Digital Media Applications in Heritage Conservation

by

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ABSTRACT

This paper addresses the need for greater emphasis to be placed on information design as pertaining to the collection and organization of heritage recording data. The author proposes to create an intelligent interactive heritage documentation system using popular, cost-effective interactive media technologies to spatially reference heritage recording data in an effort to help better organize and derive greater meaning and understanding from the data.

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TABLE OF CONTENTS

1.0 Introduction	1
1.1 The Research Question	2
1.2 Methodology	3
1.3 Context	4
2.0 Role of Technology	5
2.1 Technologies and Applications	6
3.0 Documentation	7
3.1 3D Laser Scanning	9
3.2 3D Laser Scanning Applications in Heritage Conservation	10
3.3 Image Modeling	11
4.0 Virtual Heritage	12
4.1 Virtual Heritage Case Studies	14
5.0 Multimedia Standards and Issues	20
5.1 User Centred Design and Usability	23
5.2 Future Direction	24
5.3 Data Archiving and Online Access	25
6.0 Project: An Intelligent Interactive Heritage Documentation System	26
6.1 Introduction	26
6.2 Context	27
6.3 Goal	29
7.0 Case Study: Jaisalmer	30
7.1 Jaisalmer	31
7.2 INTACH and Sustainable Development in Jaisalmer	32
7.3 Jaisalmer in Jeopardy	33
7.4 Future Plans for Jaisalmer	34
7.5 State of Heritage Conservation in India	35
7.6 Conclusion	36
8.0 Data Organization	37
8.1 Information Design	38
8.2 Application Development	39
8.3 Media Elements	40
8.3.1 Level 1 – Maps/Plans	40
8.3.2 Level 2 – QuickTime VR	41
8.3.3 Level 3 – Photographs, Hypertext and Video	41
8.4 How the System Works	42
8.5 Other Applications	45
8.6 Lessons Learned	46
8.7 Future Developments	47
9.0 Conclusion and Next Steps	49
Bibliography	52

1.0 INTRODUCTION

Our heritage sites are being threatened as never before. Rampant tourism, over population, urban sprawl, terrorism, and environmental damage are just some of the dangers facing many of our heritage monuments around the world. Many efforts are being undertaken to preserve our built heritage, however lack of funding and the scale of the problem make it difficult to wholly address the situation. Non-governmental organizations such as the World Monuments Fund and organizations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO) are amongst some of the patrons who have dedicated themselves to preserving our global heritage. However, even organizations of this magnitude are only able to address a small percentage of the world's heritage sites. Protecting and preserving a heritage site requires more than simply addressing the physical aspect of the monument. In order to ensure the protection and sustainability of a site, especially from a cultural tourism point of view, environmental, developmental and sometimes political issues must be addressed at the national, state and local levels.

Although a wide variety of approaches are necessary to seriously address the issues at hand, digital media can play an important role with regards to documentation, education and interpretation of cultural heritage. Digital media technologies can be applied to record the fragile fabric of these historic environments, which can then be re-engaged through the creation of immersive digital environments or even simply through photo-realistic images. The premise of this thesis is that the practice of heritage conservation can be enhanced through the application of digital media technologies for the purposes of conservation, documentation, education, interpretation and virtual

tourism. Using virtual reality and other digital media technologies, visitors can experience certain aspects of heritage environments without physically traveling to the site. This offers the potential of increasing the general awareness of a culture.

In addition, there currently exists a need in the field of heritage conservation, archaeology and museology for a system of organizing documentation data. Current methods are impractical and digital media can offer new insight into finding ways of organizing this data for professional practice, education and scholarly study.

1.1 THE RESEARCH QUESTION

One of the biggest problems facing the practice of heritage documentation is the organization, communication and dissemination of information. Site documentation is often an on-going process of collecting data on the as-is condition of either an entire site or a small localized area. Documentation can involve the collection of a wide variety of media including photography, rectified photography, drawings, maps/plans, photogrammetric images, three-dimensional (3D) laser scans, survey data and more. Can digital media provide an efficient means to organize, catalogue and retrieve site documentation data? If so, how should it be structured, what kind of technological platform should it be based and what other features should it contain? Can the data capture and entry process be streamlined to allow conservators to input information directly into the system while on site? Currently, the organization of this data remains a major problem for most conservation projects. Data is often disorganized and no cohesive system of data integration currently exists for heritage conservation projects. An attempt to find a solution will be made through a process of research and

development of a prototypical application.

1.2 METHODOLOGY

This thesis examines a variety of initiatives currently underway to record and interpret heritage environments and attempts to arrive at a greater understanding of some of the issues and problems related to the digital representation, organization and dissemination of this multi-use data. Experts in the field of conservation and documentation have been consulted with regards to the problems they currently face when undertaking on-site documentation projects. The paper and project propose a practical, efficient, scalable and cost-effective methodology for the organization and dissemination of heritage recording and interpretation data. The issues facing heritage sites are many and digital tools of documentation and representation can be applied to help preserve and understand our delicate past not only for us to enjoy, but for future generations to know. Most importantly they can present new opportunities for insight into data relationships which previously were not possible. Traditional paper based organization is problematic because the data is disorganized, mismanaged, difficult to reproduce and each piece of documentation must be viewed separately and not in relation to its overall context. No international standard for the organization of this data currently exists.

The approach adopted by this paper is most applicable to those practitioners of architectural heritage conservation who rely on photographic and other forms of imperial evidence for documentation purposes. Embedded within the proposed methodology and project are a set of assumptions based primarily on Western ideologies related to

technology and the representation of the real world.

The restoration work currently underway in the city of Jaisalmer in the state of Rajasthan, India is applied as a case study. This beautiful medieval desert city is currently in need of major repairs and conservation due to increasing local populations and tourist visits. A poor water and sewage infrastructure is also damaging much of the 12th Century sandstone fort. The Indian National Trust for Art and Cultural Heritage (INTACH) has been undertaking the repair work in Jaisalmer since 2000; however budgetary constraints have forced them to limit their site documentation. This thesis will use this project as a case study to reflect on the realities of an actual heritage conservation project in an effort to better understand the role new media technologies can play in a prototypical restoration project. Using the documentation data captured on-site in January 2003 a prototype for a system of organizing recording data will be developed to show the possibilities digital media can offer this discipline.

1.3 CONTEXT

Digital media technologies are playing an increasingly important role in the understanding and preservation of cultural heritage. Digital media offer many new possibilities for various applications related to heritage including: education, cultural resource management, site documentation and visualization. Many projects combining heritage or cultural content with new technologies are being undertaken beneath the umbrella of “virtual heritage”. The problem however lies in the fact that most of these projects are being initiated by technologists rather than content experts. Heritage content is being used by many university and research organizations as a means to demonstrate their most sophisticated graphics hardware and technologies and usually offer little benefit to the heritage site or heritage professionals at large. Unfortunately, many of

these projects are based on relatively immature, expensive and complex technologies which are not easily deployable and are rarely seen outside of the lab.

A reality which has not yet been addressed by the virtual heritage community is that the majority of heritage sites in the world are situated in developing countries whose heritage organizations lack the funding and technical ability to implement these complex technologies within their heritage conservation and education practices. Simple, reliable and practical digital media solutions need to be developed which can be integrated within existing workflows to help enhance the work already being done. Until this is recognized the digital media applications within heritage will continue to be created by universities and research institutions as a means of furthering their own initiatives rather than making any significant contribution to the field of heritage conservation.

2.0 ROLE OF TECHNOLOGY

Technology has always been applied in some shape or form when attempting to document, record and study the physical world. After the invention of perspective, many technologies such as camera obscura, camera lucida, film and photography emerged which sought to frame and represent the real world on a two dimensional plane. Many modern explorers who visited Egypt were not simply sightseers "...but mostly young men, artists and architects, eager to record and learn from the monuments and structures of the ancients...many were skilled draughtsmen who frequently used a camera lucida."(Hammond, 92) Even in the earliest days of documentation, technologies were applied to record historical monuments.

