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WHITEPAPER

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IMMERSIVE COORDINATES: DIGITAL ANATOLIA

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Abstract

Funding from the NEH was requested to support the development of a lightweight infrastructure for pre-publication release of curated, 4D cartographic data and narratives centered on two, lesser known archaeological sites in Roman Asia Minor, modern-day western Turkey. Using a neo-geographic, web 2.0 approach that has been highly successful when applied to broad, urbanistic studies of modern cities, Digital Anatolia focused on developing four-dimensional, interactive site reports of *ongoing* excavations of urban-scale archaeological sites.

Introduction

Every year, the Ministry of Turkish Culture and Tourism organizes a nationwide conference on excavation reports and material results of the past excavation season. The directors of over two hundred archaeological projects, which have produced gargantuan amounts of data, have three days to deliver their discoveries from the past year. The conference has a multidisciplinary, multinational audience, yet the communicative and analytical potential of such a gathering of scholars remains unrealized. Very few attendees can engage in scholarly conversation during these meetings, as tables of raw data, stratigraphy, and typological analyses are poured onto an audience ill-equipped to digest such raw information. Lately, with the introduction of digital tools, there is clear improvement in the visual representation of data, but due to limited budgets and differing priorities, the presentations rarely advance beyond simple explication of textual or material data in digital form. While much time and energy in the archaeological community has been invested in creating collaborative databases for **archiving and disseminating** such data, little time has been spent on developing a toolset designed for **presenting, curating, and analyzing space-based discussions of urban-scale archaeological sites.**

The problem is complicated by the exigencies of modern archaeological practice: (1) there is a delay in the production and dissemination of knowledge for many sites primarily due to the lack of initial start-up funds. Though the bar for entry into a Web 2.0 method of knowledge production and dissemination is low, funding is still necessary yet difficult for many projects to obtain. (2) Due to the abundance of clearly defined architectural zones in city-sized archaeological projects, highly localized and focused projects tend to study one area, one complex, or one building in its diachronic totality while leaving vast stretches of a site untouched. Those working in one trench may have only a vague understanding of what is happening in another trench. A plan might serve as the integrative mechanism, and even isolated drawings or digital models of certain areas might be built, but no holistic and fully 3D system is available. To access the more sophisticated databases on site, specialized Geographic Information System (GIS) knowledge or 3D modeling expertise might be required, which leaves many site directors struggling to find such knowledge when the local expert has graduated or moved on to another project.

In the meantime, the flood of data continues. As so often occurs when technology is first adopted, a collective scholarly group reacts to the infinite possibilities of a scaleless

digital toolset by creating and storing boatloads of data in file formats that are too often esoteric.[1] It is assumed that, by storing and cataloging *everything* and by releasing and sharing *all* data, discoveries can be made. Such data is inherently problematic, however, and the archaeological community has only just begun to fully assess the rhetorical nature of the data it generates or the potential obsolescence of such data in future.[2] Computers might one day offer robust solutions for data-mining within archaeological datasets, but for now it is worth remembering that almost every archaeological project, even those within the same discipline, use *sui generis* paper forms to record trench and find information. Even with vast amounts of data, the computer offers no magic solution to automate analysis.[3]

Similar problems of data management abound in urban projects of all scales, yet effective approaches to digital cartographic histories have blossomed in recent years with the advent of fruitful academic and commercial collaborations.[4] The histories of Chicago, or New York, or Los Angeles, built with data from the past, oral histories, photographic documentation from commercial and academic databases, and modern voices provided via various feeds, all co-mingle in advanced, massively social systems.

Building on over a decade of experience working with three-dimensional digital models and geospatial systems, the UCLA Experiential Technologies Center (ETC) has developed Immersive Coordinates: Digital Anatolia. The start-up project combines the implementation of a lightweight platform built on a proven, robust infrastructure, a modified front-end to the UCLA HyperCities environment, with proof-of-concept examples that enable the injection of space-based, pre-published material and textual data into a reconstructed geographically aware, site-model. The project aims to apply advanced, proven technologies for producing urban narratives to a similar domain, that of the ongoing archaeological excavations at Magnesia on the Maeander, located in western Turkey. Rather than promote a data-centric model, this project foregrounds analysis and storyboarding at an urban level. It is intended to be a visual, idea generation mechanism.[5]

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[1] For example, see the short review of the ways that architecture aimed too high in its hopes for Virtual Reality in Jennifer Whyte, *Virtual Reality and the Built Environment* (Oxford: Architectural Press, 2002), 25.

