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0.2. Mobile Computing in Archaeology: Exploring and Interpreting Current Practices

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MOBILIZING *the* PAST *for a* DIGITAL FUTURE

The Potential of
Digital Archaeology



Edited by
Erin Walcek Averett
Jody Michael Gordon
Derek B. Counts

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FOR A
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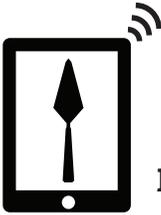
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Preface & Acknowledgments

This volume stems from the workshop, “Mobilizing the Past for a Digital Future: the Future of Digital Archaeology,” funded by a National Endowment for the Humanities Digital Humanities Start-Up grant (#HD-51851-14), which took place 27-28 February 2015 at Wentworth Institute of Technology in Boston (<http://uwm.edu/mobilizing-the-past/>). The workshop, organized by this volume’s editors, was largely spurred by our own attempts with developing a digital archaeological workflow using mobile tablet computers on the Athienou Archaeological Project (<http://aap.toumazou.org>; Gordon *et al.*, Ch. 1.4) and our concern for what the future of a mobile and digital archaeology might be. Our initial experiments were exciting, challenging, and rewarding; yet, we were also frustrated by the lack of intra-disciplinary discourse between projects utilizing digital approaches to facilitate archaeological data recording and processing.

Based on our experiences, we decided to initiate a dialogue that could inform our own work and be of use to other projects struggling with similar challenges. Hence, the “Mobilizing the Past” workshop concept was born and a range of digital archaeologists, working in private and academic settings in both Old World and New World archaeology, were invited to participate. In addition, a livestream of the workshop allowed the active participation on Twitter from over 21 countries, including 31 US states (@MobileArc15, #MobileArc).¹

¹ For commentary produced by the social media followers for this event, see: <https://twitter.com/electricarchaeo/status/571866193667047424>, <http://shawngraham.github.io/exercise/mobilearcday1wordcloud.html>, <https://twitter.com/electricarchaeo/status/571867092091338752>, <http://www.diachronicdesign.com/blog/2015/02/28/15-mobilizing-the-past-for-the-digital-future-conference-day-1-roundup/>.

Although the workshop was initially aimed at processes of archaeological data recording in the field, it soon became clear that these practices were entangled with larger digital archaeological systems and even socio-economic and ethical concerns. Thus, the final workshop's discursive purview expanded beyond the use of mobile devices in the field to embrace a range of issues currently affecting digital archaeology, which we define as the use of computerized, and especially internet-compatible and portable, tools and systems aimed at facilitating the documentation and interpretation of material culture as well as its publication and dissemination. In total, the workshop included 21 presentations organized into five sessions (see program, <http://mobilizingthepast.mukurtu.net/digital-heritage/mobilizing-past-conference-program>), including a keynote lecture by John Wallrodt on the state of the field, "Why paperless?: Digital Technology and Archaeology," and a plenary lecture by Bernard Frischer, "The Ara Pacis and Montecitorio Obelisk of Augustus: A Simpirical Investigation," which explored how digital data can be transformed into virtual archaeological landscapes.

The session themes were specifically devised to explore how archaeological data was digitally collected, processed, and analyzed as it moved from the trench to the lab to the digital repository. The first session, "App/Database Development and Use for Mobile Computing in Archaeology," included papers primarily focused on software for field recording and spatial visualization. The second session, "Mobile Computing in the Field," assembled a range of presenters whose projects had actively utilized mobile computing devices (such as Apple iPads) for archaeological data recording and was concerned with shedding light on their utility within a range of fieldwork situations. The third session, "Systems for Archaeological Data Management," offered presentations on several types of archaeological workflows that marshal born-digital data from the field to publication, including fully bespoke paperless systems, do-it-yourself ("DIY") paperless systems, and hybrid digital-paper systems. The fourth and final session, "Pedagogy, Data Curation, and Reflection," mainly dealt with teaching digital methodologies and the use of digital repositories and linked open data to enhance field research. This session's final paper, William Caraher's "Toward a Slow Archaeology," however, noted digital archaeology's successes in terms of

time and money saved and the collection of more data, but also called for a more measured consideration of the significant changes that these technologies are having on how archaeologists engage with and interpret archaeological materials.

The workshop's overarching goal was to bring together leading practitioners of digital archaeology in order to discuss the use, creation, and implementation of mobile and digital, or so-called "paperless," archaeological data recording systems. Originally, we hoped to come up with a range of best practices for mobile computing in the field – a manual of sorts – that could be used by newer projects interested in experimenting with digital methods, or even by established projects hoping to revise their digital workflows in order to increase their efficiency or, alternatively, reflect on their utility and ethical implications. Yet, what the workshop ultimately proved is that there are many ways to "do" digital archaeology, and that archaeology as a discipline is engaged in a process of discovering what digital archaeology should (and, perhaps, should not) be as we progress towards a future where all archaeologists, whether they like it or not, must engage with what Steven Ellis has called the "digital filter."

So, (un)fortunately, this volume is not a "how-to" manual. In the end, there seems to be no uniform way to "mobilize the past." Instead, this volume reprises the workshop's presentations—now revised and enriched based on the meeting's debates as well as the editorial and peer review processes—in order to provide archaeologists with an extremely rich, diverse, and reflexive overview of the process of defining what digital archaeology is and what it can and should perhaps be. It also provides two erudite response papers that together form a didactic manifesto aimed at outlining a possible future for digital archaeology that is critical, diverse, data-rich, efficient, open, and most importantly, ethical. If this volume, which we offer both expeditiously and freely, helps make this ethos a reality, we foresee a bright future for mobilizing the past.

* * *

No multifaceted academic endeavor like *Mobilizing the Past* can be realized without the support of a range of institutions and individ-

uals who believe in the organizers' plans and goals. Thus, we would like to thank the following institutions and individuals for their logistical, financial, and academic support in making both the workshop and this volume a reality. First and foremost, we extend our gratitude toward The National Endowment for the Humanities (NEH) for providing us with a Digital Humanities Start-Up Grant (#HD-51851-14), and especially to Jennifer Serventi and Perry Collins for their invaluable assistance through the application process and beyond. Without the financial support from this grant the workshop and this publication would not have been possible. We would also like to thank Susan Alcock (Special Counsel for Institutional Outreach and Engagement, University of Michigan) for supporting our grant application and workshop.

The workshop was graciously hosted by Wentworth Institute of Technology (Boston, MA). For help with hosting we would like to thank in particular Zorica Pantić (President), Russell Pinizzotto (Provost), Charlene Roy (Director of Business Services), Patrick Hafford (Dean, College of Arts and Sciences), Ronald Bernier (Chair, Humanities and Social Sciences), Charles Wiseman (Chair, Computer Science and Networking), Tristan Cary (Manager of User Services, Media Services), and Claudio Santiago (Utility Coordinator, Physical Plant).

Invaluable financial and logistical support was also generously provided by the Department of Fine and Performing Arts and Sponsored Programs Administration at Creighton University (Omaha, NE). In particular, we are grateful to Fred Hanna (Chair, Fine and Performing Arts) and J. Buresh (Program Manager, Fine and Performing Arts), and to Beth Herr (Director, Sponsored Programs Administration) and Barbara Bittner (Senior Communications Management, Sponsored Programs Administration) for assistance managing the NEH grant and more. Additional support was provided by The University of Wisconsin-Milwaukee; in particular, David Clark (Associate Dean, College of Letters and Science), and Kate Negri (Academic Department Assistant, Department of Art History). Further support was provided by Davidson College and, most importantly, we express our gratitude to Michael K. Toumazou (Director, Athienou Archaeological Project) for believing in and supporting our

research and for allowing us to integrate mobile devices and digital workflows in the field.

The workshop itself benefitted from the help of Kathryn Grossman (Massachusetts Institute of Technology) and Tate Paulette (Brown University) for on-site registration and much more. Special thanks goes to Daniel Coslett (University of Washington) for graphic design work for both the workshop materials and this volume. We would also like to thank Scott Moore (Indiana University of Pennsylvania) for managing our workshop social media presence and his support throughout this project from workshop to publication.