Within the past ten years a new generation of technologies has emerged which allow for more immersive and interactive means of representing the built world. Interactive panoramas, based on traditional photography, such as QuickTime VR allow

users to navigate and travel through a space on their desktops. The invention of 3D laser scanning has completely changed previous conceptions of documenting and recording the real world. This technology can accurately capture a three dimensional representation of an environment, as well as extract accurate measurements and dimensional data used for surveying, engineering analysis and reconstruction applications. The resulting documentation data acquired through the application of these technologies can significantly impact the interpretation of the site. This topic however would be better explored in a paper dedicated solely to this subject.

2.1 TECHNOLOGIES AND APPLICATIONS

“Today, the forward march of technology has quietly enabled a second wave of VR applications, with reality finally beginning to live up to its title role. Digital tools and techniques now emerging from academic, government, and industry labs offer new hope to the often painstakingly complex tasks of archaeology, surveying, historic research, conservation and education. (Addison, *Emerging Trends in Virtual Heritage*, p.1)

Each major advance in technology offers the potential of progressively greater sensory immersion. High definition displays, high fidelity audio and virtual reality all strive to deliver a hyper-real visual representation and technologically mediated experience that presumably is a sophisticated simulation of the so-called original. Rich media, which is a seamless composite of a number of audiovisual media types, offers the potential of a similar leap forward. The accompanying thesis project derives and proposes appropriate uses of new media in the field of heritage conservation for the purposes of documentation, education and interpretation.

This survey of documentation methods and applications will be of interest to those who require content and data relating to the as built status of a heritage or archaeological site. The paper examines the range of documentation and recording technologies currently available as well as a variety of digital media technologies

applicable to heritage documentation and makes recommendations based on a variety of possible scenarios and applications. For instance, those who may be undertaking physical restoration work on a particular site will require detailed and accurate plans, drawings, photographs and measurements of a site and will likely employ more traditional recording technologies. A tourism official or educator on the other hand may not require such accuracy and being concerned primarily with visualization will be interested more in visually engaging content such as video, 3D models and virtual tours used for education and interpretation.

3.0 DOCUMENTATION

The Venice Charter, written in 1964 by a group of primarily Western conservation experts outlines a series of guidelines for the practice of heritage conservation on a global scale. Article 16 of the Venice Charter applies to the practice of documentation and states:

In all works of preservation, restoration or excavation, there should always be precise documentation in the form of analytical and critical reports, illustrated with drawings and photographs. Every stage of the work of clearing, consolidation, rearrangement and integration, as well as technical and formal features identified during the course of the work, should be included. This record should be placed in the archives of a public institution and made available to research workers. It is recommended that the report should be published.

Site documentation is very important to the practice of heritage conservation as it allows conservationists to maintain visual records of the various stages of restoration intervention. A wide variety of documentation techniques, methods and technologies are currently used by conservationists around the world. Often times the documentation strategies are simply governed by financial resources and local expertise. Site documentation is the first stage of any restoration project and can range from the

documentation of a small detail or ornament to an entire building or an entire site. The monument or environment is recorded in its existing condition in order to assess the current state of the site and propose intervention strategies for repair and restoration. This data also provides the conservation team with a time stamp of the site, as well as evidence of the need for restoration when approaching international funding agencies and competing with other heritage sites for the limited funds made available to such projects. Traditional documentation techniques employed by most relatively low-budget restoration projects today include a collection of both new and old drawings, photographs and notes. Other technologies used by larger budget projects include: photogrammetry, stereo/digital photogrammetry, digital video, QuickTime VR, image modeling and 3D laser scanning. Although generally used in larger budget projects some of these technologies are cost effective and with a small investment in training can be employed for virtually any heritage documentation project. QuickTime VR (QTVR) for example, allows you to view and create photorealistic virtual walkthroughs on an average PC. The cost of the software is relatively inexpensive and can be created on basically any PC made within the past five years. For instance, the software used to create the QTVRs for the project component of this thesis was assembled with version 1.0 of the QuickTime VR Authoring Studio software - the first piece of software ever made for producing QuickTime VR, created in 1997. Digital video and digital still cameras have also become relatively inexpensive. Many digital still cameras have added the ability to take short video clips or record short voice recordings and link them to their corresponding pictures. Some even have the ability to stitch multiple still images into wide panoramic images. Today, many forms of digital documentation exist making it easier and less time

consuming to gather information. Once the data has been collected, the next step is to make sense of that data by organizing it in such a way which allows one to extract the most relevant information from it. The following subchapters elaborate on several different digital documentation techniques currently in use.

3.1 3D LASER SCANNING

This technology offers many exciting possibilities for heritage documentation. Its primary strength lies in its ability to quickly create a three dimensional “point cloud” from which an accurate three dimensional computer model can be produced. A point cloud is a term used to describe a cluster of points in 3D space. A laser scanner works by emitting a laser pulse into a designated space and returning a series of points which contain spatial data relating to the distance of points from the scanner and also from point to point. This technology is primarily used for quickly creating accurate and detailed measurements of a space. The density of the point cloud can be specified by the user depending on the application. The denser the point cloud the higher the resolution will be and the more data that will be contained within it; however the file sizes and time taken to produce the data will be greater as well. The greatest value of this technology lies in its ability to gather accurate as-built data, to help study and understand an object or structure in its current form. Applications for this technology include site surveying, rapid prototyping, heritage documentation, aeronautic design, reverse engineering and so on. Many different types of laser scanners are currently available and each specializes in different applications. Some laser scanners not only collect spatial data but can also accurately collect surface, textural and colour data as well. Cyra Technologies’ laser scanners specialize in documenting large spaces and are able to collect points from over

one hundred metres away. The National Research Council's (NRC) laser scanner specializes in recording small spaces and detailed objects and also has the ability to gather colour data as well. This laser scanner has been used by the Canadian Museum of Civilization to document artifacts which were then reproduced as three dimensional models for dissemination over the web and within museum exhibits. Currently, 3D laser scanning is primarily being applied to large scale engineering projects to document as-built structures. It is often applied to complex structures such as oil rigs, factories, and manufacturing plants where accurate and up-to-date two dimensional plans are unavailable. This process of reverse engineering allows accurate plans to be created from the laser scans so that replacement parts can be manufactured and installed quickly and efficiently.

3.2 3D LASER SCANNING APPLICATIONS IN HERITAGE CONSERVATION

The applications for 3D laser scanning in heritage conservation are numerous. Laser scanning technologies are being used to accurately document and record heritage sites for the purposes of virtual reconstructions as well as for assessing the current status of a heritage site for restoration intervention. Once a point cloud is created it can either be used for measuring and studying the spatial data or it can be used as a base from which to create 3D models in modeling programs such as 3D Studio Max, Maya, Polyworks or any other number of applications which support point cloud data. The biggest hindrance to its application in heritage related projects is cost. Laser scanners are extremely expensive and cost upwards of \$250,000 CDN. As well, a major investment in training, hardware and software must be made. Although the scanning process is

relatively quick and simple, data extraction, point cloud compositing and 3D modeling from the data can be very time consuming and therefore costly. Very few conservation projects, unless well funded, are able to take advantage of this technology. Although the cost is slowly declining it will take time for this technology to become a realistic option for the majority of heritage conservation projects. Leica, the Swiss camera, survey equipment and optics manufacturer, recently bought Cyra Technologies and has invested heavily in developing 3D laser scanning into a viable and cost-effective tool. Leica's investment in this technology is a tremendous boost for the laser scanning industry and community because it ensures the viability of the technology over the years to come. It is also expected that smaller, more compact laser scanners will soon become available on the market and perhaps one day this technology will find its place amongst other more common documentation technologies.