[2] Digital photography from the late 1990s is a poignant reminder of how file formats are not always the problem. Instead, the poor quality and reduced resolution of early digital cameras, coupled with an overall lack of training in creating visual arguments, led to a generation of nearly useless databases of poor quality images, i.e., garbage data.

[3] Greenhalgh, Michael. 2004. Art History. In *A Companion to Digital Humanities*, ed. Susan Schreibman, Raymond George Siemens, and John Unsworth, 31-45. Malden, Mass: Blackwell Pub, 34: "It should be difficult today to conceive of the computer as any more than a speedy idiot obeying a set of precise instructions; but many in the humanities do indeed continue to regard it as a black and magical (or black-magical) box–throw the data at it, and somehow the computer will make sense of them."

[4] See, for example, Phil Ethington's "Ghost Metropolis", <www-bcf.usc.edu/~philipje/Ethington_GM/index.html>, The Encyclopedia of Chicago, <encyclopedia.chicagohistory.org/>, the city-based projects supported by UCLA's HyperCities platform <www.hypercities.com>, and the T-Races project <salt.unc.edu/T-RACES/mosaic.html>.

[5] "Archaeology is an intensely visual as well as verbally discursive process. At all stages of their life-cycle, archaeological visualisations are integral to the conduct of archaeological research. Yet, while in recent decades a great deal of attention has been given to the dynamics of textual discourse in archaeology, relatively little has been given to the visual dimension, its modes, pitfalls, and unrealised potential." From Simon James panel CFP entitled "Images in Action: Visualisations as Tools and Arguments in

It promotes an intermingling of open and closed access, expert and amateur knowledge, and rapid, flexible, and iterative data addition and curation. The proposed project will let archaeologists, architectural historians, heritage managers, and other participants collaborate and converse on and off site with the aid of visualized, pre-published data. **Immersive Coordinates is an attempt to rethink and reengineer pre-publication of archaeological excavations of urban-scale sites.**

Success I: Technological and Pedagogical Innovation

The flexibility of the digital platform lent itself to experimentation. During the course of the project the team came to rely increasingly on computationally generated, data-driven content to support to two key areas of production: 1) adapting the 3D model to accommodate the rapidly changing facts on the ground that are the defining element of an active and ongoing excavation. 2) the creation of an accurate 3D "state" model that represents the current physical state of the site.

Using ESRI's CityEngine software, the project team moved from building "hand-built" 3D models with traditional CAD/CAM technology to a more robust and flexible procedural modeling technique. The new approach, creates a 3D urban landscape by applying a set of construction rules to the building footprints and street grids taken directly from the team's Geographic Information System (GIS), which is based on site survey data. The resulting computationally driven approach to the generation of 3D content expedites the entire 3D modeling process, especially for the creation of massing models of urban sites. If procedural rules already exist, creating a new urban 3D model takes minutes rather than days or months. In the case of Magnesia, since many of the rules had already been developed in support of the ETC's RomeLab project, the modeling and re-modeling process was streamlined significantly through the use of procedural modeling. Though the software is closed-source and the process relies on proprietary rules, the 3D mesh output can be read and edited by any robust 3D modeling package. Since our project was participating in a new survey of the site, in which the existing map, known to be filled with small errors from feature to feature, was to be updated through a new survey, having the flexibility to rapidly generate a new version of the 3D city was and remains imperative. Procedural modeling, and the rules developed by UCLA doctoral candidate Marie Saldaña during her research appointment on UCLA's RomeLab project has laid the foundation for relatively easy changes to the 3D material.[6]

As the project team connected the excavation reports to the digital maps in order to create a "state of knowledge" 3D representation of the archaeological site, it became increasingly clear that even the combination of 3D reconstruction, satellite image, 2D photograph and symbolic outlines on the ground plan was unable to convey the full three-

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Archaeological Research," at Visualisation in Archaeology 2011. <http://www.viarch.org.uk/2011-call-4-papers-sessions.asp?id=41>

[6] Saldana, M., and C. Johanson. 2013. "Procedural Modeling for Rapid-Prototyping of Multiple Building Phases." *ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* XL-5/W1 (February): 205–10. doi:10.5194/isprsarchives-XL-5-W1-205-2013.

dimensional complexity of the past and current trenches. The team turned again to ongoing internal research and development projects at the ETC to create three-dimensional state models of extant monumental remains and current trenches. Here the project team incorporated experiments with the use of Structure from Motion (SFM)-informed photographic techniques to facilitate data collection and computational generation of the 3D model.

