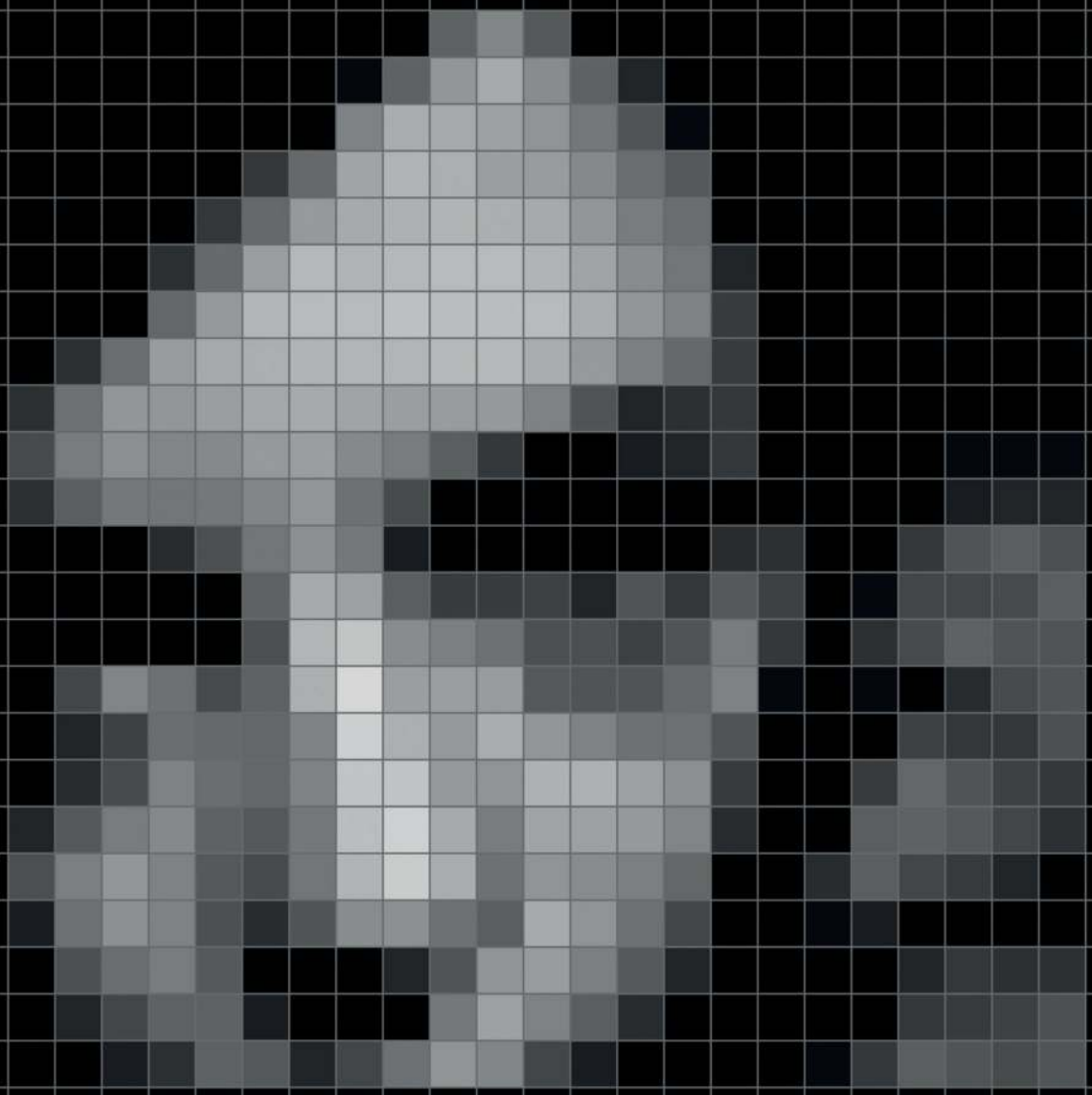
CULTURE, TECHNOLOGY & THE IMAGE

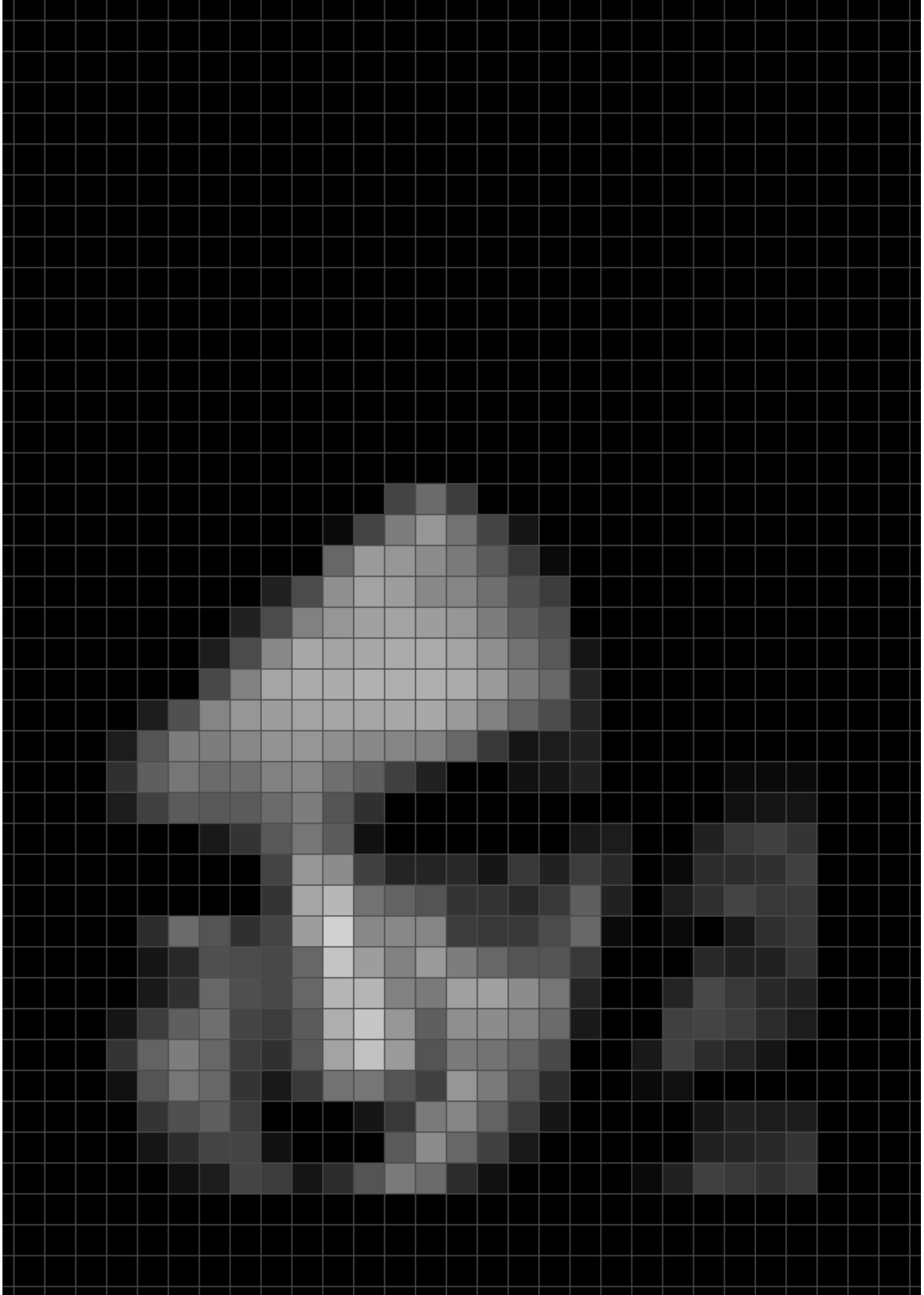
TECHNIQUES OF ENGAGING WITH VISUAL CULTURE

EDITED BY

JEREMY PILCHER



Culture, Technology and the Image



Culture, Technology and the Image

Techniques of Engaging with Visual Culture

Edited by Jeremy Pilcher

intellect
Bristol, UK / Chicago, USA

First published in the UK in 2020 by
Intellect, The Mill, Parnall Road, Fishponds, Bristol, BS16 3JG, UK

First published in the USA in 2020 by
Intellect, The University of Chicago Press, 1427 E. 60th Street,
Chicago, IL 60637, USA

A catalogue record for this book is available from the British Library.

Copy editor: MPS Technologies
Cover designer: Aleksandra Szumlas
Cover image: Michael Takeo Magruder, *Encoded Presence [auto-portrait of E. Puente]*, still from algorithmic Flash executable, 2005. Image copyright and courtesy of the artist.
Production manager: Laura Christopher
Typesetting: Contentra Technologies

Print ISBN: 978-1-78938-111-5
ePDF ISBN: 978-1-78938-113-9
ePUB ISBN: 978-1-78938-112-2

Printed and bound by Shortrun, UK.

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This is a peer-reviewed publication.

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Acknowledgements

A substantial debt of gratitude is owed to the organization, Computers and the History of Art (CHArt), without which this book would not have been possible. The chapters by Catherine Larkin, Stephen Boyd Davis, Brett Bligh and Katharina Lorenz, as well as those of Anna Bentkowksa-Kafel and Almila Akdag Salah are all based on papers that were first presented at conferences organised by CHArt. My thanks for the help and generosity in making it possible to bring together all of the contributions included in this publication. The imagination, foresight and inclusivity of the conferences and publications by CHArt since its inception in 1985 have been the source and inspiration for *Culture, Technology and the Image: Techniques of Engaging with Visual Culture*.

Introduction

Jeremy Pilcher

This book engages with the impact of the pervasive spread of digital networked technologies on the way images are archived, circulated and understood. It follows on from a series by the organization Computers and the History of Art (CHArt). In 2005, Will Vaughan, one of CHArt's founding members, identified a 'revolution that affects all our activities and not one that simply leads to the establishment of a new discipline to set alongside others' (2005: 2). Among developments in social media at the time was the creation of YouTube. Other events that have had wide-ranging transformative effects from around the same period were the launch of Facebook and the formation of the company, Google. Anna Bentkowska-Kafel has proposed that, from within art history, there has been a tendency to understand the impact of digital technologies as creating a distinct discipline (2015: 59). To the extent this is true it leads to the impacts of technological changes being underestimated. Disciplinary cores are not immune from such developments. Engaging with the changes by proposing, for example, the emergence of digital art history could be seen as part of a 'formulaic assimilation of various "new art histories" that have largely expanded the ground of existing canons and orthodoxies rather than offering substantive alternatives to the status quo' (Preziosi 2009: 489). By contrast, the approach that inspired the inception of this volume sees technological developments, which affect the ways that images are disseminated and analyzed, as bringing about fundamental changes to the humanities that engage with the visual sphere.

The core of the work gathered together in this volume was originally presented at conferences organized by CHArt to discuss the interaction between the study and practice of art and developments in information and communication technologies. It has been complemented by a selection of additional invited chapters that reflect an engagement with culture in terms of that which, 'contains an impulse toward action: it is what is "done and practiced" (Busche 2000: 70 cited in Krämer and Bredekamp 2013: 21). The focus is on the impact technologies have on the creation of knowledge and its communication through reciprocal relationships

between visual culture and the networked computer, as understood broadly to include a variety of interfaces (Krämer and Bredekamp 2013: 24). The growing quantity of data, including so-called 'big' and 'open' data sets, which are increasingly accessible on the Internet, has implications that may not simply be accounted for in terms of the quicker and more transparent transfer and presentation of information. There has been, and will continue to be, a change in the way sense is – and can be – made of the visual. As Lev Manovich has asked, with the availability of quantitative and computational techniques, 'why should we use computers to classify cultural artifacts into a small number of categories? Why not instead use computational methods to question the categories we already have, generate new ones, or create new cultural maps that relate cultural artifacts in original ways?' (2015: 24). The ongoing adoption of new methods and approaches is involved in opening possibilities for, and then bringing about, changes in the conditions by which knowledge comes into existence about art, images and culture.

At the same time, it is clear that the rhythms of unfolding technological configurations and disciplinary transformations are not synchronized. There are frictions that slow the adoption of new tools and the formation of different techniques in knowledge making. The methodological possibilities implied by the networked computer, such as the ability to study the large amounts of data that can now be obtained and analyzed, are not yet fully integrated into the visual humanities (Manovich 2015: 14). These types of asynchronies are illustrated by Catherine Larkin's chapter, 'Current research methodologies of scholars in the visual arts', which opens this book. Larkin discusses her study on the information-seeking behavior, values and beliefs of scholars in the visual arts. She addresses questions about whether research in the visual arts has been altered by digital technologies and, if so, how? This involved Larkin examining the specifics of research practices typically generically associated with art historians such as, for example, the preference of working with original works of art rather than technologically generated substitutes (Lesk 2013: 13). Her study found unevenness in the utilization of information and image retrieval systems as visual arts scholars experience difficulties in traversing digital resources. On the basis of insights derived from using both quantitative and qualitative methods, Larkin was able to propose a model of information-seeking behaviors and processes within the discipline that may be used to understand research traditions which, with technological developments, are now in transition.

In the chapter that follows, Pedro Luengo starts by observing that despite the availability of new technologies, and the potential these have for a discipline such as art history, they have not been adopted to a significant extent. In 'From photogrammetry to Big Data', he describes the deployment of the techniques of light analysis, 3D modeling from photography (or photogrammetry) and the application

of a Big Data extractor in the context of a case study of buildings constructed in the eighteenth century for missionaries in China. Luengo proposes that the application of these three techniques would facilitate research and open up a range of issues for engagement in a variety of disciplines, including cultural heritage conservation and preservation. While he discusses these tools sequentially, Luengo points out that there would be clear advantages to integrating their use in practice. A photogrammetric analysis might, for example, generate a useful visualization that could also be analyzed as part of a large data set. Luengo acknowledges that the prospects of a more general use of such research techniques, which may have been developed for specific investigations, may be inhibited by a number of practical issues. Increasing their adoption may be problematic given, for example, that the cessation of research funding for a project may also bring with it an end to the availability of the tools and methods that have been developed. The value in finding ways to resolve such issues is apparent when considering the potential significance of the knowledge and areas of inquiry that may flow from generating new methods of analysis.

While Larkin has found that many art historians continue to be daunted by technology, as Nicholas Eastaugh points out in his chapter, 'Imaging technologies applied to questions of authorship', the practice of using technology in areas such as connoisseurship and the authentication of art is well established. He discusses developments in the core established set of imaging techniques, which impact significantly on the availability, among other things, of high-resolution images and accurate color representation. The importance of these is underlined by, if nothing else, the value attached by those working in the visual arts and humanities to the quality of image reproductions, as is apparent from Larkin's study. However, as Eastaugh observes, while the impact of technology is significant, what is done with the data that is generated from its use may be even more crucial. The increase in both the quality and quantity of data available can offer objective ways in which to analyze and evaluate tangible artworks. At the same time, to achieve this involves challenges. An awareness of both mathematical and art historical issues is required. Approached in these terms, it becomes apparent that the effective generation of knowledge from new technology is intertwined with how, and the ways in which, it is integrated into preexisting disciplinary practices and techniques. Its impact, and that of the new data it makes available, cannot be isolated from the methods and materialities of the way it is archived, analyzed and presented.

Eastaugh discusses the value of animated images or visualizations to facilitate the process of creating knowledge such as when, for example, complex data sets are used to compare and contrast the characteristics of artworks. Yet, as Stephen Boyd Davis observes in opening his chapter, 'Time machines', the use of computing in the mechanization of knowledge continues to be controversial, at least for some.

Instead of intervening directly into that particular debate, he contextualizes it by looking back at the development and use of chronographics to visualize historical time. The method brought with it rigor and uniformity but, as Boyd Davis cautions, there remains scope for improvements in engaging with the complexities of history when time is charted. 'Time machines' brings into focus the need to investigate suitable ways in which to graphically represent the uncertainties that affect historical information. Boyd Davis argues that much is yet to be done in developing complex interactive visualization techniques that are entirely satisfactory for researching and presenting historical knowledge. His identification of the difficulties inherent in developing chronographics that do not oversimplify the visualization of historical narratives may be aligned with the importance Eastaugh places on using scientific methods of analysis in conjunction with established art-historical understanding. It is at such points of intersection, between developments opened up by new visualization techniques and how these are situated in relation to existing knowledge in the visual humanities, that both opportunities for, and resistances to, disciplinary change may come sharply into focus.

In '*Vorsprung durch Technik*: Multi-display learning spaces and art-historical method', Brett Bligh and Katharina Lorenz discuss the scope for the mediation of art-historical discourse by multi-display learning spaces. They start by taking an historical perspective on the importance of comparative viewing for connoisseurship and the assessment of the creation of works of art. The simultaneous projection of two images of artworks side by side has been integral to art-historical analysis. Bligh and Lorenz contrast this method with a learning space that deploys multi-display technology in a presentation ecology that facilitates the integration of shared analytic encounters. They propose this type of environment can enable discussion that complements methodological approaches that have shifted away from hermetic analyses of form and style. The significance of which is that, as Bligh and Lorenz point out, art-historical analysis both shapes, and is shaped by, the technology and methods of information presentation. In such a recursive relationship, as they identify, there is the potential for changes in analyses in conjunction with alterations in the method(s) by which knowledge is communicated. In short, modifications to the established dominant method of presenting knowledge about art history offer the prospects of wider disciplinary impacts. Bligh and Lorenz do not suggest that developments in methods of presentation are determinative of disciplinary changes. There are, of course, frictions that curb such changes. However, multi-display learning spaces in combination with methodologies that have a concern for broader cultural contexts would seem to offer the scope to expand the nature of art-historical analyses.

As Lev Manovich has pointed out, the type of traditional manual comparison discussed by Bligh and Lorenz has been a fundamental method of the humanities.

Yet it brought with it 'the most extreme exclusion – considering only tiny [*sic*] sample of "important" or "best" works from every period or field' (2015: 27) in order to enable similarities and differences to be perceived. Manovich's work provides a valuable means to unpick such impacts of technology. He understands, along with writers such as Harold Innis (2008) and Marshall McLuhan (2001), that it has a fundamental impact on shaping societies. Yet, at the same time Manovich recognizes that this is, in turn, affected and shaped by sociological factors involved in the development and use of techniques that are deployed with technologies. Data science techniques, which enable large datasets to be used to make comparisons (Manovich 2015: 26), may – but not necessarily will – disrupt established disciplinary categories and theories, which are open to transformation when in the process of being repeatedly deployed.

Importantly, the recursive relationship between knowledge and developments in techniques and technologies may not only have a transformative impulse but also has the potential for conservative effects. The point may be made in terms of the performative as understood by Jacques Derrida (1988; Hillis Miller 2007). The concept of performativity helps to convey the idea that the existence and meaning of categorizations (such as those used, for example, in the identification and use of artistic styles) are inextricably bound up with their iterability. The point is that while 'manual comparison does not scale well for Big Data' (Manovich 2015: 25) the disruptive potential of large data sets and their analysis may be reduced if, in being used, they are made subservient to established art history, which has for so long been 'a window onto a vast imaginary universal museum, encyclopedia, or archive of all possible specimens of all possible arts, in relation to which any possible physical exhibit, collection, or museum would be itself a fragment or part' (Preziosi 2009: 490). In short, it is conceivable that large datasets may be used to iterate established categorizations and in the process performatively entrench established disciplines and their frameworks of knowledge.

