

Proposed grand challenge: Bringing the past to life for the citizen

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1. Character and Rationale

“The past is all around us. We live our lives, whether consciously or not, against a rich backdrop formed by historic buildings, landscapes and other physical survivals of our past. But the historic environment is more than just a matter of material remains. It is central to how we see ourselves and to our identity as individuals, communities and as a nation. It is a physical record of what our country is, how it came to be, its successes and failures. It is a collective memory, containing an infinity of stories, some ancient, some recent: stories written in stone, brick, wood, glass, steel; stories inscribed in the field patterns, hedgerows, designed landscapes and other features of the countryside.” [1]

Many people have an undeniable fascination with the past. Evidence ranges broadly from the continuing popularity of stories told of the past (manifest in popular film, novel and theatre); to the significance of historic environments in determining tourists’ destination choices (WTO); to the frantic pressure on the recently-mounted online national census data (with the associated wide-spread hobby of tracing family trees); and even the impact of heritage on the value of properties in a district. There are in excess of 10,000 museums and visitor centres in the UK, most dealing with particular aspects of the past and recording vast amounts of data.

Much of the evidence that we have of the past relates to contentious material – most often conflict and religion – about which there are inevitably differing perspectives, affecting perception of the events themselves (and the participants in them) as well as the modern day observers with their own current ethical, philosophical and social contexts. Cultural heritage professionals are often, rightly, loathe to settle on particular interpretations of the significance of events or heritage artefacts, preferring to present a range of interpretations. They are also suspicious of the media trivialising and misrepresenting the past in the interest of a more entertaining and profitable re-interpretation. The emphasis is often on preservation and custodianship.

Computer scientists have become widely involved in attempting to assist cultural heritage professionals in their tasks but, as with any data handling, the computing professionals look for additional worth to be obtained from the existence of digital records. At times these additional uses have appeared to cultural heritage professionals as crass and insensitive, failing to address the real requirements of their disciplines and spreading more confusion than light.

1.1 The vision

The long term vision is that the citizen should be able to witness events of the past replayed interactively, but this is more than just a recreation, allowing the viewer to explore and discover more about the circumstances and motivations of the participants, linking the reconstruction to the modern day evidence if they choose and receiving explanations of the differing socio-political perspectives which are relevant to the events.

1.2 The tasks

This is a truly multi- and inter-disciplinary challenge. There are many intermediate steps to achieving the long-term vision and many technological challenges to meet on route, touching on a widely spread set of computing sub-areas and other disciplines. At the extreme the challenge re-activates the Turing Test.

However computing science has already much to offer to the many interim applications' stages of discovery, recording, analysis, cataloguing, reconstruction, interpretation, story-telling and communication of physical artefacts and records of the past. Currently these offerings are somewhat fragmented with a huge range of intermediate formats, many (mostly local) formats for classifying facts and cataloguing collections and little by way of interchange formats ensuring the persistence of the information specifically targeted at the preservation of the cultural heritage content. Instead there are common formats for general geometric information or GIS content or database/archive structures, but little specifically targeted at the preservation and reuse of the cultural heritage content. There is also a huge body of knowledge already archived in incompatible formats and often where the original data collection cannot be repeated since the original sources have been lost or destroyed, whether by acts of war, terrorism or simply the ravages of time or normal processes of archaeological excavation.

Breaking down some of the component challenges that the complete vision would need to address, the following seem key areas:

- An integrated infrastructure from data capture to deployment in cultural heritage research and scholarship is required. The main challenges here are the definitions of data formats to allow interoperability of tools and long term applicability of the base data. This provides the framework for the rest of the work.
- Whilst the principles of meeting the Grand Challenge may be met without completing digitisation of all historic information, there are significant challenges in extracting and analysing existing non-digital collections information – both artefacts and metadata. There are real challenges in digitising and preserving existing collections – for example, the challenge of digitizing and preserving the estimated 100,000,000 hours of Audio-visual material from the 20th century is a significant production automation and deployment challenge, quite probably involving research into viable automation and preservation techniques. These are not in themselves viewed as part of this Grand Challenge. There is also a parallel set of research challenges in understanding how the content of such resources might be used

within the Grand Challenge – data and metadata formats, content analysis, semantic analysis of image and 3D data etc. The principles of using these data will require exploration to meet the Grand Challenge, without completing the digitisation process.

