D:G:TAL

Between History *and* Archaeology

C:T:ES

Edited by **Maurizio Forte**
and **Helena Murteira**

DIGITAL CITIES IN BETWEEN HISTORY AND ARCHAEOLOGY

EDITORS

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AIM AND SCOPE OF THE VOLUME

Digital technologies have dramatically changed our relationship with the past. Archaeology, history, art history and museology have surrendered to the vast potentialities open to research by digital instruments. A decade ago, the inexorable impact of the digital world in the humanities gave way to the autonomous discipline of digital humanities, after having been, for a long period of time, an intersection between humanities and computing. Digital archaeology is a significant and distinct example of the relationship between history and digital technology. The onset of virtual archaeology as early as the mid-1990s and its subsequent remarkable development, due to the use of multiple digital tools, has had a crucial impact on the study of past realities, namely on the profound shift that the study, preservation and display of cultural heritage has suffered in recent years. We are facing a fast growing area of research which enables historical data to be manipulated and reinvented, thus becoming itself digital in nature. Digital technologies are not only enhancing the scope of historical research, but they are also creating new objects of study.

The study of the city stands out in this context. Cities are microcosms, which reflect the structure of societies over time. Archaeologists and historians are faced with the enormous task of understanding the city in all its aspects in time and space. Lost or profoundly changed urban environments offer a particularly challenging area of research. A vast array of digital tools, such as laser scanning, 3D models, virtual worlds technology, augmented reality and remote sensing are processing, testing and displaying archaeological data, architectural remains, built heritage, written, iconographic and cartographical sources in a scale and fashion never attained before. Multidisciplinary teams, which may bring together historians, architects, geographers, anthropologists, computer engineers and other experts, are often working in collaborative real-time environments open to interaction with a vast audience of users. Virtual reconstructions, recreations or simulations require a vast array of information. In the case of past cities, the data presented rarely reflects similar stages of research and equally consistent evidence. Besides this challenge, models are increasingly more complex in their interactive and immersive features and are thus open to a multitude of interpretations and to different inputs by users. Therefore, it is crucial to have precise methodological procedures to assure transparency and scientific accuracy. Documents such as the London Charter (2009) and the Principles of Seville (2012), aim to respond to these requirements. However, it is also crucial to understand the epistemological and ontological impact of generating digital information in this context, particularly when we are in the presence of a shared social environment. The memory of the past is not only revisited in a new sensory dimension, but it is also changed by our own actions and experience.

This volume explores the new paradigm of the Digital City as being simultaneously a past and a contemporary entity. It will consider the study of the city in the digital realm in its different affordances, namely, the methodological and epistemological impact of the use of digital tools in the study, reconstruction/simulation of historical urban environments and architectural settings and the way digital technology is reacting to the demands imposed by historical research and its dissemination. It will thus approach topics such as the challenges and possibilities that the use of digital instruments pose to the study of pre-urban and urban contexts; the consolidation of the relationship between digital language and historical

narrative; the didactic and leisure scope of virtual heritage and the questions that the study of the city within the digital context raise from an epistemological and an ontological perspective.

There is a wide and relevant bibliography on digital archaeology and virtual heritage dating from the mid-1990s to this day. These publications approach the subject of the use of digital technologies in the study of the past from various different perspectives. A significant number focuses on particular case studies and debates the methodological framework of their specific research. The widespread use of digital technology in archaeology and history in recent decades as well as the fast-growing complexity of the digital tools available have stimulated a fundamental debate on the methodological, epistemological and ontological scope of digital archaeology and virtual heritage. The following books are of special note: Barceló, J. A; Forte, M. and Sanders, D. H. (eds.) *Virtual Reality in Archaeology* (Oxford, 2000); Niccolucci, F. (ed.) *Virtual Archaeology*. (Oxford, 2002); Beacham, R.; Denard, H. and Niccolucci, F. "An Introduction to the London Charter', in Ioannides, M. *et al.* (eds.), *The e-volution of Information Communication Technology in Cultural Heritage: where hi-tech touches the past: risks and challenges for the 21st century* (Archaeolingua, 2006); Forte, M. *Cyber-Archaeology* (Oxford, 2010) and Bentkowska-Kafel, A. and Denard, H. (eds.) *Paradata and Transparency in Virtual Heritage* (Ashgate, 2012).