An inextricable aspect of art history has always been technology, as illustrated by the way in which it, 'is in a very real sense the child of photography, which has been equally enabling of the discipline's fraternal nineteenth-century siblings, anthropology and ethnography' (Preziosi 2009: 500). In the chapter, 'The hyperimage: Toward a theory of expanded photography', Alfredo Cramerotti proposes a theory of what he calls an 'expanded photography' which, with digital images that are more dislocatable from their origins and circulate with an 'unprecedented rhythm' (Derrida 1998: 17), has brought with it profound changes in methods of cultural production, distribution and archivization. The impact of the hyperimage on established practices and conventions may be understood to both amplify and transform the disruption of the modernist museum, which 'represents a nineteenth-century European model' (Hooper-Greenhill 2000: 151). Museums, along

with cultural techniques such as mapping (Siegert 2011), have brought 'the world into an apparent, single rational framework, with unified, ordered, and assigned relationships between nature, the arts, and cultures' (Hooper-Greenhill 2000: 18). By contrast, Hooper-Greenhill has introduced the notion of the post-museum as a site where the curator's voice is joined by a multiplicity of perceptions, values and opinions. As diagnosed by Derrida, the arrival of the networked computer has brought with it an 'unlimited upheaval under way in archival technology' (1998: 18) and one manifestation of this has been to bring into question the 'unassailable voice' (Walsh 1997: 77 cited in Vermeylen and Pilcher 2009: 65) of the museum.

In 'Virtual museum: The concept and transformation', Anna Bentkowska-Kafel reflects on the use of digital technology in museums, which she sees as offering unparalleled opportunities for more inclusive and collaborative museums. While photography and its current transformation have been an integral part of 'the birth of the virtual museum, a new kind of museum which is the product of the prodigious evolution of the imaginary museum' (Battro 2010: 136–37), as Bentkowska-Kafel observes, there is little agreement as to the scope of what is meant by the term 'virtual museum'. In discussions about the idea, the expression, 'a museum without walls', which typically is associated with André Malraux's *Le musée imaginaire*, is often used. Yet, as Bentkowska-Kafel points out, Malraux himself never used the phrase in his book, which juxtaposed photographic images to problematize established boundaries of western art and its relationship with other cultures. Nevertheless, as discussed in 'Virtual museum: The concept and transformation', his arguments remain relevant today in engaging with the contested notion of the virtual museum and what it means in the context of pervasive digital technologies. Bentkowska-Kafel progresses her chapter by focusing on the work of the European Virtual Museum Transnational Network of Excellence (V-MusT). In the course of which, she describes how, in creating and classifying the wide varieties of virtual museum that exist, V-MusT has created a list of types and formats that is likely to be contentious. Even a broad agreement as to the nature of a virtual museum would seem to be a challenging prospect given an environment in which it seems, 'virtually anything can be staged or deployed in a museum, and in which virtually anything can be designated or serve as a museum' (Preziosi 2009: 490).

One site that may provoke debate over what is to be understood as a virtual museum is deviantArt, which is widely associated with the tag line, 'The largest online art gallery and community'. In the chapter, 'A field guide for analyzing the curation of online social networks of arts', Almila Akdag Salah proposes that it democratizes the creation of art as well as the way it is distributed and enjoyed. She also describes deviantArt as an art market. Approached in such terms, deviantArt may be regarded as outside even such a malleable concept as the virtual museum. As Bentkowska-Kafel observes when discussing the work of V-MusT,

there is antipathy by some toward sites that, even if they display the established functions of the museum, also use advertising and entertainment to promote cultural heritage. However, Akdag Salah's engagement is not with issues of ontological categorization but the need for a methodological approach that is able to facilitate understanding an extensive online network such as deviantArt. She argues there is a need for computer-based tools and, in particular, social network analysis in order to be able to trace the way that social connections are organized and generate meaning. Moreover, Akdag Salah points toward the way in which such a methodology and the quantitative use of data may be used to elucidate the lines of influence and values manifested by, what she refers to as, 'collective curating', which has accompanied the formation of such networks. The importance of engaging with these issues in the context of sites such as deviantArt may be understood in terms of the impact of the networked computer on the practices and techniques of the modern museum. These have been significant in making 'the visible legible, thereby establishing what was worthy to be seen, while teaching museum users how to read what is to be seen: how to activate social memories' (Preziosi 2009: 489).

The contributions in this book indicate in various ways how technologies may unsettle the 'parameters of expectations established by two centuries and more of museums, galleries, salons, fairs, expositions, displays, and visual and optical demonstrations and experiments of many familiar kinds' (Preziosi 2009: 488). In the first chapter, Larkin identifies the uneven adoption of technologies in the research methodologies deployed in the visual arts. It may be that the potential for disciplinary transformation will be slow and incremental in the event that the adoption of networked digital technologies and techniques are met with a persistent and widespread unease of a sort she describes in relation to information-seeking behaviors of art historians. Of course, frictions of the type identified by Larkin cannot be seen in isolation from the massive expansion in the creation and circulation of images, which is engaged with in the final contribution by Cramerotti. In his speculative discussion he proposes a time of pervasive and kaleidoscopic recompositions of a wide range of cultural practices understood in terms of expanded photography. The anticipated effect is the 'disruption of rules, habits behaviors'. Alternative social, political and cultural modes of engagement are emerging, which translate not only meaning but also the way in which the world is experienced.

The diverse range of contributions gathered together in this book point toward a variety of changes in cultural techniques and knowledge that may be engendered by technological developments. In this regard, between the opening contribution from Larkin and the final chapter by Cramerotti, the chapters have been bracketed together in pairs under three broad themes. In the first section the contributions

from Eastaugh and Luengo have been linked together on the basis of their respective observations on the potential that new technologies have to unsettle disciplines through the generation of previously unavailable large datasets for analysis. The next part of the book brings together the chapter by Boyd Davis and that of Bligh and Lorenz on the basis of the importance of visual presentation for the creation of knowledge. In particular, both contributions draw attention to the ways in which the relationship between what is known and how it is visualized cannot simply be understood in terms of the representation of knowledge. The final combination links together the common concern in the contributions of Bentkowska-Kafel and Akdag Salah with online platforms such as virtual museums. Although the two contributions are quite different they may both be understood as concerned, at least to some extent, with values that are inherent in such sites and which inform their implications for their wider cultural environments. The framework used to order the various chapters is intended to provide one possible starting point that may stimulate and promote further engagement with the impact of technologies on the perpetuation and development of culture understood in terms of 'the (inter)play with language, images, writing, and machines' (Krämer and Bredekamp 2013: 24). In the conclusion that brings the book to an end, given the complexities of the issues discussed by the contributing authors, the difficulty of firmly identifying any specific implications of new technologies and techniques will be acknowledged. Yet, at the same time, some general observations will be offered on the basis that the developments engaged with in this book have not, and will not have been, confined to the cultural peripheries.

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Current research methodologies of scholars in the visual arts: Toward an emerging model in image and text retrieval for the domain

Catherine Larkin

Introduction

The lack of understanding the information-seeking behaviors and processes of scholars in the visual arts first came to light with the pivotal 1986 collaborative study by the Art History Information Program of the J. Paul Getty Trust and the Institute for Research and Information Scholarship of Brown University (AHIP-IRIS). Generally, the results of the study revealed that although the quantity and variety of resources needed for art inquiry were especially suited to electronic aids to research, the application of technology seemed to intrude upon established research practices (Bakewell et al. 1988).

If one attempted to characterize the idiosyncratic information-seeking behaviors of visual arts scholars, it could be couched in their use of original works and documents and the key importance of images. Depending upon the complexity of the image, research may begin with a reproduction, although hands-on investigation is valued in the visual arts domain and is considered to be the most essential aspect of knowing an image. Reproductions are considered notoriously responsible for distorting works of art (Bakewell et al. 1988). Despite the difficulties encountered in gaining access to an original work, an onsite investigation is usually necessary if a scholar wishes his or her work to be taken seriously. As the non-linear research process moves between original images and texts and secondary images and texts, the burden of proving one's hypothesis rests ultimately in the power of the evidence found in specific-related images contained in a published article or book, or those visually evident in a newly created work of art (Larkin 2010).

Related literature

Many distinctive research traditions of art historians were first reported by Deirdre Stam in 1984, such as, reliance on one's personal library, the need for original works and avoidance of technology (Stam 1984). While many secondary sources are helpful in accessing relevant theoretical issues, biographical information and interpreting the historical, cultural and visual content of works of art, again, reproductions do not replace original sources (Bakewell et al. 1988: 11). Routinely, many scholars in the domain who now understand the value of e-resources still grapple with the idea of computer-generated imagery because digital images may be generations away from their original state (Lavin 1997: 198–201). Suzanna Simor placed the responsibility of selecting and evaluating high-quality electronic materials on information professionals, librarians and art faculty and posited that the discerning human judgment of visual art scholars would remain irreplaceable. She also pointed out that among those teaching art and involved in scholarship, resistance to new media (digital resources), reliance on old research methodologies and limited access to technology continued to be problematic (Simor 2003: 36). Barbara Elam expressed concerns about the limited awareness of electronic resources and the challenge for librarians to respond to traditional and current needs of art professionals (Elam 2007: 6). Trish Rose and Sandra Cowan acknowledged the need for real user studies to bring visual arts information-seeking research forward (Rose 2002). Thus, a number of queries derived from past literature were adapted to frame this study's Phase I questionnaire (Stam 1984; Bates et al. 1995; Cobbledick 1996; Rose 2002; Cowan 2004).

Related information-seeking models

Joan Beaudoin recognized the potential application of established information-seeking models to research in the domain (Beaudoin 2005),[1] yet, one must consider that most information-seeking models generally fall within the paradigm of library science and were developed solely for text retrieval. Independently they may not address the current and specific requirements of the domain under examination. While numerous possibilities abound, a particular thread of information-seeking research emerged, that is, the concept of integrating or nesting existing models.

Nesting models

Thomas Wilson explored existing models of information-seeking already established in the literature and suggested that by combining these models, alternative

models could be created. Wilson explored a variety of models and proposed that new clarity could be accomplished by considering the complimentary aspects of existing systems toward a broader understanding of information behavioral research (Wilson 1999). Wilson defined a model as a framework for thinking about a problem and further declared that most models were statements in the form of diagrams that attempted to describe an information-seeking activity or stages of information-seeking behavior (Wilson 1999: 250). Wilson examined Brenda Dervin's *Sense-Making* information search processing model (Dervin and Nilan 1986) and posited that its strength was contained partly in its methodological consequences because it led to questioning, genuine insight and information delivery (Wilson 1999: 253). He also investigated Carol Kuhlthau's *Uncertainty Principle* for information-seeking (Kuhlthau 1993), noting that it was well accepted because her empirical research findings could be generalized to other populations (Wilson 1999: 255–56). Finally, he posed the following questions about the models he explored: 'To what extent are different models complete; in what ways are existing models complimentary; and how do modes of information-seeking behaviours aid our understanding of the search process?' (Wilson 1999: 267).

The works of Nicholas Belkin, Dervin and Kuhlthau played a foundational role in Kristy Williamson's *Ecological Theory of Human Information Behaviour* (Belkin 1978; Williamson 2005: 128–32). Williamson was motivated by an article by Marcia Bates (2002) on integrating models of information-seeking and searching, and like Wilson, conceptualized combining existing models. Since combining models may be relevant to the complicated research agendas of scholars in the visual arts, Williamson's ecological approach toward understanding the complexities of information-seeking behaviors and processes may be appropriate in current domain practices.

Methodology

The techniques used to gather data from visual arts scholars at three American Universities, namely Long Island University, the City University of New York and Princeton University, included a Phase I self-administered questionnaire to query participants on demographic information, their use of information resources and their approaches to locating information. In Phase II, an interactive survey instrument was employed to examine users' satisfaction and frustration with both web-based and academic image and text retrieval systems. This process was audio-recorded to gather experiential data and was followed by the completion of an Information Horizon graphical representation technique, which enabled participants to report on their individual information sources, thus capturing data that

could be lost by conventional methods such as a questionnaire or survey (Larkin 2010a: Appendices A and B).

Research questions

- Have digital technologies profoundly altered traditional information-seeking in the visual arts?
- Is there a new domain-specific information-seeking behavior and processing model emerging for visual arts humanities scholars?

Data collection and analysis techniques

Data collection and analysis involved an eighteen-month procedure. In a two-phase process, the user evaluated an array of information sources including electronic resources, while their domain-specific requirements, attitudes, behaviors and processes were self-documented. During Phase II, the interactive survey instrument was enhanced by mediation and recorded think-aloud protocol. Participants also crafted a graphical description of their information sources. Data collection was aimed at documenting persistent and distinctive information requirements within the population, noting changes in information-seeking behaviors over time, and determining the extent to which technology and demographics may have affected the information-seeking experience within the domain.

Selection of participants

Sixty-five participants were solicited via United States Post from the three American Universities. Their solicitation was based on the following criteria: (1) participants were full-time faculty members in the department of the visual arts and (2) during data collection, participants were involved in teaching or research in their field of expertise. Thirty-two subjects completed the Phase I questionnaire of which 30 volunteered for the Phase II process. Ultimately, nineteen volunteers took part in Phase II. While expert samples such as this are typically small, based on the theory of *User Modeling with Personas*, user demographics and behavioral data obtained from a limited number of real users, can serve as effective tools in defining users' needs and behaviors (Aquino and Filgueiras 2005). Because a non-random sample population was utilized in this investigation, its results cannot be generalized.

Phase I questionnaire

The questionnaire was divided by themes such as the use of information sources including queries on traditional text and image formats, and electronic text and image formats, as well as other modes of acquiring information such as attending conferences and art exhibitions. Data was collected utilizing a five-point Likert scale. Thus data collection was at the interval level and was analyzed using Statistical Package for the Social Sciences (SPSS 17.0) for Windows.

Based on the data collected from the questionnaires, subjects followed a precise method of information-seeking based on their personal experience and expertise. This confirmed that overall traditional methodological tools and idiosyncratic practices have remained persistent over time. The data supported the overall homogeneous nature of this study group (Larkin 2010). However when further statistical analysis (e.g. Pearson's *r*) was conducted to determine if there were significant correlations between user traits and participants' responses, dynamic changes in the domain and in technology had impacted participants' information-seeking behaviors, professional attitudes, values and beliefs.

Phase II interactive survey

In Phase II, the interactive survey and criteria, formerly used by the author to indicate domain specificity in users' information-seeking behaviors and processes using web-based image retrieval systems, were adapted to the present study (Larkin 2004). The refashioned data collection instrument used both web-based (Google Image and Google Scholar) and academic (ARTstor and JSTOR) retrieval systems to examine image and text retrievals among members of the domain. Two search techniques were employed, basic and advanced. Search terms were selected by participants to ensure that retrievals would be relevant to their research agendas (Larkin 2010).

After viewing the first page of documents retrieved during each search episode, participants ranked their retrieved results on a scale of 1 (negative) to 5 (positive) in relation to user frustration (low) and user satisfaction (high), based on the following criteria:

- Precision: The number of retrieved documents that the searcher considers to be in context.
- Utility: The number of retrieved documents with aspects interesting to the user beyond topic relatedness.
- Novelty: The number of retrieved documents previously unknown to the user.[2]

Descriptive analysis was performed to obtain demographic summary measures (e.g. frequencies) for the nineteen respondents who participated in Phase II. Inferential statistical analysis was conducted using Spearman's rho formula to determine if significant correlations existed between demographics and ranked responses. Comparisons were made across different retrieval systems as well as between basic and advanced search queries. A further analysis of participants' ranked responses was conducted and compared to affective responses and think-aloud recordings. When relevant, Phase I responses were compared to Phase II data to see if there were discrepancies in participants' self-reporting and active searching activities.

Phase II participants were also asked to select from words, phrases and sentences extracted from the related information search processing models discussed in this chapter and to choose those that best described their present information-seeking experience. For example, participants were asked to indicate whether or not they experienced feelings of frustration, confusion, optimism etc. during the process, did they encounter new information or patterns of information and was the experience optimized by physical surroundings and social interaction through mediation.

Finally, utilizing Sonnenwald's Information Horizons theoretical framework (Sonnenwald 2005: 191–97), participants were asked to create a graphical representation of information resources including people and social networks accessed in the context of a personal research agenda and to rank their selected resources in terms of their usefulness. The Information Horizon theoretical framework was effective in learning more regarding the role of social networking in the information behaviors and processes of visual arts scholars. This is noteworthy because although in the past it was often perceived that research in the visual arts takes place in isolation, it was possible that this attitude could have shifted.

Data collection instruments were designed to gather information, both quantitatively and qualitatively, utilizing a variety of approaches. The combination provided increased reliability and validity to the findings. By using this new unified and ecological approach to data collection designed to enrich insight into the information-seeking behaviors and processes of visual arts humanities scholars, progress toward an information-seeking model in image and text retrieval for the domain could be realized.

Examining information-seeking behaviors using Information Horizon graphics

Information Horizon graphical representations allowed participants to document 'this is what I do', and verified a range of findings reported via the Phase I questionnaire. In addition to gaining a more comprehensive understanding of

information-seeking in this user group, improved validity was substantiated by the high degree of overlap with information resources preferred earlier by participants. This was especially accurate in regards to personal libraries, museums and galleries and Internet resources. Conversely, other choices were unanticipated and reflected a higher degree of social interaction than previously reported on the self-administered questionnaire.

Further examinations of the Information Horizon graphics are shown in a full view on the Excel Radar Chart (Figure 1) designed to aid in visualizing patterns and clusters in information-seeking behaviors and processes, detecting new trends among information resource preferences and observing relationships among information resources. The symbols and numbers to the right of the diagram in Figure 1 represent the nineteen participants who took part in this exercise.

As illustrated in Figure 1, the perimeter of the diagram represents the 35 information sources reported by participants. Following in Figure 2, all singular references to an information source were eliminated leaving seventeen information sources and a selected view of participants' preferences as a whole.

In this concise analysis of the resources mentioned most often, nine chose the Internet and another four chose related resources such as Google and artists' websites. Of this group of thirteen, nine chose an Internet source as either a primary or secondary resource. The number of selected Internet resources correlated to Phase I data where the majority of participants used a computer for research at least once a week, almost all frequently used Google or Yahoo! and at least 75 percent downloaded images from the Internet (Larkin 2010).