- Intelligent interactive tools for use by non-IT professionals, which are tailored, so that the cultural heritage professionals can work in their domain of expertise rather than fighting to achieve particular effects using general purpose tools. Such tools would also empower the myriad of voluntary groups (preservation trusts etc) as a by-product.
- Modelling and visualisation systems which differentiate interpretation and evidentially-supported fact, so that viewers are not misled by “pretty” presentations into misconceptions of cultural heritage “knowledge”. These tools need to operate at the interface between recording what remains and reconstructing what is believed to have been there. Enormous progress has been made in some areas of recording – e.g. laser scanning of sites and artefacts, but there are very significant challenges in analysing such data as the basis for interpreting the original state of the sites or objects. Visualisation also involves reconstruction of the environment under which the originals would have been viewed. Such visualisations will include the need to understand historic lighting conditions and sound generation, as well as more obvious retracing (for example uncovering Mayan Pyramids from the subsequent ingress of vegetation)
- Such recreations involve very large data sets, for example viewing whole cities in detail including not only models of the original architectural detail but also the population. Algorithms, data-structures and systems for efficient visualisation of very large, animated, and detailed multimedia datasets are therefore required. Whilst this challenge is shared with other potential applications, one aspect that will improve the results is an understanding of the common characteristics of historic artefacts. Understanding styles of architecture and detailing allows efficient modelling and tailored level of detail operation; knowing underpinning characteristics of fabric and fashion will allow more efficient modelling and rendering.
- There are a range of challenges here under a broader heading of “Natural Language technologies” including systems that:
 - Understand how to make story-telling effective in Virtual Environments so that objective design criteria can be set for delivering engaging experiences to end users and integrating the potential exploration of the underlying data by the viewer.
 - Use Natural Language understanding with thesauri of appropriate terms and standardised ontologies applied to content drawn from heterogeneous digitized collections and catalogues spread over many sites. This sub-area also includes the analysis of historic sources – the descriptions of previously recorded collections - data mining of large, heterogeneous data collections to assist in cultural heritage scholarship and in assembly of interesting virtual collections from disparate sources.
 - Ultimately incorporate cultural and emotional interpretation, and potential historic language constructs, in particular where use of language may have had different cultural or social connotations than similar language now. Imagine the role playing experience that

allowed the user to experience the different interpretations that people of Christian or other religious persuasions might place on events, purely by selecting from a potential set of backgrounds. This is probably the longest time horizon of any of the component challenges listed here, but there are also many interim achievements that would enable in successful projects, short of the full vision. Interim solutions would include parameterised, but pre-scripted interpretations authored by experts in appropriate fields with interactive systems making selections.

- Working with experts from cultural heritage fields to demonstrate value added to traditional methods, in order to show the real value of ICT developments for cultural heritage professionals. This would have to include a better understanding of the long-term implications of digital artefacts varying from the physical media used for storage to data management and version control. Standards similar in objectives to Digital Object Identifiers and attention to issues such as standardised recording of provenance of digital artefacts, as well as addressing legal, copyright and fair-trade agendas so that socio-economic benefits are suitably returned to those whose heritage and artefacts are involved.
- Although the intellectual Grand Challenge may appear to have been solved when there is the first exemplar of an event which is suitably “living” the full challenge specifically includes the phrase “for the citizen”. This aspect will not be solved until there are sustainable business models – when the production of such experiences is achievable economically and hence allows them to be experienced by a reasonable proportion of citizens. It is imperative for technological solutions to be cheap both in initial capital and in operations costs if they were to have a widespread impact on CH operations, although it is admittedly a later stage than proving it is possible technically to produce such solutions at all.

Some of the technological challenges arise in order that the credibility of the objectives of the Grand Challenge to Cultural Heritage Professionals.

1.3 Differences from existing six proposals

The current proposal overlaps marginally with perhaps three of the existing six Grand Challenges, for different reasons.