3.3 IMAGE MODELING

Image modeling is a process of creating 3D models from photographs. This process uses photography to create accurate, measurable 3D models at a fraction of the cost of 3D laser scanning. Requiring nothing more than software and a correctly calibrated camera large structures can be quickly and accurately modeled using a series of photographs. Often this technique is combined with 3D laser scanning to provide a model of a large area, using the scan data to provide accurate details of smaller areas. For heritage conservation projects looking to integrate 3D modeling into their analysis and study, this technique is by far the most viable and cost-effective solution currently on the market. The ShapeCapture software developed by the NRC is currently being used by several

heritage related projects around the world.

4.0 VIRTUAL HERITAGE

With the advent of greater computing power, commonplace accessibility to powerful graphics hardware and software, the field of Virtual Heritage has emerged as one to lead a new trend towards the application of graphics technologies, primarily used for entertainment, for purposes of heritage education, conservation and interpretation. For the past ten years Virtual Heritage has struggled to become an organized and structured discipline. Very few University programs address Virtual Heritage directly; thus far it has been left up to independent organizations made up of volunteers to help lay the groundwork for the discipline to grow. Conferences such as Virtual Systems and Multimedia (VSMM) have dedicated tremendous effort to this domain by creating conference streams and judging academic papers in an effort to create a framework for the discipline to continue to expand. Bernard Frischer, Professor of Archaeology at UCLA in his seminal paper entitled: “*From CVR to CVRO: The Past, Present, and Future of Cultural Virtual Reality*” proposes the creation of an organization dedicated solely towards creating a forum for the exchange and sharing of knowledge and ideas in the field of Virtual Heritage. “Uniting to define their own standards, rules, and conventions for scientific CVR [Cultural Virtual Reality] models is just one of several reasons why it is important, at this point in the development of CVR, for CVR developers to start their own professional organization.”(Frischer, 9)

Although still a very young field, many projects are being undertaken around the

world to help preserve aspects of our built heritage using digital technologies. Due to the fact that this field is still in its infancy many projects seem to be nothing more than technological experiments using heritage content to test technologies and these projects rarely leave or are shown outside of university or research labs. Unfortunately, due to this field's heavy reliance on technology, most of those involved seem to be from a technical or computer science background as opposed to being heritage content experts.

"As will be seen, we think that, in view of the impressive groundwork of hardware and software already laid, the answer we seek is more theoretical and sociological than it is technological. The bad news may be the weakness of human nature, but the good news is that CVR content developers can themselves take some obvious steps – taken many times by practitioners of other professions – and become to no small extent the masters of their own fate." (Frischer, 2)

In order for this field to develop into a meaningful hybrid discipline merging technology and cultural content, architects, art historians and archaeologists need to become further involved in its development. Without the critical input of such professionals and scholars the digital artifacts produced will be unqualified, insignificant and lack experiential depth. As such, cultural content will remain a mere curiosity created by technologists as material to test their technologies. In order for the discipline of CVR to mature, it requires those who understand and appreciate the content as meaningful thus requiring appropriately sophisticated modes of presentation.

With so many different technologies, media formats, methodologies and platforms currently available the question remains as to which combination is the most effective in a given context in the field of Virtual Heritage. This is a difficult question to answer. For example, if a 3D virtual reconstruction is created on a particular platform using a certain graphics engine, will that 3D reconstruction be viewable on a different platform with a different graphics card or system configuration? It may be usable, but it

may not perform exactly as it did on the system it was created with. In other words there is no guarantee that content will be viewable on other system configurations as it was intended to. The lack of standards in computing leads to many such problems which makes it difficult to disseminate content and have it playback as it was originally designed. These issues will be discussed in greater detail in subsequent chapters. Due to the fact that research and development in this field is so disconnected, the Virtual Heritage Network (<http://www.virtualheritage.net/>) was created in an attempt to form a cohesive centralized location for the online sharing of knowledge, resources and contacts for those in the Virtual Heritage community. The Virtual Heritage Network's mandate is defined as:

“Virtual Heritage Network [VHN], is a new international organization designed to promote the utilization of technology for the education, interpretation, conservation and preservation of Natural, Cultural and World Heritage. The network is a physical and electronic network of people and resources in many countries currently working in the virtual heritage community. This organization has been formed through the many ideas from people working in the heritage and technology industry recognizing that it is fragmented, and difficult to find other researchers and information.”

The website (<http://www.virtualheritage.net/>) contains an enormous amount of content made up of papers, links, news, upcoming events, conferences and other relevant information. It is the most comprehensive resource for Virtual Heritage content and its production.

4.1 VIRTUAL HERITAGE CASE STUDIES

The following case studies are a small sample of some of the projects being carried out under the umbrella of Virtual Heritage. They illustrate the range of projects within this domain and a sample of technologies used to execute them.

Case Study 1: Virtualizing a Byzantine Crypt by Combining High-resolution Textures with Laser Scanner 3D Data

This National Research Council of Canada (NRC) project undertaken by the Institute for Information Technology (IIT) proposes a 3D non-contact laser scanning method for virtually reconstructing a heritage site in its original form without any intervention to the actual site itself. This allows the site to be untouched while at the same time showing, with tremendous detail, what the site looked like at a particular point in time. Heritage sites which may be closed for long periods of time due to restoration, or those which may be permanently closed because of their sensitivity can take advantage of digital reconstructions and allow visitors to take a virtual visit of the site. "...sites that must be closed for conservation reasons can still be studied and visited once a 3D model has been created. Computer-based visual enhancement and analysis techniques can be applied to the digital model in all of these situations."(VSMM 2002, pg. 3) Using a combination of 3D and 2D technologies the virtual restoration of a Byzantine Crypt in southern Italy was conducted. Using the NRC's proprietary 3D laser scanning technology the interior of the crypt was scanned to create an accurate 3D model. High resolution digital photographs were then taken of the walls and the frescoes inside the crypt and texture mapped onto the 3D walls of the crypt using 3D Studio Max. This application served to demonstrate the remarkable results which can be achieved using a combination of 3D laser scanning and photogrammetry. The result of this project was a spectacular richly detailed video showing the restored frescoes on the walls of the crypt. However, although funding was available from a local body to fund this virtual restoration most heritage conservation projects are not so fortunate. Funds are often extremely scarce and costly technologies are most often not an option. Regardless, the application of this technology and the

results produced from it show the tremendous potential of 3D technologies for heritage preservation, cultural education, engineering and architectural analysis. The data can then be displayed in a wide variety of presentation formats including CAVEs, Imax, and desktop systems. As 3D technologies continue to drop in price the application of these technologies will become more common and widespread and eventually find their way into smaller budget projects.

Case Study 2: WHTour, www.world-heritage-tour.org

The WHTour website, partially funded by the World Monuments Fund and other private organizations is a project whose purpose is to: “Enhance our knowledge of the world in order to improve tolerance amongst people, not to mention using our collective skills as a means of promoting the values of peace and sharing the motto: ‘Although not the same, everybody’s related.’”(quote from WHTour website) The website contains hundreds of QTVRs from heritage sites around the world. The virtual tours are listed by country and then by heritage site. This simple and easy to use website links the QTVR nodes to maps, spatially locating each panoramic image to a particular location within the overall site. The website’s value lies in the ability to jump to any number of heritage sites from around the world in an instant. There is no other resource currently available with such a rich collection of interactive panoramic images on the web.

The website relies on spherical QuickTime VR movies to give the viewer a 360 degree view of World Heritage Sites. QuickTime VRs are relatively simple to produce. Tito Dupret, the multimedia producer who creates most of the website’s content, travels the world with a couple of cameras a laptop and a tripod. All of his post-production work is done in the field and uploaded from anywhere he can find a dial-up Internet

connection. The technology chosen for this project is widely used, accepted and matured enough to know that the content produced will not quickly become technologically outdated. The low-cost nature of this technology and its relative simplicity made it ideal for reaching a wide audience. Nothing more than a standard PC is needed to view, or produce this content. The technology and platform chosen for this project make it easily updatable, accessible and easy to use.