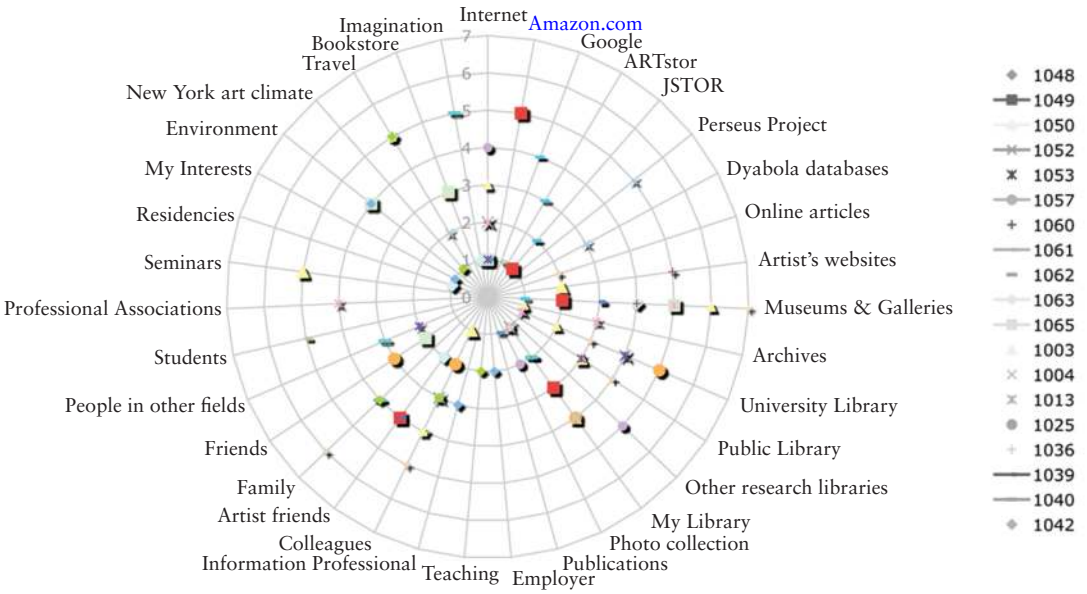

FIGURE 1: Information Horizon radar chart – a full view.

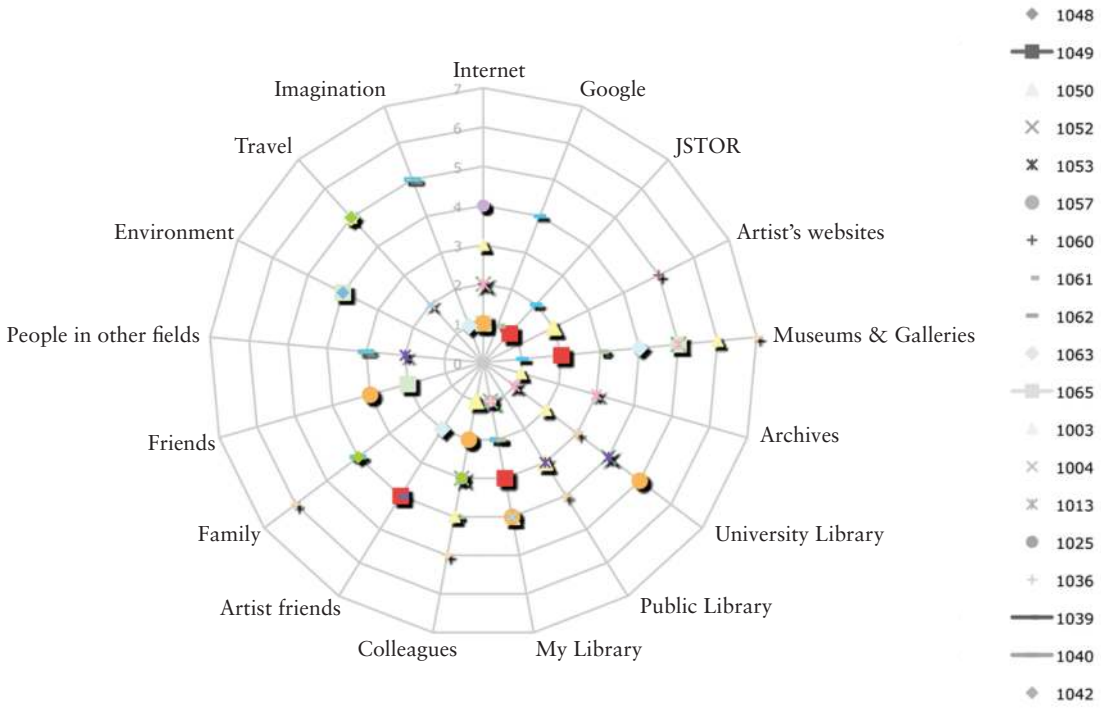

FIGURE 2: Information Horizon radar chart – a selected view.

Eleven of nineteen subjects chose their home library as an important information resource and nine selected it as a primary or secondary resource. This was in agreement with the 75 percent who reported dependence on their personal collections on the Phase I questionnaire (Larkin 2010: 52). Eleven participants chose museums and galleries, a number well in line with the over 80 percent who previously reported attending art exhibitions (Larkin 2010: 56). Five categories fell under the umbrella of social interaction. Contrary to Phase I data where only 25 percent collaborated with colleagues and over 50 percent preferred an isolated work environment, all nineteen participants selected at least one of these categories with nine relying to some extent on colleagues for information. Two clear clusters of information resources are shown on Figure 2, first, traditional resources such as museums, galleries and various types of libraries, and second, social interactions including colleagues, artist friends, family, friends and people in other fields. Participants also named a sizeable number of distinct electronic resources in addition to the commonly identified Internet, Google and artist websites. They include Amazon.com 'for new books' and numerous domain-specific databases and digital resources such as ARTstor, JSTOR, Perseus, Dyabola and a general reference to 'online articles'. All of these signaled an interest in technology characterized by a cluster that marked a shift toward a balance of traditional and electronic information sources.

Wilson's concept of nesting models and Williamson's Ecological model of information-seeking and use provided a framework toward developing Larkin's model. Based on past scholarship and the data collected here, this community had developed idiosyncratic research traditions that are now in transition due to technological advances. Currently, the domain has the opportunity to re-evaluate aspects of their methodologies and considers those that will support research for the future.

Participants in the current study spanned a number of decades in professional experience and age range, worked on a variety of artistic endeavors and came from diverse institutional environments. For instance, library use among art historians was substantial; yet owning a personal art library collection and frequently adding material to it were important practices across the domain regardless of demographics. Owning a slide collection, as expected, was commonplace among senior participants. However, studio artists have always used the medium to document their work and still rely on slides to some extent. Younger participants commonly owned digital collections although not exclusively. All participants recognized the value of traditional media for archival and digitalization purposes.

Those with years of experience traveled most often to see original works of art and were likely to recall a time when institutional support for hands-on investigation was routine. Although senior professors used print text formats regularly, printed image formats were essential regardless of participants' demographics. Despite the fact that senior professors in Phase I self-reported confusion and frustration most often when using new technologies, Phase II participants, when interacting with electronic resources, experienced confusion and frustration regardless of age or other characteristics.

This emerging model represents dynamic changes in information resources due to technology and how that couples with the idiosyncratic research methods of visual arts professionals (Figure 3). Traditional resources for the most part have not been abandoned and except for a noticeable shift to digital images, they are still essential tools. Three categories of information sources surfaced during this course of research and are applicable to a preliminary model, (1) traditional resources in images and texts made up of print materials, original works and analogue image media; (2) electronic resources in images and texts, available on the Internet in image retrieval systems, at museum sites, artists' websites, in electronic books and in academic databases; and (3) social contacts such as colleagues, family and friends and social interactions at museums, galleries and local artists' exhibitions. The three categories are not exclusive and interact vigorously.

It was also discovered that several elements played a part in impeding or enhancing information-seeking. They are shown surrounding the perimeter of the

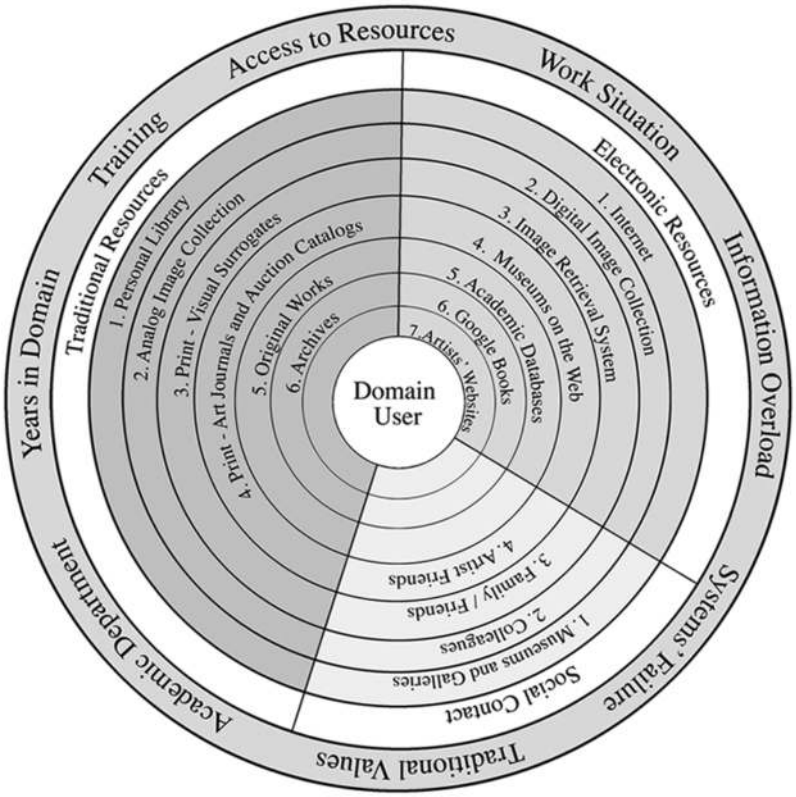

FIGURE 3: An ecological model of information – seeking in the visual arts.

model and incorporate traditional values, years in the domain, access to resources, academic department, work situation or environment, lack of training with new electronic resources, systems' failure and information overload. A major strength of Larkin's model is its plasticity since it can be fine-tuned to accommodate shifts in information-seeking behaviors and processes as new technologies impact this dynamic domain. The sizes of the fields designated on the graphic are only estimates reliant on the author's overall analysis during this investigation.

Summary of the research findings

This report is most likely the first wide-ranging examination of the use of both traditional and electronic resources and first to offer an emerging model in image and text retrieval for the domain. The overriding domain-specific requirement responsible for the differences in information-seeking and the characterization of the domain is the necessity for image and text materials, with the pursuit of images emerging as paramount. Participants commonly relied on their personal image

collections built from of a combination of media. The majority of participants, regardless of demographics, was concerned with the quality of image reproductions and frequently added materials to their personal collections of images and texts resources. Conducting an exhaustive literature search before embarking on a creative agenda and an author's authority remained essential factors.

Although all participants utilized information and image retrieval systems on the Internet, junior participants were most likely to own a digital image collection and utilize other electronic formats. While many of those over 50 years of age had discovered and utilized Google Books, all participants were disillusioned with Google Scholar because of its strong concentration in the sciences. An overwhelming majority of participants frequented museums on the web, though most avoided participating in web-based art exhibitions.

A divide emerged regarding art historians and studio artists although this data could have been skewed by the fact that most art historians were senior participants. Art historians most often owned slide collections, used university libraries and were most competent with using electronic academic databases. The complexities of interactive searching resulting in Phase II were unanticipated. Participants reflected the observations of Wendy Lucas and Heikki Topi who have proposed that searchers often do not realize that their search skills are weak, have little patience with learning new skills, rely on web search engines that promise the best possible retrievals and tend to avoid searches that go beyond a simple search (Lucas and Topi 2005). Clearly, personal biases along with the lack of experience and training with ARTstor and JSTOR were exposed during the study. Environmental factors resulting in systems' failures occurred frequently in remote locations such as art studios causing elevated levels of frustration among participants.

The author was able to present a conceptual model based on the design of Williamson's Ecological model of information-seeking and use. Williamson's design was chosen mainly because it is user-centric, flexible and adaptable. It offered an alternative to earlier linear text models that could not compensate for the idiosyncratic processes, and the dynamic activities and shifts in information-seeking occurring presently in the domain of the visual arts.

The new model offers an alternative descriptive framework for information-seeking behaviors and processes in the field and serves as a visual aid for understanding the complex and unique information environment of the domain. The model is suggested as a possible foundation for further investigations toward a productive understanding of the vigorous process of information-seeking in the visual arts. The three broad categories in Figure 3, namely traditional resources, electronic resources and social contacts, will modify over time with the advent of new technologies and other external influences.

Discussion and suggestions for further research

The selection of participants was non-random and purposeful; thus the findings of this study cannot be generalized to a larger population. The purposeful sampling was deemed necessary since domain knowledge would be essential for subjects to carry out the study's protocol. A number of participants were from the researcher's home institution, and therefore the sample must be further categorized as a convenient sample. An e-mail questionnaire would have been more effective in increasing the size of the study population. Various local environments such as open studios, where much of the Phase II data collection took place, were adverse to the use of technology. In the future, a controlled environment such as a usability laboratory should be considered for this type of data collection.

Of the three evaluation criteria, precision, utility and novelty used in this study, the criterion of utility proved to be the most frustrating and the least effective in terms of data collection. The criterion of utility, misunderstood by most, could be discarded in a follow-up study thus decreasing users' frustration levels, which may have hindered data collection during interactive searching.

Several participants had access to a variety of homegrown institutional resources and specialized databases not available to others. These subjects had formed biases against electronic resources such as ARTstor and JSTOR. Although ARTstor and JSTOR were available at all three institutions, various participants were unaware of their functionality. Training in the use of electronic resources should be investigated first, and if necessary, instruction should be implemented in preparation for a similar procedure adopting the methods used in this report. As new technologies emerge, visual arts scholars as domain specialists should be collaborators in their development. Since there were significant relationships found between user characteristics such as the length of one's professional career and age range, it may be beneficial to investigate generational information-seeking.

In 2014 a study by Ithaka S+R's Research Support Services Program was designed to address the complicated scholarly work of art historians and the impact of technology on their research practices (Long and Schonfeld 2014). To a degree, its findings parallel Larkin's conclusions. For example, the realm of digital resources remains difficult for art historians to navigate; scholars continue to build personal collections in traditional and digital formats; tools such as Google and ARTstor are improving and transforming research but there are still significant barriers to online information; reliance on online museum collections is important while examining the original object remains crucial. Finally, it should be noted that both studies were not exhaustive and differ somewhat in methodology, yet

their results reflect a domain that values advances in technology and the promise of an alternative path to finding information.

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NOTES

1. Beaudoin posited that theories provided by Thomas Mann (Subject or Discipline Model), Nicholas Belkin (Anomalous States of Knowledge) and Marcia Bates (Berry Picking Model) may have merit in visual arts research.
2. For definitions of precision and novelty, see Korfhage (1997: 328–29). For the definition of utility see Cooper (1997: 191–204).

PART I

Data Generation

This section brings together Pedro Luengo's chapter 'From photogrammetry to Big Data' and the contribution by Nick Eastaugh on 'Imaging technologies applied to questions of authorship'. Approached in certain ways the work of the respective authors deals with divergent topics. The context for Eastaugh's discussion is the use of a range of techniques to uncover the inner composition and structure of paintings, which has long been accepted as a productive intersection between art and technology. By contrast, Luengo starts his engagement by proposing that although much has been written about the possibilities for art history of new technologies, such as digitization and online databases, the traditional approaches taken by the discipline have continued relatively unchanged. While Eastaugh advances his account through the value of imaging of artworks in establishing provenance and connoisseurship, Luengo seeks to demonstrate the possibilities of a range of techniques for architectural history. Nevertheless, these chapters are linked together here because, despite these differences, the various techniques discussed all offer the prospect of the creation of large data sets. These may, in turn, be used in both the creation of knowledge relevant to established topics of inquiry and the generation of new areas for investigation.

From photogrammetry to Big Data: A case study of their possibilities for digital art history

Pedro Luengo

Much has been written on the possibilities of new technologies for the development of Art History studies. Some works proposed the necessity of creating a discussion on the topic (Rodríguez Ortega 2013; Bentkowska-Kafel 2015). Within this context, the terminological issue has also been addressed by several scholars, such as Drucker (2013), Zorich (2013) and Doulkaridou (2015), to cite just a few. Nevertheless, the traditional way of working has not changed much in the discipline. The first attempts at using new technologies were carried out in the museum fields to make the access to collections easier.[1] In this scenario, other aspects arise, such as the problems of digitalization of the pieces.[2] Conversely, in the last decade, most of the research published has not been based on these new approaches. Indeed, doubts as to the true possibilities of these emerging technologies have arisen. In spite of the increasing interest on both the process of globalization and the geography of art, to cite just two examples of the most active research fields, as well as the possibilities of the new technologies for these research goals (Joyeux-Prunel et al. 2013), scholars remain skeptical of the prospects for these emerging technologies. Many previous works have dealt with the possibilities of digital tools for conservation and restoration. Although noteworthy contributions on these topics have been carried out, they are not directly useful for updating our knowledge on art history. Furthermore, other scholars have proposed interesting approaches to the discipline from new technologies, without giving specific examples of their benefits, some exceptions notwithstanding (Rodríguez Ortega 2017; Luengo 2016). On the contrary, the manner of working with these tools from neighboring disciplines, such as architecture or archaeology, can be also useful for understanding cultural heritage.

This chapter aims to demonstrate the possibilities of three techniques for architectural history, using eighteenth-century buildings constructed by European missionaries in Beijing as examples (Luengo 2014). None of these edifices

still exist; only historical plans, reports and remains have been preserved. From this scarcity of information, the previous attempts to examine them have achieved limited success. Thus, from these emerging technologies much more information will be taken from historical sources, giving us a new opportunity to understand one of the key building processes of the phenomenon of eighteenth-century globalization. More specifically, this chapter will show the possibilities of three tools. The first is light analysis: from three-dimensional surveys, an exploration on sun light incidence in the interior of the building is shown. The second technique is photogrammetry. Although it has been used to keep record of significant pieces, in this instance, it will be used for virtual anastylosis. The third tool is a Big Data extractor. Traditional historical research has been based on qualitative analysis, mining significant excerpts from archival sources. In this case, quantitative analysis is used to show the period's key issues. The main objective of all these tools is not to bring forth a more imaginative visualization of the results of the research. Instead, it attempts to make the work of the researcher easier and quicker. Furthermore, it aims to allow for the addressing of questions that could not have been approached until now due to the quantity of information needed.

The case study is especially interesting for testing these technologies. The structures built under the government of Emperor Qianlong 乾隆 (1735–96) by European architects, both in Beijing and in the Yuanming Yuan Summer Palace 圆明园 are difficult to understand from traditional approaches (Luengo 2014, 2016a). The current ruins of the garden offer a great puzzle that could not be used for the three-dimensional reconstructions already carried out. The set of engravings published after the completion of the palaces have been the traditional source to understand the buildings, although the information given is not as detailed as the remains itself. Something similar can be said about the churches in Beijing. Almost no stone has been preserved from the originals, and only engravings and reports can be used.

