University of Warwick, Department of Computer Science

Computer Graphics Module CS234

Selected notes from lecture: "Virtual Heritage: approaches and issues"
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King's Visualisation Lab
http://www.kvl.cch.kcl.ac.uk/

Warwick 4000
http://www2.warwick.ac.uk/about/tour/archaeology/

The Theatre of Pompey, Rome
http://www.pompey.cch.kcl.ac.uk/

The London Charter Initiative
http://www.viznet.ac.uk/3dvisa/

Context
3-dimensional visualisation methods are now employed in a wide range of contexts to assist in the *research*, *communication* and *preservation* of cultural heritage.

In recent years, many people expert in working with text or 2-dimensional images have become interested or involved in creating, commissioning, or curating 3d visualisations. And others have made the cross-over from science and engineering areas to work on cultural heritage applications of 3d technologies.

3D Visualisation in the Arts Network
http://www.viznet.ac.uk/3dvisa/

The 3D Visualisation in the Arts Network was established in May 2006. 3DVisA is part of the UK Visualisation Support Network funded by the Joint Information Systems Committee (JISC) and is hosted by King's Visualisation Lab in the Centre for Computing in the Humanities, King's College, London.

3DVisA comprises Richard Beacham (Director) and Hugh Denard (Director and Manager), Anna Bentkowska-Kafel (Research Fellow) and Julie Tolmie (Network Development Officer).

The Network exists to support those interested or actively engaged in the creation and use of digital 3D visualisations in Arts and Humanities contexts by conducting targeted research, creating opportunities for community-wide debate of key issues, widening understanding of methods and standards, and facilitating the exchange of skills and knowledge.

Intellectual Transparency
Among the many challenges that have arisen along with the rise in the use of 3d visualisation in academic and cultural heritage contexts, perhaps none has proven so troubling or intractable as those of so-called "reliability" and "intellectual transparency":

For instance, in a 3d visualisation of an archaeological or historical artefact, structure or site, how does one show how much is known fact and what is mere speculation, as well as all of the shades of possibility and probability in between?

Without this kind of intellectual transparency, how can professionals assess, or comment on, or confidently build upon the work of their peers?

Cultural heritage is a domain in which material culture meets with an evolving culture of *interpretation*, so it is not enough to say that we should rely on the credentials of those carrying out the visualisation work: time introduces new perspectives upon the work of even the greatest interpreters. We must therefore be able to demonstrate the relationship between evidence and interpretation.

Paradata and Dependency Relationships
To give an example, if I present you with a visualisation of the interior of a house in Pompeii, how do you, the viewer, begin to assess it?

How can you tell if our reconstructions are well founded? Or how do you know, indeed, upon what they are founded? During this lecture, I am here and can tell you, but when I've packed up and gone home, the model alone is inadequate as a piece of scholarly communication.

In the case of the reconstructed dining room, how do you know if our couches are archaeologically correct? Have we got the proportions right? How can you tell? Do you take out a ruler and start measuring dimensions upon the screen?

If I do not provide you with a means of assessing the visualisation, e.g. by linking the model to our scientific survey data, measured drawings, photographic documentation, and our detailed notes on how we developed each component of the visualisation from available evidence, can you really claim to *understand* our visualisation?

Working on the visualisation of this house, Drew Baker, Richard Beacham and I spent a lot of time discussing the interpretation of particular pieces of evidence, often arriving at different views informed by their different spheres of knowledge.

We call this thinking, talking, researching, note-taking, and drafting that constitutes the interpretative process '*paradata*'.

After discussion, a certain interpretation may prevail, or they may wish either to document, or to model, in addition to the preferred interpretation, a plausible alternative interpretation.

But unless their deliberations – all this paradata – are documented, then all of the thinking that went into their decisions will be lost, and with it, the user's capacity to understand and evaluate their decisions.

Where the discussion is about fairly small details, it's unlikely to have sufficient import to make the final cut of a published article. However, 'the high degree of dependency relationships' in 3d models means that it may nonetheless be important to document.

That is to say, each element in a 3d model affects other elements that touch upon it: in a temple, for instance, a change in the height of a column will affect the probable width of the intercolumniations.