Probably the closest is “Memories for Life” in that some of the technologies of organising heterogeneous data sources and extracting and interpreting information would have some overlap with the technologies involved in the interrogations of metadata and collections information. The challenge lists topics in “Data and Databases,” “Information Retrieval,” “Artificial Intelligence,” and “Human-Computer Interfaces” all of which overlap to an extent with the lists of sub-topics above. However in all cases the characterisation of the technologies listed above assumes a degree of domain specific knowledge that would be different from the domain-specific knowledge required in Memories for Life. Similarly the Machine Learning component of Memories for Life would probably be distinct from the dialogue management aspects of the Natural Language technologies described above.

The second potential overlaps might be seen as with “In vivo – in silico” although the overlap here is primarily philosophical – the current proposal is to build a Grand Challenge which is targeted at quite specific application domains. The content is however clearly distinct. In some senses the objective of modelling nature is also shared – the environments to be modelled would incorporate flora and fauna as well as communicating virtual humans.

The third potential overlap is with “The Architecture of Brain and Mind” where some of the cognitive processes listed (e.g. “understanding language”; “deciding what to do”) would be part of the more advanced versions of “Bringing the Past to Life for the Citizen”. These challenges are not envisaged as addressed in the context of this proposal until significant progress has been made in the many other aspects. Should the general problem have been addressed by the Architecture of Brain and Mind then this proposal would continue to need to map the generic solutions into those appropriate to recreations of the past. This is expected to be a similar challenge comparable to many of the others above where base-line technologies may have been developed but proper integration into the domain-specific requirements has not yet been achieved. In addition it is not obvious from the current description how GC5 will deal with such factors as “cultural influence,” “belief,” and multi-lingual ambiguity (ie where terms have no correspondence in other languages or where interpretations of closest matches overlap).

Each of these potential overlaps would need discussion during the full definition process for the Grand Challenge.

2 Proposers

During a fairly short gestation period in this form the proposal has been backed in principle by the following:

Professor David Arnold, University of Brighton
Professor Alan Chalmers, University of Bristol
Professor Andrew Day, University of East Anglia
Professor David Duce, Oxford Brookes University
Professor Phil Willis, University of Bath

3 Evidence of a UK community

The following Universities are already engaged in a Network of Excellence which addresses some of these issues – Brighton, Bristol, Brunel, Kent, Oxford, Surrey, Sussex, UEA, Warwick, and York, with Southampton and King’s College, London joining. In some cases the participants are not from Computer Science departments, reflecting the multi- and inter-disciplinary make-up of that NoE. This proposal overlaps significantly with the motivation and objectives of that Network, but the proposal also targets radically more ambitious targets over a timescale that extends many years and concentrates on those aspects with a strong computer science element. The NoE concerned (EPOCH – www.epoch-net-org) is funded by the European Commission until 2008. The current proposal would have the impact of creating a longer term Computing Science agenda for the existing Network and other

participants in the Grand Challenge as well as demonstrating UK commitment and contribution to the developing international agenda. Other UK partners are known to be active in relevant fields.

4 Developing the proposal to full status

There is much to do to scope the outline sub-topics listed above and identify teams willing and able to develop the agenda further within the holistic framework offered by the Grand Challenge.

