Perspectives

A View from Cyberspace: The Silk Road Atlas of the Electronic Cultural Atlas Initiative

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Introduction

Geography is critical for understanding history and society. Space plays a fundamental cognitive role in ordering human knowledge and experience. Conflict, exchange, political authority and cultural practices all exist in space, and they are influenced by location. However, it is difficult to study the relationship between geography and culture, particularly over time. Ideas about place and time are culturally specific, and maps are always a partial and particular representation of a territory (Turnbull 1993). In recent years, emerging digital technologies have enlivened the study of cultural and historical geography. Multiple representations of places can coexist on a single map or website. The data-rich and quantitative methods of the social sciences can be integrated with interpretive questions emerging from the arts and humanities. This is best accomplished when qualitative (images and text) and quantitative (figures and coordinates) representations and analyses concerning space and place can be associated with one another.

Digital mapping offers the possibility of developing better tools for information discovery and retrieval, and for devising techniques to model, visualize, and analyze humanities spatial data (Gregory, Kemp and Mostern (in press); Knowles 2001). In particular, a digital atlas can be constructed from datasets that are located on many different servers and linked through the use of a common metadata cataloguing scheme. It can use the universal "language" of geographical coordinates to categorize information produced using diverse methodologies from many disciplines. In this way, scholars can map information resources relevant to the object of their investigation without being required to learn the cataloguing systems of any particular language or discipline.

The Silk Road Digital Atlas, developed by the Electronic Cultural Atlas Initiative in 2002, is a pilot project to apply these principles to the study of culture and history in Central Asia (Mostern 2003).[1] The Silk Road Atlas was inspired by the activities of the New York-based Silk Road Project, founded by cellist Yo-Yo Ma. In 2002–3, the Project hosted a global series of concerts and colloquia to draw attention to the musical and cultural legacies of Eurasian interaction (http://www.silkroadproject.org/). As part of this series, the University of California at Berkeley hosted the symposium "Sound Travels: A Musical Journey Along the Silk Road," and invited the Yo-Yo Ma Silk Road Ensemble to the campus for ten days of concerts and events. At the academic colloquium associated with the concert series, in opening remarks under the title "Overture: The Silk Road Past and Present," the symposium organizer Sanjyot Mehendele began with a challenge to think about the etymology of the term "Silk Road." This name is an historical construction that carries with it the complex relationship between the historical circumstances of travel and exchange in Central Asia. The symposium included papers about the creation of multinational Central Asian worlds from both Muslim and Buddhist perspectives. It continued with a series of papers on the arts and musics of the Silk Road, and ended with a lecture demonstration that used musical culture to demonstrate the connections and diversity of cultures throughout Eurasia (Abrams et al. 2003).

The digital Silk Road Atlas prototype was created both as a part of this process of scholarly investigation at the symposium, and for disseminating graphical and immediate information

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about the Silk Road to the public in conjunction with the concerts. Presented as a way to visualize several geographical and temporal views of Eurasia simultaneously, it was demonstrated for the first time at the symposium, in order to introduce new strategies of research. To be useful, the Atlas had to consist of maps that were intuitive and compelling, while conveying nuanced information of high scholarly standard. In this paper, we introduce the Electronic Cultural Atlas Initiative and its Silk Road Atlas pilot project to make the case that map-based digital scholarship can achieve these goals. By integrating the work of many individuals and creating projects of diverse scale, such projects offer the hope for new insights into history and culture. In particular, they represent a promising approach to the study of Eurasia, with the multiple cultural perspectives and coexisting geographies and histories that characterize the region.

The Electronic Cultural Atlas Initiative

The Electronic Cultural Atlas Initiative (ECAI), formed in 1997, conducts research on standards and practices for the development of digital cultural atlases (http://www.ecai.org/). It creates and maintains a data clearinghouse where scholars can register cultural spatial content and users can create customized maps based on it. It also supports the development of software tools for building and sharing cultural spatial data. An international consortium of scholars interested in digital cultural atlases, it has held thirteen international conferences since its founding.