Even the smallest decision, therefore, may silently affect other elements which are considered centrally important.

Therefore, unlike a textual argument, in 3d visualisation projects, it may be necessary to leave a documentary trace not only of major decisions, but also of each of the component decisions within the interpretative process.

The Holy Grail is that 3d visualisation should be *demonstrably* as rigorous and intellectually transparent a means of researching and communicating cultural heritage as any other well-established method.

It is difficult, though. For text, we demonstrate intellectual rigour and transparency through citing sources in footnotes and bibliographies and discussing how our argument relates to those of our precursors.

But there is no agreed means, or standard interoperable technology for 'footnoting' 3d visualisations. And the problem is also inherently more difficult owing to the need constantly to work *between* media: not in text alone, but *between* 3d objects and other documentary media, such as text, sound, still or moving images.

This is not for want of thoughtful professionals drawing attention to the problem: there is a very substantial bibliography on the subject reliability and transparency. In the published version of this paper, Franco Niccolucci has given a short history of major publications and initiatives to date.

Also, technical solutions are being developed, such as The 3D Blog being developed by Reiko Kadobyashi in Tokyo; a project by Maria Sifniotis at the University of Sussex on presenting uncertainty in archaeological reconstructions using possibility theory and information visualisation schemes, and a similar one in Prato by Sorin Hermon; and the development of graphical annotation of semantic units in 3D GIS by Thorsten Reitz and colleagues in Austria.

In the meanwhile, there are intermediary solutions, such as the illustrated research report. Because of the high degree of dependency relationships within 3d models already noted, this approach has its limitations. (Perhaps we need to take a page out of laboratory-based scientific research and keep lab notebooks - digital or otherwise).

But the problem is not so much that there is no way of recording or publishing paradata, but that *there is not as yet an accepted expectation that we should do so*. Or, to be more precise: there is no accepted guideline as to what kind or detail of paradata it may be appropriate to document *in a given context*.

Still too many 3d visualisation-based projects are critically diminished in value to the wider community because they leave insufficient trace, in any medium, of their paradata that would allow them to be fully understood or evaluated by their intended users. We are still too often expected to "take it on trust". And this is where *The London Charter* is designed to make an intervention.

The London Charter

The London Charter establishes an expectation that those using 3d visualisation for the research or communication of cultural heritage be responsible to certain principles upon which intellectual rigour and transparency rely.

The starting point was an EPOCH workshop on Standards in Pisa last year to which Richard Beacham presented the concept of "paradata", a term coined by our

colleague at King's College London, Drew Baker as part of an AHRC-funded project on the topic. Franco Niccolucci then proposed that EPOCH and our Paradata Project jointly convene a Symposium in London on making 3d visualisation research transparent. This took place in February, and the outcome was the first draft of *The London Charter for the Use of 3-dimensional Visualisation in the Research and Communication of Cultural Heritage*.

Since then the Charter initiative, which is jointly chaired by Franco and Richard, and facilitated by the JISC-funded 3D Visualisation in the Arts Network, has been extensively discussed and revised, with a number of researchers testing its implementation in actual projects, and it has won the support not only of EPOCH but also, following discussions initiated by Franco, senior representatives of ICOMOS and UNESCO.

We hope that its status as a "Charter" will lend it the necessary weight to establish its principles in the cultural heritage community as a benchmark against which funding bodies may evaluate cultural heritage applications in which 3d visualisation plays a role.

The Charter has 8 principles on:

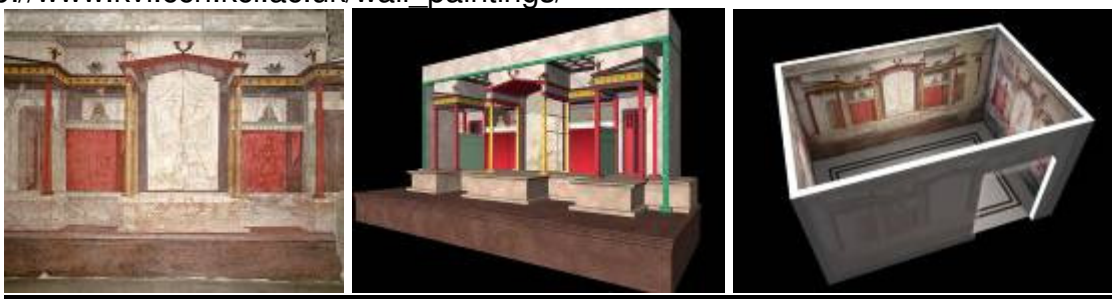
1. Subject Communities
2. Aims and Methods
3. Research Sources
4. Transparency Requirements
5. Documentation
6. Standards
7. Sustainability
8. Access

