

Cultural Heritage Infrastructures in Digital Humanities



Edited by Agiatis Benardou, Erik Champion,
Costis Dallas and Lorna M. Hughes

Cultural Heritage Infrastructures in Digital Humanities

What are the leading tools and archives in digital cultural heritage? How can they be integrated into research infrastructures to better serve their intended audiences? In this book, authors from a wide range of countries, representing some of the best research projects in digital humanities related to cultural heritage, discuss their latest findings, both in terms of new tools and archives, and how they are used (or not used) by both specialists and by the general public.

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Lorna M. Hughes**

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This book is dedicated to those tireless, enthusiastic and all too often anonymous and invisible volunteers and researchers who have spent millions of hours recording, collating, collecting and preserving aspects of cultural heritage for the benefit of others.



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Preface

The genesis for this edited book was a two-day workshop entitled ‘Cultural Heritage Creative Tools and Archives’ (CHCTA), hosted at the National Museum of Denmark, Copenhagen, 26–27 June 2013. The workshop was organized by DIGHUMLAB Denmark, and the Digital Curation Unit (DCU), IMIS-Athena Research Centre.

There were approximately two-dozen presentations from around a dozen European research organizations and infrastructures (such as DARIAH, DASHISH, ARIADNE, CENDARI, MUBIL, Europeana Cloud, 3D-icons, the European Holocaust Research Infrastructure, Serious Games Interactive, The Digital Repository of Ireland, LARM and NeDiMAH), two invited international speakers (Professor Seamus Ross and Professor Julian Richards), and a final panel, which explored how research infrastructures dealing in digital cultural heritage could work more closely together. Various future projects were kick-started from this workshop, which also saw the launch of the Europeana Researchers Coordination Group (ERCG). Some of the presenters later organized a workshop at Digital Humanities 2014 conference in Lausanne.

The intention behind both the CHCTA2013 and DH2014 workshops was to foster a shared critical understanding of the current state of digital infrastructures and the potential of digital archives, tools and services to contribute to humanities scholarship, particularly in cultural heritage. Both successes and failures were discussed and debated, for the workshops hoped to reach widespread agreement between the various presenters on how and where we could better integrate infrastructure projects, develop a richer understanding of user needs and foster more collaboration among researchers. This book carries on these aims, but the journey is long and challenging.

I would like to thank The European Association for the Digital Humanities (www.allc.org/) for providing us with a small grant award, Lorna M. Hughes of NeDiMAH who provided travel funding for NeDiMAH members, the National Museum for hosting and refreshments, and DIGHUMLAB for additional funding. DARIAH and other infrastructures helped us with publicity. Costis Dallas provided much needed academic overview, and

helped with both hosting and with programme scheduling, while Agiatis Benardou was instrumental in bringing in Europeana and Europeana Cloud representatives.

Lastly, I would like to thank Lene Elsner and Marianne Ping Huang of DIGHUMLAB. Their support and organizational skills were invaluable.

Erik Champion



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1 Introduction: a critique of digital practices and research infrastructures

*Agiatis Benardou, Erik Champion, Costis Dallas
and Lorna M. Hughes*

Digital Humanities might appear a recent phenomenon. Yet almost seventy years have gone by since Father Roberto Busa initiated his Digital Humanities project: the computer-assisted lemmatization of the complete Thomistic corpus (www.corpusthomicum.org/). Although Busa first conceived of this project in 1946, it took him nearly four decades to realize it, leveraging the power of the digital computer as an ordering machine capable of processing and listing potentially infinite amounts of textual data. The development of the first computational analysis of archaeological materials, a numerical classification of Eurasian Bronze axes conducted by Jean-Claude Gardin and Peter Ihm in the late 1950s (Cowgill, 1967; Huggett, 2013) introduced a different aspect of computer-based research: one that brought to the fore the possibilities afforded by digital methods for dimension reduction, discovery and visualization of latent structures of complex data.

Fast-forwarding to the present day, two surprisingly distinct communities have already emerged in digital arts and humanities research. On one hand, Digital Humanities, at least until very recently, appeared preoccupied with transforming the traditions of text-based humanities computing, drawn directly from library collections and scholarly practice. Digital Heritage, on the other hand, has drawn more from theories and practices in digital archaeology and the digital representation of material culture, but has often gained attention for its adoption of cutting-edge visualization and virtual reality technology. While driven by the traditions of custodian institutions such as museums, galleries, libraries, and archives and special collections, Digital Heritage leverages the capabilities of contemporary technologies in visualizing and representing cultural objects beyond text, and occasionally borrows ideas from the entertainment industry.