This publication was a pleasure to edit, thanks in no small part to Bill Caraher (Director and Publisher, The Digital Press at the University of North Dakota), who provided us with an outstanding collaborative publishing experience. We would also like to thank Jennifer Sacher (Managing Editor, INSTAP Academic Press) for her conscientious copyediting and Brandon Olson for his careful reading of the final proofs. Moreover, we sincerely appreciate the efforts of this volume's anonymous reviewers, who provided detailed, thought-provoking, and timely feedback on the papers; their insights greatly improved this publication. We are also grateful to Michael Ashley and his team at the Center for Digital Archaeology for their help setting up the accompanying Mobilizing the Past Mukurtu site and Kristin M. Woodward of the University of Wisconsin-Milwaukee Libraries for assistance with publishing and archiving this project through UWM Digital Commons. In addition, we are grateful to the volume's two respondents, Morag Kersel (DePaul University) and Adam Rabinowitz (University of Texas at Austin), who generated erudite responses to the chapters in the volume. Last but not least, we owe our gratitude to all of the presenters who attended the workshop in Boston, our audience from the Boston area, and our colleagues on Twitter (and most notably, Shawn Graham of Carlton University for his word clouds) who keenly "tuned in" via the workshop's livestream. Finally, we extend our warmest thanks to the contributors of this volume for their excellent and timely chapters. This volume, of course, would not have been possible without such excellent papers.

As this list of collaborators demonstrates, the discipline of archaeology and its digital future remains a vital area of interest for people who value the past's ability to inform the present, and who

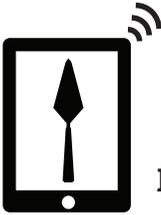
recognize our ethical responsibility to consider technology's role in contemporary society. For our part, we hope that the experiences and issues presented in this volume help to shape new intra-disciplinary and critical ways of mobilizing the past so that human knowledge can continue to develop ethically at the intersection of archaeology and technology.

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Derek B. Counts (Department of Art History, University of Wisconsin-Milwaukee)

October 1, 2016



How To Use This Book

The Digital Press at the University of North Dakota is a collaborative press and *Mobilizing the Past for a Digital Future* is an open, collaborative project. The synergistic nature of this project manifests itself in the two links that appear in a box at the end of every chapter.

The first link directs the reader to a site dedicated to the book, which is powered and hosted by the Center for Digital Archaeology's (CoDA) Mukurtu.net. The Mukurtu application was designed to help indigenous communities share and manage their cultural heritage, but we have adapted it to share the digital heritage produced at the "Mobilizing the Past" workshop and during the course of making this book. Michael Ashley, the Director of Technology at CoDA, participated in the "Mobilizing the Past" workshop and facilitated our collaboration. The Mukurtu.net site (<https://mobilizingthepast.mukurtu.net>) has space dedicated to every chapter that includes a PDF of the chapter, a video of the paper presented at the workshop, and any supplemental material supplied by the authors. The QR code in the box directs readers to the same space and is designed to streamline the digital integration of the paper book.

The second link in the box provides open access to the individual chapter archived within University of Wisconsin-Milwaukee's installation of Digital Commons, where the entire volume can also be downloaded. Kristin M. Woodward (UWM Libraries) facilitated the creation of these pages and ensured that the book and individual chapters included proper metadata.

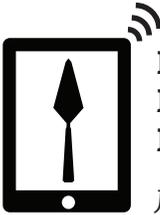
Our hope is that these collaborations, in addition to the open license under which this book is published, expose the book to a wider audience and provide a platform that ensures the continued availability of the digital complements and supplements to the text. Partnerships with CoDA and the University of Wisconsin-Milwaukee reflect the collaborative spirit of The Digital Press, this project, and digital archaeology in general.

Abbreviations

AAI	Alexandria Archive Institute
AAP	Athienou Archaeological Project
ABS	acrylonitrile butadiene styrene (plastic)
ADS	Archaeological Data Service
Alt-Acs	Alternative Academics
API	application programming interface
ARA	archaeological resource assessment
ARC	Australian Research Council
ARIS	adaptive resolution imaging sonar
ASV	autonomous surface vehicle
BLM	Bureau of Land Management
BLOB	Binary Large Object
BOR	Bureau of Reclamation
BYOD	bring your own device
CAD	computer-aided design
CDL	California Digital Library
CHDK	Canon Hack Development Kit
cm	centimeter/s
CMOS	complementary metal-oxide semiconductor
CoDA	Center for Digital Archaeology
COLLADA	COLLABorative Design Activity
CRM	cultural resource management
CSS	Cascading Style Sheet
CSV	comma separated values
DBMS	desktop database management system
DEM	digital elevation model
DINAA	Digital Index of North American Archaeology
DIY	do-it-yourself
DoD	Department of Defense
DVL	doppler velocity log
EAV	entity-attribute-value
EDM	electronic distance measurement
EU	excavation unit/s
FAIMS	Federated Archaeological Information Management System
fMRI	functional magnetic resonance imaging
GIS	geographical information system
GCP	ground control point
GNSS	global navigation satellite system
GPR	ground-penetrating radar

GUI	graphic user interface
ha	hectare/s
hr	hour/s
Hz	Hertz
HDSM	high-density survey and measurement
ICE	Image Composite Editor (Microsoft)
iOS	iPhone operating system
INS	inertial motion sensor
IPinCH	Intellectual Property in Cultural Heritage
IT	information technology
KAP	Kaymakçı Archaeological Project
KARS	Keos Archaeological Regional Survey
km	kilometer/s
LABUST	Laboratory for Underwater Systems and Technologies (University of Zagreb)
LAN	local area network
LIEF	Linkage Infrastructure Equipment and Facilities
LOD	linked open data
LTE	Long-Term Evolution
m	meter/s
masl	meters above sea level
MEMSAP	Malawi Earlier-Middle Stone Age Project
MOA	memoranda of agreement
MOOC	Massive Online Open Course
NGWSP	Navajo-Gallup Water Supply Project
NeCTAR	National eResearch Collaboration Tools and Resources
NEH	National Endowment for the Humanities
NHPA	National Historic Preservation Act
NPS	National Park Service
NRHP	National Register of Historic Places
NSF	National Science Foundation
OCR	optical character reader
OS	operating system
PA	programmatic agreement
PAP	pole aerial photography
PARP:PS	Pompeii Archaeological Research Project: Porta Stabia
PATA	Proyecto Arqueológico Tuti Antiguo
PBMP	Pompeii Bibliography and Mapping Project
PDA	personal digital assistant

PIARA	Proyecto de Investigación Arqueológico Regional Ancash
PKAP	Pyla-Koutsopetra Archaeological Project
Pladypos	PLAtform for DYnamic POSitioning
PLoS	Public Library of Science
PQP	Pompeii Quadriporticus Project
PZAC	Proyecto Arqueológico Zaña Colonial
QA	quality assurance
QC	quality control
QR	quick response
REVEAL	Reconstruction and Exploratory Visualization: Engineering meets ArchaeoLogy
ROS	robot operating system
ROV	remotely operated vehicle
RRN	Reciprocal Research Network
RSS	Rich Site Summary
RTK	real-time kinetic global navigation satellite system
SfM	structure from motion
SHPO	State Historic Preservation Office
SKAP	Say Kah Archaeological Project
SLAM	simultaneous localization and mapping
SMU	square meter unit/s
SU	stratigraphic unit/s
SVP	Sangro Valley Project
TCP	traditional cultural properties
tDAR	the Digital Archaeological Record
UAV	unmanned aerial vehicle
UNASAM	National University of Ancash, Santiago Antúnez de Mayolo
UQ	University of Queensland
USACE	U.S. Army Corp of Engineers
USBL	ultra-short baseline
USFS	U.S. Forest Service
USV	unmanned surface vehicle
UTM	universal transverse mercator
XML	Extensible Markup Language



Mobile Computing in Archaeology: Exploring and Interpreting Current Practices

Jody Michael Gordon, Erin Walcek Averett, and
Derek B. Counts

SO 2024 WON'T BE LIKE "1984": MOBILIZING THE PAST AT A CRITICAL TIME

On January 22, 1984, during the third quarter of Super Bowl XVIII, one of the most famous advertisements in television history was aired: a commercial that heralded the advent of the Apple Macintosh computer (Raw 2009: 21). The advertisement was called "1984," and it was directed by Ridley Scott, who was coming off the success of his human-versus-robot drama, *Bladerunner* (1982). "1984" alluded both to the current year as well as George Orwell's dystopian novel of the same name, *Nineteen Eighty-Four* (1949), which explored the elimination of individual thought and innovation by a totalitarian-inspired government surveillance system known as "Big Brother." The commercial depicts hundreds of vapid human subjects listening to a filmed address focused on a speaker celebrating the triumph of the "unification of thoughts." This terrifying future is disrupted by a free-thinking woman, depicted like an Olympic athlete, who hurls a sledgehammer into the movie screen and destroys the speaker's ideological power. The commercial ends with a voiceover reciting a scrolling black text: "On January 24th, Apple Computer will introduce Macintosh. And you'll see why 1984 won't be like "1984."