The full text of the Charter, and an article by Franco, Richard and myself that walks through each principle in term, are available online at www.londoncharter.org.

So, in the time that remains, let me give you some sense of how the Charter might contribute to the way in which a 3d visualisation project is conceived, planned and executed.

Theatricalism and the Roman House

http://www.kvl.cch.kcl.ac.uk/wall_paintings/



How might the principles of the London Charter affect this programme of visualisation-aided research?

Let's look at the Room of the Theatrical Paintings, from the House of the Cryptoporticus, Pompeii I.6,2-4

> **Principle 1 on "Subject Communities"** makes it clear that the Charter needs to allow for the varied nature of practices and interests within the cultural heritage domain, which encompasses museums, art galleries, heritage sites, interpretative centres, cultural heritage research institutes, arts and humanities subjects within higher education institutions, the broader educational sector, and tourism.

So, the Charter sets out principles that are sufficiently focussed to have a beneficial impact in each area, but are also sufficiently abstract to be valid across all of these areas, and indeed, to remain current even as methods and technologies evolve.

For that reason, its principles are not technologically prescriptive. Nor do they assume that a single type or level of documentation is appropriate to all areas or projects.

Rather, the emphasis is on ensuring that each 3D visualisation cycle's aims, methods and documentation strategies cohere with each other, and that they are appropriate to the task in hand.

> **Principle 2: Aims and Methods**
>
> Numerous types of 3d visualisation methods and outcomes exist, and can be used to address a wide range of research and communication aims. A 3d visualisation method should normally only be used to address an aim when it is the most appropriate available method for that purpose.

So we need to be clear about what 3d visualisation methods – if any! – would be appropriate to our own subject area perspective and aims.

In our case, the study is part of a continuing study of Roman frescos from a theatre-historical perspective…

…and our aim is to examine the perspectival properties and architectural logic of this fresco design.

The absence of perspectival ambiguity in a 3d model makes it the ideal tool with which to analyse the perspectival techniques and playful fantasies of these frescos.

> **Principle 3: Sources**
>
> In order to ensure the intellectual integrity of 3d visualisation methods and outcomes, relevant research sources should be identified and evaluated in a structured way.

In this case, the primary sources are the remnants of the frescos themselves. The paintings on the facing walls of this small room share the same design, though their pictorial content differs. Both have suffered significant damage, and on one wall the design is aligned with the actual doorway through which one passed in order to enter the room.

Frescos, Room of the Theatrical Paintings, House of the Cryptoporticus, Pompeii I.6.2-4

In 1934, Walter Klinkert created a colour drawing which conflates elements from the two walls to allow the reader to gain a sense of the complete design.

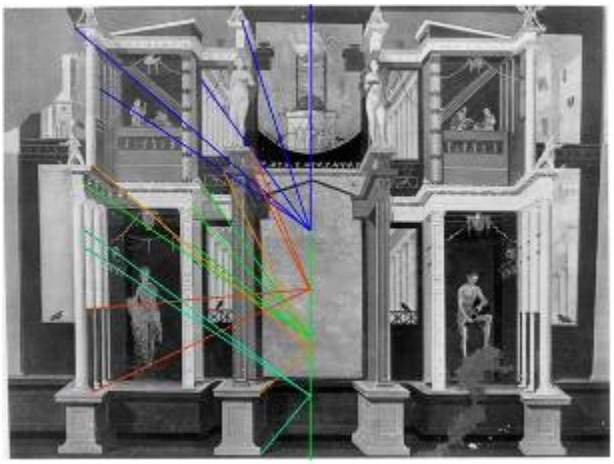
Composite drawing of facing walls, Room of the Theatrical Paintings, House of the Cryptoporticus, Pompeii I.6.2-4 in K. Schefold *Vergessenes Pompeji* Bern 1962.