In short, during all field sessions, the project team aggressively and systematically documented the site through rapid and near constant use of photography on the ground and in the air. During short 20 minute sessions, the team captured three hundred to five hundred photographs of each of the 28 extant column capitals from the Temple of Artemis. Blanketing each artifact with overlapping images, the team repeatedly photographed every centimeter of exposed surface. The same approach was applied to two open trenches and the standing architecture inside the colonnaded precinct surrounding the temple. The team used the same fundamental methodology to create partial site plan, this time by flying a computationally guided, Unmanned Aerial Vehicle (UAV). A hand-built MikroKopter Okto, remote controlled, GPS-programmable, multi-rotor helicopter with a servo-guided, Nikon D90, to capture overlapping, overhead and oblique photographs for the precinct of the Temple of Artemis.

After each data collection session, during which thousands of photographs were gathered, the team processed the imagery on personal laptops using Agisoft's PhotoScan software to create high fidelity, low resolution, fully textured, geo-referenced 3D models of the terrain around the Temple of Artemis, each of the 28 column capitals, the two active trenches, and a range of on site features to used for experimental data processing. What was accomplished over the course of three days by a five-member team sharing three mid-level SLR cameras easily superseded what could have been accomplished with weeks or months of application using a 3D laser scanner.

Both technologies, procedural modeling, and Structure from Motion highlight the increasing utility of computationally generated, data-driven 3D forms. For the purposes of this project, which emphasizes rapid data acquisition and dissemination, after an initial, steep learning curve, both tools yield extraordinarily flexible and future-proofed results, with a significant decrease in or at least a more targeted relocation of human labor or human-caused error.

More important, computationally driven visualizations create clear and documentable path between the data and the visualized form. Traditionally crafted 3D models, and even, to some extent, laser scans of a physical site, introduce steps in the creation process that require a leap of faith from the would-be reviewer to trust the result. An author might claim that a hand-built 3D model adheres to an underlying survey, but a reviewer would need to dissect the mesh of the model to study how the 3D monument connects to the 2D plan or to verify that a measurement depicted in 3D is precisely what it claims to be. For example, the measurement of a column from base to capital might be depicted as 8 meters tall, but without opening the model within the package it was created, it is difficult to prove or to regenerate. In the cases of Structure from Motion and Procedural

Modeling, the underlying data can stay the same, but the computational tools used to process the data can be advanced. Therefore, the eight meter tall column can be refined, or made more detailed by modifying the rule that describes it without actually altering the underlying data at all. Likewise for SfM, the original photographs can be processed repeatedly to produce varying levels of resolution, and, as the technology becomes more robust or as additional photographs are introduced, the processing can yield more detailed and more accurate 3D models.

Success II: Pedagogical Opportunities

In addition to funded work performed by paid graduate and undergraduate student researchers, a substantial contribution came from the classroom. Following the creation of the Digital Humanities Minor and Graduate Certificate Program at UCLA, new hands-on research apprenticeships were implemented. As part of the initial suite of offerings, my colleague in the UCLA Digital Humanities program, Miriam Posner, volunteered to lead a Digital Humanities apprenticeship course that would introduce students to building online repositories by constructing a website for Digital Magnesia. The results were extraordinary. The students designed and built, using WordPress, a complete content management system and website wrapper for the HyperCities experience of Digital Magnesia. The combination of WordPress and HyperCities was itself first developed as part of another Endowment-funded project, *Visualizing Statues in the Late Antique Roman Forum*, led by Gregor Kalas during his residency at the UCLA ETC supported by an NEH Fellowship at a Digital Humanities Center in 2009–2010.

Lessons Learned I: Student Researchers

The generous support of the Endowment through the Office of Digital Humanities Start-Up grant proved most effective when the team was augmented through classroom research. Given the rapidly rising cost of fees and non-resident tuition in the university setting, attracting top graduate student talent is almost cost-prohibitive. If one year of a graduate student researcher's time, at twenty hours per week, requires an initial investment of $15,308.38 for tuition and, as is the case at UCLA, an additional $15,102.00 for non(California)resident supplemental tuition, only relatively small amounts of funding remain to apply to actual hours to be worked, software, supplies and travel. There are of course options to pay graduate students for their time without supplying funds for tuition, but it is also difficult to retain such tech-savvy students when more lucrative offers, with tuition and fees are just around the corner.

For research projects that require data processing, curation, and web-based dissemination, the classroom offers a surprisingly robust opportunity for building an ad hoc research lab. Digital Humanities Programs that combine theory and praxis, like that of UCLA, present a unique opportunity to incorporate theoretical readings about the use of the digital in publication while simultaneously embedding students directly in faculty-sponsored research. The NEH might consider incentivizing the direct use of the classroom in Start-Up Grants.