The founding meeting of ECAI in 1997 discussed, as its very first issue, how to deal with the bewildering concept of the Silk Road." The Silk Road Atlas subsequently took shape as one of ECAI's demonstration projects. The first two meetings of the international ECAI community led to the conclusion that temporal and spatial referencing of digital resources provided the best possible way to link catalogues, web sites, and databases distributed across the globe. At the time, Geographic Information Systems (GIS) was an emerging technology with promise for facilitating this. However, it had not yet been applied to historical and humanities topics. The humanists in ECAI pointed out that GIS methodology lacked one crucial ingredient: that ingredient is time, since place alone cannot reveal the aspects of human experience that change over historical time. Consequently, ECAI has become not only a project of data development and integration, but a consortium to build tools, develop standards and good practices, and advocate for humanities and historical GIS. In particular, ECAI has developed — in collaboration with the TimeMap Project based at the University of Sydney Archaeological Computing Laboratory — a spatial browser linked to an index (a metadata clearinghouse) that points to websites, databases, aerial and satellite photography, and geo-referenced historical maps located on web, database and GIS servers throughout the world (http://www.timemap.net/clearinghouse/html/index.cgi). The TimeMap map authoring and viewing tools allow data to be filtered and animated, so as to show change over time. These are unlike traditional atlases in that users can easily create customized, interactive historical maps based on their interests, drawing upon contents that are constantly being expanded and updated.[2]

Focused on geography and time, ECAI has kinship to some other endeavors in the computational humanities. However, it is concerned not only with content and software development, but also with the institutional and technical infrastructure for community building and data sharing. Historical and cultural mapping projects such as the Ancient World Mapping Center, the Perseus Project, or the national historical GIS projects being developed for the United States, China, Great Britain, and other countries each deal with specific regions. ECAI is attempting to create a community of scholars and a clearinghouse of data that crosses all discipline and regional boundaries.

The requirements of digital humanities scholarship include some aspects that are new and often troublesome. One issue in particular to which ECAI has devoted much attention is the question of data persistence. With technology advancing at a rate that makes earlier equipment and software rapidly obsolete, we are witnessing the disappearance of large amounts of information. Developers and archivists lack plans or funding for

[2] To be sure, there are still technological challenges that need to be addressed, and the complexity of Silk Road studies embodies many of them. Our development frontier includes enhancing the capacity for inter-operability among multiple clearinghouses in many languages; developing better tools for information discovery and retrieval; improving content standards for digital gazetteers and thesauri, and devising techniques for the modeling, visualization, and analysis of humanities spatial data. See http://www.timemap.net for more information about ECAI's TimeMap technology.

preserving data over years, let alone for decades or centuries. In 1999, the ECAI leadership concluded that it was essential to forge a close collaboration between the production of digital material for the humanities on the one hand, and the policies and practices of digital libraries, on the other. With this in mind, ECAI entered into a partnership with the eScholarship program of the California Digital Library (CDL), the union library of the ten campuses of the University of California (http://escholarship.cdlib.org/). CDL eScholarship now hosts and distributes peer-reviewed, map-based digital projects of intellectual value equivalent to similar paper articles or monographs. ECAI and CDL are developing review standards, techniques, and services to maximize the longevity of functionality for these dynamic objects. The goal of this collaboration is to ensure that files and documentation are preserved in archival formats that will last even after the software has disappeared.

The ECAI Silk Road Atlas

The goals and methods of ECAI are particularly relevant to Silk Road and Central Asian studies, where languages and cultures are numerous. In this situation, disciplinary and methodological approaches are heterogeneous, and geography and timelines confounding. The land and sea routes traversing Eurasia have been zones of both cultural and mercantile exchange for centuries, but the study of these routes has been complicated by the fact that it is hard to identify the geography or termini of any formal "roads." The so-called Silk Road is a concept — a metaphor for long-distance human interaction in pre-industrial Eurasia — as much as it is a place. However, the Silk Road does also have geography, as complex as this may be. Spheres of cultural influence and political authority have overlapped throughout the history of Eurasia. The journey of silk from China and glass from the Mediterranean basin arose within large empires. However, even larger regions of cultural diffusion extended far beyond the production sites of these commodities. From another point of view, smaller centers of aesthetic taste, military power, and cultural influence radiated out from oases, camping sites, water sources, mountain passes and river banks all along the trade routes.