The commercial announced Apple's arrival into the PC market that was controlled by IBM, depicted in the ad as "Big Brother." It drew upon dystopian cyber-punk imagery, the counter-cultural bent of the punk rock movement, and the propagandistic conformity of the Cold

War communist world. It also foregrounded a battle of innovation against conformity, and the power of technology to liberate or disrupt the status quo, leading to new ideas, liberalization, and a vision of a future unfettered by traditional, restrictive, and top-down ways of doing things. “1984” was a disruptive commercial designed to challenge the soul-crushing, streamlined, and regimented life of industrial capitalism by insisting that another company offered a liberating alternative: the way to prevent the IBM-dominated dystopia of 1984 was to buy a different, and seemingly more innovative and creative, product. The commercial also caused a generation of computer users to begin thinking about how technology might shape their future.

The commercial aired nationally only once, but it coincided with the increased visibility and popularity of Apple’s Macintosh computer, which would lay the corporate, financial, and technological foundations for the smart phones and tablets that have recently transformed archaeological practice. Indeed, Apple’s interest in archaeological data collection (and archaeologists/academics as consumers) began soon after in 1985, when the famous “While studying prehistoric Greece, Dr. John Cherry discovered the computer” ad was released (Wallrodt 2011). Since then, mobile devices produced by companies using both Apple (e.g., iPad) and Google Android-based (e.g., Samsung Note) platforms have enhanced the mobility, speed, and efficiency of archaeological methods while revolutionizing the way people live their lives more generally.

Despite Apple’s self-fashioned role as liberator in 1984, the company’s success has transformed it into that of its original nemesis, “Big Brother.” This metamorphosis has had implications for current archaeological practice since Apple products have become increasingly ubiquitous on archaeological projects. In addition, Apple is a company that strongly protects its lucrative patents and ideas, and collects more data about its product users (Neal 2013) than any other company besides, perhaps, Google (Rosenfeld 2014). Perhaps ironically, the perceptions surrounding Apple’s new “Big Brother” status have not been lost on Google with its recently released “be together. not the same” Android marketing campaign. In one example, Apple’s single-version IOS universe is mocked as a piano that only plays one note, Middle C (“Monotune”: <https://www.youtube.com/watch?v=xLhJIFC8xkY>). As Rabinowitz (Ch. 5.2: 495) notes: “the paper, writing instruments, cameras and film of the analog era were not as closely coupled as our

digital tools are to the agendas of corporate entities.” Indeed, our mobile devices have become extensions of ourselves; they are so deeply entrenched in our society that it has become easier to be distracted by the devices’ “bells and whistles” and to embrace the moment’s conformity than to engage in productive and reflexive critiques that might prevent 2024 from becoming like “1984.”

This volume explores the changing nature of 21st-century personal computing in archaeology and celebrates its positive influences on methods and practices. However, the book also cautions that we may be entering the “1984” phase of our discipline. We have embraced for our purview a range of innovative digital approaches and techniques that have been recently referred to as “digital or cyber archaeology” (see Levy 2014b). We define “digital archaeology” here as the use of computerized—especially internet connected and portable—tools and systems aimed at facilitating the documentation, interpretation, and publication of material culture. The volume approaches archaeological fieldwork technologies with both a practical and critical eye. Indeed, digital or “paperless” tools, systems, and publishing platforms have been integrated into archaeological projects for several years now with no signs of abating.

Thus, we are at a critical time for digital archaeology as it moves from its initial experiments to more established and widely adopted practices. The time is ripe to reflect. After decades of nearly frenetic technological innovation, it is time to slow down, step back, and think reflexively about how new technologies can alter – or have altered – archaeological practices, interpretation, and ethics. Based on the opinions of our workshop participants and the views of our respondents and reviewers, it seems clear that a deliberate, measured, and critical approach to digital archaeology represents the most effective and responsible way forward.

The idea for the “Mobilizing the Past” workshop was a direct result of our own attempts to integrate new mobile technologies using portable tablet computers on Davidson College’s Athienou Archaeological Project (AAP), which has been excavating in Cyprus since 1990 (Toumazou *et al.* 2011; Toumazou *et al.* 2015). Our excavation is in many ways a typical, medium-sized academic project with a tuition- and grant-based funding scheme that precludes a large and permanent paid staff and dedicated digital technologists. Like many projects, we have relied on the dedication of students and academic

staff to integrate technology into our project workflows. Through AAP's early adoption of relational databases, laptops, and digital photography, as well as more recent born-digital data recording and 3D-modeling techniques, we have stayed on top of technological advances in the discipline (Counts *et al.* 2016; Gordon *et al.*, Ch. 1.4). Yet, we have also been reluctant to adopt technology in an experimental way, preferring instead to integrate with care new technologies that advance our project mission in terms of undergraduate education and archaeological data collection, synthesis, and dissemination.

The AAP experience is consistent with trends in archaeology over the last five years—a time during which archaeological projects have had to contemplate how to integrate emergent digital technologies into their workflows. AAP's experience, then, has not been unique. Currently, several forces seem to be spurring the adoption of digital archaeological techniques in the 21st century. First, there is growing pressure on archaeologists to collect and publish more data, more quickly, and more efficiently. This phenomenon is perhaps created by academic pressure to produce “tech-savvy,” “wow factor,” or “data-driven” results that can attract university and governmental grants, which are now more often oriented toward the STEM disciplines (Science, Technology, Engineering, and Math) rather than fields in the humanities and social sciences. Within the discipline of archaeology itself, these institutional pressures coincide with the growing impact of development, salvage archaeology, permit limitations, and political instability in archaeologically-important regions to address the “need for speed” that many digital devices can provide. Indeed, these pressures along with rapid technological changes have fueled a wave of technological solutionism that views the use of digital tools as offering significant benefits in terms of archaeological data collection, manipulation, and interpretation (for the idea of technological solutionism, see Morozov 2014; Kansa, Ch. 4.2). More immediately, the release of a variety of multitasking and rugged, mobile, and Wi-Fi-equipped tablet computers has spurred the speedy adoption of devices that can manipulate archaeological field data in different, and *sometimes* more effective ways than traditional tools. In short, digital tools offer us new ways of exploring past human action that coincide with changes in contemporary archaeological and academic culture. Yet, the question remains: how will adopting these digital tools and systems change the way we do archaeology both now and in the future? This question lies at the heart of this volume.

WHERE ARE WE NOW: PARADIGM SHIFT OR PROCESS?

Over the last five years an undeniable shift has occurred in archaeological field practice with a movement toward portable, fully digital, data recording systems. This change has brought with it a “new language” with a new technical vocabulary that saturates this volume’s chapters and represents a harbinger of change (Kersel, Ch. 5.1; Rabinowitz, Ch. 5.2). Although the adoption of mobile technology by a range of projects may seem incredibly rapid, digital developments are not exactly new. Archaeology has been digital since the late 19th century, at least in the limited or discrete values sense of exacting recording (Watrall 2011: 171; Caraher, Ch. 4.1). By the 1960s, further digitization occurred when processualist scholars emphasized the rigorous collection of comparative datasets, some of which began to be analyzed on computers (Dibble and McPherron 1988; Wallrodt 2011; Renfrew and Bahn 2012: 33–43). However, with the postprocessualist recognition that limited values objectivism in archaeology is difficult (Hodder 1985: 1–3), some archaeologists have begun to balance the inherent limitations of streamlined computer-generated data with reflexive methodologies that permit the collection of more diverse data types by a wider range of subjective interpretive voices (Daly and Evans 2006: 3–5; Zubrow 2006: 17–18; Morgan and Eve 2012; Caraher 2013; Roosevelt 2015: 325, 329). Indeed, with the creation of a host of robust and powerful mobile devices since 2010, many archaeologists have been forced to reconsider how digital innovations can affect archaeological practices.

