3D simulation of a site of local archaeological interest could generate projects for students in the above mentioned disciplines in addition to students who are studying with the intent of transferring to universities to study in related fields. A multidisciplinary course sequence addressing the creation of 3D environmental simulations could be of benefit to all disciplines involved and promote student interest in the subject matter.

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Projects involving multiple disciplines cross traditional departmental boundaries and fuse various divisions in advancing scholarship. Seemingly unrelated disciplines such as Art, Engineering, Geospatial Technology, Computer Science, and Archaeology can be unified in creating 3D computer simulations representing topics of scholarly research. Creating a 3D virtual reality visualization of a site of local archaeological interest could generate projects for students in the above mentioned disciplines in addition to students who are studying with the intent of transferring to universities to study in related fields. Digital 3D models of specific sites can be used for planning purposes to test various scenarios before change is made, to digitally reconstruct ruins for the purposes of further study, or to document existing monuments of cultural heritage so that understanding of the monuments would not be lost to posterity in the event of disaster.

Humans experience life in 3D. The inability to access the visual stimuli that results in spatial awareness is a handicap. Our world is not 2D, and 2D representations are inadequate to communicate the experience of a space.

Photographs and drawings have always been used as symbolic representations of the physical world. These 2D representations can provide useful communications, but they fall short of the true dimensions of reality. Digital 3D visualizations can promote an understanding of the past, present and future when communicating about structures, area and space. Accurate 3D models of historic buildings can be used to advance scholarship in the Humanities and Social Sciences, while drawing upon the skills of those in the fields of Art, Engineering, Geospatial Technology and Computer Science. Virtual reality simulations can be an important research tool in investigating the way people used historic buildings. Animations made with these models can also be an important tool for the disciplines of Architecture and Urban Planning when used to communicate to the public why historic preservation or restoration efforts can be beneficial. Animations can demonstrate the impact that a new development will have on an existing area. Geospatial surveying equipment and technologies such as laser scanning and remote sensing are often used in the fields of engineering, geography, geology and geophysics. Four types of geophysical survey instruments are commonly employed in archaeology: magnetic gradiometry, electrical resistivity, electromagnetic induction, and ground-penetrating radar.[1]

These tools provide accurate data as to what exists, whether it be intact structures or ruins. These technologies can sometimes detect the impression left in the earth by a structure long gone, informing us of the actual proportions of structures that may now exist only in legend. Accurate geospatial data collection results in more accurate models. Even when artists must extrapolate the details of a structure that no longer exists, and “fill in the blanks,” their guesses can be better informed by the information gleaned from geospatial technology.

The technology and skills of creating the accurate 3D computer models that are necessary in scientific research can be beneficial in the arts and humanities fields, as well. The preservation of cultural heritage is generally of interest to scholars in the humanities fields, and geospatial technology offers ways to create digital representations of heritage monuments as records of their existence as an insurance against damage or destruction. Investigations in the history of art and architecture are often of an archaeological nature, and geospatial technologies are readily being adopted in the field of archaeology. The field of archaeology calls for 3D models and avatars to be made as part of further study of sites and artifacts, an endeavor in which accuracy is crucial to the validity of the studies. The game development and film industries often call for animations and special effects that involve actual locations and structures that can be more accurately and efficiently represented by geospatial technology than by the artist's imagination. While, in some ways, various fields have become more specialized and isolated, the applications of digital technology transcend the boundaries of the disciplines and offer a unifying factor. Highly specialized scientific technology can work to the benefit of artists, while the animation and modeling skills of artists can benefit scientists in their investigations. The role of the artist may begin after data collection has taken place, but it is beneficial for the artist to have an introduction to the way the geospatial data is collected.

One of the most famous projects that involves digital reconstruction based on architectural ruins is "Rome Reborn." The project was previously based at UCLA School of Architecture and Urban Design under the direction of Professors Diane Favro and Bernard Frischer. Dr. Frischer is now at the University of Virginia, which has become the administrative home of the project, but work also continues at UCLA. The project reflects our state of knowledge about ancient Rome, but also our ignorance. Although omission is the rule when evidence is completely lacking, speculative reasoning is involved and carries a risk of confusing future scholarship. The advantage of a digital model, however, is that the model can be updated as knowledge advances.