Digital Heritage might influence Digital Humanities in terms of lessons learnt from visualization, scanning/recording, 3D photorealistic modelling, GPS and mapping technologies, and possibly even instructional design and serious game development. But Digital Heritage could also learn from developments and strengths of Digital Humanities: community-based collaboration of scholars, virtual research environments, critical debates,

university-linked makerspaces, flipped classroom teaching, THATcamps and Digital Humanities Unconferences.

The contemporary landscape, mapping the use of digital resources, methods and tools for scholarly research, extends to most of the disciplines under the scope of the arts and humanities, including those disciplines relying on the fast-advancing capabilities of contemporary digital technology to represent cultural phenomena through increasingly accurate visual reproduction, audio, video and 3D photorealistic modelling. In addition, information and communication technologies are now routinely adopted for the more mundane aspects of research work – from information seeking and searching to note-keeping, bibliographic citation management, organizing personal research resources and, last but not least, preparing scholarly work for publication, by the overwhelming majority of researchers, far outside the core communities of the Digital Humanities and Digital Heritage.

A considerable body of work in the humanities is often differentiated from research in the natural sciences by its interest in the particular: a concrete work or corpus, a historical event or period, a culture, an artefact, or an artist, to name some examples. In this light, humanities research can, in many disciplines, be characterized as often being *idiographic*, aiming to capture an adequate account and provide understanding of a particular phenomenon, rather than *nomothetic*, aiming to produce generally applicable (and replicable) laws, or law-like generalizations (Dallas, 1999). It is also distinctive in the higher degree of subjectivity, and lower degree of repeatability and falsifiability of research findings. A related consideration, crucial to the construction of knowledge in humanities research, concerns the centrality of recorded information, exemplified in its reliance on the construction and study of homogeneous corpora (of texts, archival resources, visual representations, etc.) and a variety of other, often complex and heterogeneous collections of information objects representing the record of human experience and knowledge.

It is therefore no accident that a major application of digital technology in the arts and humanities has been in the construction of scholarly databases and digital collections of humanities resources. As early as the 1990s, the Perseus Digital Library used the early SGML version of the Text Encoding Initiative standard for the structuring and conversion of a canon of ancient Greek texts and their English translations. Together with a broad collection of digitized photographs of Greek art and architecture, architectural plans and drawings, and even animations, this project allowed cross-referencing and analysis of sources for the benefit of research and academic education (Crane, 1998). In contrast to the monolithic research database or digital collection, such as the digital processing of text-based corpora drawn from datasets (for example, the Thesaurus Linguae Graecae, TLG), Perseus prefigured a different approach: the integration between digital information resources, a diversity of analytical and visualization tools, and an active community of researchers sharing knowledge and co-developing

research practices. This integration between a community of researchers, digital tools and organized digital resources underlies the major developments in the last twenty years, leading to the current era which has seen the establishment of a number of successful Research Infrastructures across a variety of disciplines, several of which are described in this volume.

As noted by Erik Champion, '[i]n the case of Digital Humanities, what is missing is the notion of a scholarly eco-system' (Champion, 2014). Like Perseus, contemporary Research Infrastructures have the aspiration of being not merely collections of research resources or tools to conduct research: they are energized by a community of research institutions and individual researchers, and become living environments of evolving, synergistic but also often competing research, education and communication practices. It may be argued, therefore, that an ideal digital Research Infrastructure today should be conceived of primarily as a *scholarly ecosystem*: one that supports ongoing scholarly development and use of research resources, tools and methods, and the outputs they enable, through the application of digital technologies. Viewed as an ecosystem, a digital Research Infrastructure can thus be viewed as consisting of interdependent parts, which make up a whole that should be greater than the sum of its parts. Given the dynamic and evolving nature of research, such a digital research ecosystem should provide for the survival and evolutionary development of 'traditional research' in new and more effective ways, but also enable the conceptualisation of important new research questions and the birth of entirely new forms of research tools, methods and approaches.