This complex human geography has always made mapping the historical Silk Road a scholarly challenge. In addition to conceptual difficulties, the whole of the landscape and seascape for these mercantile tracks covers a sizable portion of the earth's surface: it is a large endeavor for any individual researcher to deal with the largest east/west landmass on the earth. A further challenge is that information about the cultures and societies along the routes is sparse, heterogeneous, written in multiple contemporary and archaic languages and scripts, and often ambiguous or fragmentary. Existing repositories of recorded knowledge about this area are as widely distributed as the trade sites themselves.

With the technology, standards, and archival practices developed over the last five years by ECAI and its affiliates, a digital journey across the "Silk Road" is now becoming possible.

The ECAI Silk Road Atlas, developed in conjunction with the Sound Travels symposium, is a demonstration project. A great deal more work is needed to add contextual and representative content, to create a range of useful thematic digital maps, to allow users direct access to a clearinghouse for creating their own maps, and to integrate the maps with a website and web links. The ECAI Silk Road Atlas currently consists of four interactive maps, each comprised of many data layers. They are composed from worldwide resources accessible through our metadata clearinghouse (http://ecai.org/silkroad). One example of a thematic, interactive, full-color web-based map produced using the scholarship assembled for the ECAI Silk Road Atlas can be viewed at http://www.ecai.org/silkroad/cultures/mapspace.html. It depicts, along with the familiar boundaries of modern states, zones of musical culture defined by the use of various instruments in history and up to the present day. Sometimes, as in the instance of the (Japanese) *shakuhachi* and the (Indian) *tabla*, these zones do not overlap. In other instances they do, for example in northwestern China, where both the *pipa* and the *daira* have been played. Still other instruments are played across a broader territory: the cultural range of the *ganun* extends not just throughout the Middle East but eastward beyond the Caspian Sea.

In coordination with the musical theme of the Berkeley symposium and concert series, the map referred to above highlights the distribution of various musical instruments throughout Eurasia. Each musical instrument listed in the legend has a link to a web page with pictures of the instrument, a description of its history, production and use, and a sound file with a performance of it. The map layer entitled "musical instruments" was developed at Berkeley based on material provided by the Silk

Road Project in New York. The "world sites" map layer links map icons to web pages served from Paris for each UNESCO cultural heritage site. The "Huntington images" layer links to photographs of Buddhist art and architecture hosted at Ohio State University. Finally, the layers called "Chinese Buddhism," "Khotan Buddhism," and "Kushana Buddhism" depict the geography of the religious practices associated with several of the important ancient and medieval Eurasian empires. These were adapted from work produced by the International Dunhuang Project at the British Library.

The ECAI Silk Road Atlas brings together digital scholarly projects from diverse regions, eras, approaches, and geographical scales. Many were never created with integration or mapping in mind. The constituent projects, and additional work on the Silk Road by ECAI collaborators yet to be incorporated into the Atlas, exemplify a range of approaches to digital spatial research on historical Eurasia. At present, the Atlas combines content developed in-house with content linked from collaborators. In the future, we hope to add further kinds of digital content, such as existing archives and text-based projects that can be mapped with the aid of a digital gazetteer (see below). Other projects having a geographical component are also expected to emerge. These four types of work are described in slightly greater detail below.

In-house projects. "A Sasanian Seal Collection in Context: Electronic Cultural Atlas Initiative Publication of the Edward Gans Collection at University of California, Berkeley," by Guitty Azarpay and Jeanette Zerneke, is one of the first ECAI ePublications (http://ecai.org/sasanianweb). This project showcases a database with images of more than 300 seals produced in the region extending from Iran to Afghanistan between the third and sixth centuries. The seals themselves are an important source for anyone who studies the commerce and cultures of the trade routes. The impressions from the stone seals, serving as signatures for contracts and communications, were an integral part of commercial and political interchange. The figures used on seals also provide valuable insights into the beliefs of those who used these emblems of mythic creatures for personal identification. For this project, the seal search database has been combined with web-accessible interactive maps. On the maps, users may add contextual layers to an outline of the empire depicting the scope of production of the seals: the locations of major Sasanian archaeological sites; topographical maps; modern political boundaries, and a gazetteer of mints, administrative centers, and religious sites in the Sasanian empire.