This volume is innovative not only because it explores the challenges that archaeology and history face by using digital tools, but particularly, due to the fact that it focus on the study of the city in this context. This is an approach which requires a collection of studies such as the present volume affords. Digital Cities not only reflect a novel approach to historical research and its display but are also emphasizing and reinventing the multidisciplinary character of the study of the city. Architecture, town planning, population, mobility and location are often considered through an all-inclusive methodological approach, expressed in a non-verbal scientific domain, opened to real-time fruition by contemporaneity. In this way, Digital Cities are paradigmatic of the ever interchangeable relationship between past and present.

This volume considers the city from pre-historic settlements to the present, in different geographical contexts, and it includes carefully selected authors with different backgrounds, i.e. archaeology, history, urban history/architectural history, architecture and computer science and technology. The different chapters reflect different levels of engagement with digital tools. However, they all share a common ground: the intersection between history and the digital world as a means to advance the study and dissemination of the knowledge about the city. The different chapters thus contribute to the creation of a coherent approach to the subject and provide a suggestive snapshot of the most recent research within this field. The editors' foreword and afterword will help to reinforce the cohesion of its contents by establishing the theoretical framework of the debate and of the knowledge sharing which it provides.

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MARKET CONTEXT AND PROMOTION
This book will attract scholars and students from a variety of research fields such as archaeology, history, art history, urban and architectural history, anthropology, sociology, geography, museum studies, cultural heritage, digital archaeology, virtual heritage and computer science.

There is an emerging yet fast-growing academic market for digital archaeology and virtual heritage not only from a theoretical perspective, but also from the point of view of training and education. This book will appeal to students of graduate and post graduate courses on these subjects, which are today available in numerous universities worldwide. These

programs merge archaeology and history with computer science and technology and thus are shaping the first generations of experts in both fields. This volume will be an important supplementary textbook for these courses, particularly for scholars and students interested in the wide-ranging and more complex field of urban environments.

Also, it will be easily marketable in the many conferences and congresses organized regularly by universities and academic and professional societies, such as the European Association for Urban History, European Architectural History Network, Society of Architectural Historians, Eurographics - European Association for Computer Graphics, the International Society on Virtual Systems and MultiMedia (VSMM) and the IEEE Computer Society.

STRUCTURE AND TIMESCALE
Deadline for delivery of chapters to the editors: **November 1, 2015**. The full length of this volume will be approximately **130,000 words** including endnotes and bibliography. It will include **17** chapters of approximately **7.000** words each. The chapters will have a maximum of **5 images/graphs** each, **2 of which in colour**.

CHAPTER ABSTRACTS
Çatalhöyük as an open site? On the openness of virtual reconstructions to a multiplicity of readings
Zeynep Aktüre, Izmir Institute of Technology, Turkey

In the past two decades, employment of digital technologies in research and presentation of archaeological heritage sites widened. An example is Çatalhöyük in central Anatolia, Turkey which consists of two multi-layered Neolithic settlement mounds that are accessible from a forking road, whence comes the name of the site. Excavations that started on both mounds in late-1950s were soon abandoned, leaving the excavated areas open to the effects of a harsh climate, which further decreased comphensibility of the mudbrick settlement remains even for the most informed visitors. Despite its worsening physical condition, however, Çatalhöyük was among the highlights of the *Housing and Settlement in Anatolia* exhibition during the Second United Nations Conference on Human Settlements (HABITAT II, 1996) in Istanbul, due to the centrality of the site in debates on the emergence of an urban way of living. Çatalhöyük was inscribed in the UNESCO World Heritage List (WHL) in 2012 mainly due to the evidence it provides of the transition from settled villages to urban agglomeration[1]. Yet, there still exists a diversity of opinion on the rank of the site along this developmental course.

The particular expert opinion that was presented in the HABITAT II exhibition was the outcome of resumed archaeological research at the site in 1993, employing advanced computer-based technologies for various tasks. Research finds have been systematically disseminated in the project website *Çatalhöyük. Excavations of a Neolithic Anatolian Höyük*[2] that has presented an increasing number of virtual reconstructions of the site ever since. A considerable number of these display a preference for what may be described as an abstract and aestheticizing visual language that is also exemplified in the Çatalhöyük video published in the *Housing in Anatolia* (1996) CD-ROM in the period of HABITAT II, as a pilot project of the Information Technologies and Electronic Research Institute (BILTEN) of the Scientific and Technological Research Council of Turkey (TUBITAK).