Maurizio Forte and Thomas Levy have referred to the recent intensification of digital methods in archaeological research as “cyber archaeology” (Forte 2010, 2015; Levy 2014b), and they divide its practical features into four interrelated components associated with data: acquisition, curation, analysis, and dissemination. More recently, Christopher Roosevelt and his team at the Kaymakçı Archaeological Project (KAP) have suggested that the integration of new digital tools across the spectrum of archaeological work represents “a shift to a digital paradigm” (Roosevelt *et al.* 2015: 339). The KAP team supports this perspective mainly based on their own experience developing an accurate, efficient, and immersive born-digital data recording system that offers a “high-quality recording of an excavator’s interactions” with archaeological materials, even if a “pristine, objective

archaeological record” remains admittedly unattainable (Roosevelt *et al.* 2015: 325). Roosevelt and his colleagues emphasize that the enhanced speed, accuracy, and reproducibility of digital methods (e.g., volumetric 3D trench models) produce more robust, standardized, and multidimensional archaeological data that support more sophisticated and sensitive engagements with the “total archaeological record” (Roosevelt *et al.* 2015: 326, 339). Additionally, they suggest that the skills and reflexivity associated with conventional (e.g., paper- and tape measure-based) recording systems are not lost with digital modes, but are merely “shifted from analog to digital” (Roosevelt *et al.* 2015: 339). From this perspective, digital archaeology does not fundamentally change accepted archaeological practices, such as how to interpret stratigraphy. Instead, it provides an enhanced toolset that permits more rapid, and presumably more accurate and informed, archaeological decision-making, especially at the trowel’s edge. Thus, Roosevelt and colleagues’ thought-provoking article has challenged archaeologists utilizing digital methods to consider which techniques are improving workflows and interpretations and which are not.

Digital recording systems have become progressively entangled with archaeological practice, even though a complete “shift to a digital paradigm” is hard to support. Indeed, scholars have increasingly experimented with digital platforms not only because they might provide more data, but also because they ideally provide different or novel kinds of data (e.g., volumetric measurement or limited value data entry), offer new analytical techniques (e.g., 3D visualizations, GIS modeling, or RTI computational photography), and result in potentially more integrative, democratic, ethical, and pluralistic methodologies (e.g., archaeological methods that enhance cognition, team communication, methodological reflexivity, and data sharing). The KAP team has itself developed an innovative and largely do-it-yourself (DIY) system of paperless workflows that has improved the quality of “recording an excavator’s interactions” with material culture (e.g., making them more mindful of the inherent volumetric nature of archaeological work; Roosevelt *et al.* 2015: 325). According to Roosevelt and colleagues, this enhanced ability to engage with reconstructing the “total archaeological record” has led excavators to “(re) frame excavation strategies” in ways that increase “engagement with the material archaeology at hand” (Roosevelt *et al.* 2015: 326, 340).

For KAP, the end goal of adopting such digital strategies seems to be the achievement of “meaningful analysis across contexts, excavation areas, and even sites and regions” (Roosevelt *et al.* 2015: 342). In short, these digital methods provide better archaeological interpretations of past human actions.

Several chapters in this volume likewise claim that digital archaeological methods are beginning to provide novel datasets that potentially offer more exacting archaeological interpretations than those collected through conventional paper-based methods. Yet, at the same time, there remains room for debate about the paradigm-shattering nature of digital archaeology’s enhanced explanatory power. A key critique that can be made of KAP’s article is that, despite their claims to the contrary, the authors do not convincingly illustrate how digital archaeology’s current epistemic development fully equates with Thomas Kuhn’s standard of a paradigm shift, which encompasses a fundamental change in a discipline’s key explanatory concepts and analytical methods to the point that previous methods and concepts are no longer considered valid (Kuhn 1996: 66–76; see also Richter *et al.* 2013; Perry 2015). For example, although paper-based data recording may be in decline among archaeological projects, it has not been completely abandoned by those practitioners who feel that it provides interpretive results that remain different and equally valid (or even complementary) to those produced by digital methods. As a result, such overwrought claims about digital archaeology’s superiority and the current shift to a digital paradigm as a *fait accompli* have led Sarah Perry (2015) to note how within digital archaeological discourse “the language used is obfuscating—deploying the wow-factor to draw people into what I would argue is an unproductive, and in many cases fallacious, conversation about the revolutionary nature of the methodologies.” As Perry points out, there is a tension between the perceived potential of digital archaeology and the language and definitions used to describe what it actually does. The result of this tension is that incremental processes of change are often equated with paradigm shifts and revolutions in disciplinary thought. Based on such observations, it seems hard to argue for a full paradigm shift to digital archaeology at present because the types of data collected are largely the same as those traditionally collected, and because the explanatory theories that govern their interpretation remain largely

unchanged (see also Rabinowitz, Ch. 5.2; cf. the potential of virtual reality archaeology in Castro López *et al.*, Ch. 3.1).

For the KAP project, the insertion of the “digital filter” at the trowel’s edge through 3D photogrammetry and rapid access to a suite of digital files permitted the excavators to think volumetrically about stratigraphic relationships. In this scenario, stratigraphic levels are transformed from the uniform boxes in a Harris Matrix to shapes that reflect context formation processes as well as chronological, spatial, and by extension, ancient social, relationships. These 3D objects reflect wholly new ways of presenting the artifacts of excavation, as well as traditional archaeological practices and knowledge; yet many projects that have used these techniques have stopped short at explaining *how* these new types of data have impacted short term archaeological analyses and our understanding of the ancient past. A case in point might be KAP’s detailed description of how they used photogrammetry to document an ancient granary. Did their new digital excavation strategies and volumetric thinking result in new ways of understanding granary construction and social function in the Bronze Age (Roosevelt *et al.* 2015: 337-339)? If so, this information is only hinted at within their article; although the digital results’ enhanced explanatory power will perhaps emerge within the final publication. Indeed, many of the advantages accrued from their digital system are discussed in terms of “long-term” benefits (Roosevelt *et al.* 2015: 339; see also Nakassis 2015). Thus, the use of innovative digital techniques can sometimes overstate the explanatory power of digital data. Digital systems tend to thrive at the intersection of new techniques and traditional practices and epistemologies. As a result, it is often difficult to establish whether novel methods of collecting data, improving organization, curation, and publication have actually changed the fundamental character of archaeological knowledge production.

From our perspective, archaeology has yet to undergo a complete Kuhnian paradigm shift to a new digital era. In fact, it remains possible to practice archaeology using pre-digital tools (e.g., paper notebooks and trench drawings) or hybrid practices (i.e., adopting some digital technology alongside traditional practices) while still contributing to how we understand the past. Although the ability of digital tools to produce more robust datasets certainly strengthens archaeologists’ capacity to measure changes in material culture, current digital field practices are more symptomatic of a continuous process of adapting

new tools and practices to centuries-old fieldwork techniques than to changing—fundamentally—the ways that archaeologists explain past human actions. As a result, it is perhaps less useful to talk about paradigm shifts and revolutions and more constructive to discuss what is occurring in archaeology today as part of a wider *process* of academic and social change that is manifested through the integration of digital technologies into archaeological workflows. Indeed, if we want to explore and critique the current nature of digital archaeology, it seems best to view it as a mode of archaeological practice that is still engaged in a process of development, but that has the potential to produce different datasets that may one day engender wholly innovative views on the past than those provided by paper-based methods.

One of the reasons that digital tools and methods have not yet realized their full potential in terms of contributing to new ways of understanding the past could be because they have been “black boxed.” Mary Leighton (2015: 68) drew upon Bruno Latour’s concept of black boxing to look at the diversity of field practices understood as too basic to discuss in archaeological publication. According to Latour (Latour and Woolgar 1979: 51; see also Caraher, Ch. 4.1), black boxing is a social process referring to the way in which the details of scientific and technical work, once successful and common, become obfuscated. Leighton’s study revealed that the details of archaeological work, despite being treated as “common sense,” were in fact directly linked to the production and nature of archaeological knowledge. In short, the archaeological interpretations that publications provided were the direct result of commonplace field methods that were practiced in uncritical and unreflexive ways—an issue that may have potentially hindered their explanatory power. We argue that archaeological methods employing digital tools should be critiqued in the same vein, both in a practical sense, as well as in terms of their influence on how we produce data and understand the past. Thus, this volume is a call for more discussion, debate, and critique aimed at not only looking at digital archaeology as a process, but also as a mode of knowledge creation whose black-boxed practices may require some “opening up.”

