HERITAGE DOCUMENTATION – THE NEXT 20 YEARS

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ABSTRACT:

This paper forms part of the special session at the ISPRS 2004 Istanbul Congress devoted to *CIPA Heritage Documentation* named in honour of Hans Foramitti, one of the founders of CIPA (originally the Comité International de Photogrammétrie Architectuale). The paper attempts to predict the impact that the developing technologies used in ISPRS activities will have on the process of monument documentation over the next 20 years or so, a challenging and perhaps foolhardy exercise. However advances in information technology over the last decade or so has already dramatically changed the way that data is collected, analysed and displayed. If the pace of development was to continue, then perhaps it is worth at least to ponder the likely impact this will have on the processes of cultural heritage documentation.

1. INTRODUCTION

1.1 The Problem of Predictions

What will the process of cultural heritage documentation be like in 20 years? What developments in technology and society will be applied in documentation, or in what way will they influence the need and requirement? One could even ask will there still be a need, or will 20 years see the archive of heritage documentation complete?

In order to approach these questions it is necessary to make some (informed) predictions as to the technology that will evolve over the next 20 years or so, and the type of society that will apply these developments. A dangerous task indeed, making predictions.

Some classic predictions, with the wisdom of hindsight:

- "This 'telephone' has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us."
  --Western Union internal memo, 1876.
- "Computers in the future may weigh no more than 1.5 tons."
  --Popular Mechanics, forecasting the relentless march of science, 1949
- "I think there is a world market for maybe five computers."
  --Thomas Watson, chairman of IBM, 1943
- "640K ought to be enough for anybody."
  -- Bill Gates, 1981
- "There is no reason anyone would want a computer in their home."
  --Ken Olson, President, Chairman and founder of Digital Equipment Corp., 1977
- "Everything that can be invented has been invented."
  --Charles H. Duell, Commissioner, U.S. Office of Patents, 1899.

These quotations occur frequently on the Internet, and have become part of information technology folklore. However experiences with the technology over the last 20 years or so do give a very different foundation from which to make new predictions for the next twenty.

1.2 Some Starting Predictions: Technology

In order to develop the arguments in this paper, some initial predictions may be useful. These will be elaborated in the following sections.

- Microchips will be in most instruments, manufactured devices and appliances.
- They will also be implanted in humans for a variety of reasons.
- Their speed will be so fast as to be irrelevant
- The 'internet' will be ubiquitous, wireless, fast and free.
- Positioning technology will be embedded in most portable devices.
- Data storage will be cents per terabyte, networked, and accessible from anywhere.
- Voice recognition will be a reality
- Pattern and face recognition will be almost instantaneous
- All financial transactions will be electronic
- Biotechnology, nano-technology and gene-technology will be in production and common
- Artificial intelligence will approach that of humans
- Alternative energy sources will be a reality, battery life and energy storage no longer a concern

(derived in part from Battelle Memorial Institute, 2004)

1.3 Some Starting Predictions: Society

Predicting advances in technology is somewhat easier than predicting what our societies will be like in 20 years. The task of cultural heritage documentation takes place within cultures, so in order to imagine the documentation process in the future some idea of future society is necessary.

- The increasing ‘globalisation’ of media will create greater awareness of cultural differences (perhaps the opposite to what many expect).
- People will value more the differences and what makes them unique as a culture.
- The differences between rich and poor peoples will still exist, with many of the advances in technology available only to those who can pay (although the alternative may be forced upon rich nations as people become more ‘connected’, as seen with the release of generic AIDS treatment drugs for Africa).
- Increasingly, technology will be relied upon to solve shortages of food, energy, healthcare and water.
- A high percentage of the world’s population will conduct much of their lives on-line.
- All the world’s monuments will be documented.

Well perhaps not the last, but this is a worthy aim. It is acknowledged that it is very difficult to make these predictions, but there are some trends over the last 20 years or so that if extrapolated could result in these situations. There are however unknown events that may well change everybody’s idea of a future.

So what advances and developments have been made that gives rise to these predictions?

2. TECHNOLOGICAL DEVELOPMENT

Since the development of electricity, humankind has been harnessing this force to serve their imagination. Initially it was used to provide light, then power for machines, then to generate radio signals. Presently it does all this, and also drives the computer and telecommunications developments that are such a part of the information technology revolution. To a great extent, is has been the developments made in the IT revolution that has dramatically changed the way that monument measurement and documentation can now be preformed.