This paper discusses the openness of this visual language to a multiplicity of possible interpretations, as required by the diversity of opinion on the rank of Çatalhöyük in the range between nomadic and urban ways of living. To do that, the paper first introduces the

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[1] «Neolithic Site of Çatalhöyük», http://whc.unesco.org/en/list/1405/, last accessed on 2014-09-27.

[2] http://www.catalhoyuk.com/

competing hypotheses on Çatalhöyük and then sets a theoretical framework of discussion around Umberto Eco's theory of the open work and Siegfried Kracauer's idea of cinematic materiality. The concluding discussion uses this framework to question whether the digital reconstructions of Çatalhöyük function as works open for a multiplicity of interpretations, in reference to the London Charter for the Computer-Based Visualisations of Cultural Heritage (2009).

Neuroarchaeology for the interpretation of the Neolithic site of Catalhoyuk
Maurizio Forte, Duke University, USA

Çatalhöyük (7400-5200 BCE) is considered one of the first urban centers of the world. The importance of the site is related with the domestication of plants and animals, the first agricultural revolution, the introduction of "history houses" and symbolic art and the apparently equal organization and distribution of space within a homogenous plan. The site was excavated in the 50s and 60s by James Mellart (Cambridge University) and, since 1993, by Ian Hodder (Cambridge, then Stanford University). Since 2009 a pioneering project titled "3D-Digging at Çatalhöyük" is aimed at the 3D digital documentation and interactive visualization of the site using different technologies: laser scanning, computer vision (image modeling), GIS, tablet computing and virtual reality. The project had a twofold scope: large scale digital recording of the entire East mound and micro-scale systematic recording of all the stratigraphic layers and architectural elements of a Neolithic house (B89)[3]. This approach in fact allows a complete virtual representation and analysis of an archaeological excavation by layers and units (according to the single context excavation). The integration of all the spatial geo-data in virtual reality platforms and GISs represents the necessary step for a multidisciplinary and diachronic study of the center in its environmental context. Finally, the combination of 3D documentation and digital reconstruction of the site with different systems of simulation reveals new research perspectives for the interpretation of the site and its urban development.

On visualizing and representing the first industrial revolution in the Southern Levant: Cyber-Archaeology Perspectives on an Iron Age Copper Production Center in Faynan, Jordan
Thomas E. Levy, University of California, San Diego, USA

Following the collapse of Late Bronze Age civilizations around the eastern Mediterranean, local south Levantine polities took advantage of this geo-political disruption and ushered in the first industrial revolution in the southern Levant. Based on the production of copper, this came to fruition during the Iron Age in the early centuries of the 1st millennium BCE in the Jordan's Faynan district. Spread out over 400 km[2], Faynan is home to the largest copper resource zone in the southeastern Mediterranean basin. At this time, a widespread mining and metallurgy landscape evolved with the main production center at the site of Khirbat en-Nahas (KEN; Arabic = 'Ruins of Copper'). Using the geo-spatial work-flow of Cyber-Archaeology (the marriage of archaeology with computer science, engineering and the natural sciences), and an array of digital data capture, curation, analyses and dissemination tools were used to model both the 3D excavation process at KEN and 3D reconstruction of this ancient metal production center. Extending over 10 hectares, KEN contains one of the largest Iron Age desert fortresses in the south Levantine desert, a monumental administrative building, and over 100 other buildings linked to copper production. The site contains all the attributes of an urban center, yet it only served one industrial function. By using 3D CAVE environments to explore the archaeological excavation data in relation to

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[3] M. FORTE - N. DELL'UNTO - J. ISSAVI - L. ONSUREZ - N. LERCARI, *3D Archaeology at Çatalhöyük*, in International Journal on Digital Heritage edition 3, 2012.

the widespread architectural features at KEN, new insights into the role of socio-economic processes responsible for the early Levantine industrial revolution are achieved.

"I dreamt I dwelt in marble halls": Using Computer Based Visualisation Of Roman Domestic Architecture to Evoke the Built and the "Felt" Environment
Richard Beacham, King's College London - King's Visualisation Lab, UK

Roman domestic architecture and decor drew upon complex visual strategies to evoke in visitors a wide range of powerful sensual and emotional and reactions to what was frequently a carefully staged environment. The "mis en scene" of such dwellings was calculated and coordinated to communicate such things as a sense of the power and prestige of the domestic patron; an imaginative access to fantasy realms of mythology, or exotic landscapes; a distortion of space through the painted suggestion of grandiose, often impossible architecture.