As an ecosystem, a digital Research Infrastructure can only be effective if it addresses the abilities and needs – not to mention the lifecycle – of its diverse 'resident species' and the attributes of their environment. To engineer an infrastructure as a sustainable and effective ecosystem calls, therefore, for an understanding of the practices and needs of scholars, archivists, technical specialists as well as other end users of the knowledge production, reproduction and dissemination process. This enquiry goes beyond instrumentality: to take the example of research data creation and capture using digital means, it should not just allow us to know how data capture happens through digitization, but to contribute to a greater and more rigorous critical understanding of the whole process of digital source creation *and critical use* (van Peursen, 2010):

The creation of digital objects – be it images of inscriptions or manuscripts, electronic versions of ancient corpora, or collections of secondary literature – is a crucial part of humanities research. It is more than just preparation for research. This is a fundamental difference between databases as they are used in the humanities and those that are used in the natural sciences. The way in which inscriptions are photographed or in which text corpora are transcribed and encoded, is crucial for the way in which these research objects will be studied in the future.

The creation, curation and use of digital objects in scholarly work hinges on the development and adoption of a wide range of digital methods at the intersection between research in the disciplines and the management of scholarly collections. Such methods span the full lifecycle of scholarly research, from the inception of a research idea to publication and knowledge translation. They include text analysis and mining, image analysis, moving image capture and analysis, and quantitative and qualitative data analysis. The centrality of research methods for scholarly practices is reflected, as early as 2005, in the work of the AHRC ICT Methods Network (<http://methodsnetwork.ac.uk>) on documenting the use of ICT methods in the UK, and the methodological initiative of the *art-and-humanities.net* project, based at King's College, London, to develop and disseminate knowledge on 'computational methods used by artists and humanists'. From 2011 to 2015, the European Science Foundation Network for Digital Methods in the Arts and Humanities (NeDIMAH.eu) expanded this work within the European context (and it was NeDIMAH that funded the 2013 workshop in Copenhagen that was the genesis for this volume). The major output of NeDIMAH was a resource documenting how the digital humanities research lifecycle can be represented as a process, showing dependencies and relationships, and showing how it can, in fact, provide a framework for the creation, enhancement and use of digital cultural heritage.

This need for an explicit model of the research process, capturing the interplay of all the important elements of the scholarly ecosystem is central in the process of defining the scope and affordances of scholarly infrastructures. Inspired by the influential notions of John Unsworth's 'scholarly primitives' (Unsworth, 2000), and Willard McCarty and Harold Short's 'methodological commons' (McCarty, 2003), as well as on emerging work on scholarly information behaviour (Borgman, 2007; Palmer *et al.*, 2009), researchers at the Digital Curation Unit, Athena Research Centre, proposed a Scholarly Activity Research Model, grounded on empirical evidence for researcher practices and needs within DARIAH and EHRI, the European Holocaust Research Infrastructure project (Benardou *et al.*, 2010, 2013). The SRAM model, compliant with the CIDOC CRM ontology of cultural heritage (ISO standard 21127), was intended to support the elicitation of requirements, and the design and development of information repositories and services in digital humanities infrastructures. The confluence between this ontological approach to scholarly activity modelling and NeDIMAH's initiative of NeDIMAH to establish a formal framework for the conceptualization of research methods in the arts and humanities, led to the development of NeMO: the NeDiMAH Methods Ontology (<http://nemo.dcu.gr>).

NeMO was established as an ontology of digital humanities that formally documents the practice of digitally based scholarship as a sociotechnical knowledge activity, explicitly addressing the interplay of conceptual dimensions of agency (actors and goals), process (activities and methods) and resources (information resources, tools, concepts) in the scholarly process:

showing the dependencies of *content*, *tools* and *methods* (Hughes *et al.*, 2016; Pertsas and Constantopoulos, 2016). Researchers at Glasgow University and the Digital Curation Unit, Athena Research Centre in Athens, are currently using NeMO as a conceptual framework to describe the use of digital methods and content for research. NeMO is a tool for semantic linking in an environment of interoperable resources and services for discovering, understanding, selecting, linking and contributing content, tools and methods.

The development of the NeMO ontology incorporated existing research that had attempted to understand digital humanities projects, methods or tools by expressing them through taxonomies (e.g. Borek *et al.*, 2016): analysis of these indicated an ontology, intellectually and technically, was a missing piece of the digital humanities research infrastructure.¹ By providing a formal framework for critique and debate about the contexts and dependencies within the use of digital content for research, it facilitates much needed methodological and epistemological reflexivity within the digitally based humanities, and accommodates within an overarching conceptual framework the workings of digital infrastructures, tools and services in humanities research and digital heritage, and the processes and methods adopted by researchers, stewards and users of cultural heritage information resources.