This volume underscores the need for a more reflexive analysis of what digital archaeology does and how its tools, systems, and practices are shaping the discipline (Huggett 2004, 2015a and b; Berggren *et al.* 2015; see also Caraher, Ch. 4.1; Kansa, Ch. 4.2; Kersel, Ch. 5.1; Rabinowitz, Ch. 5.2). We must move beyond viewing digital technologies

as merely tools in the hands of technicians and consider how they can inform new approaches to archaeology and aid in the production of new archaeological knowledge and interpretation (as observed by Schollar 1999; Llobera 2011). Making explicit how new digital tools produce new forms of knowledge might also mitigate the dubious “wow factor” impression that digital archaeology creates when the digital supersedes the archaeological. As Jeremy Huggett (2015a: 80) notes, “archaeological computing has been a follower rather than an innovator,” and most computer-based tools used by archaeologists are borrowed from other sectors. However, some papers in this volume indicate that this trend may be changing with several projects developing bespoke digital systems that could have broader applications (e.g., Dufton, Ch. 3.3; Fee, Ch. 2.1; Sobotkova *et al.*, Ch. 3.2). Huggett (2015a: 83–84) has issued a “grand challenge” for digital archaeology to become more ambitious and innovative in ways that will transform not only our own discipline, but extend across other academic fields. We hope that this volume responds, at least partially, to Huggett’s call and that it can contribute to wider debates concerning the influence of technology on a range of Digital Humanities disciplines (Allington *et al.* 2016).

Whether one believes in digital archaeology’s promise or not, most scholars recognize that in the Information Age we are all digital archaeologists—at least to some extent (Morgan and Eve 2012: 523). Ellis (Ch. 1.2), for example, argues that all projects are digital, and today it is only a question of when, where, and how a project applies its “digital filter” that determines whether the filter’s application enhances archaeological interpretations or simply replicates paper-based data in digital form in order to produce novel or compelling results. Although some replicable practices in digital archaeology are emerging that save time and money and produce higher quantities and more detailed and consistent data, there still does not seem to be a single system that fits the goals and logistical challenges of every project (Caraher 2014; see also the various chapters in Levy 2014a).

Instead, digital archaeology’s utility might stem from its new approach to both data collection and dissemination grounded in a range of project-specific approaches. Thus, as with pre-digital recording methods (despite calls for their standardization, see Pavel 2010), digital archaeologies seem to offer a range of innovative and creative approaches to data recording. For example, some approaches seem

capable of focusing on both specific projects' goals and recording data in formats that can be widely shared (e.g., via online repositories or open linked data systems) and that may even offer a degree of objectivity. Digital archaeology's innovative and experimental DIY spirit supports scholars' efforts to grapple with the inescapable digital filter found in 21st-century archaeology. These efforts are enhanced by the continued reflexive and pluralistic analysis of how scholars are attempting to solve archaeological questions with digital means. By examining a range of digital archaeologies (such as those presented in this volume), scholars can begin to discern which practical methodological advancements are producing valuable new ways of interpreting the past and which have been less successful. In some ways, digital archaeology shares its ethos with what Caraher (2014) calls "punk archaeology." For Caraher, a punk archaeology is one that embraces the punk notions of performance, an openness to challenging long-held ideas, and spontaneity in an effort to forge new solutions to old practical and interpretive problems. It is these types of experiments and attitudes that mark the *process* of creating a critical digital archaeology informed by comparative exempla that reveal what is working and what is not. Indeed, such an endeavor is part of this volume's wider mission (see Rabinowitz, Ch. 5.2).

It is vital, of course, that digital archaeology embraces continuous experimentation, as well as a more mature critique. Thus, after the first initial and enthusiastic years of experimentation and adoption of mobile computing devices in the field, we have entered a reflexive phase based on these early trials. The papers collected here include calls for critical, thoughtful, and ethical uses of digital technologies as well as best practices. The "digital filter" is likely here to stay, or, as Morgan and Eve state: "We are all digital archaeologists" (Morgan and Eve 2012: 523; see also Roosevelt *et al.* 2015: 325). These sophisticated and nuanced discussions of the broader impact of digital technologies in our discipline represent an important part of the critical process of engaging with digital tools and methods in order to achieve more efficient, insightful, and data-rich archaeological interpretations.

CURRENT TRENDS IN MOBILE DIGITAL ARCHAEOLOGY

Mobile digital practices cut across a number of vital domains in archaeology. Because archaeological fieldwork and analysis tends to marshal tools, systems, practices, and publication methods into a disciplinary whole, many of the papers in this volume consider several of these key workflow elements.

Tools

At a basic, granular, and practical level, most of the papers in this volume emphasize digital tools. The emergence of robust and portable devices with significant computing power and internet connectivity has marked a divide between pre-tablet digital archaeology and the mobile-based systems that characterize many of today's archaeological processes. From apps and programs (e.g., tablet-based databases, see Ellis, Ch. 1.2, Motz, Ch. 1.3, Wallrodt, Ch. 1.1, and others) to 3D-modeling software (see Olson, Ch. 2.2) to new hardware (e.g., iPads, see Gordon *et al.*, Ch. 1.4) to drones (see Wernke *et al.*, Ch. 2.3), most of the adoption of new technologies stems from the need to solve practical problems in archaeological field recording that pertain to efficiency, accuracy, scale, and scope.

The success of these technologies is typically measured against practical needs relating to whether the digital methods improved data collection accuracy, speed, or quantity; saved money; led to quicker and wider publication; or other common archaeological goals. It often remains difficult, however, to evaluate whether projects were successful at harnessing these presumed benefits partly because archaeologists have not developed or considered methods for measuring such improvements (cf. Berggren *et al.* 2015; Gordon *et al.*, Ch. 1.4). This issue has led some scholars to question the benefits of many of these tools to archaeological practice and interpretation. For example, Kersel (Ch. 5.1) questions whether the famous Tel Dan inscription would have ever been found without the "hands-on" tactile and human intervention of the "paper-based" architect Gila Cook.

Nevertheless, most authors aver that their experiments with new digital tools were beneficial at least when compared to their previous use of non-digital tools. Such benefits can be as simple as the time saved in recopying paper-based field notes by utilizing tablet computers to

record excavators' insights in a born-digital, and hence searchable and reproducible, format. Yet, the benefits of digital tools seem even more convincing in chapters like that of Wernke and colleagues (Ch. 2.3) where drone-based technologies have, for the first time, revealed entire archaeological landscapes, such as the Inkan imperial road system. Mapping such monuments using conventional, paper-based methods have been previously prohibitive given the temporal and financial restrictions placed on most academic archaeological projects, and so the use of such digital tools is truly a game changer.

For many, digital devices provide more efficient, and sometimes more data-rich, ways to do old, often paper-based, things. Simply put, these technologies save time. This "saved" time can be put toward increased analysis (Poehler, Ch. 1.7) and field school student education (Bria and DeTore, Ch. 1.5; Gordon *et al.*, Ch. 1.4). Technologies, however, can also go beyond basic archaeological efficiency and allow for archaeological work that scale or environments would render impossible using traditional methods. Again, Wernke and colleagues' mapping of extensive road networks (Ch. 2.3) or Buxton and associates' use of digital tools to streamline underwater survey (Ch. 2.4) are cases in point. Yet, scholars have also questioned whether efficiency "for the sake of efficiency" is reason enough to adopt a new tool (Nakassis 2015; see also Caraher, Ch. 4.1; Kersel, Ch. 5.1). For example, Caraher (Ch. 4.1) suggests that in industrial practice, Taylorist approaches to managing workflows (i.e., workflows developed specifically with an eye toward efficiency and productivity) have led to a "de-skilling," or the loss of skills related to traditional, haptic, work practices (e.g., in archaeology, the move from paper-based illustration to 3D modeling). However, virtually every attempt to economize process—digital or not—presents certain challenges to interpretation and knowledge production, and thus all attempts should be analyzed critically in terms of their methodological or interpretive efficacy. Digital archaeological techniques, then, like all archaeological methods, must be carefully considered before implementation to determine how they might impede or improve data collection and interpretation.