Computer visualisation and representation of such spaces, has the challenge and potential, particularly when configured in a "virtual world" format, to evoke in users not just a sense of the physical structure of such spaces, but of their sensory qualities as well. This is particularly true when such visualisations – such as that provided by the Oculus Rift and related technologies are configured to engage the user in an immersive environment. This chapter will consider the scope and limitations of such applications, and the extent to which they may provide the user with both a perception and understanding of Roman visual strategy, and some sense as well of the sensual impact such strategy might have had upon the ancient visitor as s/he encountered and experienced these ancient spaces, now reconstituted virtually, before our eyes.

The Regium@Lepidi Project
Maurizio Forte and Nevio Danelon, Duke University, USA

Regium@Lepidi 2200 is an international project specifically designed by Duke University - Dig@Lab for the archaeological museum and the city of Reggio Emilia (Musei Civici). The project was born with the twofold scope to study and virtually interpret and reconstruct the Roman city of Regium Lepidi and to create a new virtual museum especially designed within the archaeological museum of Reggio Emilia. It is the first virtual museum in Europe with this kind of settings and contextualized within the archaeological collections. It is designed according to a bodily-kinesthetic approach: the users are stimulated to learn by interaction. The contextualization of the virtual museum inside the real one is particularly challenging because it creates a strong connection between empirical data, the museum collection (tangible), their ancient invisible context (the city, intangible) and new immersive perception of artifacts (virtually perceivable and immersive).

This new digital narrative transforms the traditional archaeological taxonomy in affordances, showing potential relationships among objects, context and environment. In this way objects and sites are embodied in and out of the museum and they can tell stories. The final goal is to open and choose multiple perspectives in the digital imagination of the city, rather than to choose a peremptory reconstruction. The project involved a very interdisciplinary approach, already outlined for analogous case studies, that entails the integration of different categories of data and methodologies, ranging from archaeology, geology, topography to remote sensing.

Imagining Change in the Historic City
Caroline Bruzelius**,** Duke University, USA

Prior to the digital revolution, the history of the city could only be represented visually as a series of "frozen moments:" sequential static images of how urban spaces expanded over

the course of time. Thus, for example, maps of Florence show the sets of urban fortifications that were created concentrically as completed projects, rather than as multi-decade process that slowly engaged with construction in one region of the city prior to another as property was acquired and houses were demolished. So, too, the sections and ground plans of buildings have been generated as representing a coherent and completed "ideal" project, rather than as part of an evolving and emerging *process* as property for expansion was acquired and as new architects introduced innovations.   The challenge of representing conceptual change in man-made space is especially challenging for the Middle Ages, but applies also to most monumental architectural projects and to cities in almost any historical period.

The capacity of digital technologies to reflect *change as an ongoing process* is especially important in the study and representation of the man-made spaces of buildings and cities. Ever since the architectural criticism of Leon Batista Alberti, planning and building have been conceived as an idealized authorial projects rather than as a series of adaptive interventions that respond to the exigencies of finances, available space, and changing use. *Visualizing Venice,* an international collaboration created in 2010, was created in order to push the affordances of mapping and modeling technologies to produce animations that reflect the transformation of cities and buildings as part of organic, "amoeba-like" process of adaptation and change.

Exploring visually knowns and ill-knowns about Krakow's centre urban evolution: an information visualisation perspective

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Studying and depicting the design and transformations of urban structures have been a concern ever since the 19th century, both from the point of view of historians, and from the point of view of urban planners. Where exactly is the impact of « digital humanities » on the way we today can renew our means of investigation? This chapter introduces on real-case experiments carried out on the city centre of Cracow, former capital of Poland. Through these experiments we, on one hand, illustrate the fundamental issue of imperfect knowledge in historical sciences, and on the other hand demonstrate the potential added-value of infovis-inspired abstract graphics in supporting reasoning tasks.

In the first part of the chapter we wish to raise a still-open research question: how can analysts formalise the ill-known, and introduce it from a pragmatic point of view into contemporary information systems?

In the second part of the chapter we wish to demonstrate that the step from analysing a single edifice to analysing an urban structure is not quantitative, it is primarily methodological. An urban structure is a system where interrelations, interdependencies, play a major role, may they be between edifices, between edifices and open spaces, or may they be between the fabric and a context – wars, floods, laws, aesthetics of a time, etc.. In that sense, switching to the analysis of a whole urban structure may reveal interrelations, patterns of change, possible causal chains, and ultimately allow for information and knowledge discovery.