Over the last 20 years, and most probably condensed over the last 10 years or so, the following advances have been made.

2.1 Computer Hardware Technology

The advances in computer technology over the last 20 years have been nothing short of phenomenal. The oft quoted Moore’s law (in one of its many interpretations) implies that processor speed will double every 18 months, however this now seems to be coming up against physical limits. Nevertheless that is more a limitation of the materials and approaches used currently, this will not stop the relentless search for faster, bigger, energy efficient processors (Meieran, 1998).

In 1970 Intel introduced the 4004 chip, equivalent to several thousand transistors. In 2000, Intel introduced the Pentium P4, with the equivalent of 100 million transistors, with almost a linear rate of development in between. Suffice to say for the sake of this paper, processor speed will be almost irrelevant in 20 years.

2.2 Data Bases

The advances in data base design and structure over the last 20 years has extended the application of large scale data bases to desk top computers. The development of relational data bases and the associated query languages like SQL now offer a uniform method of querying data,, and indeed supports much of the information delivery over the Internet. From a documentation point of view data base structures are important, as many records now are digital and these need to be stored, indexed, standardised and referenced.

For example, the Cultural Site management System developed to document, monitor and conserve the rock painting sites at Uluṟu in Australia (Ogleby et al, 2003) contains scans of forms, maps, layers from the site GIS, movies, photograph and audio all within one data base with extensive metadata about the records. The project has now been extended to include the intangible heritage of the Aṉangu people who live at Uluṟu – an application not possible without modern computers and a flexible data base. The system operates in a browser, making access and maintenance of the system relatively easy for the people using it on a daily basis.

2.3 Standardisation

The development of cross-platform standards like Java, HTML, SQL, XML and so on encourage common forms of data representation, storage and access. It frees the digital information society from the confines of proprietary software and promotes the development of services, as well as the sharing of data and derived information. The explosion in the availability of information on the WWW is the result of open, accessible and uniform ways of storing, displaying and navigating that information.

In addition, the development and acceptance of a variety of metadata standards facilitates the retrieval of relevant data and gives some meaning to web pages. Metadata also provides some quantification and qualification of the reliability of that information.

2.4 Imaging Systems

Digital photography is now a consumer item, with 5 megapixel cameras being an affordable alternative to 35mm film photography. Digital imaging has also had a major impact on the photogrammetric process as many (most) of the newer systems operate solely in a digital environment.

From an image point of view, the quality is capable of equalling that of medium format professional film cameras. From a metric perspective, the cameras are easily calibrated making them a simple measurement tool with the appropriate software. Image storage formats have been standardised, allowing the interchange of images between systems and the compression of images to reduce storage requirements.

In 2003 there were 50 million digital camera units sold world wide (Digital Photography Review, 2004), up from 5 million units in 1999. Naturally this trend is expected to increase (Google Answers, 2004), along with increased chip resolutions, and new approaches to the sensor operation (for example developments in CMOS sensors).

Space borne imaging has also seen dramatic developments, with 1m pixel resolution imagery now being available in a post processed, geo-coded format. Radar imaging systems in space, and also from airborne platforms, are also providing regional data for use in cultural documentation (for examples see any recent proceedings from the International Archives of Photogrammetry and Remote Sensing).

Coupled with the explosion in digital imaging systems has been increases in the automatic understanding of these images, from face recognition to the automatic development of cityscapes. Researchers in robot vision, visual cognition, medical imaging and the measurement sciences have all contributed to an automated approach to image analysis.

2.5 Artificial Intelligence

It has been predicted by some that over the next 20 years or so artificial intelligence, AI, will approach that of humans (in particular, Ray Kurzweil, 2004). AI is being developed for applications ranging from robot vision and autonomous navigation, image understanding and analysis, financial predictions and modelling, student assessment, telephony, network routing, medicine and, unsurprisingly nowadays, security. For an overview of developing AI applications see the Conference Proceedings of AAAI (AAAI, 2004).