The intimate interdependence between the affordances of Research Infrastructures and the scholarly methods and practices they enable is confirmed by work in the broader domain of practice studies (Schatzki *et al.*, 2001), and in the more focused area of infrastructure studies (Edwards *et al.*, 2009; Edwards *et al.*, 2007; Jackson, 2007).² In her work on the ‘relational undergirding of epistemic practice’, and the characterization of research as a creative and constructive ‘objectual practice’ relying on evolving sociocultural arrangements around knowledge objects, Karen Knorr-Cetina (2001) has demonstrated how infrastructures are not just the site of routinized enactments of established research protocols and methods, but a site of dynamic reinvention and change for research through the discovery and invention of new approaches to intellectual enquiry – in our terms, evolving ecosystems.

From the perspective of those creating digital archives and resources, this ecological approach to digital Research Infrastructures can form the basis for a theoretical reflection concerning the mode of production of scholarly knowledge in the arts and humanities. Developing maker spaces, drop-in data labs, open-sourced data and online review communities as part of a critical feedback process that informs and helps improve the role and function of Research Infrastructures could be vital components in the development of this scholarly ecosystem. However, there are still too few complete and coherent examples. Too many Research Infrastructures lack clear evidence of impact and engagement by the wider public, too many Research Infrastructures live and die based on short-term funding of technology rather than on meaningful usage, too many research groups are divided by institutional or national political or historical diversions that

prevent them from benefiting from the potential synergy of different backgrounds, interests, experiences, skills and data sets.

The development of digital Research Infrastructures in the last decade was in many respects anticipated by the publication of the Atkins Report on cyberinfrastructure for e-science (Atkins *et al.*, 2003), the ‘cultural commonwealth’ report of the American Council of Learned Societies (ACLS, 2006) and the European Strategy Forum on Research Infrastructures (ESFRI) roadmap (http://ec.europa.eu/research/infrastructures/pdf/esfristrategy_report_and_roadmap.pdf). Benefiting from European Commission funding, such infrastructures in Europe include CLARIN, the European Research Infrastructure for Language Resources and Technology (www.clarin.eu), DARIAH, the Digital Research Infrastructure for the Arts and Humanities (www.dariah.eu), both recommended in the context of the ESFRI roadmap, and also ARIADNE, the Advanced Research Infrastructure for Archaeological Dataset Networking in Europe (www.ariadne-infrastructure.eu). A further number of specialized Research Infrastructures are expected to emerge in the context of new rounds of infrastructural European funding made available in the foreseeable future.

The expectations of digital Research Infrastructures are high, in accordance with the funding they have received. Ideally, such infrastructures should address the complex nature of Digital Humanities data sets, research methods and collaborative work practices, offering humanities scholars new and productive ways to explore old questions and develop new ones, even addressing some of the ‘grand challenges’ in the humanities, linking data and researchers through support for digital research practice. They should also offer more specific opportunities for data-driven and quantitative humanities research. Finally, they must provide a platform to address institutional and social issues, such as strengthening higher education programmes, as well as the recognition of digital research and the implications of this for scholarship and research careers. To meet these expectations, Research Infrastructures may offer a range of complementary opportunities and challenges: researcher input and engagement; preservation and sustainability; the evaluation of digital research and its outputs; communities of practice; cultural and linguistic variety (transnational Research Infrastructures); and education and training.

These considerations on the emergence, traits and requirements of Digital Heritage Research Infrastructures, viewed as living ecosystems, set the stage for this volume. Inspired by a Digital Heritage workshop in Europe (Cultural Heritage, Creative Tools and Archives, Copenhagen, 2013), this collection of chapters is predominantly European-focused and discusses European Research Infrastructures, but the findings may be extrapolated to other countries and regions. The current range of initiatives in much of the digital cultural heritage research presented in this volume points to salient challenges and prospects for further work in shaping the future scholarly ecosystem. They underscore the importance

of ambitious, long-ranging ('blue skies') research on the affordances and specifications of digital infrastructures sustainable in the long term that will anticipate what scholars need in the future, working in collaboration with holding institutions (such as libraries, archives, museums and galleries) as well as the technical disciplines.