Our approach bases on the idea that the gap between historical sciences one on hand, and information visualisation (infovis) on the other hand, should and can now be filled. Our contribution will illustrate on real cases in what the above mentioned methodological bridge can be a solution-provider in the context of urban analyses, and point out the actual scientific and technological locks we are facing.

Historic Centre of Porto (WH) – From Historical Research to (Real) Virtual Heritage Visualisation

Maria Leonor Botelho, University of Porto - Faculty of Humanities, Portugal

In 1996, the World Heritage Committee added the Historic Centre of Oporto to the World Heritage list on the basis of its unique cultural criterion. The criterion used identified Oporto as having an outstanding universal value, as the urban fabric and its many historic buildings bear remarkable testimony to the development of this European city over the past thousand years which has looked outward to the west for its cultural and commercial links. The value of the multi-layered urban fabric is the result of a complex topography, articulated through streets, lanes, alleyways, stairs and squares and its architecture (whether residential or monumental), culminates in cultural values accumulated over successive eras.

To study the complex character of urban space has to be through an interdisciplinary approach. There is a growing awareness that the methodologies must be rigorous with solid academic studies forming the basis irrespective of the form of dissemination or media used. Furthermore, to provide accurate, detailed and relevant heritage conservation, we need a full and detailed knowledge of the historic environment, in this case the Historic Centre of Oporto.

This chapter will argue that by drawing on the wealth of evidence for the historic development of Oporto and the use of virtual heritage visualisation (VHV), an established method in presenting and understanding urban environments, we can further our understanding of the historical significance of monuments and their setting, and in turn facilitate the process of heritage conservation and dissemination of information. Through two case studies of different approaches to the visualisations of Oporto, a physical scale model of Medieval Oporto (1999, Municipal Historical Archive of Oporto) and a more recent digital model, "Virtual Porto XVI Century" (2005), this chapter will argue that virtual heritage visualization (VHV) is already an integral part of the interpretation and dissemination of Oporto's heritage. The potential these projects have for meeting the needs of public engagement and different communities will be explored and the potential for maintaining and updating information represented in the model through ongoing historical research. Through these case studies and a consideration of literature, notably the London Charter, regarding the creation of virtual heritage, and the examples of projects in other European cities, this chapter will question the gains that VHV have as a tool for research but also for knowledge transfer to the public, whether local communities or tourists.

Historic Virtual Cities as Memoryscapes: the case of Lisbon

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This chapter aims to analyse and discuss the idea that digital recreations of a city's past, besides representing what is known about the history of that city, represent also its imageability (Lynch, 1999).

A city's imageability is related to the qualities of the identity and of the structure of the mental image which that city evokes. Those qualities were defined through time by the way they were repeated, inter-related or individually, in representations and descriptions of the city. This is due to the fact that they were connected, literally or symbolically, to the memories of events or public figures which were considered particularly significant to its history. In hindsight, the imageability corresponds to the intersection of the layers of meaning which the city acquired through time and which provide it with legibility and intelligibility in the present (Clack, 2011). It is therefore a determining factor for creating virtual recreations of cities, rendering them *memoryscapes* (Nutall, 1992).

Its theoretical validity will be verified by applying it to the city of Lisbon (Portugal), which in the last five years has been the subject of at least four virtual recreation projects. Although they presented distinct goals and made use of different technologies, the four

projects took as their starting point the same benchmark event, the 1755 earthquake (a disrupting event for the history of the city).

All four projects focus on the point of view conveyed by the city's iconography dated between the 16th and 18th centuries, and more specifically on the topographic relationship between the city and the Tagus river, mainly through its main square, the Terreiro do Paço (Palace Courtyard) and the Royal Palace complex (the Royal Palace tower, the Royal Opera House and the Patriarchal square and church). This image of the city remained unchanged in several of its depictions throughout the 18th century, even after the reconstruction works, which followed the 1755 earthquake, had significantly changed the city's urban and architectural tissue.

Spatial Representation of Vienna's Street-Level Environment—3D-ZPA (Zusammenhängende Parterre-Aufnahme)
Angelika Psenner, Vienna University of Technology, Austria

There is a strong and direct relationship between urban street space and the structures and uses of the buildings' ground floor. When addressing urban development issues the necessity to consider the *"street-level-environment"*—a holistic urban zone of *public*, *private*, and *semi-private spaces*—must therefore be emphasized. In consequence the Spatial Representation of Vienna's Street-Level-Environment 3D-ZPA is covering both *built-up* and *non-built-up areas*, it includes the street as well as the adjacent houses and yards.