Case Study 3: The Multimedia CD-ROMs of the Centro Internazionale di Studi di Architettura Andrea Palladio: A resource for the study of architectural history and for the scientific examination and promotion of the works of Palladio.

This large scale multimedia project seeks to create a complete and comprehensive study of the works of Andrea Palladio. This four disc CD-ROM set uses a variety of data sources and multimedia formats to compile a rich digital collection of the works of this Renaissance Architect. All of the media formats including: maps, plans, photographs, drawings, 3D models, videos, QTVRs and animations have been organized into an interactive database authored in Macromedia Director. The goal of this project was to produce a product which would appeal to the architectural historian as well as the tourist interested in viewing and learning about Palladio's body of work. The problem was to find a way to organize, present and disseminate a great deal of content in an engaging, educational and organized manner. The choice of technologies and motivation for the use of multimedia technologies was a very conscious decision made on behalf of the Centre:

"...the Centro intends to make use of these new technologies (alongside the continued use of traditional formats such as monographs, exhibition catalogues, facsimile reproductions, etc.) to take advantage of the special opportunities these new means offer. The management of information through databases that facilitate research across numerous types of catalogued materials (maps, drawings, manuscript documents, prints and photographs) not only makes the work of scholars more rapid, but also augments the range of possibilities."

In addition to the CD-ROMs and the traditional formats outlined above, a web module is also available online at (<http://www.cisapalladio.org>). This multifaceted approach to the organization, and dissemination of Palladio's work allows the Centre to use readily deployable and widely accepted presentation formats to assist in their goal of furthering architectural education. The content is not dependent on sophisticated graphics technologies, thus allowing anyone with a PC made within the past three to four years to view the content without any trouble and making it accessible to the public at large.

Case Study 4: Extending Virtual Heritage Beyond the Local Site: Creating an International Digital Network

Undertaken at the Digital Worlds Institute (DWI) at the University of Florida, this project aims to create an international forum for the sharing and worldwide dissemination of heritage content via high-speed networks and scalable presentation methods. To initiate this venture into shared multi-user heritage environments a 3D model of the historic city of Mandu, India was created. After making a site visit and collecting local textures, images, plans and sounds a complete 3D interactive model was produced. This model can now be explored in real-time in the DWI's visualization environment. The primary motivation of this project was to produce a virtual reconstruction of the site for educational and scholarly purposes. This allows those who may have never visited the site to make a virtual visit and, to some degree, experience this historic monument. Based on the premise that greater understanding of one culture can be achieved through parallel understanding of other cultures this project aims to create a collection of similar 3D projects to be shared amongst other universities and institutions with a comparable technological infrastructure. Through the use of high speed networks and large projection technologies the Digital Worlds Institute seeks to create a content distribution

standard allowing communities from around the world to share cultural content and learn from one another using these technologies to bridge the distance gap. The DWI's Non-expensive Audio Visual Environment (NAVE) is a scale projection environment designed to be inexpensive and relatively simple to produce. Unlike most Computer Aided Virtual Environments (CAVE) which can cost close to a million dollars the NAVE can be built for less than fifty thousand dollars. This large viewing environment makes use of 3 flat walls, 3 projectors and a computer to control the environment (audio and video). Using the metaphor of a world globe this project seeks to link heritage sites from around the world onto a single globe allowing users to visit and explore heritage monuments from a single access point. This project addresses a very important point which is the creation of a centralized and linked method of accessing other similar 3D reconstruction projects.

Case Study 5: CLIOH: A Cultural digital Library Indexing Our Heritage

The CLIOH project undertaken by the School of Informatics at Indiana State University is a project whose goal is to create a new media digital library of some of the world's most threatened cultural resources. Using the Dublin Core metadata standards for the organization of the content this project makes use of computer databases to organize multimedia content in a way which is easily retrievable. This approach is intended to provide a model for the collection, storage and dissemination of museum and library data for cultural heritage content. The project began by gathering QTVRs, video and hundreds of photographs from the ancient Mayan cities of Uxmal and Chichen Itza. Once the data was captured on site it was digitized, indexed and organized using the

Dublin Core standards. The search capabilities take into account a variety of search possibilities, names and naming conventions for the documented buildings and artifacts. The content is available free online at: <http://clioh.informatics.iupui.edu/> The website provides users with three separate viewing options including: Shockwave, Flash and HTML. The multimedia content has been well organized and is a tremendous resource for students, educators and anyone interested in historic civilizations. The scalable approach taken by this project allows the content to be viewed by a wide audience using a variety of computer configurations, thus allowing greater access to the documentation data. Normally access to this type of content is extremely limited and is rarely easily available to the public. This project also serves as an example of how important the organization and dissemination of cultural data is.

Although these projects propose interesting means of utilizing digital media for heritage education they do not propose the creation of new tools or systems for improving the practice of heritage conservation. Each project seeks only to create virtual representations of historic sites but does not offer any new tools for the on-site architects to use throughout their daily work process. Unfortunately, little work within the domain of virtual heritage is being done to address the needs of heritage architects.

5.0 MULTIMEDIA STANDARDS AND ISSUES

“Information and entertainment services that really take advantage of and define new multimedia must evolve and need a gestation period long enough to accommodate both successes and failures. As a consequence, multimedia products today are like newborn children with good genes, but not yet sufficiently developed to have a recognizable character and strong physique. Most of today’s multimedia applications are somewhat anemic, rarely more than one kind of opportunism or another. But we are learning fast.” (Negroponte, 63)

Digital multimedia content in its own right does not yet exist in any cohesive manner. It is still in the process of trying to define itself and the inter-relations that

would constitute one medium as multiple in nature. The sheer plethora of standards hinders multimedia content from evolving into its own distinct breed. On the other hand, perhaps this lack of unity allows it the freedom to pick and choose from amongst the best media and playback formats currently available for a given situation. This can be seen as a problem simply because there are too many formats, standards and platforms available to work with making interoperability and sharing of content extremely difficult. Digital video playback formats, for example, currently include the following: QuickTime, Windows Media, Real, DVD/DVD-ROM, CD/CD-ROM, VCD, MiniDV, DV, DVCam, NTSC, PAL, SECAM as well as dozens of other readily available and proprietary formats. Although many of the formats listed above are well established, any attempt to coalesce them into a true “multimedia” project not only requires a creative approach to the problem but also a highly technical understanding of formats and authoring software.

When the film industry was first established it took more than five years for filmmakers to consider that the camera could be moved and that actors did not have to simply stand in front of a static camera frame to act. It took an additional thirty two years to add sound and even more time to add colour to the images. The film industry is an excellent example of an established and now mature technological medium. The fundamentals of film production and playback technologies have not changed since its inception and remains to this day a standard adhered to around the world. Thirty-five millimetre films can be played at any movie theatre around the world. The fact that this medium is so well established allows filmmakers to concentrate on their craft and the content as opposed to dealing with the unpredictable nature of new technologies. Film is probably the most well defined and creative medium of our time largely due in part to the

fact that it is so widely accepted and constant in its base state.

Current multimedia content on the other hand has no standard playback format or device. Although produced on computers, the content is also played back on a variety of devices. In theory multimedia content should be able to play back on any average PC made within the last four or five years. However, with so many authoring and playback platforms currently available, producing content which will run identical to its original one hundred percent of the time is next to impossible. The problem here lies in the multitude of configurations currently available on the PC market and the ability to customize them so easily.