Since the late 2000s, European research institutions have benefited from European Union funding to develop transnational Research Infrastructures in different disciplines, the funding intended to increase the development and competitiveness of the European research space. Initial projects funded under a European Commission grant programme have subsequently been encouraged to form a particular form of transnational structure, a European Research Infrastructure Consortium (ERIC), to provide a variety of research services to researchers. As noted by Erik Champion in his chapter in this book, 'the ERIC status is reserved for state-of-the-art Research Infrastructures that will create unique opportunities to carry out advanced research, attract the best researchers from across the world and train highly qualified students and engineers' (Champion, 2014). It is possible to map these requirements to the sources and methods for digitally enabled cultural heritage research: content, tools, methods, technical infrastructures and communities of practice, both researchers and users, as well as collaborative and open publishing and dissemination routes. Underpinning these infrastructures are national and international networks of co-operation, which bear the promise of bringing together institutions and individuals from research in the disciplines, holders of research data and resources, and technology specialists involved in Research Infrastructure design and development. Much of this thinking has informed the development of Research Infrastructures in the sciences, where many sophisticated supporting infrastructures have been developed, benefiting from the relatively stronger funding environment for scientific and technological research. Infrastructure initiatives in the arts and humanities are fewer and funded at a smaller scale, but nonetheless still significant.

While Research Infrastructures in the sciences often take the form of highly specialized physical laboratories and sophisticated experimentation set-ups, the reliance of humanities research on tangible resources that can be made accessible through information technology, as well as the erosion of disciplinary boundaries and the growing importance of public discourse and feedback, privileges a different kind of Research Infrastructure for the arts and humanities, centring on digital services that are built around communities of epistemic practice characterized by shifting research agendas and diverse theoretical and methodological orientations. The challenge is brought in focus by comparing CLARIN, addressing primarily the needs of literary and linguistic computational research, with DARIAH-EU, addressing the far more complex and less focused field of 'the digital arts and humanities' – a vast and moving target. Both infrastructures seek to address complex issues of governance associated with scholarly practice in a digital

age, such as policies associated with data ownership and preservation, ownership and licensing of tools and services, IPR issues. But DARIAH-EU, presented in this volume by Tobias Blanke, Conny Kristel and Laurent Romary in their capacity as its directors, rather than being a centralized infrastructure, acts more as an effective umbrella organization for successful national infrastructure initiatives (like DARIAH-DE in Germany), providing broad support at a highly strategic data management level, as well as the ability to facilitate the sharing of data and tools through partner organizations and affiliated projects. One identifiable result of DARIAH-EU to date has been the initiatives of its Virtual Competence Centre on Research and Education (VCC2) on researching the information practices and digital needs of European humanities researchers, on mapping the landscape of courses and learning resources on Digital Humanities available in Europe, on examining the applicability and preferred characteristics of Virtual Research Environments (VREs) for humanities research, and on mobilizing an active community of interest including researchers from the arts and humanities, as well as information scientists and computer scientists active in the design and development of digital infrastructures.

In Chapter 4, Blanke, Kristel and Romary argue that DARIAH-EU ‘focus[es] on Research Infrastructures rather than (digital) library and archive integration projects such as Europeana, because Research Infrastructures share the ultimate aim to action research. Europeana on the other hand aims to primarily fulfil the needs of a culturally interested public rather than a research community’. Yet, in the work carried out under the auspices of the Europeana Cloud project, described by Benardou and Dunning in their chapter, we find a clear focus on understanding the research needs of users of digital content, and the tools that can support humanities research, that goes beyond serving just the users of cultural heritage content. This exploration of ‘deeper engagement’ with primary sources in digital format and the tools for their analysis is now the focus of the Europeana Research initiative, which draws also on research such as that conducted by Christina Kamposiori, Simon Mahony and Claire Warwick, who, in their chapter, analyse the transformation of scholarly practices in a specific discipline (in this case study, art history) afforded by increased access to digital resources, specifically examining how scholars approach, create and manage information. As the digital resources and related tools and methods for using these resources expand, there is an ongoing need for this development to be informed by the needs of researchers, if the digital turn is truly to effect transformative research in the arts and humanities.