Collaborating digital atlas projects. The International Dunhuang Project (IDP) at the British Library takes quite a different approach to mapping and visualizing some of the cultural exchanges that collectively comprised the pre-industrial Silk Road (http://idp.bl.uk/). Rather than investigating large-scale movements across Eurasia, this project is an intensive effort to integrate and display records about one extremely important site. Under the direction of Susan Whitfield, the IDP has become the most important center for research on the primarily Buddhist manuscripts and artifacts from the hundreds of caves of the monastic library in northwest China at Dunhuang, sealed on the eve of invasion in the eleventh century. The central focus has been on the manuscripts and other Dunhuang artifacts catalogued by Sir Aurel Stein during his expeditions to Central Asia. Thousands of manuscripts, dispersed among collections in Asia, Europe and North America, can now be virtually linked with the caves where they were originally discovered. In addition to the manuscripts, Stein's exhaustively compiled maps, photographs, field notes, and images of additional artifacts have all been digitized and geo-referenced. This project digitizes and spatially integrates important resources on medieval Buddhism but also provides an intellectual history of Central Asian archaeological practice at the turn of the twentieth century.

Gazetteer development. Gazetteers are databases about places. An index at the end of a paper atlas can be considered as a kind of gazetteer, linking the names of places to their locations on maps. Increasingly, ECAI's atlas development activities are focused on the creation of historical digital gazetteers. In a digital environment, gazetteers can include many names for the same place in different languages or at different points in time. They can include multiple and complex spatial references for places (as points, bounding boxes, or complex polygons) and information about how those locations were transformed over time. They also include information about place types, so that a place in the gazetteer can be identified as a route, a city, a pass or a monastery. Gazetteers can enable a limitless and constantly expanding amount of cultural material — museum collections, library catalogues, and the work of individual scholars — to be inter-associated and visualized through a digital map. As a step toward the development of a Silk

Road Gazetteer, ECAI is collaborating with Hsi Lai University, a Buddhist institution in Los Angeles, to build a Chinese and Central Asian Buddhist gazetteer that can be incorporated into the Silk Road Atlas. Once the gazetteer database and system are accessible, it will be possible to integrate some of the projects that are collaborating with the Silk Road Atlas.

One of these is the Golden Web Project being executed by a group at Cambridge University led by Paul Keeler. It uses travel narratives as a source for geographical information about historical Eurasia. This group of researchers does not use the phrase "Silk Road," preferring instead the term "Golden Web" (http://www.goldenweb.net/) because they consider that "Silk Road" implies a trade corridor by land, although trade was equally important on the sea lanes. Organizing their work around digitized versions of accounts and journals of pilgrims and travelers from Chinese Buddhist pilgrims to Arab travelers, they are developing a project that deals with the entire "web" of trade that extends far beyond the traditional view of the "Silk Road." The Golden Web project provides materials in the original language and English translations. Place names mentioned in the diaries are linked to maps of the journeys themselves, and descriptions of sites and commodities mentioned in the text are hyperlinked to pictures, and to related narratives produced by other travelers, as well as to additional information. Once the locations from these maps and texts become associated with entries in a gazetteer database, the project will become a unique resource about trade routes over the centuries as well as a pioneering study of methods for linking maps, texts, and images.

A project under way at the Huntington Archive of Buddhist and Related Art, Ohio State University, represents another large effort that can be mapped once a gazetteer is complete (http://kaladarshan.arts.ohio-state.edu/). The archive contains more than 300,000 photographs of art and architecture of East and South Asia taken by Professors John and Susan Huntington, including presently endangered sites as well as sites, such as the Bamiyan Buddhas, that have since disappeared. For several years the archive has been digitizing the images. Under the guidance of curator Janice Glowski, they are being made available on the Internet. At present, the database of images may be searched by country and by site name, but a map interface has not yet been developed. In collaboration with ECAI, the archive is experimenting with map-based access to the collection, including one project that matches line drawings of the interior of the Buddhist caves at Yungang, China, with icons on the map interface representing each place inside the caves that was photographed. Users can move around the cave virtually, clicking on each icon to view the photographs that were taken from that location. A gazetteer system and database capable of associating places where photographs were taken with their geographical coordinates would enable this kind of map visualization of the whole collection.