Multimedia content is still in the process of trying to figure out what it really is. Film, television, video games, text and music all make up the framework of multimedia content. Often referred to as “New Media” or “Rich Media” digital media is still trying to discover itself and find out what makes it unique in comparison to other media formats. Currently, it is nothing more than digitized versions of analog media types distributed in electronic forms. As Negroponte’s quote above suggests it will take time to mature and grow into its own format. The term multimedia itself is ambiguous. It doesn’t define the medium, it simply informs us that it is a combination of more than one media type. Interactivity and connectivity will be critical to the success of defining multimedia on its own terms. Hypertext is interactive and so are video games, but the level of interactivity of hypertext is quite different from that of video games. Many video game producers are taking advantage of high-speed Internet connectivity at home by creating online multiplayer games for both PCs and console gaming systems. As such, it can be assumed that the shifting nature of technology and related market forces will not

allow us to settle on one best digital medium. In the meantime, practical means of using digital media need to be developed with the input of professionals to spawn and develop future generations of applications for heritage conservation, architecture, museology and archeology. Digital media, by their very nature, lies in a state of continual transformation. From a practical usage point of view, user needs should define their evolution. To become accepted tools they must be useful, easy to integrate into existing workflows, and cost-effective; otherwise like many other Virtual Heritage experiments they will never move beyond the lab-based experimental phase of development.

5.1 USER CENTRED DESIGN AND USABILITY

“Today’s computers are still poorly designed, at least from the user’s point of view. But one problem is simply that the technology is still very primitive – like the 1906 auto – and there is no standardization. Standardization is the solution of last resort, an admission that we cannot solve the problems in any other way. So we must at least all agree to a common solution. When we have standardization of our keyboard layouts, our input and output formats, our operating systems, our text editors and word processors, and the basic means of operating any program, then suddenly we will have a major breakthrough in usability.” (Norman, 2002)

Apple Computer stands out as a company who is particularly sensitive to user needs and has the courage to define targeted individual user groups. Their hardware line up ranges from computers designed for schools and classroom environments to dual processor towers aimed at high end video, graphics and print production. Although each computer can perform the same tasks each one is geared towards a particular user and price range. Their software packages, particularly those for video production, also cater to different users and experience levels. Apple’s free iMovie and iDVD software both cater to the average consumer’s needs for simple and easy-to-use, template based applications for video editing and DVD authoring. For the professional, Apple provides

Final Cut Pro and DVD Studio Pro which allow for greater control and more complex functionality. By providing a range of hardware and software solutions Apple is able to cater to different needs and allow people from different skill levels to accomplish tasks relative to their interests, skill levels and time. From a usability point of view this approach allows less skilled users to accomplish what are normally difficult tasks with relative ease. iDVD allows one to simply drag and drop a video into a template to produce a professional looking DVD. In what is normally a relatively complex task, iDVD simplifies the process by doing most of the work for the user and limiting the number of available options. These applications are appealing to most users who are more concerned with accomplishing a task as opposed to trying to learn a new piece of software.

Good user design constitutes an awareness on the designer's part of the end user's needs and requirements. Designing applications geared to a particular user's needs and skill level allows the end user to accomplish their tasks in an efficient manner while providing them with new means of accomplishing those tasks.

5.2 FUTURE DIRECTION

As interactivity and connectivity converge with gaming technologies on a mass scale lessons will be learned which will be applied to other fields including architecture and heritage conservation. New applications for both hardware and software will begin to be developed specifically for these professionals in these fields.

One big advantage of producing digital content is its ability to be easily deployed and used in different media. Digital media, like all other forms of digital data can be

identically reproduced on any other digital playback format without any loss in quality. The same however does not hold true for analog media. The same digital video shot on MiniDV or DVCam can be disseminated via CD-ROM, DVD or the web. Once any bit of media reaches the digital common denominator it can be repurposed in any way whatsoever. This issue leads to the question of data storage and information access.

5.3 DATA ARCHIVING AND ONLINE ACCESS

The value of heritage recording data lies in its context to past and future recordings. Archiving these documents in a manner which allows them to be compared to past and future documents is critical to a site's historical record. Traditional forms of paper based archives are cumbersome, difficult to manage and over time become fragile. Digital archives allow various forms of documentation to be indexed, organized and even hyperlinked to one another allowing greater access to larger quantities of data in an intelligible manner. Documentation related to heritage monuments is always particular to a specific location within a site. Digital media allows for all forms of data to be spatially located allowing the user to understand the context of each piece of information within a site. Digital media can also be easily distributed without any loss of quality on CD/DVD-ROM, the Web and other distribution methods.

Metadata tags allow each piece of information to be indexed and searched under a variety of headings and search topics, depending on the requirements and different types of users and their uses for the data. When organizing large quantities of data it is important to employ metadata standards to ensure the information is well organized and accessible. Custom fields can be created to allow users the ability to search data using

industry specific terminology. Various standards currently exist, however new industry specific standards will need to be created catering to the needs and requirements of professionals.

The World Wide Web allows for easy access to digital media. The Web supports almost all forms of digital media and is a tremendous asset for those looking to distribute content to a wide audience. The Web serves as a vehicle not only to disseminate information to the public for educational purposes, but also to professionals who may be working on a project off-site and who require daily updates and information on a project.

6.0 THESIS PROJECT: An Intelligent Interactive Heritage Documentation System

The following and explains the motivation and process used to create the project component of the thesis.

6.1 INTRODUCTION

This section will focus on the documentation process and propose the creation of an Intelligent Interactive Heritage Documentation System to assist professionals in recording and interpreting heritage sites and environments. Conservation architects are constantly faced with the problem of organizing and making sense of the vast amounts of data and media collected while performing a site documentation or survey. The data collected is often disorganized and difficult to relate to the overall site context. Applying basic principles of information design to the organization of site documentation and survey data can have an enormous impact on the way this data is interpreted. By contextualizing this data through a process of spatial referencing, valuable information

and knowledge can be extracted giving new insight and perspective into what may otherwise have been purely static data.

Site survey and documentation strategies can be enhanced through the application of new media technologies, and information design principles, for the purposes of heritage recording and digital reconstruction of heritage environments. Emerging digital technologies are making it possible to organize, categorize and contextualize vast amounts of recording data as never before.

6.2 CONTEXT

Large amounts of resources can be raised for certain outstanding heritage projects which are seen to have economic potential for cultural tourism. However, the reality is that most conservationists are faced with tight budgets and the recording and interpretation budgets of most heritage projects are often among the first to be eliminated. In recognition of this reality, this project proposes the use of new media technologies that are affordable and can be used by conservation teams anywhere in the world without the need for advanced technological infrastructure. The resulting interactive documentation system not only provides an intuitive visual interface to the content of a typical site or environment, but is organized in such a way that the user is able to navigate through space and its associated information in an integrated manner.

Of the many stages of any heritage conservation project, the first of the actual physical restoration is the documentation and recording stage. In order to study and fully understand the components and current state of a structure, that structure must be carefully documented to make an accurate assessment of its physical status. This

thorough site documentation is important for a number of reasons. First, conservationists can make important decisions with regards to the type of physical intervention required. Secondly, the documentation provides a “time stamp” of the status of a building at a particular point in time. Lastly, but perhaps most importantly the documentation provides evidence for the project team to make its case for soliciting funds to undertake the remainder of the project and begin the process of restoration. The development of this application will build on the existing skills of conservation architects and site surveyors by incorporating their existing methods while extending their abilities in new directions.

To truly understand the physical condition of a heritage site, an accurate assessment of its status must be made. An assessment which makes use of a comparative study of multiple data types and information, over a given period of time, allows the conservation team to produce a complete picture of the current building status.

Traditionally, conservation architects have used drawings, photographs and notes to document and take note of aspects of a building’s condition for future repair and study. These drawings, photographs and notes were often created over an extended period of time, using different technologies and media formats and as a result were often poorly organized. Today, conservation architects employ a variety of technologies, media and recording formats including: drawings, photographs, video, text, photogrammetry, 3D laser scanning etc. to attempt to accurately document the condition of a heritage site. The result in most cases is a vast amount of data but not always an equivalent amount of useful information.