2.6 Telecommunications

The area of telecommunications has seen an unprecedented plethora of advances over the last 20 years, mostly in the development of mobile telephony. The mobile telephones today are almost indistinguishable from that used by Dick Tracy in the cartoons, a wrist communicator with a real time video link – think 3G networks. In Australia, mobile telephones were introduced in the 1980s, they were large, unwieldy and gave very limited battery life. Today a Nokia 6600 has a camera with VGA resolution that captures still and video images, and can transfer the photographs directly to a printer, or other devices using either infrared or the *Bluetooth* wireless system. It has a personal organiser, xHTML web browsing using WAP 2.0 (Wireless Application Browser), it plays streaming audio and video, acts as a voice recorder, converts currencies and measures, comes installed with Java MIDP2.0, has voice dialling, and weighs 125 grams (www.nokia.com).

With a little imagination one could program the telephone to edge detect the images, extract the data and convert to a CAD drawing. The device could also analyse a sequence of images, and derive a 3d model, and then transmit this to a client or master data base server.

Advances are also not limited to terrestrial networks, after an unfortunate start satellite telephony is now also a reality, enabling real time reporting from the front-line in Iraq, and switching between GSM and satellite networks on the one handset.

2.7 Positioning Technology

The Global Positioning System has migrated from a military navigation solution to the car dashboard. Originally established to aid in positioning, navigation and mapping (somewhat specialist uses) it has become a consumer item much like a digital camera. DVD-ROM based in-car navigation systems now sit side by side with personal stereo players, MP3 jukeboxes and other consumer electronics.

The E911 ruling by the United States Federal Communications Commission (FCC) has already added embedded GPS positioning into all new cellular telephones in the US, and Garmin have released a handheld radio (Rino 110) with embedded GPS. A GSM (Global System for Mobile Communication) mobile telephone with GPS, WAP mini browser, mapping software, and an orgainser has also been released by Garmin, opening up the positioning device to a world market (the Navtalk GSM, Garmin, 2004). It is a small step to embed this positioning capability into a camera.

Allied with GPS is the development of other sensors for acceleration, orientation and inclination, with appropriate software to integrate these into full positioning and orientation systems.

2.8 Mathematics and Algorithms

Much of these technological developments depend on the rapid processing of mathematical instructions in order to function, so without those advances in mathematical modelling many of these would not work.

However modern photogrammetric processes are also dependent upon recent advances in the algorithms that solve the 'unknowns'. The bundle adjustment and direct linear transformation have given software packages like *Photomodeler* an entry to model creation for web marketing, not a traditional area for photogrammetric applications. With further developments there will be real time analysis and understanding of features in images, real-time restitution and feature extraction as the images are acquired.

2.9 The Internet

Computer networking has changed the life of most in the technology rich nations significantly over the last 20 years. Already today at the end of September 2003 in Australia there was reported to be over 5.2 million Internet subscribers, a 3% rise over the three previous months with over 47% being for broadband subscriptions (Australian Bureau of Statistics, 2004). This is a country/continent with a population of 20 million where when one moves from the more populous regions one needs satellite telephones for communication.

The Internet now facilitates international communication, finance, news reporting, information distribution and entertainment. This has come about in less than 10 years.

The Internet will soon become insidious, already wireless networks are available where it is possible to connect to data and information providers from locations without the need for a telephone network. Indeed the distinctions between a telephone network, wireless computer network and a hard wired internet connection are rapidly disappearing. All the literature and web sites consulted predict a ubiquitous network for the future.

2.10 Measurement Technology

There have also been substantial advances in the instrumentation and approaches used in measurement science (the metric component of documentation). Reflector-less distance measurement, automated recording of attribute information, automated input into data bases and Geographic Information Systems (GIS) are already operational.

Laser scanning systems are now also making an impact with the relatively new technology being used to acquire 3d data on monuments and sites. Although presently the processing of the point clouds into useful 'filtered' information is in its infancy, the full impact of this is yet to be felt.

3. PROCESSES OF HERITAGE DOCUMENTATION

Monument documentation has been undertaken in a variety of ways for centuries, although a formalised approach to documentation has only been around for a few hundred years. The Romans copied much of the Greek architecture, a different approach to documentation, and one that is not feasible these days. Before the invention of photography, monument recording was a manual task undertaken by architects, surveyors and engineers, specialists at measurement. Even after the development of photogrammetry, the 'formal' task of recording was still a specialist task. With recent developments is it now possible to treat practically any photograph as a metric record, using point or line based solutions to the extraction of meaningful 3d data from un-calibrated single or multiple photographs.