An international consortium of contacts. Future development of the Silk Road Atlas depends upon a network of additional researchers around the world who are developing historical spatial content in a digital form. As the Atlas evolves, we remain in contact with these and other scholars. The very scope of the efforts illustrates why an Atlas of the sort we are developing is an important goal. For now, their work exemplifies the range of creative efforts underway in digital studies of Silk Road and Central Asian geography. One such project that is just coming to completion is the work of a team at the University of Michigan, headed by historian Michael Bonner and his student Robert Haug, to explore the pilgrimage and marketing network between Baghdad and Mecca. The springs and streams in this region have remained relatively stable over the centuries, and many ancient camping sites are still being used. Following the hydrography along the route, the Michigan group has been able to create a reasonably precise map of the trails that led pilgrims and merchants between these two important centers. The work of these scholars relies not only on physical geography but also on textual information, such as topographies culled from ancient Arabic poetry and from accounts by medieval Islamic travelers and geographers.

Many other digital efforts concerning the geography of cultural heritage along the Silk Road and in Central Asia are underway. Maurizio Forte, of the Italian Institute for Technology Applied to Cultural Heritage at the Italian National Research Council, is surveying archaeological sites in Kazakhstan using GIS, remote sensing, and three-dimensional technology, with a particular concern to identify sites at risk of degradation or destruction. Geographer Irina Merzliakova, of the Institute of Geography in the Russian Academy of Sciences, Moscow, is digitizing Russian maps of Central Asia dating back to the seventeenth century, and has also created a gazetteer of Russian Central Asian

mountain passes. Philologist Tsymzhit Vanchikova, of the Siberian Branch of the Russian Academy of Sciences, Ulan-Ude, has led a team to create a digital cultural atlas of Buryatia, in Russian Mongolia, with particular attention to the geography of religious interaction in this region. UNESCO, the Japanese National Institute of Informatics, and other large institutions are leading further multinational efforts (http://www.nii.ac.jp/dsrtokyo/gaiyou2-e.html). A digital atlas like the one ECAI is creating is a promising way to integrate these and other efforts in the region.

Conclusion: The Future of Central Eurasian Studies in the Digital Age

What is the future of Central Asian studies in the digital age? Some scholars will find it too demanding to digitize texts and images, determine and document temporal and spatial information, create databases, and register them in a clearinghouse. Such projects call for the development of novel analytical frameworks and skills, and new kinds of collaboration between humanists and information technology researchers. These collaborations will require significant funding to launch larger scale projects than the humanities have traditionally supported. Nevertheless, a new generation is coming to depend on Internet digital atlases like ECAI's. These digital tools enable the researcher to discover and assemble datasets from multiple sources. The result of research through such innovative techniques is the ability to create customized animated maps tied to texts. It is possible that "unhyperlinked" material that is not accessible through a clearinghouse will become less appealing, particularly in a field like Central Eurasian studies. This may be true for those who do not have the individual resources to devote to its many languages, complex geography, substantial lacunae, and diverse disciplinary approaches.

One lesson of the ECAI Silk Road Atlas is about the power of data integration and map visualization. Another is about the substantial barriers that must still be overcome if the digital spatial humanities are to become a mature field. Information technology researchers must be closely tied to humanities scholars. It is crucial that technology follows the research needs of those who are part of a text-based tradition. Only in this close collaboration of scholar and technical expert can the practices that characterize the humanities be sustained in the new medium. The Atlas that is currently available online is merely a first step that indicates directions for future work. We hope that it will become an increasingly valuable tool for integrating and analyzing data through developing gazetteers, fostering international collaborations, adding further content, and working with scholars and teachers from many disciplines.

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Instructional Technology and Digital Asset Management: Implications for the Scholarly Community

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Introduction

Technological advances are once again driving changes across the academic landscape. The latest manifestation of this phenomenon, which originally dates back to the development of the printing press, involves a series of technologies that collectively have given rise to Digital Asset Management (DAM).[1] There are two major reasons why higher education is moving in this direction.