As our aim, also, is better to understand the perspectival properties and architectural logic of this type of fresco design, rather than to study the contents of any single instance of the design, Klinkert's approach is equally valid.

However, Klinkert's colours do not correspond to those observable in the fresco today, so colour correction will have to be made, working directly from photographic documentation of the frescos.

Preliminary Perspectival and Structural Analysis

The architectural structure depicted in the wall-painting is divided into two distinct zones, each with their own set of perspectival points: the bottom section, including the *pulpitum* and lower *scaena*, and the top section comprising the upper *scaena*. (Figure 1) The top section has a single perspective point, while the bottom portion has multiple perspective points. The architectural structure is horizontally symmetrical, with the result that the perspectival lines are also symmetrical.



Analysis of perspectival points.

Discrete scenes appear in each of the four corners of the fresco: the bottom-right painted scene is of a temple situated on a hillside, while the top-right painted scene directly above it portrays a row of buildings. These two scenes are therefore not to be viewed as spatially contiguous. Similarly, in the upper-left scene, minute figures stand in the street, indicating that this area is to be thought of as ground level, not as an upper level. In the upper-centre scene, the base of a tripod floats in mid-air, unless it, too, is considered to be on ground level (*cf.* The Villa at Oplontis, *Oecus* 14).

Anthropomorphic figures appear within the architectural façade on both upper and lower levels, those on the lower level (perhaps suggesting statues) much larger in scale than those in the domestic scenes above.

The upper colonnade is composed of a different intercolumniation to that of the lower colonnade. These conflicting depictions suggest that the two sections are not intended to represent a unified structure, but rather two discrete compositions. However the architecture of the *scaena* schematically unifies the upper and lower colonnades, giving the impression of a unified whole. The two together are a typical example of deliberate Roman visual ambiguity.

An Iterative Approach to Applying the Charter

Although the charter necessarily presents its principles sequentially, in practice, to ensure that aims and methods remain congruent with each other, at numerous stages in the project, whole reflective cycles are required. So, at this point, having explored and documented the nature of our sources, we need to return the question of our methods: we have identified that 3d visualisation is a useful tool to address the questions we have in mind, but what *kind* of visualisation is the best suited for the task?

Visualisation Options

With the multitude of perspective points incorporated within the scene, the structure depicted is painted using many unrealistic and conflicting angles. An exact 3D interpretation based on the painted stage set would therefore be very difficult to create. Calculating the depths of structural elements would be virtually impossible as they all coincide with different lines of perspective.

Two options for visualising the three-dimensional structures evoked by the fresco:

(1) a visualisation of the structure actually depicted in the painting replicating its unrealistic multiple perspective points and Escher-like anomalies.

(2) a visualisation of a feasible architectural structure using the measurements given in the fresco wherever possible but "correcting" anomalies.

From a theatre-historical point of view, modelling the stage set as a realistic structure would give a far better understanding of the possible relationship between the structure in the fresco real architecture from the period, including theatrical stage sets, as apposed to trying to create a fantastical structure which is already shown in the painting. The process of interpreting the fresco as a more realistic structure is more likely to reveal why the structure is painted in the way it is.

Colour information will be important in determining possible relations between visual signifiers, e.g. between "actual" architectural structure, distant views, and/or painted panels incorporated within a display façade. Visualisation of architectonic detail will also be necessary in order to understand what kinds of architectural features are evoked, and how they relate to real-world examples.

However real-time navigation will not greatly contribute to the primary task of structural or perspectival analysis. Nor are photo-realistic lighting / environmental conditions likely to be germane to the particular questions we wish to address, and may compromise clarity of understanding of the fresco's graphical properties.

Consequently, the approach will be to create a detailed, colour, static model of a feasible architectural structure derived from the fresco, correcting structural anomalies as required. For optimum analytical clarity, the model will be graphically indicative rather than fully photorealistic.