An ongoing multidisciplinary project promotes a scholarly community. A project such as "Rome Reborn" is an exemplary undertaking, but beyond the scope of a small community college. The technology and skills required for a project of this magnitude, however, could be adapted to a more modest undertaking by a small college with limited resources. By combining the technology and skills existing in various departments and choosing a project of a manageable scope, a campus-wide effort would offer students the opportunity for skill-building in a multidisciplinary endeavor. For a small college in Kansas City, for instance, a site of local archaeological interest such as the Quindaro ruins might offer appropriate subject material for a 3D simulation. Beyond the disciplines of Art, Archaeology, History, Engineering, Geospatial Technology and Computer Science, the project would offer the opportunity for skill development for students who are studying with the intent of transferring to a university for further study in such subjects as Digital Humanities, Film and Animation, Game Development, Geographic Information Systems, Architecture and Urban Planning.

The selection of an archaeological site for a simulation project would be a laudable endeavor for many reasons. People have often explored the remnants of previous cultures in order to better understand their own existence. Unfortunately, even the most careful archaeological practices with the best intentions cause the destruction of sites and artifacts. To a large degree this can't be helped – "digging up the past" causes disruption to the very site that is worthy of study. Visitors seeking knowledge of the site can, by their very presence, contribute to its deterioration.

Responsible archaeologists have engaged in careful site documentation so that through the documentation, future scholars will have the opportunity to "see" the site as it was before being disturbed by the archaeological investigation. 3D representation of the site offers enhanced opportunities for that documentation. Dr. Bernard Frischer of the Rome Reborn project has commented:

3D modeling has the potential to mitigate the irreversible and destructive nature of archaeological excavation, an unfortunate, ironic, and unavoidable central fact of archaeology as traditionally practiced. Up to now we have had, perforce, to murder to dissect. With the widespread adoption of 3D technologies to record and reconstruct archaeological sites we can virtually preserve the site through 3D data capture as we dig it up. And, once we model the 3D data gathered in the field, we can allow our colleagues to retrace our decisions and to test the validity of our conclusions with more precision and confidence.[2]

Viewing a 3D model of a space can bring a richer understanding of the experience of the space. 3D models allow the study of the way light and shadow would change in the structure according to the time of day and the season of the year. The participation of acoustic engineers in 3D simulations can increase the immersive sensory experience by including sound.

Such simulations can help us understand the experience of a building that no longer exists, or offer a glimpse of the experience of an existing environment to which travel would prove difficult. Bernard Frischer explained the teaching applications of virtual reality simulations:

The main educational advantage of computer models of cultural heritage sites is that they offer the vicarious experience of data that is inherently sensory (buildings, works of art, music and other sounds, etc.). Models enable the instructor to overcome limitations of time and space, taking students to see something that either no longer exists or, if it exists, is located too far away to be visited during an academic term.[3]

Simulations can also offer a view of the site to a casual audience when, for various reasons, access must be restricted to serious researchers. Simulations offer the means to consult about the site with interested parties at distant locations.

The ability to simply create and view the site model provides abundant opportunity for learning. There are, however, opportunities for more complex research if exploration involving artificial intelligence is desired. Research has been conducted that goes beyond the static models of “Rome Reborn.” Dr. Frischer, with Diego Gutierrez and others, has used the existing scholarship on the Roman Colosseum to create a virtual environment in which the ergonomics and circulation patterns of the Colosseum can be studied.[4] Computer-generated avatars programmed with artificial intelligence function as Roman citizens in this experiment. As an example of the potential of virtual reality in Cultural Heritage studies, this project is of great interest. It should also be mentioned that the validity of the study is highly dependent upon the accuracy of the model. Researchers may take different approaches in creating models for the simulation. Accurate 3D models of recent buildings or buildings still in the planning stages can often be developed from an architect’s CAD (Computer Aided Drafting) files, a fairly routine proposition. Meticulous measurements can be taken of existing structures and CAD files can be developed based on these measurements in a practice of reverse engineering, and then a model can be produced as usual from the CAD files. Software packages such as AutoCAD and Revit are typically used for such purposes.

However, geospatial technology offers a different approach. Remote sensing techniques such as satellite imagery, scanners, ground radar and LIDAR can offer additional data for measuring and positioning the structure to be modeled. Geospatial technology is widely in use in the fields of engineering, geography and geology. In 3D modeling of structures, data regarding the geographic location can be extremely useful in determining the exact layout and proportions of a site. This information can form the basis of a spatially accurate model. From the collected geospatial data, models can be created by using 3D modeling software. The second iteration of the Rome Reborn project was christened “Rome Reborn 2.0.” The new version of this extensive project depended heavily on 3D modeling software that had, up until its release, been used primarily by research universities. Developed by Pascal Müller, a former researcher at ETH Zurich (also commonly known as the Swiss Federal Institute of Technology), the software, CityEngine, was officially released to the public in July of 2008.