First, whereas the growth of the Web has contributed greatly to the creation and dissemination of information, DAM technology seeks to transform this vast sea of undifferentiated data into useful information by making it more accessible to contemporary knowledge workers via powerful search tools. These tools permit faculty to take full advantage of classroom time by providing ways to capitalize on learning's most sacred premise — the teachable moment. Commercial search engines, like Google, make information retrieval much simpler than ever before, but they still do not incorporate the degree of specificity that most instructors require in order to adopt these tools for regular and effective use in the classroom. Attaching potentially extensive lists of metadata (data about data) to digital assets (files) has made it possible to locate and retrieve information in real-time (on-demand) environments with much greater confidence than ever before.[2]

Second, competition in the marketplace is driving institutions of higher learning to seek more effective and efficient means of cataloguing and controlling the dissemination of intellectual property produced by their employees. In this, there is no difference from corporations seeking better protection of their investments through the use of digital rights management tools. In both cases, sharing information among designated communities takes a back seat to controlling the transactions for commercial gain.[3] It should therefore be no surprise that attempts to clarify and/or revise existing campus intellectual property agreements frequently accompany academic DAM initiatives.

That said, this article addresses pedagogical applications and institutional challenges posed by DAM projects like the Electronic Cultural Atlas Initiative (ECAI).

Technology and Teaching

The ECAI is an interesting project with a great deal of promise in both technical and disciplinary terms. Essentially a shared repository of databases with a proprietary interface — much like the MERLOT (www.merlot.org) collection of shared learning objects — ECAI provides humanities scholars with an excellent opportunity to explore the benefits of collaborative learning through the use of instructional technology. ECAI uses Geographic Information Systems (GIS) technology to assist the visualization and study of culture and place. Its main premise is that its sophisticated mapping tools permit the (re)creation of new knowledge by integrating previously separate datasets within a single framework. Indeed, new (re)combinations of data can readily be translated into new forms of information; however, the key to knowledge development resides not simply in the synthesis of disparate data, but in the effectiveness of its application. There lies the catch — not in ECAI itself but rather in the general reticence of many humanities scholars to use technology.

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[1] In its most restrictive form Digital Asset Management is really nothing more than a synthesis of library cataloguing strictures, web-based data bases, emerging technical standards and the plethora of digital formats in which contemporary scholarship is produced — image, video, text, audio and GIS files.

[2] One noteworthy example of this technology is the Canto Cumulous DAM system. Canto's software application, Cumulous, is available in both client and Web-based versions, making it readily adaptable to the vast majority of faculty instructional needs. The software's interface is fairly intuitive, and its back-end database program provides ample latitude for users to create detailed metadata labels that facilitate swift retrieval of stored information.

[3] One of DAM's unavoidable consequences has been to give new life to the age-old struggle between faculty and their institutions over their prescribed relationships and roles of employee and employer.

These scholars in the humanities frequently find themselves ill-prepared for the challenges associated with developing effective applications for the types of materials that ECAI is designed to produce. Despite the prevalence of GIS technology, the vast majority of scholars across disciplines are unfamiliar not just with the principles and interfaces of the technology itself but with the very purposes towards which it may be employed.[4] Of course, scholars should keep current even with the purely technological advances in their fields, but the fault here is not the faculty's. Rather, most institutions that are not research-intensive doctorate-granting universities lack the staffing and expertise to provide the discipline-specific support that the majority of faculty require to make full use of technology in teaching.

For example, in order to appreciate ECAI's ability to create time-delineated maps one must first download and install the TimeMap software needed to generate and display the maps. This should be simple enough to do, but network and security concerns preclude faculty from downloading such software applications to their desktops in many academic environments. Even if faculty do enjoy the privilege of being able to download programs to their office machines, they often have little or no control over the configuration of classroom and lab computers where they would also need to have the software should they choose to use it in class. While not insurmountable, such inconveniences deter faculty from following such creative and innovative learning pursuits as ECAI; and to note these obstacles does not address whether faculty know how to accomplish these tasks, irrespective of permission and authorization.