Principle 4: Intellectual Transparency Requirements

Sufficient information should be provided to allow 3d visualisation methods and outcomes to be understood and evaluated appropriately in relation to the contexts in which they are used and disseminated.

AND

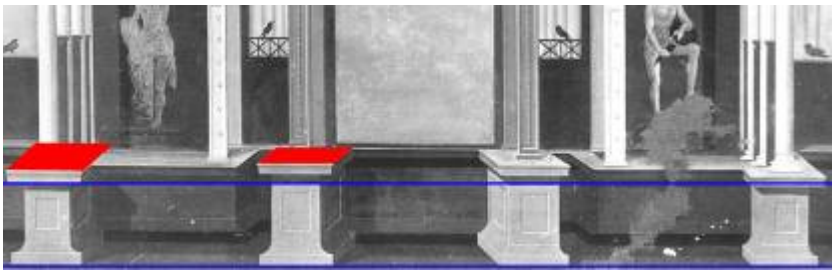
Principle 5: Documentation

The process and outcomes of 3d visualisation creation should be sufficiently documented to enable the creation of accurate transparency records, potential reuse of the research conducted and its outcomes in new contexts, enhanced resource discovery and accessibility, and to promote understanding within and beyond the original subject community.

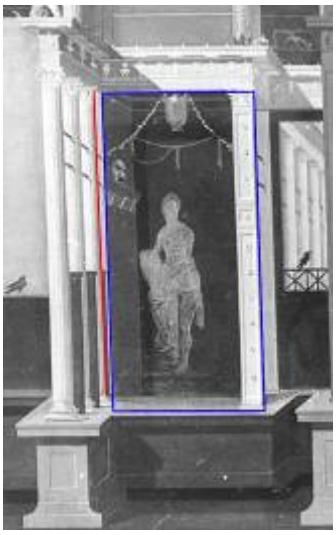
The work is being produced as part of an historical research project in an academic context. It must therefore be made susceptible to peer review. The project must therefore produce documentation on context, aims, methods, as well as detailed notes on the process through which a structurally-coherent model is derived from the illusionistic fresco. A combination of textual and visual documentation will be required. Interactive system capable of dynamically integrating image and text are work in progress. In this instance, documentation will be published within an illustrated report.

Calculating Dimensions

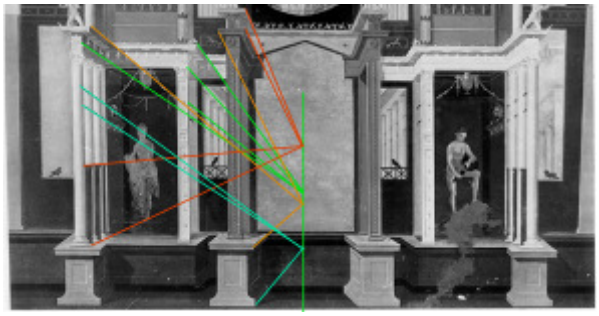
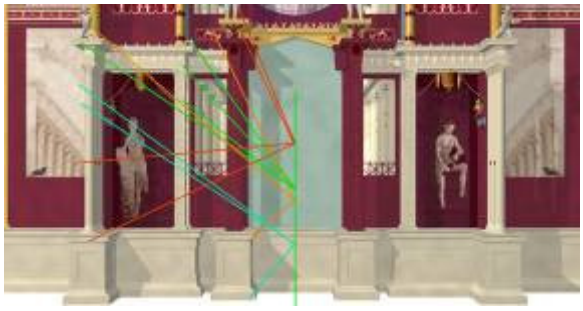
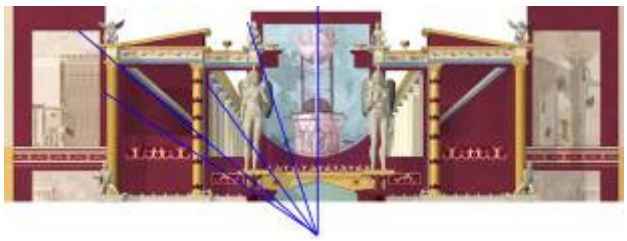
Deriving plausible real-world dimensions from a highly illusionistic fresco is a complex task: the key here is documentation, so that others can review our work in detail, and evaluate it critically.