Light analysis

The management of light has been considered a key point of baroque culture, and more specifically in the pieces developed by the Society of Jesus. Although this issue is remarkable in several artistic disciplines, it is even more evident in architecture. The 'theatrical' use of light has been a common concept on Baroque studies (O'Malley et al. 1999: 43). Likely, light had a more profound meaning in China. First, religious space in China is characterized by darkness. Second, the Jesuits adopted the concept of Jingjiao, *brilliant religion* or *the religion of light* 景教 from the Nestorian Christians. As a result, the churches were described by several sources as bright spaces where *quadratura* painting was effective (Luengo 2014).

Despite the importance of the light in baroque architecture both in Europe and in Beijing, scholars have not transcended subjective interpretation with objective data. Most likely, the software commonly used by architects to evaluate light management in contemporary architecture was not too useful. An answer to this problem is Diana-X®, a piece of software developed by University of Seville to get better answers about architectural cultural heritage than that provided by Radiance® or Relux®. Unlike these two, Diana-X is based on the control of the windows where the sunlight comes in, taking into consideration variables such as sunny/cloudy radiance. Furthermore, it can work with incidences of direct sunlight. Finally, it permits working with curved surfaces. As can be easily understood, architectural cultural heritage requires analyzing the incidence of sunlight on cupolas or apses, to cite just two examples.

To prove the possibilities of this software in heritage studies, two cases were analyzed: Sant'Andrea della Valle (Rome, Italy) and San Luis de los Franceses (Seville, Spain) (Cabeza-Laínez 2008, 2009; Cabeza-Laínez et al. 2001; Almodóvar Melendo 2003). The results provided interesting data on these two remarkable examples of baroque architecture. In spite of such progress, the later studies on the churches have not paid much attention to these results. Once the data are reproduced from computational techniques and correctly visualized, it is essential to use them to answer questions of architectural history. The same software used to analyze these churches has been applied to eighteenth-century Nantang Church (Beijing, China). Only three original views of the building have been preserved: a plan, a view of the interior and another from outside. All of them were done by Fernando Bonaventura Moggi, likely the building's architect, following the western-scaled techniques, being thus a pretty reliable source.

The results are interesting, considering the traditional interpretation of theatrical light in Jesuit buildings. A general view, avoiding the particularities of hours and seasons, can be done. As it can be seen in the figures, the light was much more powerful in the nave than in the presbytery. After a curtain-mode entrance, the light was concentrated in the first two sections. Then the transept was not well illuminated. The center of the presbytery also maintained a secondary role, although its two lateral sides were in darkness.

From all this, it can be said that the Jesuits proposed an illuminated religious space, in contrast to traditional Chinese customs. On the contrary, they did not focus the light on the main tabernacle or in the transept, but instead on the nave, against the Society's common practice. At the same time, the walls were not directly illuminated. Thus, a sense of diffusion of the features would be clear. This resource is significant for a church whose decoration was painting with *quadratura* techniques. The use of *quadratura* paintings in eighteenth-century Beijing has been

highlighted by many scholars, Kleutghen (2015) serving as a recent review. These results are explained because of the lack of a cupola in the transept or the presbytery. The windows of both spaces are not as useful as other solutions, which allow light to come from the upper side. The Jesuit architects could have solved the incidence of light in these areas, either with a dome or with little windows underneath the roof, but they resolved against these solutions. Technical problems might explain this choice, but it seems probable that it was a symbolic decision.

In sum with regard to the possibilities of this first tool, it can be seen that the question of issue cannot be addressed from subjective interpretations. The existence of windows does not guarantee a bright space compared to other parts of the room. On the contrary, the complexity of light behavior is better understood from the above figures. Only from this objective data visualization can a scientific approach to baroque interior spaces be performed. In spite of all this, several obstacles have to be overcome in the coming years. First is the role of furnishings in light management. The use of mirrors, curtains, stained glass or oyster shell windows propose a new dimension in this analysis. Also, the use of wall painting or tabernacles along the nave can change the impact of light in the space. Second is the improvement in the knowledge of the monuments' surroundings. Although churches did not have higher structures adjoining them in China, this can be a problem for the application of this technique in other urban spaces. Finally, it is important to update our information with regard to the hours of sunlight in these cities. Sun charts allow for the opportunity of making these illustrations, but many places are characterized by cloudy days, altering the light incidence.

D modelling from photography

The use of photogrammetry in science can be found starting in the nineteenth century, although only in the early twentieth century did the tools' possibilities grow (Richtmyer 1935: 382). At this point, it was only used to create photos of flat surfaces from aerial photographs. Its development in architectonical history was adopted soon thereafter (Peterson 1958: 27). Even so, the possibilities remained limited during most of the second half of the twentieth century (Saint-Aubin 1990: 44–54). Both in architecture and in art history, the attempts have been constant, although its impact in the discipline has still been minimal. In the last two decades, the progress of computer visualization has been noteworthy. As a result, today it is possible to reconstruct scenes from arbitrarily distributed viewpoints (Kutulakos and Seitz 2000). Indeed, the technical approach is increasingly improving (Anke et al. 2008). Different software is able to do it, giving an accurate result in terms of measurements (both micro and macro) and textures. From these tools, it is

possible to create precise three-dimensional surveys of pieces. The possibilities of 3D surveying for cultural heritage motivated the creation of the International Committee for Documentation of Cultural Heritage (CIPA) by ICOMOS. From this initiative, several summer schools, publications and conferences have been held to create a profound discussion on the topic, comparing the different options to survey cultural heritage. As a consequence of this interest, different disciplines have taken advantage of 3D surveying, including archaeology (Granados 1992; Hermon and Nikodem 2008) as well as architecture and urban planning research (González Aguilera and Finat Codes 2006; Buill et al. 2007). Scholars in all these disciplines use it to improve works on cultural heritage (Baltsavias et al. 2006; Bock et al. 2012), yet surprisingly art historians have not paid much attention to its possibilities for historical studies.

A crucial discussion is that comparing the possibilities of photogrammetry against 3D scanning (Boehler and Marbs 2004a, 2004b). According to the results, it can be said that both tools should be combined in many cases and used for specific intentions, depending on the need. The 3D scan be used to give a more detailed mesh, but cannot give a colored version. On the contrary, the most important advantage of photogrammetry is its possibilities in recording texture. In recent studies on architectonical sculpture, the mesh was done by a terrestrial laser scanning and close-range photogrammetry, comparing the results (Pérez Ramos and Robleda Prieto 2015). As a conclusion, it can be said that the development of

FIGURE 1: China. Beijing. Yuanming Yuan. Xiyanglou. 3D reconstruction of an element of the balustrade. Simulation by Arqus3D.

FIGURE 2: China. Beijing. Yuanming Yuan. Xiyanglou. 3D reconstruction of a capital. Simulation by Arqus3D.

photogrammetry software has achieved a similar density between that provided by photogrammetry and by 3D scanning. Nevertheless, the combination of these two techniques is usually considered as the best option (Drap et al. 2003; Jordá et al. 2011). Although both aspects are relevant for cultural heritage, especially in sculpture and architecture, the case study presented here requires a better analysis of texture.

Taking again the examples from the Xiyanglou ruins, it has to be said that the remains can be found today both in the archaeological site, many far from their original location, and even in European museums (Figures 1 and 2). In this last case, many pieces have been linked to the palaces when in fact they were taken from other imperial buildings in Beijing. Only from detailed reconstructions can a final adscription be achieved. Furthermore, the impossibilities of putting together all these pieces of a puzzle requires three-dimensional reconstructions, only recently used in surveys from the eighteenth-century engravings and the nineteenth-century photos of the buildings. Some initial attempts have been recently carried with excellent results, which are now currently being enriched with new reconstructions (Gao et al. 2015).

As has been said with regard to light analysis, these tools cannot be used just as a way of visualizing the lost cultural heritage in form of reconstructions. Nor even can it merely be a way of preserving the archaeological site as it is. In this occasion, the pieces have to aid in the understanding of the buildings in a wider and more detailed sense. For example, three-dimensional reconstructions have

helped discover the engravings from which they are probably taken. At the same time, other surveys have shown that the engravings do not show all the building elements, or at least, not as they were ultimately built. Thus, some virtual reconstructions are not completely accurate, without including these tools.

Big Data

The possibilities of Big Data in History have been a recurrent topic in recent years (Manning 2013). This coincided with the interest on Global History or Geography of Art. Many scholars saw the possibilities of dealing with a large quantity of varied sources to arrive at a new history from several perspectives. Unfortunately, most of the approaches to Big Data have dealt with the possibilities that it might achieve and not about the application of the technique to specific cases. On the contrary, other scholars have worked on the theoretical and technical problems of Big Data.[3] Thus, the discussions about normalization, thesauri or terminology have been commonplace. Surprisingly, the deontological approach has overshadowed its application in specific cases, focusing on the scientific results of the new tools, and not so much on the software itself. Although the theoretical discussion, and the technical improvement, is always welcomed, it is necessary to insist on producing results from the possibilities of the tools. Fortunately, in recent years these same scholars have used the tools to reach new answers (Rodríguez Ortega 2015).

The attempts to use Big Data in history have to take into account a profound theoretical problem, viz. changing from a qualitative to a quantitative approach. Until now, most of the historical research on Early Modern History is based on the analysis of specific data, mainly from written sources. The information given by multiple textual passages is used to reconstruct a historical process. This approach has some problems. First, the sources used have to be read by the scholar(s), who can make a qualitative selection of passages, and thus the number of records is always very limited. Second, the original writer can manipulate the qualitative information given for different reasons. This circumstance is very common in overseas colonial administration as a result of distance between metropole and colony, for example. Third, the qualitative extraction might assign importance to a topic selected by the scholar, but one perhaps irrelevant to the historical development of that society. Finally, the qualitative analysis of sources has been done across decades on the same sources, making the results less valuable. That being said, a good use of the qualitative analysis can be very fruitful if done from scratch.

From this perspective, this project has adapted an existing piece of software used initially for sociological research (Barros et al. 2005). The tool is based on a simple .csv file with few fields, such as date, title of the document, text,

language and link to the transcription. Then this database is fed into the extractor, which offers the results in a .json file. The software also provides a visualization in different charts. For this project, a list of forty documents has been selected. They are Spanish-language manuscripts and printed sources from the late sixteenth century concerning the European presence in China. The transcriptions were done by the project called *La China en España,* thus providing several assurances.[4] First, the documents were manually transcribed by scholars. In contrast to the typical dirtiness from digital transcriptions, the texts were correctly written. Unfortunately, the paleographical labor maintained the original spelling, making the extractor's later searching more difficult. Second, a wide range of sources from that period on the topic in Spanish were provided in plain text. Conversely, the texts from the eighteenth century were digitized and/or transcribed by different projects and are of various qualities. Furthermore, the selection of texts had no scientific basis; thus, the results given by the software are not worthwhile.

Nonetheless, once the sources are collected, the list of terms to be used by the extractor was created. In this occasion, four different word groupings were carried out ultimately to compare the range of the presence of these topics in the texts. The categories were (1) architecture, (2) religion, (3) commerce and (4) war.[5] At this time, the presence of missionaries in China resulted from religious expansion. Thus, it was probable that the terms related to the apostolic mission would be the most common in these religious texts. But their role in China was not only religious, but also strategic, that is, imperial. During this period, the possibility of attacking China militarily was studied and consequently the information on China's defensive prowess was also addressed. Commerce was also a key topic at this time, in an attempt to connect continental activity with the new Spanish presence in the Philippines. Finally, the architectural interest of the missionaries should be limited relative to the other three topics. Although architecture's importance can be found as part of the problem of religion, such as information for building churches and colleges, as well as under the guise of war, attempting to explain, for instance, the characteristics of the cities and their defences, the missionaries ought not to have had the task of reporting on architecture.

However, according to the Big Data extractor's results, the importance of architectonical terms was noteworthy, compared with the others. The topic with the second-most importance is commerce. Surprisingly, the missionaries did not pay much attention to religious topics. Terms such as 'rite', 'god', 'friar' or 'martyrdom' were not too commonplace. Finally, topics related to war seemed to be the least important issue for them. From these results, which may lead to a more in-depth analysis of the data, it can be said that the Spanish presence in China at the end of the sixteenth century was characterized by the interest in architecture, and along with it, the Chinese culture generally.

From these results, it can be said that the possibilities of Big Data in history are not just a promise (Eijnatten et al. 2013), but a reality. This does not show all the options available, but merely a single one. As it has been shown by other scholars, Big Data can provide many other answers when insisting on metadata analysis.

Conclusions

In general, it can be said that the scientific work on art history requires taking into consideration these tools, and maybe other similar ones. Without them, many topics would not be addressed fully, and many of the current discussions would have a different perspective. Not only do studies on conservation, restoration and enhancement of cultural heritage have to take advantage of them, but so do archaeological or architectonic studies, which have a longer historical foundation. Art historians have to work on developing these sources and put them into open access. Both tools and contents are usually lost after the end of the projects' funds, which requires the next researcher to repeat the labor.

From the aforementioned tools, another conclusion can be reached. Although here they have been introduced as parallel instruments, it is obvious that in the near future they should work together. Light analysis cannot work properly without the complexity of the dense clouds created by photogrammetry. As such, the possibilities of the anastylosis are not reduced to a visualization of a scientific proposal or even to a way of preserving the building virtually. Reconstruction allows for a lighting simulation, which can be even complemented by including furniture, for example, later. Similarly, the architectural element analyzed with photogrammetry is not merely a visualization, but rather a translation of the piece into geometry. As a 'mathematic object', it can be included in a database, and then treated with Big Data. To take advantage of these possibilities requires a wide range of pieces to be reconstructed and a powerful piece of software.

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NOTES

1. According to Promey and Stewart, three terms are common in the discussions on the development of emerging technologies in the history of art: access, interaction and collaboration (Promey and Stewart 1997). Other scholars have noted the advantages and disadvantages of access to the images (Cohen et al. 1997). A more recent approach to some of these online databases can be consulted in Bentkowska-Kafel et al. (2006) and also in Zorich (2012).
2. Some interesting works on digital images can be found in the proceedings of the conferences organized by CHArt in 2005 (Bentkowska-Kafel et al. 2005), and, more specifically, in Bentkowska-Kafel et al. (2009).
3. One of the key contributions in this context in recent years has been the results of the ATENA project (Rodríguez Ortega 2009).
4. The Research Project *La China en España: Elaboración de un Corpus digitalizado de documentos españoles sobre China de 1555 a 1900* (BHA2000-0939) was directed by Mª Dolors Folch-Fornesa at the Universitat Pompeu Fabra between 2003 and 2006.
5. The software is being adapted from a previous tool used for discussions in the European Union. For this reason, the titles of the chart are not yet changed. Thus, 'education' corresponds with 'architecture'; 'European common identities' with 'war'; 'European international ties' with 'commerce'; and 'youth' with 'religion'. 'European regional identities' is a fourth category that was not used in this case. For this reason, that part of the chart is empty.

Imaging technologies applied to questions of authorship

Nicholas Eastaugh

Introduction

There is a long-standing history of using imaging technologies, such as infrared reflectography and X-radiography, to study artworks. These complement other elements of the scholarly apparatus like connoisseurship and provenance, to support and enable judgments around questions of originality and intent, authorship and authenticity. Interest in, and study of, the materiality of artworks itself has a long history: largely orthogonal to other approaches for the understanding of paintings and their contexts it has been slower to establish as a separate scholarly domain. Nonetheless, the last 20 to 30 years have seen dramatic growth such that 'technical art history' and 'art science' have developed into a vibrant field. Inherently multidisciplinary, researchers in a wide range of domains now contribute, from historians (not only of art but also technology and economics), through to 'hard' scientists, conservation specialists, software engineers and more. Within this, imaging (in its numerous manifestations) forms a key subdomain.

Imaging and image interpretation of artworks is used for many purposes and demonstrates much of the breadth of thought and approach in the current field. These range from material composition through pigment identification, compositional development (an artist's *pentimenti* say), physical condition, to attribution and authenticity issues. Extensively applied to explore questions about specific paintings, these tools are also finding increasing use in broader studies of artists and schools. They also apply in the art market as part of larger-scale risk-mitigation strategies during commercial transactions.

Imaging is not confined to these 'hardware' aspects alone though. It is equally important how images are interpreted during later stages of a study where the raw data of an image is taken and converted to meaningful knowledge. The topic can thus be broken down into three elements: the underlying technologies used; the

nature of the data that comes from these techniques and what can be derived and inferred from it; and the ways in which that data can be interrogated to provide insight over questions such as authorship.

Object to image

A canonical set of imaging techniques exists, long established, applicable to the examination of artworks. In addition to conventional film-based photography, a suite of four specialized technologies evolved based on infrared, X-ray, so-called 'ultraviolet fluorescence' and 'raking light' (oblique illumination to show surface texture). These became an established family of approaches from early in the twentieth century and remain in general application today. X-radiography was first applied to paintings very shortly after the discovery of X-rays, then routinely from the 1920s and 1930s onwards (Vanpaemel 2010). Likewise, the Wood's lamp, a practical ultraviolet light source, similarly joined the suite of tools soon after its development. Infrared photography was equally found to reveal important information and added to the canon by the 1930s, though the development of so-called 'reflectography' in the 1960s along with the advent of IR sensitive video cameras was perhaps the defining development (van Asperen de Boer 1968). These have been found to give rich insights from practical, easily applied technologies. Long-standing use of these canonical methods also means that there are by now extensive archives of resulting images along with considerable accumulated expertise in reading and interpreting them. Consequently, they continue to be a mainstay of physical examination, even if practitioners have moved from photographic emulsions to digital sensors of one sort or another. At the same time the large embodied knowledge of image collections has provided a level of inertia to replacement by newer technologies. On the other hand, the implementations of these canonical techniques have benefitted enormously from improvements to both sensor technologies and the ready availability of image processing and analysis tools.

One of the strongest areas of development has been in the accurate representation of objects, including color accuracy and spatial resolution. A critical part of this has been in the availability of low-cost high-resolution sensor chips based on silicon. With a response to light from the ultraviolet into the near infrared and available in increasingly high pixel densities with falling price-performance points, silicon sensors have revolutionized the market. This has led not only to enormous improvements in quality, but also radically extended the technical possibilities.

The drive to improve color accuracy was perhaps originally motivated by the desire to precisely record works of art as part of their long-term care by monitoring

whether chromatic changes are taking place (Martinez et al. 1993). Central to this has also been the move from simple color sensors – the red, green and blue of most cameras – to systems capable of recording numerous bands across the visible light spectrum. The inherent advantage is that this gives a more precise representation of the spectral characteristics of the reflected light. Typically, these systems – 'multispectral' cameras – record perhaps a dozen or more bands. In a further evolution, the spectrum is sliced up even more finely into hundreds of bands to give what is termed 'hyperspectral' imaging. The benefit of this for applications such as color reproduction are, however, frequently redundant since the reflectance profiles are typically broad and without fine detail. Rather, it is in the deeper applications of the technology that the merits of hyperspectral imaging come to the fore (Liang 2012).