The tools presently available include laser scanning, digital photogrammetry from single, stereo-pairs and multiple images from almost any still or video camera, hand held infra-red distance meters, and even measuring tapes. These data can be stored digitally in the field on a variety of devices, or drawn by hand. The processed results can be stored and transferred digitally, referenced in data bases, augmented with metadata, or stored in drawers and cupboards.

What could add to this process, make the task easier and more efficient?

4. SOME FUTURE TECHNICAL SCENARIA

The task of documenting the various aspects of cultural heritage will become increasingly dependent on technology, although the technology may be presented as simple, affordable and 'non-technical'. The technology will be designed to enhance the documentation process, not replace the hands-on experience but shift the emphasis from just documentation to understanding.

4.1 The Ridjidigital Documatic©

Presenting the metric solution to the task of monument recording – the Ridgidigital Documatic©. This portable device has the following features:

- Multi-resolution terra-pixel imaging system
- Laser and/or radar scanner
- Terrestrial wireless and satellite network connection, always on and very fast
- GPS and terrestrial position systems
- Inertial sensors
- Image understanding
- Voice control
- Limitless storage (when on-board storage is full data is transmitted)
- Instantaneous derivation of features, 3d data and 3d models using AI
- Continual updating of record with successive photographs
- Real time links to data bases

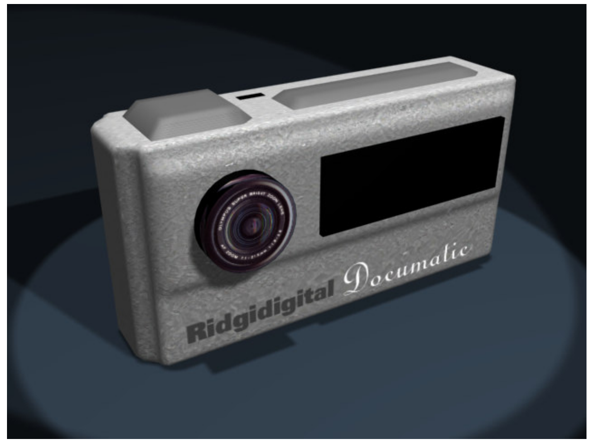

Fig 1: The device of the future for heritage measurement

Imagine a camera sensor where the resolution of the sensor changed depending on the circumstances as required, making decisions on which part of the scene needed what resolution? As the photograph is taken, the scene is also laser scanned with either infra-red light or radar as the case may be, co-registered with the image and geo-coded based on GPS and inertial sensors. The camera then makes a 3d model and overlaps this onto the image, giving feedback to the operator. As more images are acquired the model is updated, with surface materials being extracted and infilled from alternate camera positions. The data can be stored, and also transmitted to a central server reducing the need for storage space on the device. If requested, the camera also generates metadata as a result of scene analysis, turning pixels into Doric Columns or timber panelling using AI and accessing a variety of wireless networked data bases. The device also records audio and video descriptions, as well as interviews with stakeholders, and tags this with meta data regarding the people involved.

The technology exists presently to produce such a device. The expected developments in processor speed, network access and band width make the realisation of such a concept a production reality.

5. CONCLUSIONS

The main theme of this paper has been to review the developments over the last few decades and to use this as a basis to predict some future scenario. It is evident that the technology required to expedite the documentation process is going to exist.

Technology is however only one part of the documentation and recording process, which in itself is only one part of cultural heritage preservation. What will change the entire process of preserving the aspects of culture that are deemed important will be the political and fiscal environment of the future.

Governments, aid bodies, money lending institutions will need to factor the preservation of cultural heritage into each and every action. Lesser developed nations will continue to raise the standard of living of their population through copying the rich nations; by facilitating development, by generating more electricity, by construction. Even developed nations will seek to keep their advantage.

Unless the preservation of monuments and sites, and the intangible heritage that is associated with these, is seen as an important part of any development decision made the world's monuments will not be saved by documentation.

What an accelerated documentation and recording program brings about will be accessible archive of 'the things we want to keep'. The existence of an archive may well be justification for the destruction of the actual monument or site if the archive, and the processes used to create the archive, are deemed more important than the objects themselves. This should not be allowed to happen.

The technology needed to record and document cultural heritage will in all likelihood be as predicted, fast, cheap, flexible and accessible. The technology needs however to be incorporated into an integrated governmental, institutional and social policy on heritage conservation. The next 20 years will see whether this can become a reality.

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