CityEngine has capabilities for incorporating geospatial information such as street networks, building footprints, and terrain data. These GIS files can be used for digital city modeling.

CityEngine’s capacity to drag-and-drop various architectural styles onto a footprint and allow the software to fit the model to the footprint offers great potential for investigating alternative scenarios. Archaeologists and other scholars will more easily have the opportunity to try out different appearances to test various theories in models designed for cultural heritage purposes. Just as the model adjusts to fit the footprint, the footprint can be changed and the model will adjust accordingly. This technology allows researchers to more easily direct artists to make changes for greater accuracy.

A multidisciplinary course sequence addressing the creation of 3D environmental simulations could be of benefit to all disciplines involved and promote student interest in the subject matter. To implement a cross-disciplinary computer simulation project would require an investment of computers, software, and workspace. This may appear as a daunting prospect to a small college with limited funds. Many of the needed components may, however, already exist in the respective departments. Existing courses in Drafting are probably using AutoCad software. Courses in Engineering, Geography or Geology may be using the tools of geospatial technology, such as surveying equipment and geographic information systems software such as ArcGIS. There are probably existing Art classes using Photoshop, and perhaps 3D animation software such as Maya or 3DS Max, as well. The addition of CityEngine software for 3D modeling is likely to be welcomed by any department addressing art, film and animation, game development, drafting, architecture, urban planning or archaeology. The knowledge base of those individuals associated with departments of computer science, history and archaeology would be crucial in organizing a cohesive project with scholarly applications, bringing together the technological skills of the various disciplines. Participating students would have the opportunity to practice skills related to their own discipline while, through their participation in the project, broadening their horizons and their knowledge of other disciplines.

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**ADDITIONAL RESOURCES:**

[1]Computer Applications and Quantitative Methods in Archaeology is an organization often known by the shorter name, Computer Applications in Archaeology (or CAA). CAA is an important advocate of the 3D modeling of cultural heritage sites. “Virtual archaeology” is a term that has been coined to describe this practice.
http://www.caa.leidenuniv.nl

[2]Procedural, Inc. produces the software **CityEngine** which was used extensively in Rome Reborn 2.0.
http://www.procedural.com
http://www.procedural.com/showcase/showcases/rome-reborn.html

[3]The University of Virginia is the home of the “**Rome Reborn**” project at the Institute for Advanced Technology in the Humanities under the direction of Professor Bernard Frischer.
http://www.romereborn.virginia.edu
http://www.iath.virginia.edu

[4]UCLA (The University of California at Los Angeles) participated in the Rome Reborn project and maintains the **Experiential Technologies Center** and the **Visualization Portal** for instruction and research involving virtual reality. Professor Diane Favro is a principle researcher. Studies include Historical Architectural Monuments, Scientific Visualizations and Digital Technologies for the Performance Arts.
http://www.etc.ucla.edu
http://www.etc.ucla.edu

[5]Texas Tech University was involved in a project creating a 3D model of the Statue of Liberty from laser scan data. The project was called “**Digital Liberty**.”
http://www.arch.ttu.edu/digital_liberty/

[6]The University of Arkansas maintains the **Center for Advanced Spatial Technology (CAST)**, offering a resource of geospatially-based 3D modeling and simulation to a variety of disciplines. Professors W. Fredrick Limp and Kenneth L. Kvamme are principle researchers in the applications of geospatial technology in archaeology.
http://cast.uark.edu/

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**REFERENCES:**

Frischer, Bernard, 2008. "From Digital Illustration to Digital Heuristics," in Beyond Illustration: 2D and 3D Digital Technologies as Tools for Discovery in Archaeology, edited by Bernard Frischer and Anastasia Dakouri-Hild, BAR International Series 1805 (Oxford) v-xxiv.

Frischer, Bernard, 2004. "Mission and Recent Projects of the UCLA Cultural Virtual Reality Laboratory," in Proceedings of the Conference Virtual Retrospect 2003, Biarritz, France 6-7 November 2003, edited by R. Vergnieux and C. Delevoie, 65-76.

Gutierrez, D., B. Frischer, E. Cerezo, F. Seron. "AI and Virtual Crowds: Populating the Colosseum," *Journal of Cultural Heritage* 8(2), 2007, 176-185.

Kvamme, Kenneth L. Electrical Resistivity Surveys in Historic Kansas Archaeology, *Geophysical Society of Kansas Newsletter* January-February 2007, Volume 3, Issue 1, p. 6, 9-10.