Vienna's official digital map serves as matrix where the individual ground level plans of the flanking buildings is set in—both historical plans and most recent conversion documents are taken into account, so that the morphological evolution of the street-level is reflected. Given the importance of ceiling and building heights the plan is elevated into the *third dimension*, which marks the major distinction from the *Comprehensive Ground Floor Surveys*, originally carried out in the 1960ies (Muratori, Caniggia).

3D-ZPA differs in precision and scale from the current settings of 3D city models that mostly render a distant bird's eye perspective and that by simply showing the external building perimeters do not provide an objective representation and description of the city's *interior structure*. 3D-ZPA precisely represents the buildings' ground floor; the areas above and below are generically outlined as a rather simple cubic model, so that street profile and day light situation on the ground are reflected.

3D-ZPA yields information about a building's spatial and functional relationship to public space and topographical environment; qualitative statements can be made concerning use, use-frequency and intensity. It facilitates conclusions regarding use-potential of the ground floor zone and places structural functions of the *street space* in relation to it. Interrelations can be identified, problematic situations considered and resolved in context; thus 3D-ZPA is providing a fundamental tool for planning *and* research.

Unreal Projects: Using Immersive Visualization to Learn about Distant and Historical Locales
Gabriela Campagnol, Stephen Caffey, Mark J. Clayton, Julian Kang, Geoffrey Booth, Nancy Klein and Kevin Glowacki, College of Architecture, Texas A&M University - College Station – USA

Our team, drawn from the departments of Architecture, Construction Science, and Landscape Architecture and Urban Planning, proposes to construct digital models of places remote in distance and/or time to enable students in core curriculum courses to enhance their spatial and sensory understanding of place. A BIM-CAVE, devised and implemented by Dr. Julian Kang and his students, is used to enable groups of students to navigate through the digital models. The technology of immersive visualization (IV) has progressed to where it can be employed to deliver experiences of places and environments that are otherwise difficult or impossible. The BIM-CAVE provides particular advantages that allow this project

to be practical. It makes use of commercially available software that is used widely in the architecture and construction industry. Building Information Modeling (BIM) software enables the quick modeling of 3D architectural and urban spaces and the ability to embed non-graphic information into the model to control the visualization. A student may watch a building being constructed, inspect it at different phases of its history, or visually highlight the structure or other technical characteristics. The modeling software is available free of charge to students and faculty, and the BIM-CAVE is proprietary to Texas A&M University. The skills acquired in using BIM-CAVE readily transfer to other courses and to professional design practices once the student enters the workplace. The project will enrich students' understanding of history and culture by allowing them to navigate freely through the simulated, unreal world of IV environments. Inhabiting this unreal world offers the potential of greater understanding and insight about the spatial and sensory qualities of the environments than cannot be obtained through engagement with other media. The IV facility can become a standard for excellence in teaching about historic, contemporary, and future environments in architectural and other disciplines.

BIM-CAVE refers to the modeling technology used in the building industry, Building Information Modeling, and an early and influential immersive visualization environment, Cave Automatic Visualization Environment.

Embodied Cities: histories and strategies for inhabiting cultural heritage landscapes in museums
Sarah Kenderdine**,** National Institute for Experimental Arts, University of New South Wales - College of Fine Arts, Australia

This chapter brings together a series of pioneering installations and research that define new approaches to visitor experience of digital cultural heritage cities and landscapes using the technologies of virtual and augmented reality. Building on theories of presence, phenomenology, performativity, interactive narrative, information visualisation, psychogeography and deep mapping, the discussion is informed by a media-archaeological approach to the history of immersion in virtual cities. By charting trajectories from Robert Barker's Panorama in Leicester Square (1787) and August Furhmenn's Kiaserpanorama (1890) through to Michael Naimark's *Aspen Movie Map* (1970-80) and *Be Here Now* (1995-97), Jeffrey Shaw's *Legible City* (1989) and, Bernd Lintermann's *Globorama* (2008—the strategies taken to build interfaces to the virtual city are revealed, laying the foundations for subsequent analysis taken this Chapter.

Extrapolating on this media-art history, the discussion explores a series of award-winning cultural heritage installations focused on two world heritage precincts the— Monuments at Hampi, Karnataka, India (*PLACE-Hampi* 2006/2012) and, Mogao Grottes at Dunhuang, Gansu, China *(Pure Land: Inside the Mogao Grottoes at Dunhuang*; *Pure Land Augmented Reality Edition* 2012 and; *Pure Land Unwired* 2015). In doing so, the discussion encompasses a range of scalable technologies while also exploring new forms of embodied museography.