Having said that, let me briefly recount my own experience with the TimeMap application and my venture into cultural mapping. I would not describe my teaching/technology skills and experience as being at the "expert" level, but I have served as the director of "Centers for Innovative Learning" and "Teaching/Learning Technologies" departments at various institutions, so I am fairly confident of my abilities. After two failed attempts, I successfully downloaded and installed TimeMap and then set out to explore ECAI and its database. When I generated several maps just to see what would happen, I was, to be honest, surprised at the detail that was available. Still, I found the interface and its presentation of that detail a bit cumbersome, not to navigate and operate, but rather to interpret and apply. The timeline features were especially interesting to use, although on a number of occasions I was not certain that I was seeing what I thought I was supposed to be seeing. After a few days of playing at home I shared my creations with several of my students. (This remains the best sanity check I know.) They all responded enthusiastically to the capabilities of TimeMap, but they were less enthusiastic about taking the maps we had created and incorporating the information elsewhere.

To be fair, ECAI deals with rather context-specific materials that, for full comprehension and appreciation, require at least a working knowledge and understanding of the subject-specialized matter. But this is the sort of barrier that prevents the more experienced learners among us (faculty) from initially playing with and later adopting applications such as ECAI on any level. So I found the program much better suited for subject experts than I did for novices or casual explorers.

Where does this leave us? What are faculty to do with projects like ECAI, in view of the pedagogical and disciplinary obstacles noted above? Scholars struggling to deal with the needs of the new learner will find the ability to generate on-the-fly materials to be a tremendous classroom advantage as the overall acceptance of DAM applications increases, the ECAI database grows, and the TimeMap interface improves. Irrespective of our comfort or discomfort with the fact, the world is quickly becoming a highly integrated environment that will make current standards of information retrieval look archaic. The days of having to thumb through stacks of books to locate educational minutiae are gone; the age of on-demand information is already upon us. The future to which ECAI aspires is this transformational age of generating and applying knowledge. The highest barrier to adopting and implementing technologies like ECAI are not technical but cultural. Projects like ECAI will continue to grow, but they will do so more slowly than they might otherwise until higher education transforms itself so as to meet the needs of learners in the twenty-first century. This includes

[4] GIS use has been expanding exponentially across the curriculum as faculty seek to use its mapping powers to expose increasingly subtle layers of meaning. For scientists the application has been a matter of practicality — ecosystems, animal behavior, resource distribution and other highly quantitative endeavors have led the way. For those in less "quantitative" disciplines the technology has been increasingly used to visually demonstrate heretofore-unseen phenomena.

tackling such issues as tenure, intellectual property, copyright, technical standards, learning assessment and organizational accountability.

Organizational Challenges

It is useful to enumerate the general obstacles that obstruct the path of scholars who may wish to explore and apply such technologies as ECAI and to suggest some strategies for overcoming them.

Governance. If campus administrators are to support faculty in using technologies in teaching, they need to: (a) develop and maintain a sufficient information infrastructure, both hardware/software and professional support/expertise; (b) implement a system of incentives for faculty to make use of learning technology, including credit within the tenure process for risk takers; and (c) create a transformational culture that values creativity. These challenges have a tremendous impact on whether, how and how well faculty use available learning technologies.

Decentralization. Colleges and Universities are decentralized businesses, organized toward intradepartmental competition, where units often compete for scarce resources. Though adequate resources may be available for technological innovation in teaching, their allocation often is suboptimal.

Faculty Expectations. Some faculty deride advances in teaching/learning as "fads," and demand high levels of proof of their effectiveness before adopting them. The new learner is a born-and-bred multitasker capable of processing several sources of information simultaneously. New models of instruction are needed to meet the needs and expectations of these students. Faculty should be encouraged to utilize existing opportunities and adopt new technologies. Since earning a Ph.D. does not usually require study of instructional design, faculty should seek help from those who have specialized knowledge of instructional technology.

Technical concerns. Access to appropriate instructional technology remains the single greatest challenge facing instructors today. The lack of professionally trained support personnel is a close second. Specialized digital and video labs are commonplace on campuses, but many institutions impede the transfer of the work done in those labs to the classroom. However, a classroom that is well-equipped with digital imaging devices presents no insurmountable barriers to the use of technologies like ECAI.

Conclusion

Instructors in higher education face great challenges today when adopting and applying new instructional technologies. However, these challenges are miniscule when juxtaposed to the opportunities that they offer for improving instruction and learning in the twenty-first century. Our collective futures depend on our collective ability to address these issues squarely and directly. Nothing less than our future in that *terra incognita* is at stake. Projects like ECAI help us to visualize and understand this new territory.