6.3 GOAL

Using a complementary set of media and data types which can be seamlessly integrated can result in numerous benefits. Within this context, the aim of this project is to develop a prototypical application using new media technologies for monitoring and recording heritage conservation projects. This tool is intended to be used by conservation teams and architects to maintain project history and gather the necessary information for appropriate interventions. This assemblage of visual data becomes a fully interactive and immersive context sensitive, or “intelligent” database, resulting in a modular and flexible template which can be populated over time, customized and be re-used for other projects. It is intended that the user be able to navigate through space and information simultaneously using immersive environments such as Cubic/QuickTime VRs, maps/plans, as visual interfaces to all other media types and data sets. The challenge then becomes: Once the field data is collected how can it be structured in such a way so as to facilitate an accurate recounting of the history of a heritage site over time? In response, a set of guidelines, addressing this issue, have been developed with the aim of generating an Intelligent Interactive Heritage Documentation System.

Briefly, the system should be:

1. able to integrate data collected over time and by different people;
2. able to incorporate both digital and accepted analog recording formats and media types and make use of current and readily available computer technologies for production and playback during interpretation;
3. cost-effective and not be dependent on major funding to begin or support the project;

4. easy to use and adaptable to different types and scales of projects to become widely accepted and used by conservationists in the field;
5. portable to be considered a valuable field tool.

7.0 CASE STUDY: JAISALMER

The city of Jaisalmer in the state of Rajasthan, India is being adopted as a case study. This beautiful medieval desert city is currently in need of major conservation effort due to increasing tourist visits. Poor water and sewage infrastructure is damaging much of the 12th Century sandstone fort. A nonprofit organization called “Jaisalmer in Jeopardy”(JIJ) (<http://www.jaisalmer-in-jeopardy.org>) based in the UK has raised over \$300,000 USD from the World Monument Fund, American Express and others to repair the city’s damaged buildings. However, there are a number of challenges facing the conservation effort and this study is intended to make a contribution to the overall effort, while developing a tool for the wider heritage conservation field.

At present, there is very little documentation available of Jaisalmer Fort. Aside from a few plans and photographs there is very little data available in the form of documents or photographs. Few books have been written on the site and few scholars have studied its architecture and produced comprehensive studies of the site. For its part, INTACH has produced two official documents related to its conservation efforts. One of them very briefly outlines some of their future and current projects in Jaisalmer and the other contains details and assessments related to the various locations within the site where restoration intervention is required. This document contains proposals and ideas

for restoring various parts of the fort as well as details on planned public programmes to generate greater awareness about the site.

This site was chosen as a case study for four primary reasons. First because it is a site currently in the process of undergoing major restoration which will take place over several years and secondly because very little information and documentation is available on the site. Thirdly, and perhaps most importantly it is a conservation project which like many other heritage sites around the world is forced to operate within a very tight budget and which has resulted in having to significantly reduce its documentation budget. The documentation which does exist for this site is unorganized and found within a variety of paper based documents and small publications. No centralized organization system currently exists for this project's documentation records. Lastly, it is a very large site with a wide variety of different physical restoration issues that need to be addressed. These four primary reasons make Jaisalmer an ideal site on which to test this documentation system. It poses a variety of unique challenges and opportunities to test the usefulness and methodology prescribed in this paper for producing a system to organize documentation data.

7.1 JAISALMER

Located on the edge of the Thar Desert in Western Rajasthan, Jaisalmer is a unique historical city which once played an important role along the trade routes between India, Persia and the Middle East. It was the last stop for traders before traveling west on the long journey across the desert. Because of the importance of its location along the trade routes it became a strategically important city and was the site of many large scale

battles. Today, Jaisalmer is still an important draw for foreigners, but now they come as tourists rather than invaders or traders. The fort, at the centre of the city, is Jaisalmer's main attraction. Still home to over two thousand permanent residents, the fort is a living monument unlike most other heritage sites. The problems facing the restoration of the Jaisalmer fort are unique and must be approached delicately so as not to disturb the permanent residents or the revenue generating tourism industry. With little other local industry, Jaisalmer is heavily dependent on tourist dollars for survival. Within the fort there are a multitude of hotels and restaurants to choose from catering to foreign tourists. At the base of the fort, excursions to the nearby Sam sand dunes can be made by hiring a jeep and driver, or for those with a flair for adventure week long camel safaris are also available. Jaisalmer is not easily accessible and therefore making the stay of those who do venture to the city an enjoyable one is of utmost importance to the city's tourism industry.

7.2 INTACH AND SUSTAINABLE DEVELOPMENT IN JAISALMER

Leading the cause of turning Jaisalmer's fort into an economically viable and sustainable entity is the Indian National Trust for Art and Cultural Heritage (INTACH). This Indian NGO has taken on the task of raising funds and undertaking the restoration work within the fort. INTACH has adopted a multifaceted approach to deal with the complexities of local politics and industry, heritage conservation, and education within the fort. With the understanding that the survival of Jaisalmer is dependent on the influx of tourist dollars, INTACH first set out to repair some of the most architecturally and historically significant buildings within the fort. Unfortunately, in most cases these were

the most damaged buildings of all and were still the property of the Maharawal of Jaisalmer. INTACH then struck a deal with the Maharawal who agreed to hand over his badly damaged palaces to INTACH with the understanding that INTACH would restore the buildings, take ownership of them and convert them into a museum showcasing the history of Jaisalmer. Within the palaces, certain areas were dedicated to local development and education. INTACH has spawned a variety of public awareness, children's education and women's development programs within the fort in an effort to help improve the lives of the local community. Street plays have been organized to educate the local public on the importance of preserving their local heritage. Actors play out scenes from Jaisalmer's past glory and explain why the restoration work is important to their community. A women's centre, run by volunteers was established two years ago to teach local women how to sew so that they can make repairs to clothing, earn some extra money and gain a feeling of confidence and financial independence. A children's library was also founded which is open for several hours after school where children can read books, watch movies or learn how to use a computer. No other library is available within the city so the establishment of this library offers children an opportunity to meet with friends, play games and learn outside of the school setting. INTACH has also helped local women establish a small craft shop where women make and sell small goods to tourists and generate income for themselves and their families.

7.3 JAISALMER IN JEOPARDY

In 1996 British writer Sue Carpenter established Jaisalmer in Jeopardy as a charity to raise funds and awareness for the preservation and restoration of Jaisalmer. Through

fund raising campaigns, organized tours to Jaisalmer and a variety of other initiatives Jaisalmer in Jeopardy has raised over US \$300,000 for restoration purposes. In 2000, Jaisalmer was placed on the 100 Most Endangered Sites in the World list and was awarded the World Monuments Fund's largest grant of US \$100,000. In 2002, Jaisalmer in Jeopardy was awarded a UNESCO Heritage Award for its Streetscape Revitalization project. This project involved upgrading the drainage systems for the eleven main streets within the fort. The main problem facing Jaisalmer is its lack of a proper water and drainage system. Over the years, many ill conceived sewage systems were installed but they were poorly designed and were not adequate to meet today's needs. Much of the water and drainage began to seep into the dry sandstone and destroyed the foundations of many building in Jaisalmer. Recognizing the dual benefit of improving the fort's sewage system, Jaisalmer in Jeopardy made this their first priority. A modern water and sewage infrastructure was installed which kept with the original design of the streets. Building façades were restored and new toilets were provided to those fort residents who required them. This project won praise from many locals as well because it directly benefited them and improved some of their basic amenities which were in need of upgrading.