Alongside color accuracy, the availability of ultra-high definition images is opening out further possibilities. Probably best known through the Google Art Project as well as numerous other applications of zoomable and scrollable images such as in geographical mapping applications, the resulting 'gigapixel' images (so-called because they contain billions of pixels rather than millions) give access to extremely high-resolution imagery, far in excess of what is often available as 'high resolution' that may in practice be only a few 10s of megapixels in size. Importantly, such images now allow examination of very fine detail in paintings down to the level of, for example, individual brushstrokes and craquelure. In consequence, much more refined judgments regarding style and technique can be made about an artwork. This is especially helpful when the work is no longer available for direct study, allowing cross-comparisons with other examples that might normally be impossible to bring together, reliant on the personal memory of a specialist.

Silicon is not, however, the only sensor substrate in use. Of the alternatives, indium-gallium-arsenide (InGaAs) and mercury-cadmium-telluride (MCT) are probably the most important for their sensitivity deeper into the infrared. Such sensors unfortunately have a low native resolution, so for serious imaging on artworks they are built into scanning systems to allow mosaic-building, where hundreds to thousands of images are composited into a high-resolution, seamless panorama (Martinez et al. 2002).

The interest in technologies capable of imaging artworks past the red end of the visible spectrum, the 'near' infrared (NIR), has primarily developed out of the long-standing application to reflectography. This exploits the phenomenon of variable transparency of paint films at different wavelengths to enable visualization of features lying beneath the surface. Imaging of underdrawing has been a major contribution to the study of authorship in paintings, permitting a fuller comprehension of artists' working practices and extending the evidence used in attribution questions. Practical experience (as well as theoretical consideration)

has further shown that deeper IR cameras can confer additional benefits, such as in the case of the National Gallery, London version of Leonardo's *Virgin of the Rocks*, where important new underdrawing was revealed (Syson and Billinge 2005). Higher spatial resolutions, deeper IR sensitivity and falling costs are all contributing to much wider availability of such data, to the point of it being routine rather than specialist to use these tools.

Such systems can be further optimized by selecting specific parts of the spectrum where transparency is maximized, though this is dependent on the composition and structure of the painting, properties that may not be well known in advance. A solution to this can be to capture a series of images in bands across the spectrum and then examine for features in multispectral images. This has been a key development, if one where the tools to handle and meaningfully assist in the interpretation of the data sets are still evolving.

At the same time a frequent misconception of IR imaging is that it somehow allows one to successively 'remove' layers of paint to see what lies underneath. This is not so. While deeper structures can be revealed, IR reflectography is not a process by which overlying strata can be selectively divested from top to bottom. To do that one needs to apply a technique capable of providing true 3D information, of which the most significant technology currently applied to paintings is optical coherence tomography (OCT). OCT captures volumetric data sets from light-scattering paint films by utilizing a technique known as low-coherence interferometry. The resulting images are extremely high-resolution, potentially down to the wavelength of light, and can reveal structures that are otherwise difficult to acquire non-invasively (i.e. without taking physical samples of paint). Embedded features such as paint layer boundaries and underdrawing are found by scanning depth-wise through the volumetric data set. However, it is currently challenging to apply routinely across large areas of a painting, so effectively sits as an approach between data from point-like micro-samples such as paint cross-sections and whole-object mapping by, say, conventional IR imaging (Liang et al. 2005).

Like IR reflectography, X-radiography is still widely practiced but is reaching a point where new approaches are arriving that supplement or even begin to replace it. Radiography works on paintings because X-rays are blocked to different degrees by the constituent materials by virtue of their inherent absorption and thickness. For example, pigments based on lead (such as 'lead white') stop the passage of X-rays more effectively than materials based on organic compounds (such as carbon blacks or the binding medium of the paint). The main transition at the present time in the conventional technology is the shift from photographic film, which is still quite widely used, to direct X-ray sensors such as amorphous silica panels and line-scan cameras. These simplify the routine acquisition of high-quality, high-resolution digital images (Schalm et al. 2011), again raising quality and availability of key data.

X-rays can also be used in more specific ways though to reveal the internal composition and structure. The simpler form of this involves a phenomenon known as X-ray fluorescence (XRF), where X-rays are absorbed by atoms and re-emitted at energies associated with specific elements. XRF has been used for many years to identify the elemental composition of paintings, but recently the technology has been developed to perform these analyses in situ in very small areas and sufficiently fast that elemental composition maps can be built (Howard et al. 2012). Although essentially a surface technique, enough of an underlying structure can be detected to reveal buried details, with some notable successes with this approach (Dik et al. 2008).

Finally, some mentioned should be made of so-called 'terahertz' technology (THz). THz is another segment of the electromagnetic spectrum, falling between infrared and microwaves; probably the best-known application is to non-X-ray airport security screening. However, it has been shown that THz radiation will interact meaningfully with materials in artworks and provide information on hidden structures and composition. Typically, in the variant known as THz Time-Domain Spectroscopy (THz-TDS), this is an active area of research both for the 3D imaging potential and for molecular characterization of constituents of paintings. Whether it becomes a canonical technique very much remains to be established, however (Fukunaga et al. 2009; Groves et al. 2009; Picollo et al. 2015).

Image to data

So far, the discussion has focused on the acquisition technologies currently in the toolkit used to structurally explore and document the construction of physical objects. However, this leads to a much larger set of questions surrounding what, precisely, can be done with that data. This is relevant on two levels: what types of information are forthcoming from each technique (or, conversely, what technique should be selected to elicit a particular sort of information) and, crucially, how does one go about extracting meaningful knowledge from the results?

The canonical methods generate images that have traditionally been interpreted visually and stylistically alongside the object itself to reach deeper understanding of embedded structures such as underdrawing and *pentimenti*, as well as make more purely stylistic judgments relevant to authorship questions. The outputs of these imaging technologies have also long been exploited not only by the specialists who prepare the images, but also by a consumer class in need of information to support better judgments. That is, a wide range of people by now claim a right to interpret the results – for the visually acute images are beguiling, whether or

not the full technical possibilities and limitations are necessarily apparent without specialist scientific knowledge. Conversely, it may be debatable whether the content and implications of such images can be laid entirely bare without considerable art-historical knowledge and sensitivity to form and function of artists' intent.

Increasingly data sets are being created that push the boundaries of direct visual evaluation, n-dimensional data hypercubes that cannot be simply displayed but which are nonetheless amenable to higher-level mathematical analysis. Even when there may be a direct spatial correlation to the object itself, the information can be such that data-reduction algorithms are required to visually explore it or require a more abstracted interpretation and statistical evaluation. The questions then become what form the data takes and how to make good use of it, including the possibilities and pitfalls of such abstraction. A simple example is the use of hyperspectral imaging described earlier in the context of accurate spectral reconstruction. There are other ways to use the data sets created though. One grows from the capacity to relate the spectral reflectance data to the intrinsic composition of the paint film and attempt pigment characterization. Another exploits the phenomenon of variable transparency of paint at different wavelengths that underlies infrared reflectography to provide a kind of 'tunable' imaging system for underdrawing as a means of optimizing revelation of what is hidden beneath the surface.

In spectral imaging for analysis, the reflectance characteristics at each 'pixel' are used to compare to known spectra for specific pigments. By reference to a suitable library, inferences can be made regarding the probable composition of the paint film (Casini et al. 1999; Ribés et al. 2005). Pigment analysis and identification is in practice a hard problem though. The kinds of information required to make truly meaningful judgments beyond the relatively trivial and potentially error-prone require multiple approaches not necessarily amenable at this time to in situ interrogation if the analyses are to be sufficiently specific and robust. For example, it may be difficult or impossible to differentiate natural and synthetic analogues of the same compound, essential when trying to, say, identify synthetic ultramarine, a compound only introduced in the earlier nineteenth century, in contradistinction to its earlier counterpart, the mineral lazurite. Similarly, detection of low levels of critical admixtures or contaminants can be considerably challenging, such as traces of 'dateable' pigments like titanium dioxide white in otherwise historically appropriate pigments. These kinds of problems render practical limits to the technology, and it is perhaps surprising therefore that to date there is little in the way of rigorous and systematic cross-comparisons of performance.

Hyperspectral imaging can on the other hand help with problems such as alleviating a fundamental challenge for invasive analysis: the need to both identify as many differences (say, all pigments in the artist's palette or critical features

of individual technique) while minimizing – for ethical reasons – the amount of physical material removed for laboratory analysis. Alternatively, another way of asking this is the question to what extent does a sample taken at a specific location represents the rest of the painting? It is possible to go some way toward resolving this through image segmentation, classifying regions of the painting on the basis of their spectral characteristics. The simplest approach to segmentation like this involves using color, multi- or hyperspectral data and converting it into a color space, such as CIE LAB, that separates out lightness from color components to remove the impact of admixtures of a neutral white pigment. The resulting color-map can then be segmented into uniform regions using algorithms such as principal components analysis or k-means clustering, allowing the analyst to more efficiently and effectively target further analysis, perhaps much lower resolution XRF mapping and/or ex situ sampling. Combined approaches like this, exploiting the benefits of each, hold significant potential (Conover et al. 2015).

More problematic though is how to meaningfully extract information about embedded structures from these types of data set. Since they do not form true 3D images, interpreting observable features requires significant care – one cannot necessarily tell where a particular mark lies in the overall stratigraphy. Expert judgment is applied to form an interpretation, with reference back to the original object where additional confirmation might be needed. This becomes increasingly complex with multi- and hyperspectral data sets since there are correspondingly many images to be cross-examined, only some of which may contain features of interest. Moreover, contiguous features may not be visible optimally in one channel alone – differences in the overlying structure may mean that parts are apparent across multiple wavelengths. To overcome this, a simple strategy of giving a viewer an animated image, sweeping through the spectrum so that the brain can perform a higher-level process for significance, is used. Apart from the inconvenience (there is perhaps a sense that a static feature like an underdrawing should be visible in a single image) this can also unfortunately lead more easily to misinterpretation with features visible to one observer and not another, or open to ambiguous interpretation. This is somewhat antithetical to the scientific process, though in due course, no doubt, more robust approaches will be developed to address these concerns.

At the same time forms of assisted interpretation are already finding significant use for other areas. A good example of this is canvas weave analysis – stemming from signal processing, this uses frequency-domain analysis of fabric structures, typically via X-ray images, to determine fundamental properties such as thread count and orientation. The resultant data allows statistically meaningful cross-comparison to other artworks, such as to show which paintings may have come from the same bolt of cloth or fall within the range known to have been used by a specific artist. Work on Van Gogh is a notable example here (Johnson et al. 2009).

Data to knowledge

To this point the discussion has been about the imaging technologies on the one hand and material/structural relationship of the resulting data sets on the other. However, there is a further 'meta' level of interpretation that can be considered, roughly akin to stylistic analysis.

A well-known example of this is fractals in the dripped and poured works of Jackson Pollock. Fractals are mathematical sets that are self-similar at every scale. Examples of fractal-like structures are found extensively in nature, which means that natural phenomena can be potentially modelled using fractals. In the case of Pollock's dripped and poured paintings, the argument has been made that the paint flows follow such scalar self-similarity and are therefore amenable to fractal modelling, the 'fractal dimension' further being claimed to be distinctive for Pollock as opposed to copyists and imitators (Taylor et al. 1999, 2007). In practice the basic analytical strategy is to perform a color separation step and then use a technique known as box-counting, the application of a successively scaled mesh to determine features across a range of scales. For the curious there is an extensive literature providing the evolving debate over the validity of the approach, but in essence problems have been pointed out ranging from issues of whether the fractal dimension can be reliably determined, through whether Pollock's paintings are actually 'multi-fractal' (i.e. have different fractal dimensions at different scales), to whether the fractal dimension is, truly, diagnostic for Pollock (Shamir 2015).

Extending the idea of metrics, a range of visible features are amenable to these approaches and one simply has to think of typical pictorial elements to begin a list: the range of colors present, the shape and orientation of brushstrokes, the way boundaries and compositional features are constructed, appearance in other modes like X-ray and so forth. There is a corresponding (and growing) toolkit of algorithms to quantify these: color gamut, oriented spatial filters, wavelets and curvelets, Zernike polynomials, Haralick textures and numerous others. Metrics can also be combined, boosting the individual performance by using multiple, perhaps individually weak but jointly strong, parameters (Irfan and Stork 2009; Shamir 2015).

At this point the elements are in place to relate the data to knowledge. 'Classifiers' are in essence ways of taking a set of metrics and calculating similarities and differences between the objects represented. Perhaps the simplest way of imagining this classification process is to view it as a form of map, values of the metrics providing locations akin to latitude and longitude. Similarity is then distance and place – say, how far it is from London to Paris, Madrid or New York, or whether the city falls within a specific country, the United Kingdom, France or the United

States of America. However, this process can be done using many dimensions rather than just the two or three that can be easily visualized as surfaces using algorithms such as 'support vector machines' (SVMs), extracting the most statistically significant similarities, those objects that are 'closest' in an n-dimensional space or within certain bounds.

These approaches can also be extended to address other types of art-historical questions, such as where a painting fits into an artist's stylistic evolution – that is, how properties correlate to the known progression of works and where would a painting of unknown date lie in this (Brown et al. 2013). Comparable attempts have also been made to exploring how many artists were involved in the production of an individual painting, such as with Perugino (Lyu et al. 2004).

The future

There is perhaps an interesting parallel with the evolution of formal approaches to attribution of art through examination of micro-scale features: Morellianism, as well as its descendent the 'Pictology' of van Dantzig, emphasize the close analysis of small details (Dantzig 1973; Wollheim 1973) . Algorithmic approaches potentially offer a similar means of 'measuring' the features of an artwork, though in more open and replicable ways. For example, van Dantzig's methodology encourages the analyst to attribute values to features such as stroke length and orientation, though providing no clear metric scales for them. On the other hand, measures like color gamut or texture orientation can provide robust and objective frameworks in such studies. There are significant challenges involved and one needs to be aware of both the mathematical complexities and the art-historical foundations required. For example, while the algorithms being used are widely applied and understood within image processing, there also needs to be a correspondingly full comprehension of the issues that surround art-historical attribution and *oeuvre* construction. Poorly defined or overly limited training/test data can, say, be as much of a problem as inappropriate algorithm choice, while boundary questions of authorship and differing scholarly opinion are a perennial challenge. Moreover, the attribution problems for which solutions are most needed are rarely the core cases where all are agreed, but at the boundaries where uncertainty and ambiguity will always lie.

Such challenges notwithstanding, the forward trajectory of this field is probably not hard to discern. For the recently novel imaging techniques, the capabilities and limitations are still to be fully explored and the essential process of technology transfer into the wider use market is slow. There is potential to resolve new and interesting features in artworks but the extent to which each technique builds sufficiently on current capability, or is fully practical to implement, frequently

remains an open question. Whether they will go on to become part of the canonical set therefore remains to be seen, though some notably hyperspectral imaging are already significant tools, while others, like XRF mapping, apparently offer such significant upside capabilities that current disadvantages will probably be overcome simply because the will to do so exists. At the same time, it may not be the underlying technologies that ultimately have the greatest impact, but what is done with the data. This is the era of 'Big Data': massive collections of complex information being mined for fresh knowledge. Accumulating large-scale corpora of high-quality scientific image sets presents its own set of practical issues, probably requiring order of magnitude drops in speed to acquire and cost, but the ultimate rewards are potentially enormous. The greatest challenges then come, not from the technologies themselves, but how the field goes on to use them and integrate them into new forms of art history. This is no less true of the commercial art market, where there is a huge need for timely and objective evaluations. The future impact will undoubtedly be profound.

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PART II

Knowledge Presentation and Visualization

The chapters in this section are both connected by a concern for the visual presentation of knowledge. Stephen Boyd Davis provides a discussion, with an historical focus, of attempts to visualize time mechanically by using timelines. In doing so he encapsulates some of the central issues digital timelines encounter in representing history. In the contribution that follows, Brett Bligh and Katharina Lorenz explore the use of multi-display learning spaces in art history to present, analyze and interpret pictures and other visual evidence. In doing so, they contextualize their account with a description of the centrality of the traditional use of double-slide projection as part of art-historical methods. Clearly, the techniques and technologies discussed respectively by Boyd Davis and Bligh and Lorenz are quite different. However, at a broad level, the respective contributions both share an underlying interest in the way in which visualization and the presentation of images mediate the activities of disciplinary inquiry. Boyd Davis contrasts the established use of a uniform scale to depict historical time with the possibility of a more interpretative and rhetorical approach. Bligh and Lorenz compare multi-display learning spaces with the use of dual slide-projections, which promote the perception of objectivity and authority in the analysis of images. In doing so, both chapters identify that there is greater scope for current technologies to provide opportunities for disciplinary understandings that are more nuanced and complex.

Time machines

Stephen Boyd Davis

Computing mechanizes knowledge. For some people this continues to be controversial. In recent years, some of this controversy has centered on the Digital Humanities, though attempts to defend the human in historiography go back further (e.g. Bridenbaugh 1963: 326 on the 'dehumanizing methods of social sciences'). There is a fear of 'an age where new electronic resources make it possible to do literary research without reading at all' (Culler 2010: 24) or in which 'digitization leads to the decline of the sacred' (Marche 2012). The purpose of this chapter is not to prolong that debate, but to cast it in a historical perspective by looking back to an earlier mechanization of knowledge in the form of uniform, arithmetic representations of historical time. Principally from the eighteenth century, these diagrams predate mechanized computing by almost a century, but are driven, I argue, by a similar enthusiasm for the mechanical – reflected in the concepts of automated cognition and mechanistic knowledge structures, set in a broader mechanical culture – perhaps the first emergence of a machine aesthetic.

When computational machinery was introduced in the mid-nineteenth century, an important dichotomy immediately emerged between mechanical approaches to repetitive work and mechanical approaches to humanistic endeavors, casting light forward to the debates of our own time and backward to attitudes to mechanism in the previous century. When Babbage made his famous remark that astronomical tables should be calculated by steam (Swade 2001: 9) he was invoking the mechanical as a way of eliminating human weakness in ability and performance, maximizing reliable production. This is the mechanical in its most obvious form, where the application of industrial mechanisms such as textile machinery, previously devoted to alleviating or improving the work of the hand, is reapplied to the work of the mind. The *Difference Engine* does useful work, minimizing human toil and avoiding the errors that bedevil some kinds of human performance. Yet as Schaffer (1996: 58) recounts, there was quite another side to Babbage's concept of the machine. Babbage owned an automaton dancer that he put on a glass pedestal in his Marylebone salon in the room next to the unfinished portion of the *Difference Engine*. He also owned a silk portrait of Jacquard, the inventor of the punched-card system

for programming looms, woven on just such a loom (Hyman 1985: 181). Babbage used these items to demonstrate to his guests the subtlety and apparently humanistic qualities achievable with an automatic, mechanical system. As Ada Lovelace realized, his *Analytical Engine,* far exceeding the capabilities of its predecessor, was not merely capable of useful work: such a mechanical system might compose elaborate music (Fuegi and Francis 2003). And when the *Analytical Engine* 'weaves algebraical patterns just as the Jacquard-loom weaves flowers and leaves' (Menabrea and Lovelace 1842), this is mathematics considered as philosophical inquiry not just as functional work. This 'other history' of mechanization is important when we consider the relationship between historiography and mechanism.