5 Matching the Characteristics of a Grand Challenge

- a. *International scope.*
The proposed GC has a undoubted international dimension at many levels. Every culture has a past and many geographic locations have multiple contributing cultures. The UK as a multi-cultural society ought to be well placed to offer leading contributions to advancing the field and indeed ought to benefit from anything that assists in inter-cultural education and understanding.
- b. *Ambition can be far greater than that of a single research team/grant.*
As is obvious from the list of UK universities involved in the current NoE. The NoE itself has almost 90 partners with significant clusters of computer science research institutions in many European countries
- c. *The grand challenge should be directed towards a revolutionary advance.*
Success in this Grand Challenge would be a revolutionary advance and would have a major impact on the public and on future generation's educational and leisure experiences. Although it might be considered related to industry sectors where there are substantial commercial interests (e.g. computer games or other entertainment sectors) it is very important for the credibility of the research that the technologies developed are firmly embedded in the search for truth about the past (or multiple valid interpretations) which is the goal of historical research. There are too many examples of the commercial interests of the entertainment sector re-interpreting the evidence, which would lead the credibility of the work proposed here were it to be seen as an off-shoot of the entertainment sector ("Don't let the truth get in the way of a good story").
- d. *The topic for a grand challenge should emerge from a consensus of the general scientific community, to serve as a focus for curiosity-driven research or engineering ambition, and to support activities in which they personally wish to engage, independent of funding policy or political considerations.*
The proposed Grand Challenge is grounded in widespread work already being undertaken which would contribute towards the early stages of creating the vision. There are clear political agendas (for example widening Europe) which would be served by the ability to explain the past from the multiple perspectives of different cultures. For example the re-unification of Germany or the issues surrounding the division of Cyprus and its desire to join the EU are very real examples of a past which has been contentious between social groupings who now have a desire (at least at some level) to share a common future. The example of Northern Ireland is perhaps closer to home and very

real too. The sensitivity of exploring such contentious situations means that they should probably remain off the radar for many years and well beyond the establishment of effective technologies to support the story-telling etc. but the presentation techniques that are an inevitable consequence of meeting the interim challenges will remain useful in presenting authored experiences to public audiences. In addition the usability studies that would be necessary to determine effectiveness with public audiences would also provide contained experimental results.

6 Comments on Criteria of Maturity

- (i) *It arises from scientific curiosity about the foundation, the nature or the limits of a scientific discipline.*
As indicated above the proposed GC is peppered with unsolved computing, science problems as well as interactions with many other disciplines.
- (ii) *It gives scope for engineering ambition to build something that has never been seen before.*
Clearly this is the case
- (iii) *It will be obvious how far and when the challenge has been met (or not).*
This area needs scoping, in particular the various stages short of a self-scripting system using fully autonomous agents could be anticipated in much shorter timescales and would be much more likely to find acceptance in the Cultural Heritage community. They would also still be very interesting and challenging. Experimentation with public reactions, learning and understanding in using systems of less capability would be needed to build progressive confidence in the interim results, before attempting more ambitious agendas became acceptable.
- (iv) *It has enthusiastic support from (almost) the entire research community, even those who do not participate and do not benefit from it.*
See above. Further canvassing of opinions can be undertaken as necessary and would be part of any discussion of the proposal at GC06
- (v) *It has international scope: participation would increase the research profile of a nation.*
See above.
- (vi) *It is generally comprehensible, and captures the imagination of the general public, as well as the esteem of scientists in other disciplines.*
In considering the current list of Grand Challenges the current proposal would appear in many ways the easiest to explain to a public audience. The public are thirsty for such content:

“In a recent survey undertaken in England it was found that “More than half (52%) of people in a nationwide poll in 2003 had visited a historic park or garden in the last twelve months, and 46% had visited a historic building. According to the same poll more people had watched a TV programme about history or archaeology over the same period (66%) than had visited the cinema (51%)” [3]

The resulting applications in tourism, education and edutainment would be substantial. (see quotations below)
- (vii) *It was formulated long ago, and still stands.*
Telling stories of the past is as old as society itself. Many early examples of rock art present pictorial interpretations of the past and the tradition of oral heritage passed from generation to generation is part of the tradition of

language. Hand-written and printed histories and novels reflect various levels of interpretation. Theatre, cinema and television represent a progression of media but all have dealt with themes drawn from history and varying levels of accuracy. An understanding of what makes an engaging interactive experience which nevertheless imparts understanding is at best not well understood and quite probably not understood. Evidence of this would be the limited success of books with “goto’s” – take a decision for the character and move to defined page as a result. Even in linear text the number of courses in creative writing and the volume of remaindered and unpublished novels attests to the complexity of the problems.

- (viii) *It promises to go beyond what is initially possible, and requires development of understanding, techniques and tools unknown at the start of the project.*

See above

- (ix) *It calls for planned co-operation among identified research teams and communities*

The proposal would require contributions from research teams working in many areas of computing science and in other disciplines related to cultural heritage, including media, museology, archaeology, history, religious studies, art history, etc – the list would go on.