Lessons Learned II: International Collaboration

After receiving notice from the Endowment that the Start-Up Grant application was successful, all work on-site at one of the two archaeological sites included in our original proposal was brought to an end prematurely, and therefore our team's initial on-site digital field season was compelled to focus entirely on the archaeological project at Magnesia on the Maeander. This initial change of subject reverberated throughout the remainder of the project. Though it is disappointing that the project was unable to realize all its initial goals, it is also a reminder that the exigencies of life and the difficult combination of multiple moving parts in multiple countries driving an international project can lead to dead ends, where no amount of technology can solve a problem. It is extraordinarily fortunate that this proposal included two sites rather than one. If we had centered our work on only one site and one collaborating partner, we might have faced the difficult prospect of having assembled a digital team with no possible way forward.

Future Plans

Funding from the NEH has supported the production of an invaluable tool that will serve as the digital hub for the site of Magnesia on the Maeander for years to come. In addition, it offered a potential model for adoption by other projects. In fact, during spring of 2014, Gulden Varinlioglu, a visiting scholar at UCLA, developed a course centered around the creation of an Underwater Cultural Heritage Museum. Her project will be the second to use the infrastructure built through the Start-Up Grant to construct a web presence affiliated with Digital Anatolia.

Recent research and development at UCLA through the Humanities Virtual World Consortium, funded by the Andrew W. Mellon Foundation, has led to the creation of a beta virtual world platform meant to facilitate rapid development of multi-player, online, virtual world environments. The next phase of Digital Anatolia will expand beyond Google Earth, to incorporate multi-user, avatar-based explorations of the archaeological data and the cartographic, symbolic landscape.[7] It is envisioned that future versions of Digital Anatolia will unite a Unity3D front-end, with a geographic database backend.

Grant Products

During the funded period of the project, the Digital Anatolia team created an interactive 3D site report which continues to be developed:

http://hypercities.com/magnesia/

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[7] For more on avatar-based exploration of digital cartography see: Favor, Diane, and Chris Johanson. Forthcoming. "Jumping over the Line." In *Hypercities: Thick Mapping in the Digital Humanities*, by Todd Presner, David Shepard, and Kawano, Yoh. MetaLab 3. Harvard University Press.