Chronographics and the timeline

The history of chronographics – visualizations of chronology – has tended to escape serious study: an early exception was Twyman's work at Reading (Twyman 1986, 1990). However, there are signs of increased critical engagement with these significant cultural forms: Rosenberg and Grafton (2010) is the standard work on the history of 'cartographies of time', while Rosenberg (2007) is essential on the chronographic work of Joseph Priestley, an important figure discussed below. A salient word in such studies is 'timeline'. The earliest relevant citation in the Oxford English Dictionary (2011) is from William James' *Principles of Psychology* (1890: 86). Only one component of James' diagram is the 'time-line', rather than the whole design (Figure 1). Nevertheless it shows the key concept of events marked against a regular, uniform 'clock', an idea fundamental to the examples discussed below.

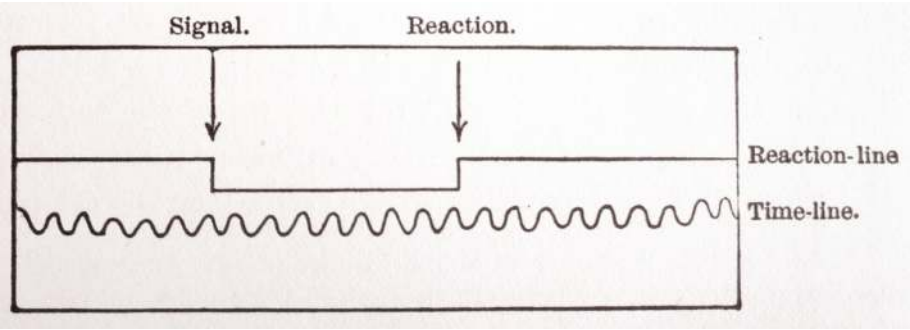


FIGURE 1: An early use of the word timeline (spelled as time-line) in something like its present sense. The waves of the time-line here represent regular time intervals, while the *reaction-line* above it shows a pair of events. From p. 86 of William James' *Principles of Psychology*, vol. 1, 1890, Wellcome Library, London.

Chronology was once a discipline in its own right. Early chronologists, working with lists and tables of events, provided the essential scaffolding of historical time that we now take for granted. Feeney records many instances from classical times (Feeney 2007), while Grafton has traced extensive Renaissance practice, in particular the work of Scaliger (Grafton 1975, 1983, 1985). In the eighteenth century, while 'history' had connotations of perhaps unreliable narrative, chronology offered rigor. It added – various authors argued – meaning, vividness, memorability, an evidential basis and a unifying framework. Locke considered chronology necessary to give history form and meaning (Locke 1693). A landmark in the discipline is Eusebius's *Chronicle* of *c.* 300 CE, which synchronized Christian history with that of the Pagans and Jews in a series of parallel columns, allowing parallelism of events to be observed as well as sequence (Feeney 2007: 29). Meanwhile a quite different graphical tradition exploited the metaphorical and pictorial, attempting to give to history an image and character derived from creatures, humans and other natural phenomena, to assign to history a meaningful shape. I will return to this metaphorical impulse at the end of the chapter. Yet a third influence is that of machines in the form of astrolabes and other devices, and their paper equivalents as *volvelles*. These employed cut-out paper components, typically a small movable disc mounted within a larger one, to determine the locations of the heavenly bodies, tides, the timing of Easter and as other analogue calculators (Kanas 2012: 234). They did not generally deal in historic time, but they may have influenced an early eighteenth-century *volvelle* that did, discussed below.

Nicole Oresme, alone in the 1350s, anticipates later quantitative time graphics (Oresme 1428; Clagett 1968). He traces variation in 'qualities' by altering the distance of a drawn arc from a horizontal baseline that represents elapsed time – perhaps the first visible line-as-time, though Oresme himself traces the idea to Aristotle (*Physics* Book 4) (Clagett 1959: 333). It is intriguing that Oresme also anticipated later adoption of the clock as a metaphor of the heavens (Clagett 1970: 223).

In 1609 Helvicus (1581–1617) attempted to use visual space to enhance the reader's grasp of temporal intervals in his tabular chronology, by using an equal number of pages for every century: '*per aequalia Centenariorum et Decadum spacia distributio*)' (Helvicus 1609: *Ad Lectorem*). Like Eusebius and others, he recognized the potential of the other, non-temporal, dimension: 'the Synchronism of Famous Men, renowned either for their Vertues or their Villanies, doth very much promote a sound knowledge in History' (Helvicus 1687: *To the Reader*: iv).

At the opening of the eighteenth century, the *Discus Chronologicus* (1720) of Christoph Weigel (1654–1725) offered a circular diagram with a paper pointer pivoted in the center, marked in equal intervals of historic time, echoing the form of a clock. Weigel emphasized the structural qualities that his *volvelle* brings out – the 'correct year-order and succession' (*richtigen Jahr-ordnung und folge*). Like

Helvicus, he highlighted his ability to show both sequence and synchrony of events: 'one can see in one effortless view which rulers reigned in the same time together' (*man auch dabey in einem anblick onschwer sehen könne, welche zu gleicher Zeit miteinander regieret haben*, Weigel 1720: rubric on chart).

This theme is taken up in a large rectangular chart published in 1750 by Jean-Louis Barbeau de la Bruyère (1710–81), which attempted comprehensively to map historic time against location, capturing all of the known world since the biblical Flood. Barbeau is not explicit about any mechanical inspiration, but it is interesting to compare his design with those of the man whom he assisted, the Abbé Lenglet du Fresnoy (1674–1755) who in 1729, when Barbeau was 19, published the *Méthode pour étudier l'Histoire* (Lenglet 1729a) and *Tables Chronologiques* (Lenglet 1729b). The four folio sheets of Lenglet's *Tables* together comprise a matrix of roughly synchronized columns of kingdoms, a layout that harks back to the many tabular, typographic productions of the past. The widths of Lenglet's columns are more or less arbitrary, dictated only by the amount of information they need to contain, and the vertical intervals are not uniform, simply listing one event after another regardless of the time elapsing between – but Barbeau reworks this design on a more rigorous, arithmetic, basis, true to his own mechanical-sounding terms: 'order and precision' (*ordre & précision*, Barbeau 1750b: rubric on chart). Barbeau's *Explication* shows a vital difference from Lenglet's *Tables*: measurement. Width shows each regime's territorial extent, and height its duration (*La largeur marque son étendue, & la hauteur sa durée*, Barbeau 1750a: 7), so that any part of the chart yields with some accuracy both the geographic and temporal extents of a particular nation (Boyd Davis 2015b).

Three years later, in 1753, historic time was mapped truly arithmetically to space by doctor, botanist and philologist Jacques Barbeu-Dubourg (1709–79), who created a chart 16.5 meters long plotting all history from the Creation to his own time on a uniform timescale (Ferguson 1991). It is accompanied in the author's explanatory leaflet by a significant appearance of *mechanism* as a desirable model.

Mechanizing cognition

Barbeu-Dubourg acknowledges that he has been inspired by Geography, with its maps, globes and other appealing visual aids[1]; he now plans to make Chronology equally beguiling:

> a science of memory so cold, so sterile, so insipid, may become a science entertaining, and so to speak *mechanised* [pour ainsi dire *méchanique*], which speaks to the eyes and to the mind, […] where memorable events so strike the senses,

> organise themselves so effortlessly in the memory, and are imprinted there so strongly, that we learn almost *automatically* [on s'instruit presque *machinalement*], hardly needing to think what we do.
>
> (Barbeu-Dubourg [1753] 2009: 8, emphasis added)

Machinalement like all mechanical terms was an ambivalent concept. On the one hand *machinale* was said of natural movements in which the will plays no role (*se dit des mouvemens naturels où la volonté n'a point de part*, Dictionnaire de l'Académie Française 1762). In this context, thoughtless automatism is foremost. At the same time in English the word *mechanical* had a number of derogatory senses. It could deprecate materialist philosophies: 'meer Mechanical Principles' are compared unfavorably with those of St. Paul (Anon. 1708: 149). An attack on the 3rd Earl of Bute's encouraging scientific interests in the young George III complains of his 'mechanical toys, baubles, and gimcracks' (Almon 1792: 287). Class condescension is evident, especially where, as was traditional, the mechanical arts are contrasted with the liberal. Defoe mocks one who had 'an Inclination of laying aside his mechanical Employment, to translate himself into a Gentleman' (Defoe 1742: 211). Even Franklin could write 'The Arts, which are more or less liberal or mechanical, as they more or less partake of assistance from the operations of the mind' (Franklin 1769: 331), and elsewhere regrets the 'mechanical sort of Enjoyment' experienced by 'People of low Education and mean Understandings' (Franklin 1750: 39).

So much for the mechanical, apparently. But there is implied praise in Hume's view that the mechanical and liberal arts are mutually dependent (Hume 1753: 26), while Hooke saw Wren as admirably combining 'such a mechanical hand, and so philosophical a mind' (Hooke 1665: Preface), and was later himself praised for 'his mechanical inventions' (Albin 1795: 654). The great *Encyclopédie* of Diderot and d'Alembert, inspired by Bacon and Locke, aimed to treat the mechanical and liberal arts with equal respect (Pannabecker 1994). Though Mayr (1986: 125) suggests a growing British aversion at this time to mechanical metaphors and models, a more nuanced impression emerges when these terms are mapped to the motivations of the authors. For freethinkers, dissenters, proto-scientists and atheists 'mechanical' could be a term of admiration, while for conservatives it was generally a term of abuse. McCallam (2014) contrasts the push at this time among French radicals for rational, logically interrelated measures, against the arbitrary units of the *Ancien Régime*.

In Barbeu-Dubourg's argument, the claimed facility to perceive and to remember *presque machinalement*, effortlessly, is clearly a virtue. Lenglet had claimed that his design constituted '*une méthode que je présente autant aux yeux qu'à l'esprit*' (a method that I present as much to the eyes as to the intellect; Lenglet 1729a: 108), while Barbeau had also claimed that his chart enabled the reader *de*

voir d'un coup-d'oeil tous les Siécles passés (to see at one glance all the Centuries that have passed; Barbeau 1750a: 38). Barbeu-Dubourg is the first to connect this to the concepts *méchanique* and *machinalement*, which he promotes somewhat naively.[2] By contrast, the explanations of Joseph Priestley (1733–1804), theologian, dissenter, natural philosopher and radical, are subtle and thoughtful. At one point in his booklet describing his 1765 *Chart of Biography*, he explains that the chart is 'one of the mechanical methods of facilitating the study of that science [ie. history]' (Priestley 1764: 4*n*) – a familiar praise of the mechanical. But another usage is noteworthy: Priestley discusses how the timescale of his *Chart* (like Barbeu-Dubourg's) is linear, using equal space for equal time. He compares his own design favorably with the non-linear design of a recently imported French chart, almost certainly that of Barbeau de la Bruyère discussed above (Barbeau 1750b). Clearly the mechanical in visual perception is a quality that must be handled with care:

> the same scale is made use of through the whole of the chart of Biography [i.e. Priestley's own], whereas several are used in that of History [i.e. Barbeau's]: the consequence of which is that, in comparing intervals of time in different parts of that chart, the imagination is necessarily imposed upon. Even the notice which is given of this change is not sufficient to correct the error of the imagination, which is *impressed mechanically by the view of the spaces* […] in the chart.
>
> (Priestley 1764: 8, emphasis added)

In other words, something misleadingly designed, once perceived, will be fixed in the memory: what is cognized mechanically cannot be undone by ratiocination. In our own time the visual is often presented as unambiguously beneficial; since that early remark by Priestley the potential of visualization to deceive has been little touched on, though a worthy heir of Priestley in this respect is Tufte (1983; 1997), who repeatedly emphasizes the misleading nature of much visual information.

Mechanical knowledge structures

Barbeu-Dubourg seems in 1753 to have been the first to plot historical time linearly and arithmetically on a uniform scale, while in 1765 Priestley was the first to represent duration using a printed line to represent each life (Twyman 1986): 'They are the lines, in this case, which suggest the ideas, and this they do immediately, without the intervention of words' (Priestley 1764: 9). This eminently mechanical approach to representation takes Priestley some effort to explain, but he suggests that it works because it is natural to think about time as

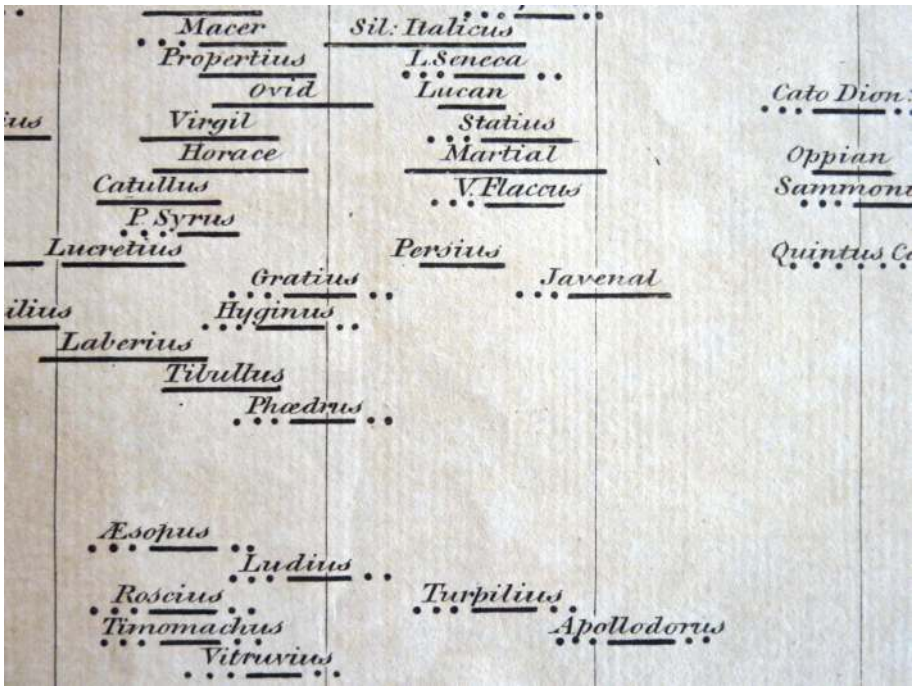


FIGURE 2: Joseph Priestley's 1765 *Chart of Biography* (detail). Clusters and periods with little data are clearly visible in this mechanical mapping of time to space. Photo: Stephen Boyd Davis. With permission Chetham's Library, Manchester.

though it were space (1764: 7). One automatically maps to the other: a certain lifetime produces a line of a corresponding length, as though drawn mechanically (Figure 2). The result has an intriguing resemblance to the later invention of the piano-roll, which of course embodies a reverse relationship, in which a representation drives a machine.

In 1753 Barbeu-Dubourg went so far as to build an actual machine (*une Machine d'un usage facile e commode*) to house and present his historical timeline (Figure 3).

In his 1777 *Harmony of the Evangelists in Greek* (subsequently 1780 in English), Priestley grappled, as many have done, with the problem of deriving one history from the four gospel accounts in the New Testament, and espouses an explicitly mechanical approach. He shares some of Barbeu-Dubourg's over-enthusiasm for rapid and automatic comprehension:

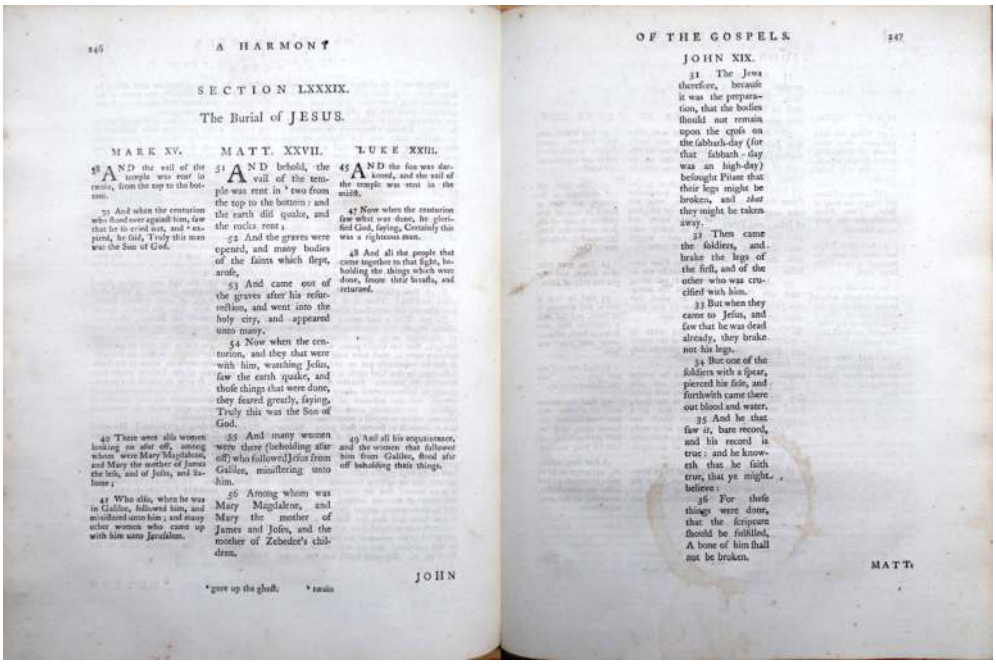
> I venture to say that, by the help of such a *mechanical* contrivance as this, a person of a very moderate capacity, or critical skill, will have an advantage over a person of the greatest genius and comprehension of mind without it.
>
> (Priestley 1780: xvii, emphasis added)

FIGURE 3: J. Barbeu-Dubourg 1753. The *Carte Chronographique* housed in its machine. Photo: Stephen Boyd Davis. Permission of Rare Book Division, Department of Rare Books and Special Collections, Princeton University Library.

This unfortunately echoes all too closely Swift's parodic professor with an *Engine*, who announces to Gulliver that 'the most ignorant person at a reasonable charge, and with a little bodily labour, may write books in philosophy, poetry, politics, law, mathematics, and theology, without the least assistance from genius or study' (Swift 1726: 71). Swift's intolerance of the mechanical is explicit – this is 'a Project for improving speculative Knowledge by practical and mechanical Operations' – cohering with his generally conservative point of view.

Figure 4 shows the result of Priestley's mechanical process. The most striking feature is the visual gaps, the empty spaces, at times resembling the famous empty page in *Tristram Shandy* by Priestley's older contemporary Sterne (1713–68). He describes his approach: 'If I should be thought to have succeeded in this work better than the generality of my predecessors, I shall attribute it chiefly to the *mechanical methods* I made use of' (Priestley 1777: xvi, original emphasis). He goes on to explain how he cut up two copies of the gospels and rearranged them (1777: xvii) to create his design.

Priestley had already noted in his *Description of a Chart of Biography* how empty space has meaning. The empty spaces in the *Chart* reveal to Priestley the disastrous absences in the Dark Ages: 'the thin and void places in the chart are, in fact, not less instructive than the most crowded, in giving us an idea of the great interruptions of science, and the intervals at which it has flourished' (Priestley 1764: 24). A mechanical model of historical time is crucial to revealing these patterns, clusters, drifts and absences. What Poole calls the 'lumpish quality of time' (Poole 1998: 23) of previous centuries, with its uneven succession of periods



246 A HARMONY

SECTION LXXXIX.