7.4 FUTURE PLANS FOR JAISALMER

In addition to the programs already initiated by INTACH which are currently underway there are plans for many future programs which not only address the physical restoration of the fort but also social and legal issues which affect the local residents directly. As published in INTACH's *Jaisalmer Conservation Initiative* document, many programs have been designed to generate awareness amongst the local community with regards to the idea of creating a "Culture of Conservation". Programs are also being

formulated to educate local politicians and decision makers on the complexities of considering historic urban areas when making decisions without sacrificing the historical and cultural integrity of the fort. The objective of this workshop is to introduce heritage values into the decision making process in the Jaisalmer municipality. It would include the sharing of ideas and experiences by leading conservation professionals with the local level decision-makers and officers responsible for day-to-day work in the fort and city itself. Other public and tourist related programs currently being formulated include: a *heritage walk* within the fort, a *heritage shop* which sells local handicrafts and helps generate income for local women, a *heritage trail* which guides tourists to a selection of interesting locations around the city and the development of a *portfolio of the Jaisalmer school of painting* in an effort to document and study this unique school of painting.

7.5 STATE OF HERITAGE CONSERVATION IN INDIA

The practice of heritage conservation in India and its many associated disciplines is governed primarily by two bodies: the Archaeological Survey of India (ASI) and INTACH. The ASI is a government controlled body that maintains and restores over 3500 of the country's heritage sites and monuments. Recently, the ASI has received criticism for its outdated practices, inefficient management of resources and crude restoration techniques. Its publications were extremely outdated and poorly written until this year, when they were contracted out to Good Earth Publishing, a private publishing company which has completely re-written a set of ten books on some of the country's most popular heritage destinations. The writing, photographs and production values of the new books far exceed the older books and are an attempt to improve the image and

quality of communication materials produced by the ASI. INTACH on the other hand is generally seen as a smaller and more efficient version of the ASI governed by a more modern set of rules and guidelines for the preservation of heritage. Operating outside of government bureaucracy, INTACH is able to conduct its business much more freely and without the difficulties of being part of a large government body.

7.6 CONCLUSION

The multifaceted approach adopted by INTACH to address the various issues of restoration, sustainable economic development and cultural tourism is a practical approach to this delicate situation. Unlike most heritage monuments which cater entirely to tourists, this site must deal with the delicate balance of local residents and tourists. The challenges facing the site are many and must be addressed at many levels including local governments and administration who make decisions which directly impact the affairs of the conservation team. With limited funds, INTACH has been able to successfully restore some of the most architecturally significant buildings within the fort and convert them to museums for tourists and locals to learn about the local history and culture. Other initiatives such as the streetscape project and the children's library directly affect the lives of the locals who in the end will be the people protecting the site for years to come. INTACH has recognized that protecting the fort and city is accomplished not only by restoring the buildings, but improving the lives and futures of the local residents. By educating and creating greater awareness amongst the residents of Jaisalmer this idea of creating a "Culture of Conservation" will eventually lead to the revitalization of the city and create new opportunities for the locals and an exciting and vibrant cultural climate for tourists.

8.0 DATA ORGANIZATION

Once the documentation process is complete and the data has been collected this data must be organized into a context sensitive database to be transformed into useful information. For example at a heritage site like Jaisalmer Fort where nearly the entire structure is made from the same (sandstone) material it becomes very difficult to document the exact locations of close-up photographs. This is an important issue for this project. One of the main problems facing Jaisalmer Fort is water damage to the stone walls resulting in a number of long cracks, in many locations around the fort and especially in the sandstone blocks which make up the overall structure. The recording team has taken many pictures of these cracks from different locations throughout the fort over a period of years. When viewing these images off-site it is often very difficult to accurately locate a particular crack within the overall site. Such a photo of this nature could have been taken from virtually anywhere in the huge fort complex. How does one know exactly where this picture was taken from? How does that particular image relate to its surroundings and the overall context of the site?

The key to such questions lies in the organization of the data in such a way that it yields meaningful information. We can understand the exact location of content and data relative to its location in the overall site plan by using a “drill-down approach” to spatially referencing recording data. All collected data is visually referenced to a particular physical location within the site. As a result of its organizational structure, each element and media type reinforces the other by providing its context, which is key to the understanding of the data as it relates to the overall site as a whole.

The final deliverable for the project component of the thesis is a complete rich media record of the current status of a selection of buildings in Jaisalmer including

Jaisalmer Fort, organized within a spatial/information framework. This rich media record forms the basis of a custom prototypical application that could be applied to any similar heritage conservation project. This tool and information is useful for conservationists and architects to be able to maintain project history and gather the necessary information for restoration intervention.

8.1 INFORMATION DESIGN

A major problem which has plagued heritage restoration projects is the organization of recording data and content. As many forms of data enter the digital realm, so does the practice of heritage documentation. Currently, very few computer applications exist for this practice and it is up to the heritage community to begin producing its own. Digital media can provide many interesting possibilities and solutions for the organization of heritage data. Traditionally, disparate data sources and media formats are examined separately and relationships between the data are often unseen because of the large amount of data which must be organized and filtered. By understanding the relationships between the data and how they reference one another new possibilities emerge which offer new insight into the data.

This project was spawned by the need to organize documentation data in a useful and practical manner catering to the needs of restoration architects, project managers and funding agencies. Documentation data is an essential requirement for each of these parties to perform their individual project duties. INTACH's documentation of damaged buildings in Jaisalmer comprises of little more than photographs, drawings and notes. For the purposes of project briefings and soliciting funding from national and international agencies, INTACH relies on printed documents containing details related to

the needs for funding as well as an outline of the restoration schedule. The images (drawings and photos) are usually of nothing more than details of damaged areas within the site in need of repair and little visual information is available regarding the surroundings and context within which the damaged areas lie. A great deal of information is available to the conservation team; however the inability to spatially locate individual images and drawings within a large historical site such as the Jaisalmer Fort makes it difficult to compose a detailed and accurate picture of the overall site. Ideally, all of the data available, both past and present, including photographs, drawings, maps, plans, panoramas and notes should be linked and cross referenced into an interactive visual database. The system should be able to integrate standard metadata information for search and reference purposes. It is the goal of this project to seek an answer to these questions and make this system a reality. While attempting to formulate a conceptual model for this system it became apparent that the various media and data types were all related to one another in some form or other and that the key to understanding more about the site was to find ways to establish relationships between the various media types.

8.2 APPLICATION DEVELOPMENT

As mentioned earlier, one of the goals of this project was to develop a documentation system which was modular, flexible and based on well tested technologies which could be appropriate to the budget of the average conservation project. To this end, it was important to identify an affordable “container” which could bring together a variety of media and data types in an intelligent manner within the context of so many

tools, formats and methods for documentation currently available. Tribeworks' iShell technology serves as the base for the development of this application. iShell has been developed around Apple's popular and widely accepted QuickTime technology. It natively harnesses the power of QuickTime's most advanced features. As a media format, QuickTime is not only a digital video playback standard, it is a sophisticated and complete multimedia authoring environment which encompasses digital video, QuickTime VR, audio, still images, Flash and much more. iShell is designed to take advantage of QuickTime's ability to link a variety of media formats in an intelligent manner. This media standard made it possible to link the many formats and media elements employed by conservationists.

8.3 MEDIA ELEMENTS

The following explains the role and purpose of each media/data type within the overall system. See *figure 1* for an illustration showing the relationships between the various media elements. See *figure 2* for a screenshot and description of how the interface works and the relationship between all of the media elements.

8.3.1 LEVEL 1 – MAPS/PLANS

Level 1 elements are classified as data/media which provide a broad overview of a large area. Maps and plans fall into this category. Maps and plans provide a distant abstracted view of an entire heritage site providing the framework and context for the location of all other data types.