Another benefit of digital Research Infrastructures is that they can become the hub for nurturing an interdisciplinary community of researchers working on focused and discrete research themes or topics. Based on the presentation of one of these initiatives, the European Holocaust Research Infrastructure (EHRI) project, Veerle van der Doelen (this volume) presents an intriguing view of how user requirements may ensure that the data

collected by large infrastructure projects remain appropriate to the needs of its target audience of researchers spanning different disciplines in the humanities and the social sciences, as well as of important communities beyond professional researchers.

Similarly, in their account of the Digital Repository of Ireland's research into tools for Digital Heritage in Ireland, Sharon Webb and Aileen O'Carroll (this volume) reveal that an understanding of the needs of researchers can also be shaped by considerations of what services and resources can be provided at the national level for preserving, curating and sustaining digital cultural heritage. Webb and O'Carroll raise a very pertinent question that underpins so many discussions of sustainability of digital collections and research outputs: 'Why save a million objects if users cannot usefully engage with those objects?' The reliance of the future use of Digital Heritage on concrete measures ensuring its sustainability has been documented by a number of research projects³ and, in this process, a pertinent question emerges: what is the degree to which the developers of Digital Heritage should encourage their reuse for new and unforeseen purposes in order to justify the investment in the creation of resources?

In their chapter, Alexandra Angeletaki and Marcello Carrozzino also address this issue as they explore how libraries can improve the integration of digital technologies with their archive material to promote better engagement with their audiences. This is an important consideration as we move beyond the idea of digitization being driven solely by the prerogative of information access: users increasingly demand enriched access to heritage, and greater engagement with sources, rather than just accessing digital resources as passive consumers of information. Introducing a 3D space for reading and studying in the Norwegian University Library of Trondheim, the authors further demonstrate the importance of a user-centred approach to this kind of innovation.

Wider issues of digital anthropology and ethnography are addressed by Gertraud Koch (Chapter 5, this volume), who looks at one important articulation between Digital Humanities and cultural anthropology through the notion of the 'ethnography of infrastructures'. Koch raises an important question: why has Digital Humanities turned to information technology to solve questions of use, and what might be the use of tools and methods developed over decades of research and practice in cultural anthropology in the field of Digital Humanities?

An ongoing concern in this context remains the need to develop enhanced, open publication models to communicate research in the arts and humanities, and the field of cultural heritage, to the widest possible audience. In the light of the fact that many digital publications do not go beyond replicating the culture of print, Julian Richards's chapter on the challenges and opportunities for a much more enriched understanding of online publishing is especially timely. His insights originate from his experience of publishing *Internet Archaeology*, a pioneering journal bringing

together scholarly articles with interactively accessible data publication. The move towards open access, not just for research outcomes, but also for research data, is now a requirement by many funding agencies, so an exemplar of good practice from archaeology, a discipline that relies on a rich and comprehensive variety of complex digital sources, is particularly valuable. While Richards largely focuses on the challenges associated with developing open access approaches, there are wider issues associated with publishing innovative research online, specifically the ability to integrate interactive and experimental approaches to working with data. There is a great deal of expertise in open and innovative publishing within Digital Humanities, and more creative and sustained knowledge transfer between Digital Humanities and publishing is required. Initiatives like *Internet Archaeology* are excellent exemplars for this debate.

The volume is concluded by Seamus Ross's reflection on the future of digital infrastructures for humanities research and cultural heritage at a time of huge intellectual, technological and sociocultural challenges. Grounded on a historical account of advances and setbacks in the digitization of information resources and scholarly communication, and drawing from insights in the domain of digital preservation and curation, digital humanities scholarship and publishing, Ross advances the view that the future of digital infrastructures for the digital humanities and digital heritage lies in coordinated work on several interconnected areas, including advocacy, understanding of the needs and mobilization of research and cultural heritage communities, and 'intelligence at the level of the digital object'. He recognizes the huge new challenges faced by cultural heritage institutions at a time of increased commodification of cultural information, and increased risks to ensure the integrity and authenticity of cultural objects, and argues for alternative, post-custodial approaches to both preservation and access, possibly leveraging new mechanisms of ensuring a 'web of trust' such as blockchain technology. In his view, collaboration in underlying mechanisms for scholarly resource curation, access and publication are inextricably linked to forging a common vision that unites the fields of humanities research and cultural heritage.