The Burial of JESUS.

MARK XV.

38 AND the veil of the temple was rent in twain, from the top to the bottom.

39 And when the centurion who ſtood over againſt him, ſaw that he ſo cried out, and *expired, he ſaid, Truly this man was the Son of God.

40 There were alſo women looking on afar off, among whom were Mary Magdalene, and Mary the mother of James the leſs, and of Joſes, and Salome;

41 Who alſo, when he was in Galilee, followed him, and miniſtered unto him; and many other women who came up with him unto Jeruſalem.

MATT. XXVII.

51 AND behold, the veil of the temple was rent in *two from the top to the bottom: and the earth did quake, and the rocks rent;

52 And the graves were opened, and many bodies of the ſaints which ſlept, aroſe,

53 And came out of the graves after his reſurrection, and went into the holy city, and appeared unto many.

54 Now when the centurion, and they that were with him, watching Jeſus, ſaw the earth quake, and thoſe things that were done, they feared greatly, ſaying, Truly this was the Son of God.

55 And many women were there (beholding afar off) who followed Jeſus from Galilee, miniſtering unto him.

56 Among whom was Mary Magdalene, and Mary the mother of James and Joſes, and the mother of Zebedee's children.

LUKE XXIII.

45 AND the ſun was darkened, and the veil of the temple was rent in the midſt.

47 Now when the centurion ſaw what was done, he glorified God, ſaying, Certainly this was a righteous man.

48 And all the people that came together to that ſight, beholding the things which were done, ſmote their breaſts, and returned.

49 And all his acquaintance, and the women that followed him from Galilee, ſtood afar off beholding theſe things.

JOHN

*gave up the ghoſt. *twain

OF THE GOSPELS. 247

JOHN XIX.

31 The Jews therefore, becauſe it was the preparation, that the bodies ſhould not remain upon the croſs on the ſabbath-day (for that ſabbath-day was an high-day) beſought Pilate that their legs might be broken, and *that* they might be taken away.

32 Then came the ſoldiers, and brake the legs of the firſt, and of the other who was crucified with him.

33 But when they came to Jeſus, and ſaw that he was dead already, they brake not his legs.

34 But one of the ſoldiers with a ſpear, pierced his ſide, and forthwith came there out blood and water.

35 And he that ſaw *it*, bare record, and his record is true: and he knoweth that he ſaith true, that ye might believe:

36 For theſe things were done, that the ſcripture ſhould be fulfilled, A bone of him ſhall not be broken.

MATT.

FIGURE 4: Pages 246 and 247 of Priestley's *Harmony of the Evangelists* of 1780. Aligning the four Gospel accounts according to time, using between one and four columns per page. Collection: Stephen Boyd Davis. Photo: Stephen Boyd Davis.

of different qualities, has been replaced by Newtonian time, an absolute, neutral and uniform container for events, whose patterning emerges graphically.

Priestley is linked to Barbeu-Dubourg by a shared friendship with Benjamin Franklin, whose works the Frenchman translated. Mechanical methods for handling knowledge emerge also in a letter from Franklin to Priestley. Writing in response to a request for advice, Franklin, instead of answering the question, outlines his 'moral or prudential algebra' (Franklin 1772). A miniature of Bentham's later felicific calculus, it is a visual method for balancing all the weighted advantages and disadvantages of a course of action on a single sheet of paper until a clear preference emerges. Like Priestley's innovations in diagramming time, it depends on having all the data in view and organized on a surface according to a mechanical system, and emphasizes the automatic emergence of sense. Both the information handling and the resulting cognition are mechanized.

Mechanical culture

Today it may be difficult for us to enthuse about mechanical uniformity, but this was one of the great cultural innovations of the eighteenth century – though admittedly with deep roots, for example in the shift from hours of unequal length to

those measurable by clocks (Dohrn-van Rossum 1996: 19) or the aural uniformity introduced by the ticking of Huygens' spring mechanism in the 1670s (Sherman 1996). The eighteenth century was the century of Tull's improved design of seed drill which, though not widely adopted, would have been familiar in 'improving' circles like Priestley's: hand-broadcast seed was replaced by multiple parallel lines of plants. Natural watercourses were mechanized through the canal system, with over 3,100 miles of canal built in Britain between 1760 and 1800 (Lowson 1998). Urban terraces in improved cities like Bath and Edinburgh employed simple repetition and equality of every unit in the façade. Even pavements, until mid-eighteenth century in Britain the responsibility of individual householders and therefore having different heights, materials and quality, began to be replaced by uniform paving funded through local taxation (Cockayne 2007: 202). In terms of measurement, it was in 1758 that a standard Yard measure was first established in Britain (Sawday 2007: 71), while in 1752 Britain's calendar had at last been made consistent with that proposed by Pope Gregory XIII in 1582.

Schaffer shows how the principles of mechanization in this period encompassed such apparently diverse fields as the world of entertainment and the factory system (Schaffer 1999). The year 1759 saw both Van Kempelen's mechanical chess-playing Turk and Arkwright's patents for the spinning frame. At its worst, machine inspiration resulted in proto-Taylorist images like Adam Ferguson's: 'Manufactures, accordingly, prosper most, where the mind is least consulted, and where the workshop may, without any great effort of the imagination, be considered as an engine, the parts of which are men' (Ferguson 1767: 273). Interestingly it was this same Ferguson (1723–1816) who created another early timeline, the first to appear in the *Encyclopaedia Britannica* (2nd edition 1780: plate opposite p. 3689). Perhaps the timeline and the mechanical vision of the workshop are two indicators of a single informing fondness for the machine. One of the students whose thesis examination Barbeu-Dubourg presided over, in February 1768, would later find his name given to a famously mechanical engine of death: Joseph-Ignace Guillotin (Delaunay 1904: 12). Sawday (2007: 97) makes the interesting observation that, for machinery during the Renaissance period, simplicity and efficiency were not important criteria: complexity was welcomed. It is the eighteenth century that sees the emergence of a machine aesthetic as we would recognize it today: the rigor and abstemiousness of the Barbeu-Dubourg and Priestley timelines are a part of this visual culture.

Though Babbage and Lovelace's thinking pointed to the future, their work also had echoes of the automata of Barbeu-Dubourg and Priestley's century, which intrigued by showing subtle behaviors while being mere machines. While perhaps to our eyes projects such as Vaucanson's automaton *Duck* and *Flute Player* appear bathetic, in contemporary accounts what comes across strongly is the desire to make machinery sensitive and subtle. Vaucanson had to acquire new knowledge

about how the sounds of a flute are produced, to the extent that his notes are used today by musical scholars studying the flute playing techniques of the period (Lasocki 1979). Subtle investigation and transformation were essential to his working method, not 'mere' mechanization.

The application of mechanical uniformity to chronography created new problems of its own, including the alarming extent of nearly blank paper. Because of the long timescale of Barbeu-Dubourg's chart (he starts with the Creation in 4700 BCE while Priestley starts at 1200 BCE), his readers are presented with a large area of nothing very much: there are almost no persons or events in the first eight sheets of his long timeline. The new format could not accommodate the fact that there is almost always more data available for recent times than for the distant past, and that this would seem to require some kind of non-linear 'perspective', where the nearest time is assigned more space. Such a perspective was indeed adopted by Barbeau de la Bruyère, of which Priestley was so critical.

Mechanical approaches in question

The mechanical approach to chronographics, new in the eighteenth century, led to the emergence of quantitative graphics such as Playfair's 'lineal arithmetic' in the form of line graphs and bar charts in the 1780s (Costigan-Eaves and Macdonald-Ross 1990: 325), mechanical diagrams devoid of figurative visual metaphor. Twyman (1990) notes how this emergence of modern information graphics in the late eighteenth century, including Lambert in Germany in the 1760s and 1770s and Playfair in the 1780s, is an important cultural shift 'yet to be satisfactorily explained'. It is also important to note that the ancient figurative-metaphorical tradition was by no means overwhelmed by this emergence of the arithmetic-mechanical. The very neutrality of mechanical approaches seemed to some to diminish their ability to 'tell a story'. Though the clustering through time, combined with the grouping into countries and categories common in such visualizations, has evident explanatory power, it seemed to some rhetorically inadequate. They abandoned the abstemious mechanical plotting of lifelines to time for richer visual forms. As Rosenberg (2007: 83) highlights, Strass (1766–1845) specifically objected to the flatness and neutrality of Priestley's view, favoring a highly authored, hand-drawn grouping and linking of currents and tributaries in the stream of time (Figure 5).

Similarly, Emma Willard (1787–1870), educator and activist, complained:

> Mere straight lines not wrought into a picture, and presenting no form or comeliness to the eye, are unattractive. The young (and the old too) do not feel any

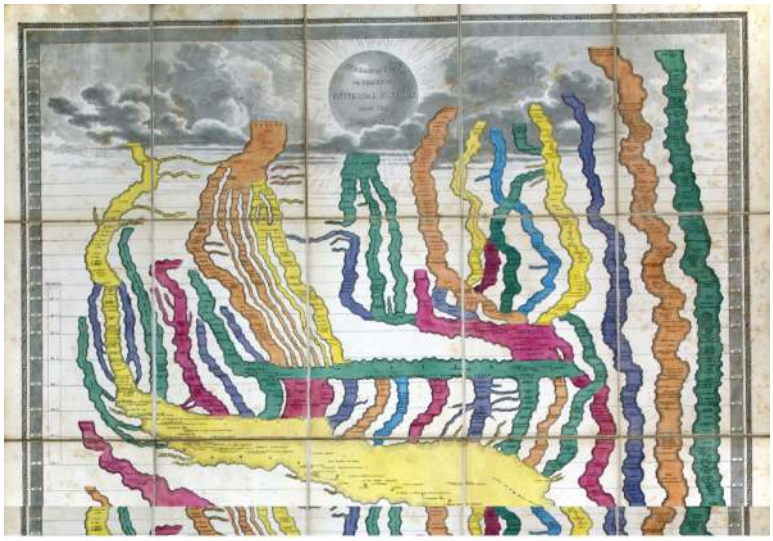


FIGURE 5: W. H. Strass 1849. *Stream of Time, or Chart of Universal History*. London: C. Smith, Mapseller. Detail. The mechanical neutrality of Priestley's chart is replaced by the rhetoric of hand-drawn rivers of time. Collection: Stephen Boyd Davis. Photo: Stephen Boyd Davis.

> wish to look at them, and thus they carry away no distinct impression. They are like a succession of monotonous sounds, which no one remembers; while the arrangement of sounds in tunes, or lines in pictures, are attended to with pleasure, and easily remembered.
>
> (Willard 1849: 12n)

Willard invokes pleasure and memorability as the key advantages of her preferred visual rhetoric. She does not acknowledge that it facilitates her projecting a very particular interpretation of history, to translate her country as a physical entity into the image of a unified nation (Schulten 2007).

Implications

The objection that charts such as Priestley's do not properly represent *history* is echoed still today: 'history is not imaged in the graph, only time. Priestley's chart took time for history' (Maas and Morgan 2002: 102). The application of mechanism or of computing to any task habitually prioritizes those things that are easiest to do, and the automatic distribution of events across a graphical space is no exception. It is easier to chart chronology than to chart history. Little has so far been done to extend visual sense-making to embrace the rhetorical or narrative tradition championed by Strass and Willard. This is an important topic for research.

Yet even within 'simple' chronographics there is much to play for. At their best, they yield knowledge unavailable by other means. Where they are interactive, they can be interrogated to yield new insights. But they must be designed with the complexities, subtleties – the sheer messiness – of history in mind. The growth of Digital Humanities has seen a new interest in historical visualization – some conceiving time as an obvious 'dimension' against which to map artefacts, such as Manovich's *Software Studies Initiative* (Manovich 2010), while others question such use, for example in the *Temporal Modelling* project at Virginia and its successors (Nowviskie 2004; Drucker 2011; Nowviskie et al. 2013). The relative lack of critical debate around temporal mapping is particularly regrettable when contrasted with the richer discourse around cartography and its digital forms, now often discussed under the aegis of Spatial Humanities (Bodenhamer et al. 2010; Gregory and Geddes 2014).

Thoughtful practical attempts at interactive, digital timelines started to emerge in Massachusetts Institute of Technology's *Simile* (Simile 2009), Southampton University's *Continuum* (André et al. 2007) and a long series of deeply considered temporal visualizations (but not applied to history more broadly) at University of Maryland (Plaisant et al. 1996; Wongsuphasawat et al. 2011; Du et al. 2016). Three-dimensional chronographics have been evaluated experimentally, though inconclusively (Korallo et al. 2013). Kräutli has investigated the contribution of critically informed design at the intersection of the humanities and the digital (Boyd Davis and Kräutli 2015). As he points out, crucial to visual historiography is a mature approach to uncertainty. Most of the generic forms of data-uncertainty identified by Pham et al. (2009) affect historical material, including limited accuracy, missing data, incomplete definition, inconsistency, personal bias, ambiguity of description and embedded assumptions. At the United Kingdom National Archives, a recent AHRC-funded project has devised methods of computing the likelihood of two named individuals in fact being the same person – and the answers produced by such a process must be a likelihood, not a binary choice (Bell and Ranade 2015), with complexities that demand suitable graphic representation. Yet because computers deal most easily with certainty, we pretend graphically that our data are sure, precise and uncontested (Boyd Davis et al. 2013). Indeed digital methods often introduce *new* problems such as quantization (Kräutli and Boyd Davis 2013; Boyd Davis and Kräutli 2015: 108).

Though each of these insights and advances is helpful, much remains to be done before we can say we have a digital repertoire worthy of historical research and presentation. Simplistic use of machines produces simplistic representations of knowledge. Perhaps now is the moment for Temporal Humanities, in which the visual representation of historic time would become a substantive, perpetually contentious subject rather than a series of assumptions.

Acknowledgments

I am grateful to Prof. Michael Twyman, Prof. Anthony Grafton, to Chetham's Library Manchester and Princeton University Library, the Bibliothèque Municipale Dijon, and Wellcome Library London, and also to Christine North and Florian Kräutli for advice on translation. My thanks to postgraduates at Middlesex University, Emma Bevan and Aleksei Kudikov, and research students at the Royal College of Art, Florian Kräutli (EPSRC CASE award EP/J502169/1 and System Simulation Ltd), Sam Cottrell (AHRC CDA AH/M004775/1 and The National Archives) and Olivia Vane (AHRC award AH/L503782/1 through the London Doctoral Consortium), for grappling with the design challenges of digital chronographics.

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NOTES

1. See Boyd Davis (2015a) for the adoption of geography and cartography as metaphors for history and chronology. I argue there that this is in itself dependent on historical time being seen as a dimension analogous to those of space.
2. Barbeu-Dubourg seems to have tended toward the naïve. His political essay Petit Code de la Raison Humaine (1773) seems almost childish, though admired by Benjamin Franklin. He lost his small fortune in attempting idealistically to supply arms to the American Revolution, competing unsuccessfully for the role with Beaumarchais, the author of *The Barber of Seville* and *The Marriage of Figaro* (Bass 1970).

Vorsprung durch Technik: Multi-display learning spaces and art-historical method

Brett Bligh and Katharina Lorenz

Introduction

This chapter considers the potential of multi-display learning spaces for presenting, analyzing and interpreting art-historical visual materials – in other words, for mediating art-historical discourse. More specifically, we suggest that a display ecology, shaped around a suite of multiple screens, can be used to support methodologically appropriate teaching and learning practices in art-historical disciplines. By 'display ecology' we mean employing together 'a variety of tools for collaboration and information sharing […] in which the individual displays influence the roles of others' (Huang et al. 2006: 321).[1]

The use of PowerPoint and similar digital presentation tools has attracted widespread criticism across domains such as business meetings. In contrast, these tools have supplanted the role of their predigital antecedents across art-historical disciplines with minimal critical comment (Reichle 2002: 50–52 with a critical stance). This is surprising, in particular because art history as a discipline, and the heuristic processes of discovery of knowledge within it, have always been linked to the mechanisms for visualizing a corpus of core materials. We argue, therefore, that the typical use of PowerPoint-like tools (slideware) invites inappropriate forms of argumentation by presenters and constrains questioning and other forms of interaction by members of audiences. We subsequently document how slideware can be used within a novel display ecology to offer more favorable conditions for disciplinary argumentation.

Our discussion is structured as follows. First, we briefly summarize the use of double-slide projection in the late nineteenth and early twentieth centuries. We refer in particular to Heinrich Wölfflin and his use of projected slides to support art-historical rhetoric in the formalist tradition. We examine how this technology

was used to construct methodology and influence discussion. Second, we acknowledge the shift away from the formalist tradition within art history. We discuss how arguments are scaffolded around pictures in the visual culture studies and postmodern iconology traditions. Third, we assess general criticisms of slideware from the vantage point of art history and suggest that the rhetoric that is typically fostered, stunts different forms of engagement. Finally, we consider our experiences of using technology-rich multi-display learning spaces (MD-LS) within postgraduate education in the area of ancient art history and classical archaeology. We describe the emerging methodology. We conclude by suggesting that such settings, if used with thoughtful planning, enable presenters and audiences to consider visual evidence together, in an episodic and exploratory manner, rather than as isolated images considered in a predetermined sequence.

Historical context

The analysis of pictures and other visual evidence forms the core of both research and teaching activities in art-historical disciplines. Such analysis typically assumes a verbal form, which poses a multifaceted challenge, since what is being studied is material whose essence relies on a visual modality. This challenge of *ekphrasis*, the translation of a visual experience into a linguistic modality, has been acknowledged since the beginning of modern art-historical inquiry in the eighteenth century (Elsner 2010). A successive range of tools has been adopted that supports art historians to address this challenge, including sets of originals, casts and photographs, lantern-slide projectors (used either singly or side-by-side to support double-slide projection) and contemporary digital presentation technologies. Each tool provides a range of possibilities to *mediate* the activities of art-historical inquiry (on mediation see Lektorsky 2009). One way in which this mediation is accomplished is by altering the structure of the process of viewing and affecting how verbal exposition is synchronized with visual evidence, for example in the course of a lecture. Another occurs through enabling the development of the rules of activity operating within the community, both explicitly and tacitly – rules that influence how argument is structured by presenters and how disagreements between participants are allowed to be resolved in lectures.

Art-historical method works to structure the process of viewing at both material and intellectual levels. Well into the twentieth century, art history was dominated by methods concerned with the morphology and style of individual works of art. Priority was given to questions of connoisseurship and the attribution of art works to individual artists. From the early twentieth century onwards this tradition of inquiry utilized the structuring process of comparative viewing

(Nelson 2000: 429; Friedberg 2006: 196). Works of art were described and analyzed in relation to other artefacts.