8.3.2 LEVEL 2 – QUICKTIME VR

QuickTime VRs provide a 360 degree photo-realistic panoramic view from ground level. The location of all QuickTime VRs are shown as “nodes” within the overall site plan and maps. By selecting a node from the site plan the user can jump to a particular location for a closer examination of the immediate surroundings. QuickTime VRs are key to spatially referencing all Level 3 data and media types. Their ability to allow for the incorporation of colour coded “hot spots” to demarcate areas of interest within a 360 degree view makes them ideal for referencing data to a physical location within a site.

8.3.3 LEVEL 3 – PHOTOGRAPHS, HYPERTEXT and VIDEO

While on-site, heritage architects shoot photographs, video and take notes on the status of the heritage site. Often, hundreds of photographs, pages of text notes and hours of video are shot at a site. Level 3 elements are most common and usually much greater in number than Level 1 and 2 elements and therefore need a system within which to be organized.

Metadata provides information on each particular data element categorizing it by date, name of creator, data type and any other classification which may be required for the project.

When viewing spatially referenced data in this format the conservation team is able to better understand the relationship between the data, its overall context and its role within the greater framework.

HIERARCHY OF DATA ELEMENTS

figure 1

8.4 HOW THE SYSTEM WORKS

The documentation system interface as shown in *figure 2* demonstrates how the various data elements would be presented to the user after having been inserted and organized according to the project requirements. Following the same hierarchy as shown in *figure 1*, the user would first select a QuickTime VR node from the scalable site plan. Once a QuickTime VR node has been selected the user then “jumps” to that location within the site and is presented with a list of “areas of interest” within that 360 degree node. The user can then either choose an area of interest from the list and have the QuickTime VR automatically pan and zoom to that location or by using the mouse and panning within the node, the user can click on a colour coded hotspot to select an “area of interest” to access corresponding photographs, notes, video and any other recording or survey data which may be available. Once the user has found the data they were looking for, they can either continue within that node or move on to another node to access data pertaining to other “areas of interest” within the site.

This system responds to all of the goals set out in section 6.3. The system is able to integrate standard recording formats from different time periods, it is relatively cost effective and can be applied as a valuable field tool. In addition, the system can also simplify the recording process by being able to capture and document the recording data directly in the field. It also has the power to link to documents and reports which may include non-graphical data such as reports and budgetary documents.

Intelligent Interactive Heritage Documentation System Interface Description

figure 2

Enlarged photograph chosen from thumbnails below.
All internally linked data elements appear in this area.

LEVEL 2 ELEMENT
QuickTime VR showing highlighted hotspot over area of interest. Clicking on area of interest will bring up all related data elements.

LEVEL 1 ELEMENT
Plan showing QTVR node locations
Red line indicates circulation path within fort and between nodes
Node with surrounding red circle indicates location of selected QTVR node

Clicking on areas of interest will zoom and pan QTVR node to exact location

Metadata provides details on selected image or media type above. It also provides fields for searchable data.

LEVEL 3 ELEMENT
Data elements related to selected area of interest.
Data elements can include photos, videos, drawings, as well as externally linked files such as AutoCad, PDF and Word documents.

8.5 OTHER APPLICATIONS

Museums and art galleries could also use this system for documenting exhibits. QTVRs can be linked to a floor plan with hot spots linked to artifacts allowing curators to accurately document an exhibit as it was designed within the museum environment (*figure 3*). This would allow museums to have a complete record of their exhibitions for future archives and study. The Musée de la Civilisation in Quebec City has already shown interest in this application and work has begun to document an exhibit which will soon be nearing its lifespan at the museum. The documentation data will then be integrated into this system.

An extension of this application could develop into the use of wireless hand held devices for the purposes of interpretation at heritage sites and other such venues. Visitors to heritage sites could tour a site with a wireless handheld device and be fed rich media content relative to their physical location within the site. Rich media content such as a virtual tour guide, or video reenactments of scenes which took place at the site could be viewed through this handheld device or Tablet PC.

figure 3

8.6 LESSONS LEARNED

After having completed building the application many important lessons were learned which can be applied to future developments. The most important stage of the project is the initial gathering and organization of data. All of the media elements had to be organized according to their node or location within the overall site. All of the data related to each individual node was collected and organized using a numbering system to keep track of media elements, node numbers and hot spot ID numbers. Once this process was complete hotspots within the QuickTime VR movies had to be created which outlined the individual areas of interest within each node. The charting of all of this data was by far the most important stage of the project. Once all of the relationships have

been deciphered and the individual media elements have been prepared, re-sized and optimized it is simply a matter of assembling the data together as planned.

8.7 FUTURE DEVELOPMENTS

Ideally, a conservator would want to carry all of the necessary recording data with him/her while on site. Unfortunately, in most cases it is simply not feasible or physically possible to do so. Tablet PCs (*figure 4*) however would be an ideal means of carrying all of the data in this format while on site. It would allow one to access any information one might need to refer to while physically standing in front of that area of interest. Other developments would include adding the ability to input new data while on site using a Tablet PC with a digital camera. Photographs could be shot and notes could be written and attached to the photographs which could then be linked to the rest of the database (*figure 5*). Capturing and preparing data while in the field allows the conservator to attach notes directly to the photographs without having to do so afterwards. This makes the process more efficient and allows the conservator to complete the task in one simple step.

This system as described here is still very much a work in progress and is continuously evolving. As recording and survey technologies quickly enter the digital realm, more tools and standards for data organization catering to the needs of heritage conservationists, will need to be developed. The cross fertilization of digital media types and formats has created exciting new possibilities for the heritage conservationist and for

the practice of heritage recording.

figure 4

Data Capture and Input Module

photo capture

Metadata Input

Creator: Romy Randev

Date: January 27, 2003

Description: Detail of Jharokas on King's Palace

Locate Image

reconstructed panorama

figure 5

9.0 CONCLUSION AND NEXT STEPS

As information technologies continue to show greater promise for application in the practice of heritage conservation, it is the responsibility of those working in the field to shape its future. From documentation to data organization to virtual reconstructions, information and virtual reality technologies are playing an increasingly important role in many facets of heritage conservation. As these technologies mature and industry specific computer applications are produced, they will quickly become an essential component of the conservation process and methodology. Currently, the use of such methods are raw and untested, however as they become used and field ready they will mature into solid tools which will complement and build on the other skills of a heritage conservator.

Many pioneers in this field are organizing their efforts through conferences, websites, publications and journals. This multidisciplinary community is growing, yet it still requires the participation of conservation architects, archaeologists and others working directly in the field to help guide and shape its future direction.

In an effort to develop a faster and more efficient process of gathering survey data, a surveyor/programmer from a Montreal-based survey company began to develop an application for linking traditional survey equipment to a tablet PC version of AutoCad. In 2003 Autodesk released AutoCad for the tablet PC and the portability this new technology offered coupled with the ability to use this software in the field afforded new possibilities for the surveying community. Traditionally, surveyors gather data and points in the field and then use that data to plot that information in two dimensional space. FieldDesigner marries the two technologies and allows the surveyor to control the survey equipment through an AutoCad plug-in and automatically plot points directly into AutoCad. This saves a tremendous amount of time in the office by eliminating the labour intensive and time consuming process of making drawings from field data. It also allows the surveyor to validate the data in the field before leaving the site. In case of any errors the surveyor can correct them while on-site. If errors are not caught until back at the office making another site visit to redo the survey can be very costly and time consuming. It is initiatives such as this which serve as examples of industry specific software applications made by experts who found a way to improve their way of doing things. This approach will be required to push innovation and development of digital tools for heritage conservation. Industry experts and those with a thorough understanding of the process of heritage conservation management, documentation, interpretation and

education should begin to work together to find ways to streamline their individual tasks by employing or creating digital tools to assist in each of these tasks. Most importantly however steps are, and should continue to be taken to employ digital media to improve upon everyday tasks as well as share knowledge and resources within the conservation community around the world to help save and protect the architectural remnants of our past, present and future.

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