This diverse collection of chapters introduces perspectives on a number of initiatives (many funded by the European Commission) that have developed resources, tools, services and methods for digital research engagement with cultural heritage content. Authors span a diverse community of stakeholders in digital infrastructures in the arts and humanities that ranges from Digital Humanities and digital archaeology scholars to information scientists studying scholarly work, museum studies researchers engaged with questions of learning and engagement based on cultural heritage resources, archivists and data managers tasked with the curation of databases and collections of cultural materials useful for scholarly research, and computer scientists involved in the specification, design and development of digital infrastructures. It represents a snapshot of emerging practice around

sharing and using resources useful for cultural research, manifested within officially sanctioned Research Infrastructures under custodial control, but also ‘in the wild’ by researchers and data curators employing the capabilities of pervasive networked digital technologies (Dallas, 2015, 2016), and exemplifying practices of collaboration and innovation that push the boundaries of what can be achieved in the digital mediation of heritage.

If significant investment in Research Infrastructures is to have value for scholarship, there needs to be a clear role for scholars to contribute to a greater scholarly investigation and critique of the digital content lifecycle, and, more generally, to nurture a deeper theoretical reflection concerning the role of the digital in humanities research. Reviewing elements of a research ecosystem mapped in the chapters presented in this volume is an important opportunity for a praxis-based critical engagement, the key to understanding how digital is actually affecting knowledge production. Lessons drawn from research presented in these chapters will inform the future development of Research Infrastructures with affordances that address more closely the practices and needs of humanities scholars, drawing us into new collaborations, leading us to encounter new methods for engaging with content, and assisting in developing new insights into cultural heritage as a field of intellectual inquiry and social engagement.

Alan Liu (2012) and others have explored Digital Humanities as a vehicle of cultural critique (e.g. Berry, 2012; Gold, 2012; Terras *et al.*, 2013), but this collection of chapters aims also to extend critique to the role and effectiveness of Research Infrastructure *in practice*. By looking at the insights of those who have been involved in actually crafting digital tools and infrastructures, we can see that maker perspectives and theorist perspectives are not incompatible. For it is in the developing and building of digital projects in the humanities that we can conduct cultural and critical analysis more effectively. It is through questioning many of the assumptions on which digital resources are built and communicated that we can develop a better framework for understanding how working with digital content and digital infrastructure transforms our practices of production and consumption of knowledge. By building and using digital collections for research, we can develop a better understanding of their role in the humanities research lifecycle, and start to address questions about how digital content is not just helping us to do research more effectively, but can act as a disruptive, transformative intervention that unsettles epistemic paradigms and allows the emergence of new kinds of intellectual enquiry.

Notes

- 1 This conclusion was reached through an assessment of the complexity of the multidisciplinary landscape of digital research in the humanities, involving a combination of digital content, tools, and methods and research practices from a range of disciplines and traditions: making practice seem fragmented and hard to define. Recent debates about the nature of Digital Humanities exemplify how this

lack of transparency inhibits a shared understanding of digital research methods, their contexts, dependencies and affordances, and prevents effective peer review of digitally enabled research outside one's 'home' discipline. Similarly, the role of cultural heritage organizations and collections can be opaque: by expressing the dependencies within the 'methods/tools/content' triad, NeMo provides a 'layer' that allows arts and humanities researchers to express the work they have done to develop, refine and share digital research.

- 2 As argued by Geoff Bowker in his study of corporate information infrastructures for oil-drilling research at Schlumberger (Bowker, 1994), the institutional arrangements and affordances of an information infrastructure have a huge effect on research practice, in what he calls 'infrastructural inversion' – examining the mundane workings of infrastructure becomes therefore central to understanding practice. Conversely, his study on the development and use of the International Classification of Diseases – a major component in the information infrastructure of medical research – demonstrates how the infrastructure itself is shaped by the contingency of practice and the sociocultural norms and pragmatic implications of medical practice (Bowker, 1998).
- 3 See, for example, Hughes, L. M. (2014) 'Live and Kicking: The Impact and Sustainability of Digital Collections in the Humanities', in Proceedings of the Digital Humanities Congress, 2012, eds Mills, C., Pidd, M. and Ward, E. Special edition of Studies in the Digital Humanities. Sheffield: HRI Online Publications; and Hughes, L.M. (ed.) (2008), The AHRC ICT Methods Network. Office for Humanities Communication, London.

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