Appendix 1. A Selection of Images from Digital Magnesia

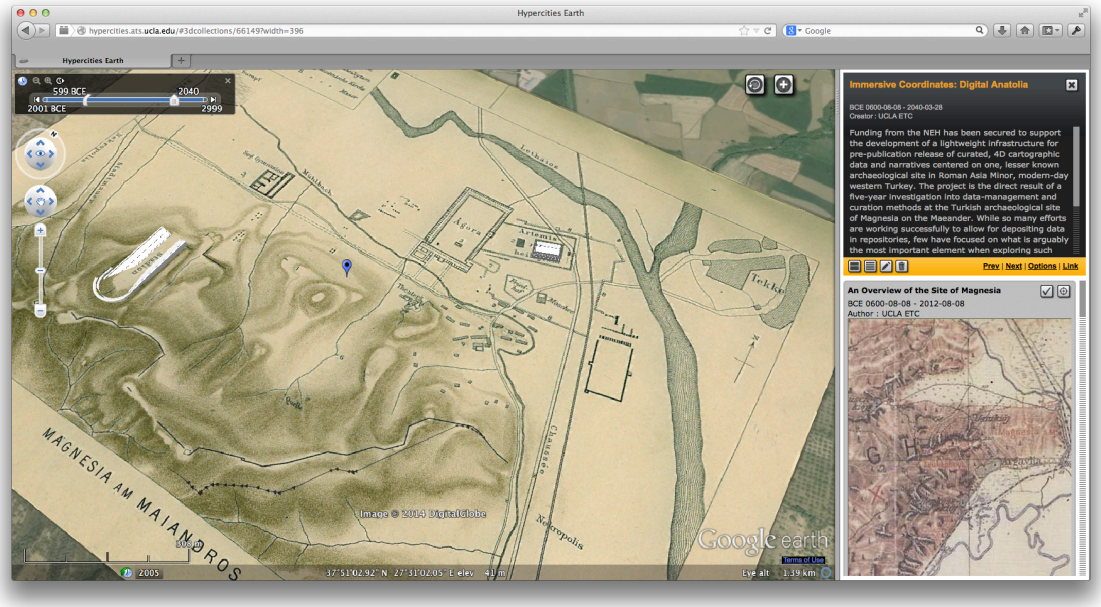

Figure 1: Overview Map of Digital Magnesia

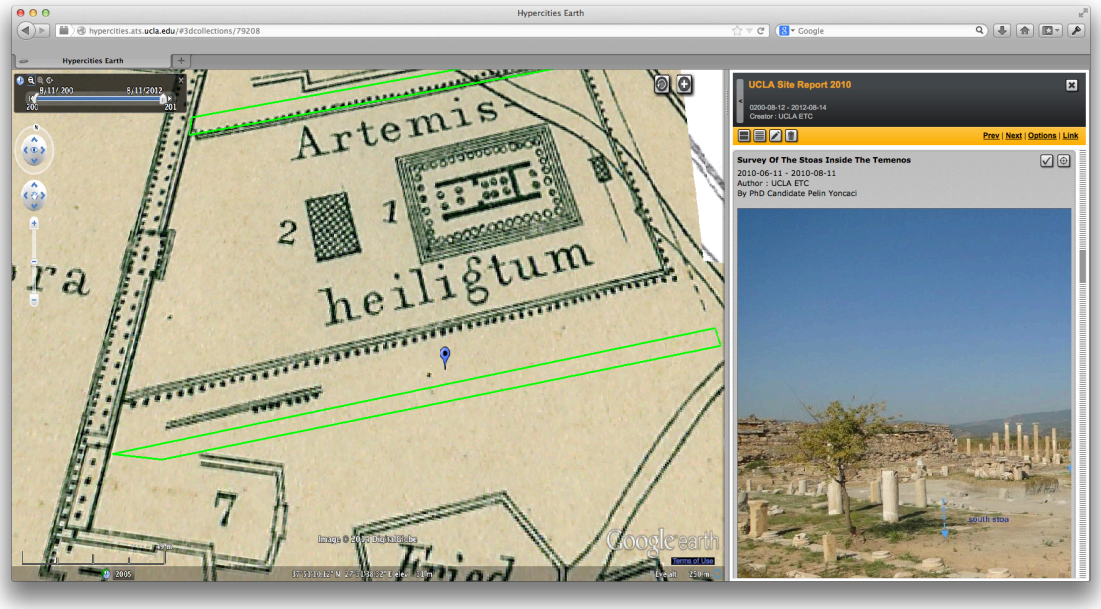

Figure 2: UCLA Expedition Documented in Digital Anatolia

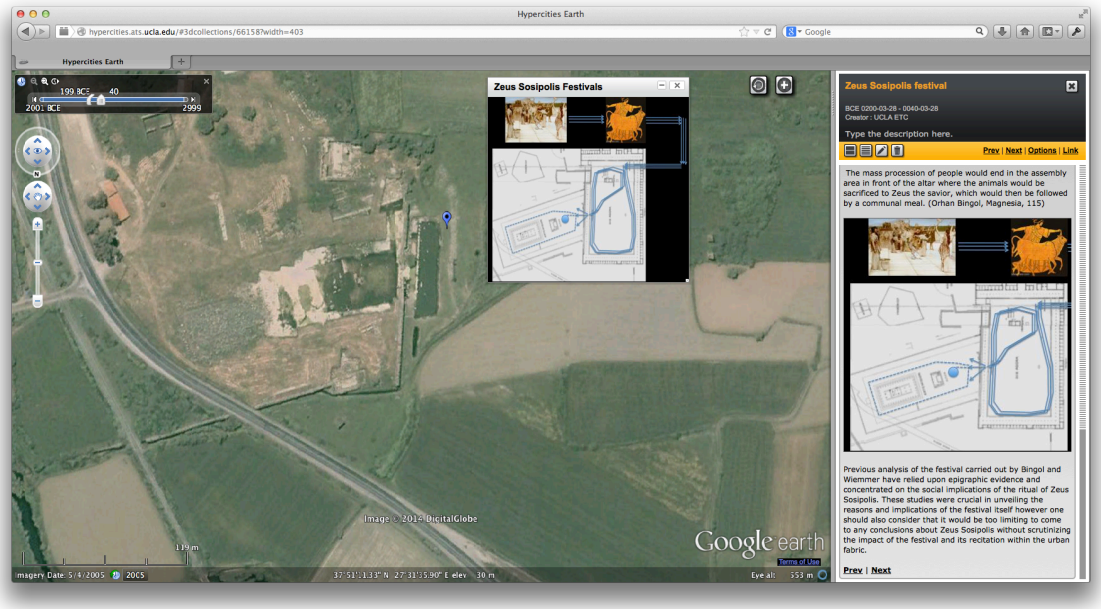

Figure 3: Draft Narrative of the Festival of Zeus Sosipolis

Figure 4: Model and Terrain Built by Applying Procedural Modeling Rules