Images and Artefacts of the Ancient World

A joint discussion meeting took place under the auspices of the Academy and the Royal Society, at the Society's premises, on 6–7 December 2000. The meeting was attended by about 100 people. **Dr Alan Bowman FBA**, *co-organiser of the event with Professor Mike Brady FRS, describes the event, and overleaf* **Dr Hugh Denard** *highlights recent work on imaging Pompey's theatre in Rome.*

Dr Bowman is co-director of the Academy Research Project on Romano-British Writing Tablets, supported at the Centre for the Study of Ancient Documents, University of Oxford (www.csad.ox.ac.uk)

The stimulus for holding a joint symposium was the idea that dialogue between the disciplines of archaeology and history on the one hand and science and computer technology on the other can yield dynamic results, of genuine benefit to both. Of course, scientists have developed standard techniques for solving problems involved in electronic reproduction of different kinds of three-dimensional artefacts; and archaeologists and historians employ different skills, methods and techniques to interpret the results. But dialogue between the disciplines enables the scientists better to understand precisely what the classical scholars' problems are with specific and different types of artefact, and thence to experiment with different techniques and combinations of techniques. The results can be innovative, of genuine scientific value, and allow more generalised application to a wider range of materials and artefacts.

The theme of the meeting emphasised the vitality and necessity of dialogue between the humanities and the sciences. It provided a forum for wide-ranging discussion of state-of-the-art computer-based imaging, bringing together sixteen presentations of which half were technically scientific and half archaeologically or historically focused. The intention was to stimulate further research and to encourage people to talk introspectively about their methods and problems, to analyse their own processes of problem-solving and visual cognition and, in particular, to focus in a very precise and realistic way on what is empirically desirable and technically feasible.

The discussion format was particularly valuable because it made it essential for participants to talk across techniques and categories of material. Among the general issues which speakers addressed were: the current effectiveness of the application of computer vision techniques to interpretation of ancient artefacts and the organisation of bodies of evidence from the ancient world; the ways in which computers can acquire images of three-dimensional objects; and the ways in which techniques of signal processing can analyse and enhance the captured images.

Three of the archaeological papers focused on problems presented by written texts. The incised wooden stilus tablets from Vindolanda near Hadrian's Wall contain partial, damaged and sometimes overlaid texts which require understanding of the cognitive processes involved in decipherment, a method of image capture which optimises the visibility of the letters illuminated from different angles, and a method of signal-processing which detects and enhances the marks identified by the expert reader as significant (Dr A.K. Bowman and Dr R.S.O. Tomlin, University of Oxford). In the case of cuneiform clay tablets from the ancient near east, the use of a digital camera in the field has allowed new discoveries to be recorded, and difficult texts, such as those with 'mirror-writing', to be understood (Professor Karel Van Lerberghe, Leuven). Laser scanning is used for larger-scale rock-surfaces with runic inscriptions, using machinery which has also been employed for studying Bronze Age rock carvings and for measuring coastal erosion in Europe. Data collected in the field can be processed to produce visualisations in the form of 3-D models, contour maps and digital shadow images (Professor Jan Swantesson, Karlstad).

Small artefacts were represented in a presentation of Italian pottery (terra sigillata) with appliqué decoration in which the images are reconstructed by photogrammetry (Dr Eleni Schindler and Dr Ulrike Fastner, Magdalensberg and Technische Universität Graz), and by a discussion of the potential uses of imaging in numismatics, an under-exploited area. An extension of imaging techniques to die-studies is rich with possibilities for chronology, attribution and quantification of coin production (Dr Christopher Howgego, Ashmolean Museum). The potential for imaging on a larger scale was dramatically illustrated by the international collaborative project to reconstruct, from scattered archaeological remnants, Pompey's theatre in Rome, originally the most magnificent and extensive single architectural complex in the city. Dr Hugh Denard (Warwick) illustrates the project below. The town of Sagalassos in Turkey is a test site for the use of advanced computer vision techniques, modelling the finds in three

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dimensions, applying special illumination to recover shape and texture of a surface and synthesising artificial textures to produce virtual landscape models which are texturally realistic.