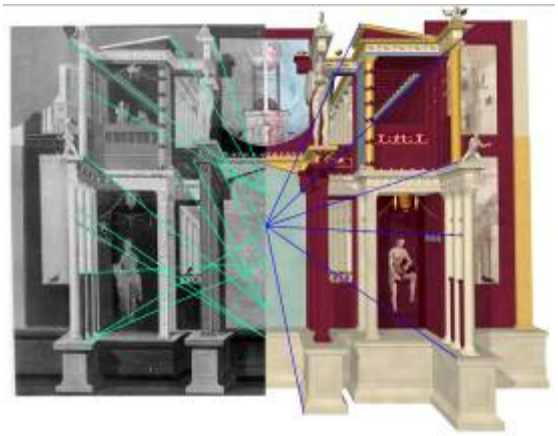


Measurements of depth

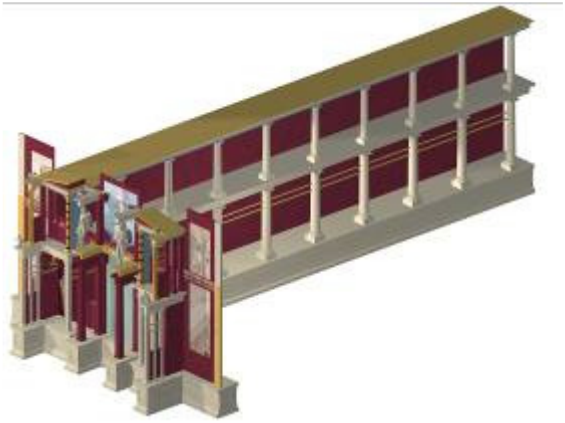


Structural problems

Wall-painting	Corrected 3D Model
 Bottom half of wall-painting showing perspective points.	 Bottom half of the 3-D reconstruction rendered from a lower camera point. The perspective points from wall-painting are then overlaid as a comparison.
 Top half of wall-painting showing top perspective point.	 Top half of the 3-D reconstruction rendered from the top camera perspective point. The perspective points from wall-painting are then overlaid as a comparison.

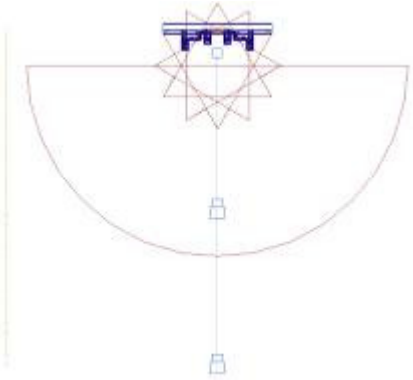


Comparison of wall-painting and corrected 3D model



Doric colonnade with Vitruvian dimensions

Comparison of the Doric colonnade with the corrected Vitruvian colonnade



Plan view of camera positions within the theatre

Elevated view of camera positions within the theatre

Principle 6: Technical Standards

Appropriate standards and ontologies should be identified, at subject community level, systematically to document 3d visualisation methods and outcomes to be documented, to enable optimum inter- and intra-subject and domain interoperability and comparability.

This is work in progress. (e.g. CIDOC-CRM ontology is being pushed by EPOCH)

Principle 7: Sustainability

Strategies should be planned and implemented to ensure the long-term sustainability of cultural heritage-related 3d visualisation outcomes, in order to avoid loss of this growing part of human intellectual, social, economic and cultural heritage.

So good strategies for long-term digital preservation, and also migration into other media – including those, such as print media, in which preservation practice is more developed.

Principle 8: Access

Consideration should be given to the ways in which the outcomes of 3d visualisation work could contribute to the wider study, understanding, interpretation and management of cultural heritage assets.

We should be in touch with Pompeii authorities, for instance, to see if our work may contribute to interpretative materials available on site, as well as exploring whether our outcomes could usefully contribute to aspects of school or university curricula

The London Charter: Conclusions
Where do we go from here?

We are carrying out consultation process with people, projects and organisations in the cultural heritage domain, and have extended a wide invitation to interested parties to take part in these discussions, and to join the Charter mailing list to be kept up to date with developments.