Rabinowitz (Ch. 5.2) further asserts that digital archaeology's reconfiguration of time in relation to the logistical and procedural elements of practice has a pivotal influence on how and why we mobilize the past. Moreover, he suggests that time's intersection with cost has emerged as another key consideration in the adoption of digital

tools. The purchase of technology is often the main expense incurred in digital archaeology, even though relatively large-scale government and university grants can offset such costs (see Castro López *et al.*, Ch. 3.1; Ellis, Ch. 1.2; Gordon *et al.*, Ch. 1.4; Sobotkova *et al.*, Ch. 3.2). In the private sector, the cost of adopting digital technology is especially important (Spigelman *et al.*, Ch. 3.4) because the decision about how to go digital or whether to do it at all is often dependent on the company's bottom-line financial and operational logistics, as well as on the desires of clients to whom such costs are often passed along. On the other hand, the relatively low cost of some devices (such as mobile tablets, smart phones, or similar products) and software programs (many, such as Agisoft Photoscan, provide educational discounts or free trial versions) have encouraged experimentation and the widespread adoption of these tools. Some projects even adopt a BYOD (bring-your-own-device) policy (Wallrodt, Ch. 1.1), which, although useful, can complicate recording methods through the introduction of multiple devices and platforms and can feed the perception that archaeology is reserved for those who can afford it (Opitz 2015; Kersel, Ch. 5.1). As Sayre has illustrated (Ch. 1.6), a project's engagements with technology can be interpreted as a display of privilege.

At the same time, however, digital tools and born-digital archaeological data also have the potential to expand the impact of archaeological projects into local communities (Kersel, Ch. 5.1). For example, the Proyecto Qhapaq Ñan's (Wernke *et al.*, Ch. 2.3) mapping of endangered Peruvian sites and the public outreach initiatives of the Forum MMX Project in Spain (Castro López *et al.*, Ch. 3.1) focused on virtual reality reconstructions are both designed to engage local communities through digital methods. Sayre's chapter on digital archaeology in Peru (Ch. 1.6) further describes how digital tools have allowed archaeological projects to collaborate in new ways, particularly with the indigenous communities whose past they interpret, while also acknowledging that digital tools can serve to exacerbate the privilege that foreign archaeological projects often hold over host communities. Such studies illustrate that a self-aware digital archaeology can present opportunities for both outreach and critical views of the growing impact of technology on contemporary culture.

Despite digital archaeology's potential to make research processes more participatory, many digital tools remain expensive and only accessible to projects with large budgets and technology specialists (see Buxton *et al.*, Ch. 2.4; Castro López *et al.*, Ch. 3.1; Ellis, Ch. 1.2; Sobotkova

et al., Ch. 3.2; Wernke *et al.*, Ch. 2.3). A long-term issue is that with more software moving to subscription-based fees, the need to migrate data to updated media and the newest versions of software and hardware, and the persistent costs of long-term digital storage schemes, projects not only need start-up grants for the purchase of technology, but they also require funding for the continuous support of existing digital infrastructure. Thus, projects are increasingly required to plan for long-term finances to keep up with technological change. Moreover, for those projects seeking funding from institutional agencies, there continues to be some danger of privileging technical innovation over archaeological research questions. For example, the use of digital tools to produce “wow factor” or “tech-savvy” academic products (e.g., 3D-printed artifacts or the construction of virtual environments) might seem impressive to institutional funders, but their use may not actually succeed in answering pressing archaeological questions (Allington *et al.* 2016; Kansa, Ch. 4.2).

Systems

The next domain to consider is that of the integrated project workflow systems within which digital tools are manipulated. At this level, archaeologists’ concerns are related to the ways in which tools function within technological and human ecosystems and how people, machines, and data input, sharing, and output interact to produce meaningful results. For example, how does one integrate 3D structure-from-motion (SfM) imagery into traditional recording and publication practices? How does one manage the flow of wireless data between an archaeological site and a lab-based server? Or, how do various personnel (e.g., producer/consumer; teacher/student; director/digger; data collector/computer specialist) work together to marshal, manipulate, and interpret data in effective ways? In order to elucidate such questions, several chapters in this volume deal with the technical structure of digital systems including issues of data management, the movement of data between connected devices, the convergence of digital technologies and functions, and the social organization of digital practices (Castro López *et al.*, Ch. 3.1; Dufton, Ch. 3.3; Fee, Ch. 2.1; Motz, Ch. 1.3; Sobotkova *et al.*, Ch. 3.2; Wallrodt, Ch. 1.1). While the main thrust of this scholarship is practical, several chapters also reflect on the disciplinary impact of such approaches. Overall, we must view digital archaeologies not as a congeries of tools,

but rather as functional systems so that we can better understand how these methods affect our recording and interpretation of archaeological data.

One of the primary issues currently associated with digital systems in archaeology concerns the relationship between collecting, interpreting, disseminating, and preserving accurate data. At trench-side, excavators using digital tools now collect a much wider range of data types than ever before (e.g., photogrammetry or video files in addition to traditional data types such as context forms or diary entries). The results can lead to “data deluge” (Bevan 2015) or “avalanche” (Levy 2014b), that is, the production of a massive and unwieldy dataset that is too large to analyze, interpret, and publish effectively and expeditiously. In fact, these archaeological data floods are often collected in highly fragmented ways that require significant post-processing to reassemble the parts into an integrated, holistic, and ultimately manageable and interpretable representation of material and space (Caraher 2015; cf. Wallrodt, Ch. 1.1). As a result, archaeological systems designers and managers now need to pay close attention to how the data being collected relates to research goals, how it can be organized and integrated coherently, and how it can be published and curated properly. Access and management of data, thus, continues to be a topic of concern as does sustainability, archiving, curation, and publication standards (Elliot *et al.* 2012). Yet, when digital systems are thoughtfully and critically managed, they can often provide quicker and more effective ways to collect, preserve, and disseminate data and, in doing so, offer new ways to facilitate archaeological interpretations.

Many papers highlight a tension between custom-designed, integrated systems and those created from off-the-shelf apps. Developers have crafted integrated digital systems such as the Federated Acquired Information Management System (FAIMS; see Sobotkova *et al.*, Ch. 3.2), the Archaeological Recording Kit (ARK; see Dufton, Ch. 3.3), and TooWaste (Serrano Araque and Martínez Carillo 2014; and others, e.g., Codifi Pro, not discussed in this volume) to fit a specific project’s in-field logistics, workflow goals, and even publication and preservation aims. FAIMS, for example, offers the complete package from the trench to the final phase of publication and archiving. In addition, some of the programs, most notably FAIMS and ARK, have adopted open-source standards so that they can be modified to suit a project’s particular needs. Another, perhaps equally common, approach to the

development of digital systems, is the DIY model. These are systems that utilize off-the-shelf apps and devices according to a range of configurations and protocols in order to improve project workflows in terms of time, money, and, ideally, archaeological interpretation. Even off-the-shelf, proprietary apps like FileMaker Go offer a degree of customizability in terms of color schemes and scripts that can effectively facilitate and streamline the recording process (Motz, Ch. 1.3). Furthermore, sometimes a single bespoke app, such as Fee's PKapp (Ch. 2.1), can be combined with other off-the-shelf apps to create an integrated DIY system. Overall, the chapters by Wallrodt (Ch. 1.1), Ellis (Ch. 1.2), Motz (Ch. 1.3), Gordon *et al.* (Ch. 1.4), Bria and DeTore (Ch. 1.5), Sayre (Ch. 1.6), and Fee (Ch. 2.1) illustrate the wide variety of ways that archaeological projects work to shepherd information from the trench to the lab and to publication.

The development of a coherent system is more than just a technical concern; indeed, the issues of who controls digital recording systems and how the disparate voices within the archaeological process are integrated should also be discussed. Projects are composed of a range of individuals (including directors, excavators, artifact specialists, architects, illustrators, registrars, conservators, and online archivists or publishers), who collaborate to produce archaeological knowledge. Many digital systems allow each project member to participate explicitly in the archaeological process (Berggren 2015; see also Ellis, Ch. 1.2; Wallrodt, Ch. 1.1). In many ways, this collaborative knowledge building makes visible a plurality of voices, beyond the names that grace the covers of final publications. Digital archaeology, when practiced in this way, can thus have a positive, pluralistic, and democratic influence on how archaeological knowledge is formed and disseminated.

When uncritically adopted, however, digital systems can also put limits on the democratic nature of archaeological practice. For example, some mobile databases record all users' file changes and limit the values that can be entered in the name of data clarity and efficiency. This "Big Brother" monitoring of user actions and the delimiting of a user's interpretive and expressive vocabulary can thus be undemocratic if these functions are deployed in an uncritical and top-down fashion. Nevertheless, if they are critically deployed, they can also make visible who is involved in knowledge production and who controls and limits the process (Caraher, Ch. 4.1; Rabinowitz, Ch. 5.2); they can also help to safeguard more participatory and open forms of

archaeology. In sum, understanding the impact of these practices is vital for the future of digital archaeology since it can help to define which emergent practices will be more democratic, participatory, and bottom-up and which will be simply more streamlined, narrow, and top-down. As they have done in traditional archaeological settings, power relations continue to play a role in how digital archaeologies are created and practiced.