Other scientific highlights included a compelling lecture on the potential of various forms of (affordable) microscopy, in particular confocal scanning optical microscopy (Professor Fred Fitzke, UCL). In a similar way, Andrew Wallace (Heriott Watt) presented some stunning results of direct calculation of 3-D range/depth profiles of objects from a device he and his colleagues have developed based on single photon counting (based on a very fast avalanche diode). Roberto Cipolla (Cambridge), Andrew Fitzgibbon (Oxford), and Luc van Gool (Zurich and Leuven) presented alternative methods for reconstructing three-dimensional scenes such as sculptures, buildings, and archaeological sites from a sequence of monocular images. All of these speakers addressed the issue of estimating 3-D reconstruction errors, an issue that is particularly important to the historians' community as they assess alternative interpretations of the artefact or site. A broader, and enormously important, aspect of these fields of research is the understanding that the historian or archaeologist is engaged in a perceptual-cognitive task when transforming often noisy and impoverished signals into semantically rich symbols that have to be set within a cultural and historical context. Jan Koenderinck (Utrecht) addressed some fundamental issues in human assessment of depth from pictorial cues such as silhouettes, shading, etc., and proceeded to develop a mathematical theory to explain those human perceptions.

There should be no assumption, however, that computers can do everything better in the 21st century and participants were reminded of individuality and the human factor by discussions of ancient faces and three dimensional mummy-portraits from Egypt which underlined, in the latter case, the value of 3-D reconstruction on the basis of a CT scan (Dr Alf Linney and Dr Gus Alusi, UCL) and, in the former, the necessity of using the expertise of the medical illustrator working manually (Dr John Prag and Mr Richard Neave, Manchester).

Publication of the proceedings will also break new ground. The British Academy will publish the papers in a volume which will appear as a joint publication of the Academy and the Royal Society. The web sites of both organisations will carry abstracts and a selection of images to illustrate the talks. Some of the research projects discussed will also be presented at the British Association Science Fair in Glasgow (September, 2001).

Virtual Archaeology: Reconceiving Rome's 'Theatre of Pompey'

Figure 1. Theatre of Pompey: porticus postscaenum *and Temple of Venus Victrix. Rendered image from 3-D model by John Burge. Copyright University of Warwick.*

On 29 September, 55 BC, Pompey the Great dedicated a monument celebrating his military conquests. Rome had never seen anything like it. The complex contained the first permanent theatre in the city; seating up to 35,000 spectators and housing a stage almost 300 feet wide, it remains probably the largest theatre ever built. A temple of Venus Victrix crowned the auditorium, while behind the stage building lay a vast colonnaded garden adorned with statues, trophies, pools and fountains. Completing the complex was a Senate House where, on the Ides of March, 44 BC, Julius Caesar was assassinated at the foot of Pompey's statue.

As the first major example of Roman 'imperial' architecture, the Theatre decisively influenced the style of Rome's urban development. When Vitruvius wrote his treatise, *De Architectura*, Pompey's edifice formed the basis of his account of theatres. Through Vitruvius, it became the prime