Building upon these findings the Chapter unfolds new research aimed to resolve the fundamental challenges of narrative coherence for museum audiences as they explore digital atlases. This research integrates a unique cultural heritage dataset—the *Atlas of Maritime Buddhism.* This *Atlas* has accumulated historic evidence for the spread of Buddhism from India to Korea through the seaports of South East Asia. Its pan-Asian spatially and temporally enabled sources are significantly diverse in both type and format (e.g. archaeological materials, travellers' accounts and historic gatteers to name a few). The aim of this research is to develop a pioneering narrative-driven deep mapping schema, as an innovative information visualisation framework for interactively exploring the narrative patterns, processes and phenomena in the Atlas. This schema will investigate narrative coherence through the experimental application of the world's first deep mapping data

browser—an interactive interface developed in a 360-degree 3D (omnidirectional) virtual environment.

Experiencing past, present and future urban environments through digital representation, storytelling and simulation
Eva Pietroni (Institute of Technologies Applied to Cultural Heritage, CNR, Italy)

The Application of digital technologies can result in a significant advance in the research and valorization of the urban built heritage. In the digital domain we can analyze, classify and represent transformations on urban scale, integrating information from multiple fields (art-historical and archaeological, architectural, urban, legal, tourist, social, symbolic, etc.).

3D representation is a powerful tool, not only for final communication but also for interpretation. It has to be considered not only for its perceptive and cognitive impact but also as visual interface towards multiple and deeper connections of meaning and contents: it can be linked to a database, or it can be used a stage for interactive storytelling, for immersive/multi-sensorial perception or as "scenario" for simulation of complex dynamics based on "agents" and artificial life algorithms (for instance to simulate the tourist impacts inside an old town, a management plan, the inclusion of new buildings in bonded historical contexts).

This combination and aggregation is bigger than the sum of its parts and produces the best impact in terms of understanding and learning.

The chapter will also analyze the approaches commonly adopted in the 3D reconstruction of urban contexts. Methodologies, technologies, software and data required by these approaches will be underlined, together with the possible outputs (still images, 2D or 3D GIS, computer-graphic movies, real time or augmented-reality applications) and further new perspectives. It will underline how issues and problems regarding the reconstruction of our past, such as the management of uncertainty, should be faced with a new and deeper awareness.

Finally a study case will be presented, Matera Città Narrata project (2009-2012), whose aim of is the creation of a digital platform, (a web site, www.materacittanarrata.it, and applications for mobile devices with different OS for different targets), able to support the public before and during the visit of Matera (South Italy, Unesco Heritage since 1993). It allows to access 3D reconstructions of the urban context evolution through 8 chronological phases and it tells the stories that took place in those ancient sites, real fragments of life, myths, events, characters, memories. Experts have been involved together with local population, students, artists, everyone bringing his own vision of the context.

Locus, loci: Toward an history driven approach for location based ludic artifacts
Filipe Penicheiro, University of Coimbra, III - Institute for Interdisciplinary Research, Portugal

Concepts like space or time are inherent to any reflection in areas of knowledge like history, geography or architecture. Discussion around these concepts extend from more theoretical approaches to a renewed focus, draped by late 20th century technological advances, that introduce concepts like mobility, embodiment or pervasiveness in the discussion. Mapping these intersections is a challenge that becomes even more relevant when we consider its relation to historical understanding. The present work aims to trace these multiples discussions over the concept of space in relation with location based history driven ludic artifacts. Although the question of spatiality in ludic artifacts has been approached by different authors, the present chapter will review several location based mobile projects that aimed to explore historical understanding and will discuss the importance of space and mobility to enhance a more comprehensive framing of historical processes. The implication of this reflection is of key importance to refocus on the provisional status of historical knowledge ant to question "linearized time and marginalized space". Understanding better

what are the implications of location based history driven ludic artifacts for historical understanding will provide paths for historians and game designers to engage with meaningful practices to map theory and actions towards engaging new artifacts.