Interpretation

Despite the increased prevalence of digital tools and integrated systems, it is also becoming clear that there are a variety of ways that digital technologies impact archaeological practices. For example, technological changes in recent years seem to most often occur on projects that are well funded because they can afford to hire the requisite technological personnel. On the other hand, the decreasing costs of mobile devices and the emergence of open-access sharing of protocols has allowed smaller, less well-heeled projects to integrate DIY digital workflows (for DIY archaeology more generally, see Morgan and Eve 2012; Caraher 2014; Morgan 2015).

Caraher (2015; Ch. 4.1) has issued a clarion call for a more reflexive set of digital practices, especially in the field, through his espousal of what he has coined “slow archaeology.” This concept arose from his recognition that there was a growing celebratory (and often self-congratulatory) chorus of archaeologists who touted the improvements brought by digital tools, without adequately assessing how such tools impact archaeological practice. Thus, drawing on the popular slow food movement and more sophisticated philosophical critiques of speed, Caraher views this development as a problem that stems from the uncritical adoption of various digital tools and methods. In short, he states (Caraher, Ch. 4.1: 437): “[s]low archaeology challenges any claim that gains in efficiency through the use of digital tools is sufficient reason alone to incorporate them into the archaeological workflow.”

Caraher scaffolds his critique of digital practices by illustrating that archaeology as a modern discipline has always faced tensions related to data fragmentation and uncontextualized analysis. He suggests that these issues have stemmed from the need to process material culture remains in an efficient manner that has often embraced

Taylorist principles and eschewed more descriptive techniques. Such trends have tended to separate “data collection” from archaeological interpretation. New Archaeology reinforced such systematic practices to the extent that certain activities, such as the creation of Harris matrices, systematized the divergent practices and ambiguities that actually occur in field archaeology (see also Pavel 2010: 145). The result of these divides and the matter-of-fact acceptance (or black boxing) of certain archaeological practices is that archaeologists often accelerate crucial steps in the interpretative process that previously provided a deep familiarity with material, practices, and embodied processes. In particular, Caraher has cautioned that the uncritical use of technology can potentially privilege processes and uniform types of data collection, which can fragment and narrow archaeologists’ perspectives (cf. Wallrodt, Ch. 1.1, on the fragmentation of data). Digital archaeological methods can allow *more* data to be collected faster, but the results do not necessarily yield *better* data that promote more insightful interpretations.

Rabinowitz (Ch. 5.2: 503) also critiques digital archaeology’s ability to aid in the interpretation of the past by stating, “[m]achines can collect data and they can begin to integrate them into the contextual systems that we think of as information, but they cannot perform the leap of informed imagination.” Similarly, Caraher advocates for a slow archaeology that thoughtfully considers *why* digital tools are integrated into workflows and *how* they might affect archaeologists’ “informed imaginations.” Such an informed archaeology does not require the abandonment of digital tools and methods, but rather it emphasizes that one should take the time to engage critically with the potential risks of black boxing and not simply adopt methods for the sake of efficiency alone. Instead, archaeologists should carefully consider which digital tools might best be employed without denigrating (or eroding) human practitioners’ interpretive powers and skills.

Publication

From the outset, the goal of this volume was to focus on how mobile computing technologies, such as tablets, smart phones, and the on-site systems that support them, have changed the way we are practicing archaeology and interpreting the past through material remains. For the “Mobilizing the Past” workshop, however, we also included voices

concerned with what happens to the archaeological data once they leave the lab. Kersel (Ch. 5.1) laments the lack of space many chapters devote to how and when they intend to publish the results of their digital projects. This lack of focus on publication and its attendant issues of long-term data accessibility and preservation, which has been a central concern of the discipline since its inception, is indeed a notable omission in the digital archaeological process at present.

Eric Kansa's Open Context (<http://opencontext.org>) is one of several online data-publishing platforms that have emerged in recent years along with the Digital Archaeological Record (tDAR), the Digital Index of North American Archaeology (DINAA), the Online Cultural and Historical Research Environment (OCHRE), Heurist, and Mukurtu. Each platform has grappled with issues related to the publication and preservation of the digital archive; Kansa has written extensively about the possibilities for an open and accessible digital space(s) for archaeological data (see <http://opencontext.org/about/bibliography>). He has also raised ethical concerns about the creation and preservation of such places in the face of a range of pressures stemming from the socio-economic conditions affecting the so-called alt-ac (alternative-academic) liminal academic spaces where digital data repository projects currently reside. Kansa's contribution to this volume foregrounds several important issues about where the archaeological data are going, how they are curated, and who will have access to them.

Kansa offers a new approach to these issues in his concept of "slow data," a concept modeled on Caraher's slow archaeology. He calls for a critical approach to access that considers the need to protect provisional and sometimes sensitive data while also offering a framework for linked and machine readable data sets. For Kansa, a slow data approach to digital archaeology should involve a thoughtful process of data management and dissemination that strives for excellence in data quality and takes the time to consider the communities that should have access to the data and for what reason from the perspective of professional anthropological ethics. Perhaps Caraher (Ch. 4.1) has phrased this best as a process of imbuing archaeological datasets with a "human character." By mitigating the "publish or perish" academic reward system with a new "slow" model, the commercialization of alt-ac digital tool development and the monopolistic practices that attend this process can be avoided to allow for new, more critical, open and ethical ways of publishing, disseminating, and preserving the increasingly large datasets created by digital archaeologists.

AN ETHICAL DIGITAL ARCHAEOLOGY

Current trends in digital archaeology have demonstrated that practitioners are doing more than simply adopting tools, systems, and practices best suited for streamlining collection, interpretation, and publication of archaeological knowledge. Archaeologists are now actively debating the ethical and methodological character of technological change in the discipline. The final four papers in this volume—by Caraher, Kansa, Kersel, and Rabinowitz—bring together a cross-section of ethical and methodological critiques of digital practices in archaeology. These papers, as well as the general spirit of critique throughout, make clear that the tools and techniques we use shape the kind of knowledge we produce.

Kersel's response, "Living a Semi-digital Kinda Life," draws upon on her wide-ranging experience as a field archaeologist and cultural heritage expert and focuses on the ethical implications of archaeologists' "semi-digital" lives (Ch. 5.1). Like Caraher and Kansa, she questions the "need for speed" in archaeology and its results. Kersel (Ch. 5.1: 478) cuts to the heart of any arguments for efficiency when she asks, "are we publishing more? . . . Are we thinking more?" Archaeologists have always considered how they are going to publish the massive amounts of data they gather; yet, data collection in a born-digital age has perhaps compounded such concerns. Kersel (Ch. 5.1: 481) argues that academic digital archaeology must consider the publication of results as one of the discipline's key ethical responsibilities: "whether we are 'born-digital,' semi-digital, or paper-based, our ethical obligations to the people, places, and objects with which we work remain the same." The first obligation she highlights is that digital archaeologies need to be inclusive in terms of who can use them and who can participate in shaping local pasts. She pointedly notes that digital technologies have great potential to increase efficiency, accuracy, and data collection; yet, if they are uncritically implemented, they also have a more disturbing power to accentuate disciplinary problems already present in our field, such as gender imbalances, socio-economic inequality, the use of the past for political gain, and divides between practice and theory.

Time for a Manifesto

Rabinowitz's response, "Mobilizing (Ourselves) for a Critical Digital Archaeology," recognizes the importance of time's intersection with money within the context of capitalism (Ch. 5.2). In recent years, neoliberal philosophies focused on speed and efficiency have caused practitioners to redesign archaeological systems in ways that leverage digital tools to achieve enhanced data collection, accuracy, and quantity. Rabinowitz advocates for the creation of a manifesto for a "Critical Digital Archaeology," which he outlines via three intersecting mini-manifestos, each of which is flavored with a different attitude: celebratory, reflexive, and cautionary. It is easy enough to celebrate the potential of our ever-expanding digital tool kit, but for Rabinowitz, a digital archaeology must be both critical and cautionary in its ethos. Following Huggett's (2015b) "introspective and open" manifesto, Rabinowitz calls for a more reflexive digital archaeology among practitioners. In particular, he suggests that archaeologists need to be aware of how digital tools can distance users from their objects of inquiry and how their interactions with different types of tools (e.g., pen and paper versus a digital tablet) can lead to different haptic experiences and, consequently, different effects on people's cognitive processes of understanding and re-imagining the past. Rabinowitz's most significant critique, however, takes aim at the current economic model that sustains many digital projects. Money (along with time), as it is procured and used within the context of current socio-economic structures, in many ways dictates how digital archaeology is practiced, what it produces, and how such "deliverables" are disseminated and shared in society. Although archaeologists will likely be forced to work under such structural conditions for the foreseeable future, Rabinowitz cautions that a critical (and ethical) digital approach to archaeological practice must recognize the economic forces that shape it.