- (x) *It encourages and benefits from competition among individuals and teams, with clear criteria on who is winning, or who has won.*

Whilst this would inevitably be the case in terms of the individual component technologies as clear theme of the work proposed is that the components should fit together and be developed with proper understanding of the cultural heritage domain. As such inter-disciplinary teams are a virtually inevitable condition for successful contributions and assume a great deal of cooperation.

- (xi) *It decomposes into identified intermediate research goals, whose achievement brings scientific or economic benefit, even if the project as a whole fails.*

There are many intermediate stages which would bring major benefit socio-economic benefits. Tourism is a huge market sector and historic interest is a major factor in determination of choice of venue. (see quotations below)

- (xii) *It will lead to radical paradigm shift, breaking free from the dead hand of legacy.*

Then paradigm shift in terms of the traditional dissemination of the evidence of the past would be substantial. Visitor experiences would allow a level of engagement with the contents of, and knowledge about, collections and a step-change in augmenting the educational value of artefacts.

- (xiii) *It is not likely to be met simply from commercially motivated evolutionary advance.*

Generating investment for preservation of the past from commercial sources is usually regarded as an appeal for charitable donations. Politicians are increasingly looking for justifications for investments in cultural heritage in terms of socio-economic impact and investment in pure preservation or conservation is less likely to find favour than investments which promote access to the heritage. Access (tourism, education, etc) is where the economic contribution is most easy to observe, even if hard to measure. Other social effects (such as a decrease in graffiti and vandalism in well-maintained historic environments) have been observed but not widely quantified. The perception is that the heritage sector is populated more by social enterprises

where profit is not the lead motivator and hence commercial investment is less likely to flow.

7 Interesting Quotes/Facts

7.1 On Tourism

1) “In 2000 tourism expenditure in the United Kingdom totalled some £75 billion, and the value added by the tourist industry represented around 5% of GDP-larger than the car, steel and coal industries put together. The impact of foot and mouth disease on the tourism industry demonstrated both the importance of the industry to the economy and its interconnectedness with the wider economy.”[1]

2) In a recent study [2] “Historic interest” was cited as the 5th most common reason for the choice of tourist destination (by 32% of those surveyed), behind (1) “Scenery” (49%) (2) “Climate” (45%) (3) “Cost of Travel” (35%) and (4) “Cost of Accommodation” (33%). The citation of scenery may also have a cultural heritage component.

3) In 2002 the World Tourism Organisation [5] were reporting that “Worldwide receipts amounted to US \$462 billion in 2001... . Half of all receipts are earned by Europe, The Americas have a share of 26%, East Asia and the Pacific 18%, Africa 2.5%, Middle East 2.4 % and South Asia 1.0 %”. In Europe Tourism represented 12% of GDP in 98-99 [1].

7.2 On Heritage in Education/Social Engagement

4) “The historic environment has immense value as an educational resource, both as a learning experience in its own right and as a tool for other disciplines. Whether at school, in further and higher education or in later life, the fabric of the past constitutes a vast reservoir of knowledge and learning opportunities. This is as true of the oldest archaeological remains as it is of buildings of the last fifty years. The history of buildings and places is also the history of the age in which they originated and of the eras in which they flourished. They can tell us about the individuals and the institutions that created them and occupied them and about the societies and the local communities they served. Nor is the educational significance of the historic environment confined to the teaching of history. It is also relevant to subject areas as diverse as economics, geography, aesthetics, science, technology and design. Buildings and places can also play a role in developing a sense of active citizenship; by learning about their own environment and how they can participate in its evolution, people feel a greater sense of belonging and engagement.” [1]

5) “Policymakers need to regard the historic environment as a unique economic asset, a generator of wealth and jobs in both urban and rural areas. With this recognition there needs to be coupled intelligence and creativity. We must value the fabric of our past for its importance in attracting millions of visitors to this country each year. At the same time we must recognise that effective management strategies are needed to ensure that much-visited fragile sites are not irreparably damaged. A high-quality, sustainable tourist product must be our aim...” [1]

8 Bibliography/References

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