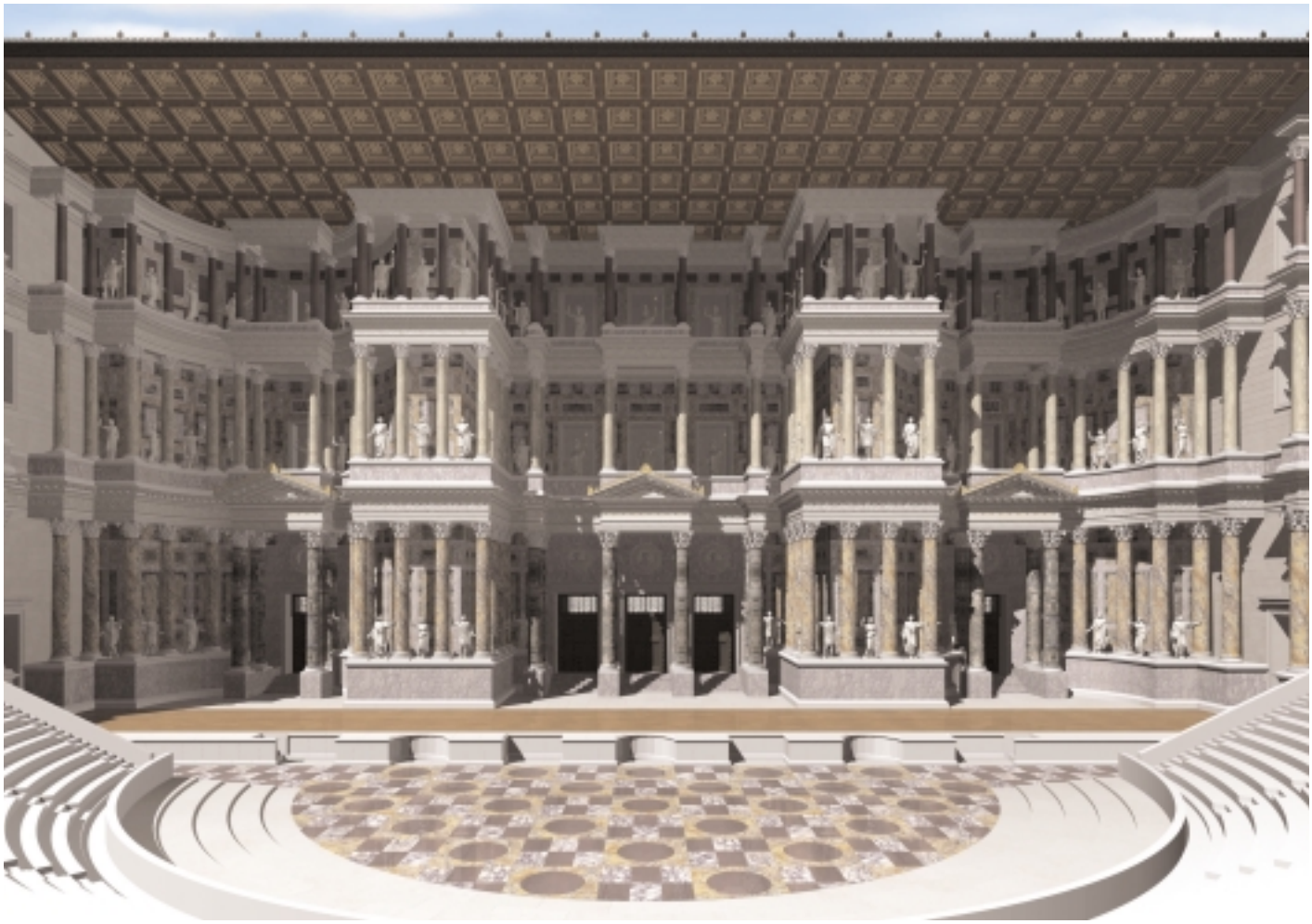

Figure 2. Theatre of Pompey: scaenae frons. *Rendered image from 3-D model by John Burge. Copyright University of Warwick.*

architectural model for vast numbers of theatres constructed throughout the Empire, from Arles to Timgad, Caesarea to Athens.

For over five centuries the Theatre of Pompey remained one of the city's great showplaces and its preferred theatrical venue until the end of the Roman Empire in the West. As late as the 6th century AD, the theatre was still sufficiently imposing for Cassiodorus to describe: 'caves vaulted with hanging stones, so cleverly joined into beautiful shapes that they resemble more the grottoes of a huge mountain than anything wrought by human hand.' Now, however, there is little to see above ground. Subsumed into post-antique structures, the monument can not be extensively excavated; no comprehensive analysis of the site has ever been conducted and questions of major importance remain unsolved.

Virtual Reality (VR) technologies, however, have greatly enhanced our capacity to understand such structures. So, in the spring of 1999, the AHRB granted Professor Richard Beacham (University of Warwick) substantial funds to co-ordinate, together with Professor James Packer (Northwestern University), a major, interdisciplinary study of the monument, to be aided by 3-dimensional digital modelling. The Pompey Project spans the entire history of the site, from antiquity to the present. When complete in December 2002, it will have produced three-dimensional computer models, acoustical renderings, images of artefacts, a database of all known references to the site, a history of scholarship on the site, and an analysis of the Theatre's place in the evolution of Roman theatre architecture. Most recently, VR has enabled the Project to pinpoint the optimum location for new excavations, which are scheduled to take place in the summers of 2001 and 2002.

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The Pompey Project received pump-priming research grants from the British Academy in 1996–97.