Kansa's ironic title, "Click Here to Save the Past," (Ch. 4.2) critiques the spirit of technological solutionism by emphasizing that digital archaeology remains entangled with commercial and semi-commercial interests that both shape and reflect wide ranging social pressures (Morozov 2014). He argues that our critical appreciation of technological change involves more than just selecting the best digital tool for the job; instead, it requires archaeologists to engage critically with the economic, cultural, social, and political trends playing out in both

academia and contemporary society. Indeed, such analyses of the social contexts wherein digital tools are used and how the data they produce are curated sit at the heart of Kansa's slow data concept. Thus, by incorporating slow data into this manifesto, perhaps digital archaeology can make its most meaningful contribution to the increasingly contentious debates about the role of neoliberal ideologies in the digital humanities and academia in general (most recently, see Allington *et al.* 2016; *contra* Greenspan 2016).

FROM THE TABLET'S EDGE TO THE DIGITAL ARCHIVE AND BEYOND

This volume's themes move from the practice of archaeology in the trench and the collection of information to the curation and dissemination of data via the digital archive. It concludes with two broader reflective responses.

Part I, *From Trowel to Tablet* (Wallrodt, Ch. 1.1, Ellis, Ch. 1.2, Motz, Ch. 1.3, Gordon *et al.*, Ch. 1.4, Bria and DeTore, Ch. 1.5, Sayre, Ch. 1.6, and Poehler, Ch. 1.7), provides testimonies from a range of field projects working in both the New and Old World that have attempted to implement born-digital workflows via mobile computer data acquisition and manipulation. In particular, this section offers myriad perspectives on digital archaeology that occur on-site at a level barely removed from the archaeological remains themselves and the modern peoples that identify with them. It reveals an emergent discourse on how hardware devices and software apps intersect—often via DIY systems—within the context of on-site workflows to provide new modes of data collection, curation, and analysis that have changed the way archaeologists both practice and learn their discipline. Moreover, the diverse experiences of projects working in different cultural and economic contexts reveals that there are larger social forces at play in terms of social class or pedagogical concerns and that these practical issues can affect how digital devices and skills are used and taught on-site.

Part II, *From Dirt to Drones* (Fee, Ch. 2.1, Olson, Ch. 2.2, Wernke *et al.*, Ch. 2.3, Buxton *et al.*, Ch. 2.4), presents studies dealing with the development of tools beyond the trench, from data recording apps to the manipulation of various 3D imaging and mapping technologies in both terrestrial and marine archaeological landscapes. Because these tools are still used to record archaeological artifacts in situ, these

chapters also complement the workflow analyses covered in Part I. At the same time, they shed light on the slow mechanization of archaeological practices. From apps that correct practitioners' errors, to cameras that document artifacts and architecture in granular detail, to aerial drones and marine remotely operated vehicles (ROVs), these devices replace some tasks previously performed by human archaeologists (see also Rabinowitz on "transhuman archaeology," Ch. 5.2). Part II illustrates both how new apps and devices are transforming archaeological practices—and especially analyses—and how these changes might significantly alter how future archaeology is practiced for better or for worse.

Part III, *From Stratigraphy to Systems* (Castro López *et al.*, Ch. 3.1, Sobotkova *et al.*, Ch. 3.2, Dufton, Ch. 3.3, Spigelman *et al.*, Ch. 3.4), reviews the development of more-or-less complete digital systems and workflows from the perspectives of both academic and cultural research management (CRM) projects. In particular, this section presents a forum for archaeologists—several of whom double as digital technologists—to discuss how and why they developed bespoke archaeological systems that can shepherd data from the tablet in the field to a final online repository. In addition, these papers further address the economic and technical debates about whether to create bespoke fully digital recording systems or use the DIY approach highlighted in Part I with off-the-shelf apps and hybrid paperless/paper-based systems and protocols. Lastly, this section offers testimony from Paleowest, a CRM company that explores how the use of new archaeological devices, workflows, and systems are revolutionizing the way private-sector firms practice archaeology in relation to legal strictures, tight budgets, and fixed deadlines.

Part IV, *From a Paper-based Past to a Paperless Future?* (Caraher, Ch. 4.1, Kansa, Ch. 4.2), provides two critical views of the current state of digital archaeology and thoughts on its future. These chapters offer reflexive and cautionary perspectives on how current social and structural pressures affecting 21st-century politics, economics, and institutions of higher learning are contributing to the at times unreflexive and rapid adoption of born-digital fieldwork with questionable results for archaeology. They also touch on the contentious issues of technology's effect on human haptics and the risk of "de-skilling" through increased tool use, as well as on the need for open and accessible modes of online data publication and preservation that are

both sustainable and ethical even as neoliberalist social pressures are transforming how such projects are developed.

Finally, Part V, *From Critique to Manifesto* (Kersel, Ch. 5.1, Rabinowitz, Ch. 5.2), provides two invited responses from established archaeologists not directly involved with our workshop. Our first respondent, Morag Kersel, is a field archaeologist who has experimented with some digital technologies, but is not a digital expert (in her own words, she is a self-professed “Luddite outsider” facing a “digital life”). Our second respondent, Adam Rabinowitz, is an engaged digital archaeologist with experience in developing digital workflows at a range of sites. We selected these two archaeologists purposely because they have experienced the rapid transition from paper-based to increasingly paperless workflows over the last five years, and we felt that that they could provide some historical and disciplinary context for what a mobilized and digitized archaeology is doing right and what it could do better or avoid. In prompting their response, we provided few guidelines other than that they engage with the chapters from their own viewpoints. Both respondents have provided erudite and vital observations about how we can and should be mobilizing the past.

MOBILIZING THE PAST

We initially envisioned the “Mobilizing the Past” workshop as a forum for developing a set of best practices and protocols—a manual of sorts—for archaeological projects to use in the adoption of mobile tablets in the field. In retrospect, this proposed outcome was naïve and overly simplistic. In truth, there is a staggering array of practical and theoretical considerations at stake in adopting mobile computing for archaeological data recording. A one-size-fits-all solution for implementing such schemes proved not only impossible, but also undesirable. Instead, the workshop reinforced the close ties between the deployment of mobile computing tools and systems in archaeology and the methods, research goals, and pedagogical priorities of individual projects. Given the many ways that projects are beginning to integrate digital tools, we structured the workshop and its subsequent publication as an opportunity for projects to share their ongoing successes and failures, methods, and practices.

At the same time, workshop participants recognized that we are at a critical time for digital archaeology as it moves from its

initial experiments to more established and widely adopted practices. Indeed, given the stimulating ideas and debates raised during “Mobilizing the Past,” it seems that the discipline will benefit from continuing such discussions at academic annual meetings and at fora such as Michigan State University’s Institute on Digital Archaeology Method & Practice’s summer institutes (<http://digitalarchaeology.msu.edu>) and the Digital Archaeology Commons (<http://commons.digitalarchaeology.msu.edu>), an online forum, which they describe as “dedicated to supporting work and community building around digital methods and practice in archaeology and closely related fields.” Hopefully, such new online spaces will offer digital archaeology practitioners a democratic and open locus to continue this dialogue. For now, however, our hope is that this volume can contribute to such scholarly discourse and perhaps formalize, for a brief moment, conversations that are often informal. As Kersel proclaims (Ch. 5.1), a mantra for all field archaeologists with regard to their data should be “we publish them!” We agree, and thus we offer these fresh and vital dialogues about archaeology freely, digitally, and in a timely fashion via this open-access volume.

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<https://mobilizingthepast.mukurtu.net/collection/oo-mobile-computing-archaeology-exploring-and-interpreting-current-practices>

http://dc.uwm.edu/arthist_mobilizingthepast/2

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