Simplified Crowd Simulation In Virtual Heritage Sites
Luís Sequeira, University of Trás-os-Montes and Alto Douro, Portugal

For the past two decades, historians and archaeologists have reconstructed heritage sites using computer-generated graphics in three dimensions, a technique known as 'virtual archaeology'. Early research focused merely on displaying models of the architecture or of archaeological artifacts, but, with the emergence of virtual worlds, researchers and the public could 'immerse' themselves in the reconstructed environment and experience the equivalent of a guided tour. In the special case of virtual worlds with user-generated content (such as Second Life® and OpenSimulator), historians could go a step further and modify the models themselves, by formulating hypothesis and testing them interactively inside the virtual world, therefore creating the concept of a 'virtual laboratory of archaeology'.

At first, such environments lacked a human presence, beyond the participating historians, but recent projects include crowd simulation with autonomous agents, driven by artificial intelligence algorithms, allowing researchers to simulate the way those heritage sites were inhabited. The issue is that such simulations usually require a thorough understanding of computer programming in the realm of artificial intelligence; thus, most projects rely on a team of technicians to actually develop the crowd simulation based on descriptions and guidelines provided by the historians.

In this chapter, an alternative solution is offered, whereby historians are able to manipulate the parameters of the crowd simulation itself — using the virtual worlds platform OpenSimulator — without the need of learning conventional computer programming. The conceptual framework for this solution is loosely based on strategy computer games, which also allow players to simulate relatively complex crowds by visually placing markers on the ground. It extends the concept of the virtual laboratory of archaeology beyond the architectural representation of heritage sites by placing the tools of crowd simulation in the hands of historians.

Bits of the City: Innovation in 3D sensing and printing tomorrow's urban fabric
Alonzo Addison, University of California, Berkeley; United Nations Educational, Scientific and Cultural Organization, UNESCO

This contribution will be focused on future and past of digital cities in the light of the 3D reproduction of urban plans, architectural models and digital environments. 3D close range and long range sensing systems are able to return hybrid pictures of human cities whereas knowledge is augmented knowledge and reality switches to hyper-reality.

At the Interface of Viewing and Multimodal Sensing —The Dynamic Transformation of the Cityscape
Bill Seaman, Duke University, USA

Differing forms, scales, and uses of computational media are changing the face of the city in multiple ways. This includes; the ubiquitousness of 'changing' media-based facades driven by a series of different forms of interface – both empowered by singular interactants and at times driven by a multiplicity of users simultaneously that are being "sensed"; the use of multiple screens employed on architecture and in foyers; the use of architecture itself as an impromptu screen; the employment of mobile screens that are driven by moving vehicles; the employment of lighting systems as a means of aesthetic layering of changing color; the exploration of moving screens on blimps; the use of screens in SUVs and cars; screens on boats; the use of small mobile screens by pedestrians standing, walking, and commuting on

trains and busses; the use of built-in media in taxis and busses; and the illegal use of small screens by drivers; all play into this changing world of media-proliferation. Along with screens the ubiquitous use of mobile mp3 players, iphones, ipods, ipads, and related devices add a visual and/or sonic layer of image, music and text to the city. Differing 'reading systems' like the Kindle are also ubiquitous. The new addition of the Apple wrist oriented device. One can be reading "Ulysses" by James Joyce at their local pub or encountering a contemporary poetic work, also providing intellectual stimulus as an overlay or momentaty focus. Locative media both aesthetic and information-based also enables media to be accessed as triggered by particular 'locative' relations. GPS units provide another layer or shall we say give a voice to ongoing navigation, which can also be authored to be poetic in nature. Machinic sensing systems become ubiquitous both built in as well as mobile, and function as differing forms of interface to multiple aesthetic assemblages and potentials. The smartphone enables a multiplicity of distributed machinic sensing devices to be employed that form a connective tissue – routing images and information in real time via face time and small portable camera devices, texting and email. Socail media is everywhere also providing access to works of art. New forms of locative gaming are also in play. Artists have taken advantage of all of these forms as a new "space" for showing and/or distributing works of art, in part moving out of the gallery, and into and across the City as a new site for aesthetic activity. Such works may also be highly critical in nature, enable new forms of protest, and new forms of intercommunication between specific interest groups. The employment of augmented reality enables differing forms of aesthetic overlay, and/or textual interplay with a relational environment. VR presents many approaches to the design of the city as well as creative visualisations of imaginary cityscapes, nested in the actual space. Such ubiquitous systems as Occulist Rift as well as gaming environments also provide spaces for game-modding and 3D navigation. All in all – the city as portrayed in many forms of science fiction is the now the city as it is...

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DIGITAL CITIES Between History and Archaeology

Edited by Maurizio Forte and

Helena Murteira

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