Technology was intertwined in both the development and implementation of the comparative viewing process. Innovations generally have both structural and historical character: they occur by taking advantage of possibilities for change within a system, and by remolding available resources. In this sense, it is necessary to consider the immediately preceding history of the introduction of lantern-slide projectors, which laid some necessary groundwork for what was to come. Herman Grimm spearheaded this introduction, suggesting that lantern-slide projectors could be the 'microscope' of art history and so allow findings to be constructed on top of quantifiable data (Grimm 1897: 280). Illustrated lectures based around lantern-slide projection became internationally popular and came to represent the discipline itself (Fawcett 1983; Dilly 1995; Nelson 2000: 415; Reichle 2005: 169–81). So the technology and the repertoire of actions around it became accepted practice within the art history community.

Part of the practice associated with lantern-slide projectors reduced the load of *ekphrasis* by adopting a deictic model of argumentation, that is, by suggesting that the lecturer spoke on behalf of the images themselves. Prior methods of illustrating lectures, such as passing round photographs, meant that the visual and the verbal were poorly synchronized. Members of the audience might have already seen the relevant photograph and half-forgotten it, or else it had not yet reached them. This necessitated hard narrative labor. Narrators needed to describe and argue simultaneously to capture the contextual meaning of their points. With the lantern-slide projector, the visual evidence required in-the-moment was available as a common resource, and orators' new ways of expressing their analysis were able to *assume* this visual point of commonality and thus to concentrate their efforts more selectively. Grimm was keen to highlight the structural objectivity and interpersonal authority that were the perceived result (Grimm 1897: 307–08).

The innovation of placing two lantern-slide projectors side by side was in some sense merely a progression. Properties of images can be captured verbally in a straightforward way by progression or comparison and the use of lantern-slide projectors was being commonly advocated. Yet this vantage point misses the qualitative nature of the change that was about to occur – changing how visualization, on the one hand, and analysis and knowledge production, on the other, mutually supported each other.

Heinrich Wölfflin was specifically interested in comparison, thus opening up an exploratory field for discourse *between* two items on offer. Wölfflin's *technical* innovation was indeed double-projection, simultaneously displaying two slides using two lantern projectors that were operated independently of each other (Bligh and Lorenz 2010: 1617). This formed the material basis for Wölfflin's *analytical*

innovation, allowing comparative viewing to operate as a structured comparison of artworks based around five 'binary concepts'. The internal dynamics of this technical and analytical system meant that, over time, new actions were introduced to the repertoire of presenters, building further on the conventions associated with the use of two projectors. An example is the use of 'anchor slides', in which one image is used to provide long-term contextualization to a sequence of other images presented on the opposite slide-projector.

In turn, the repertoire of technology use and analytical methodology underpinned particular forms of knowledge production with wider significance. Presenters now proceeded according to a specific analytical structure, invoking a yet greater sense of argumentational 'objectivity' and reinforcing the authority of the speaker as an 'ideal beholder' working on behalf of members of the audience (Landsberger 1924: 93–94). The darkness of the room and the brightness of the lantern images further supported the creation of what have been characterized as 'epiphanic' experiences (Dilly 1995: 42).

This historical excursus demonstrates that the technical means of visual presentation can form part of a mutually supporting system that also encompasses analytical method and knowledge production, in turn providing new possibilities for art-historical discourse. Or, put differently, analysis within an art-historical tradition can shape the method of presentation and the supporting technological tools; in the process, art-historical analysis is itself reshaped. To adopt methods of presentation from outside the discipline uncritically means missing out on the rich potential of this interaction.

This argument is not coupled exclusively to those forms of art-historical analysis concerned with form and style. Some of the specifics of practice we describe will be problematic to many art historians viewing our account from a contemporary perspective. Structurally, the tight clustering of visual objects and the linear drive of the exposition in lantern-slide projection curtailed the construction of alternative dianoetic perspectives based on the visual evidence. Interpersonally, discussion was discouraged by the accreted rules of the lecturing activity, whether explicitly acknowledged or not, and by the darkness of the physical setting.

Contemporary knowledge production

In recent decades, art history has shifted away from its traditional focus on form and style; increasingly, disciplinary practice values forms of knowledge that are holistic, multi-voiced, more widely contextual and culturally aware. If we are to suggest that new techniques for visual presentation might benefit from

similar forms of systemic, disciplinary interaction as those we have discussed for dual-slide projection and comparative viewing, then we need some understanding of contemporary approaches to analytical method and knowledge production. To proceed only from the assumptions of art-historical practice focused on form and style at this juncture would be a gross error. We therefore provide a brief overview of some pertinent aspects of two interrelated traditions – visual culture studies and postmodern iconology (or image studies) – both of which enjoy considerable popularity in contemporary practice.

Visual culture studies

Contemporary visual culture studies present an attempt to address the challenges posed by those new forms of transmission of mass media information that have emerged since the 1960s (on visual culture studies, see Bryson et al. 1994; Mirzoeff 1999; Elkins 2003; Dikovitskaya 2005; for a critical assessment, see Mitchell 2002; Schulz 2005: 86–124). Based on the fundamental assumptions of semiotics, this strand of scholarship examines the relationships between the content of a visual representation and the medium used to deliver it, focusing on the social significance of these relationships and so drawing attention to issues of audience. A sociopolitical mission is conspicuous: the ideologies of viewing are dissected; the mechanisms of existing power in both image production and consumption are highlighted; forms of visual representation are targeted as propagandistic; and the ideological implications of media in terms of class, gender and culture are foregrounded.

Postmodern iconology

Postmodern iconology, or image studies, aims to pursue the types of epistemic meaning elicited by an image in terms of aesthetics and philosophy. Discussed most prominently by William J. T. Mitchell (most recently: Mitchell 2006: 28–56, 48–56), postmodern iconology stands in contrast to visual culture studies' conceptualization of images in terms of audience and transmission because it starts from the image itself.

Postmodern iconology is influenced by Erwin Panofsky's methodological approach to iconology (for Panofsky's iconology, see Elsner and Lorenz 2012); in line with Panofsky, postmodern iconology assesses the visual elements within an image – figures and objects – in terms of their position within the history of styles and iconographical types. But the emphasis of the method has shifted away from Panofsky's focus on symbolic meaning toward issues of production and perception.

Criticisms of PowerPoint

Having examined the terrain of discourse concerning the interpretation of images within art-historical disciplines, we turn to a quite different strand of extant argumentation that is consequential for our argument about the display of images as slides. That strand of argumentation is concerned with constructing a general critique of how slideware (such as PowerPoint) is used, for example in business meetings.

The famous detractor of PowerPoint, Edward Tufte, argues (Tufte 2006: 158):

> PowerPoint's convenience for some presenters is costly to the content and the audience. These costs arise from the cognitive style characteristic of the standard default PP presentation: foreshortening of evidence and thought, low spatial resolution, an intensely hierarchical single-path structure as the model for organizing every type of content, breaking up narratives and data into slides and minimal fragments, rapid temporal sequencing of thin information rather than focused spatial analysis, conspicuous chartjunk and PP Phluff, branding of slides with logotypes, a preoccupation with format not content, incompetent designs for data graphics and tables, and a smirky commercialism that turns information into a sales pitch and presenters into marketeers. This cognitive style harms the quality of thought for the producers and the consumers of presentations.

Tufte, who is an information visualization expert, proffers myriad substantive complaints based mainly on content analysis of corporate presentations and PowerPoint manuals. We propose to attempt briefly the task of analyzing the relevance of Tufte's criticisms to art-historical presentations. We distinguish between these latter and the presentations Tufte studied in terms of, first, the differences in typical content and structure of materials and, second, how the slideware is used in-the-moment to support analysis and knowledge production.

As we have already established, art historians have been engaged in practice with slide projection technologies for well over a century and those tools have interacted with (and reciprocally shaped) analysis and discourse within the discipline over that time. Thus, historically established rules guide presentation activity within the discipline. This may explain why some of the worst excesses of slideware use are routinely avoided. Art-historical practitioners perceive their own discipline as one where presenters speak well in front of slides (Nelson 2000: 420 considers the experience of an art historian watching a presentation by a medical doctor). Art historians frequently structure a heavily verbal narration around slides containing only pictures and mainly avoid Tufte's hierarchical bullet lists and 'chartjunk' such as clipart. Where digital slideware is perceived as an advance over

lantern slides, it is due to its ability to present multiple pictures on one slide and to merge text and pictures (and even video and music). Image captions providing citation details are added easily and are common. Annotations drawing attention to elements within image objects are useful in complementing more traditional forms of highlighting, such as hand gestures or the use of a laser pointer.

Where the overt hierarchy of structure is avoided, the single-path nature of presentation is fully present. The low resolution of the computer projectors used with slideware, in comparison to lantern-slide projectors, means that slides that juxtapose multiple images may render those objects insufficiently legible. The result is that many presenters favor only a single image on each slide, in effect returning to the situation before dual-slide projection was introduced in the early twentieth century. To be precise, in the extended quotation above, Tufte is complaining about low resolution in terms of *information*, while we are using the word more simply, to mean the number of pixels that are displayed. But the effect here is the same: sequentiality, that is, many slides are required, separated by time rather than space. A heavy descriptive load is placed once more on exposition, the verbal mode, which must describe the works not currently present, as well as argue (structurally) and persuade (interpersonally). This fragments art-historical narrative.

If we want to point toward a better system of tool, analysis and knowledge production for art history, then we need to first establish what kind of presentation the discipline wants. Our summary of post-formalist traditions emphasized the explicit ways in which meaning is to be elicited from context. Rather than seeing meaning as immanent in the images, and thus potentially authoritative, this kind of contextualized knowledge production is participatory and allows for multiple interpretations. There is a desire to be persuasive, but also a desire for engaged audiences to disagree and resist, while remaining constrained within boundaries of relevance set by presenters. The situation is analogous to that of visual argumentation within film: 'we are neither compelled to share the point of view of the filmmaker, nor entirely free to supply pragmatic inferences or critical assessments of our own' (Alcolea-Banegas 2009: 260).

So our situation is both similar to and different from that considered by Tufte. The engineering and business presentations he tackles need to discuss issues that are causal, multivariate, comparative, evidence-based and resolution-intense (Tufte 2006: 170–71). The art history presentations we want share many of these properties. But Tufte's reasons for fomenting such discussions are to give the presenter 'nowhere to hide': to open the authority of the presenter to scrutiny by disallowing baseless assertions; to avoid the sloppy presentation of analysis which –in the most extreme cases in engineering – can lead to fatal accidents. So Tufte seeks to ascertain the *facts*, and derive authority by enforcing *rigor*. Our reasons for wanting discussion activity to be mediated differently by tools is to support better

conversations, opening up the space for response in order to better engage audiences with our *ideas*. This is not a question of assessing reliability, but of supporting multiple, valid, vantage points. In this context, those presenters whose ideas are challenged and reinterpreted by members of the audience have achieved a measure of success, rather than having been undermined.

This is our point of departure from Tufte. We share his distaste for many typical uses of PowerPoint-type slideware, but Tufte's vision of abandoning this slideware entirely in favor of written reports, to be read in communal silence at the start of a meeting, does not move us toward achieving our aims of better shared experiences of *ekphrasis*. We want the audience to engage with our narrative in-the-moment. So, while our art-historical presentations may be causal, multivariate, comparative, evidence-based and resolution-intense, they will also be deictic, performative, subtly orchestrated and both cognitively and interpersonally interactive.

Multi-display learning spaces in action

To illustrate some of our points, we provide an overview of a technology-rich learning space in a university and describe how this space has been used to teach ancient art history to students of classics. A detailed empirical report is offered elsewhere (Bligh and Lorenz 2010; for a technical overview, see Bligh and Sharples 2010). We limit ourselves here to a focus on technology and our experiences of using it.

Presenting art-historical argument to students involves drawing on the same repertoire of actions used to communicate with academic peers. This commonality serves a purpose: to introduce students to the art-historical discipline as a community of practice (Wenger 1998: pp. 45–47). One aim is for students to 'become' art historians, and for this to be accomplished by fostering engagement with authentic disciplinary discourse – in this case, argumentation about evidence from a vantage point influenced by definite methodological assumptions. A key difference between students and academic peers exists, however, with regard to the desire for engaged, critical discourse about pictures. Students are more often reticent, shy and hesitant in their attempts to intervene, or lack willingness to even try. So the challenge of overt engagement is rendered more difficult.

The work we describe here took place in England as part of the Visual Learning Lab project.[2] The aim was to investigate the use of presentation technologies across a range of projects. We had already been involved in investigating use of PolyVision Thunder,[3] and other novel presentation technologies, within an open access university library setting. For the work we describe here, however, we wanted to strip away the distractions of unusual teaching environments and radically idiosyncratic technology to focus on the use of PowerPoint across multiple screens within a small seminar room.

Multi-Slides is a plug-in for Microsoft PowerPoint that allows the presentation slides to be cascaded simultaneously across multiple screens as shown in Figure 1.[4] The information resolution of the presentation, that is, the amount of information that can be seen at the same time, is therefore increased. Sets of slides are juxtaposed together in space to form a display ecology of shared information, rather than only being encountered one at a time. Somewhat ironically, given our prior discussion of its limitations, a perceived advantage of Multi-Slides was that users could call upon their existing skills when authoring presentation materials by using PowerPoint itself. Later, at the presentation venue, the cascade of presentation materials is easy to set up by using a dialog box where the order in which material is displayed across the various screens is defined. In the seminar room used for this work, six large screens were available across two walls of the room. The slide cascade was set to move across the screens in order from left to right (Bligh and Lorenz 2010: 19).

The topic of the presentations was *Ancient Art and Its Interpreters*, being the title of a seminar-based Master of Arts module in which students are encouraged to think critically about ways of interpreting Greek and Roman art and archaeology. A number of sites, statues, vases, paintings, sarcophagi and other artefacts are introduced alongside various analytical methodologies. Students are expected to have some prior knowledge in the seminars and to this end are set a series of recommended readings. To support discussion within the seminars, different recommended readings are suggested for students, or groups of students, within the cohort.

FIGURE 1: A multi-display learning space at the University of Nottingham. © Brett Bligh, 2010.

The effect of the presentation tool on the structuring of visual materials was felt before the seminars, at the authoring stage. Motivated by a desire to enable comparisons across the spatially juxtaposed slides, the tutor started to construct her materials in 'chunks' of six, matching the number of screens across which these slides would be displayed and anticipating their simultaneous display. The word chunk is used to mean a *subdivision* of an ongoing stream of information, chosen so as to support convenient recall later. We use the term by loose analogy with the term 'chunking', used in both psychology and computer science. One difference between these uses is that, in human cognition and machine memory management, chunks are usually constructed so as to be convenient relative to *memory* size; in our case, the choice is made because of the convenience of later *display*.

The number of slides actually authored approached double that for equivalent sessions presented more conventionally. Yet the composition of the slides was overwhelmingly simple: nearly always just a single image, perhaps with a caption underneath. Given the abundance of slides, there was little temptation to fit multiple items on a single slide since this was not necessary to enable comparison. Over time, these sets of slides were so precisely authored to be shown together that they became thought of as a single entity, a 'slide-chunk'. The standard Microsoft PowerPoint authoring environment is ill-suited to authoring slides in this way; the slides cannot be seen together and so their juxtapositions are not easily checked, forcing the author to think about this task abstractly.

When enacting the presentation, the tool supported what we termed a 'loosened', episodic structure, varying from the standard single-path, with the presentation progressing in a linear manner overall, but operating in discursive episodes at the granularity of 'slide-chunks' rather than individual slides. An episode typically began by introducing six slides. A verbal argument was enacted by the presenter, and then time was provided for critical response by students. In general, enough visual material was available in spatially parallel form to support plausible art-historical discussion. The structure of the series of episodes, which would make up the seminar, was designed in advance to be cumulative. It aimed at building a lengthy participative discussion out of the framework formed by the individual episodes. Occasionally, the presenter briefly returned to the previous episode, necessitating a cumbersome backward-stepping through at least six slides. In other cases, progression between episodes was visually supported by displaying the first three slides of the current episode with the last three slides of the previous one. These 'mezzanine' episodes were, perhaps, less effective since the visual juxtaposition often appeared haphazard.

A significant factor supporting the mode of analysis and knowledge production was that of physical space, or, more broadly, materiality. The students had a clear field of view across all the screens and could scrutinize what they liked within

them by slightly turning their heads. In fact, students were also able to consult their own private papers (handwritten notes, paper copies of their set reading, etc.). The display ecology was therefore complex. Yet, during exposition, the presenter was able to suggest how to navigate through this information in various ways. First, the verbal narrative made clear reference to the images on display, inviting immediate scrutiny. Second, a laser pointer was used to highlight image elements using circling and underlining motions. Third, the presenter used bodily movement, physically walking around the room to stand next to an appropriately chosen screen. This latter mechanism served to support a multi-voiced deicticism, imperfectly realized. The presenter could speak on behalf of the artworks depicted in the images and quickly appear to change role (or shift persona) by moving in space to stand next to a different image.

The spatial configuration associated with the display ecology supported a change in how the presenter *performed* analysis and knowledge production. This, in turn, provided a mechanism for the constrained freedom of interpretation that we described previously as being analogous to film. These performative techniques, combined with other situational factors – such as the prior knowledge of the audience, the cumulative structure of the topics being discussed and the constant (and therefore predictable) visually partitioned structure of the room – served to reduce inappropriate forms of cognitive load (for a discussion on the limitations of applying cognitive load theory to classroom instruction and other orchestrated scenarios such as that discussed here, see de Jong 2010). We wanted the experience of students to be intellectually participatory (germane cognitive load) yet as free as possible of confusing or overwhelming visual stimuli (extraneous cognitive load). We contend that the tutor's mechanisms of orchestration allowed us to achieve this. The less frequent episodic transitions, produced by having double the amount of slides but only transitioning approximately one-sixth the number of times due to the size of the 'slide-chunks', seemed to enable a relaxed, contemplative atmosphere.

As well as cognitive interaction we also wanted to encourage more visible, interpersonal responses. Yet student reticence had not disappeared overnight. Students needed encouragement to speak and – more ambitiously – to develop their voice within the discipline. Partly, the rhetorical method used to provide this encouragement involved asking questions that students were *resourced* to answer using the visual materials being displayed. This is a form of visually stimulated *prolepsis* – that is students were supported in anticipating and then responding to the points of the presenters. Once a student had started to speak, the pedagogical task of encouraging them to flesh out their contributions more fully was rendered easier because the evidence underpinning their analysis remained available.

Students responded in a variety of ways, supported by the presentation tool. Students themselves used laser pointers to support 'shared looking' around the

room, in order to provide an evidential basis for their arguments. They referred to the screen 'over there'. On the other hand, we deliberately marked screens with numbers, but we were not successful in encouraging presenters to cite these numbers in their verbal exposition. On some rare occasions, students stood up and walked to the screens, emulating the performance of the speaker. Taking inspiration from the Design, Functions, Tasks (DeFT) framework for learning with multiple representations (Ainsworth 2006), students were encouraged to think in terms of contextualization, complementarity and competition. For example: an anchor slide depicting an aerial photograph of the Sperlonga grotto was used to contextualize catalogue images of artefacts originally discovered there; different views of a wine vessel were provided to allow students to provide an argument that linked together the unfolding narrative across the vessel's surfaces; and, to encourage thinking about competing evidence, images providing divergent interpretations of a myth were used to allow students to contradict the presenter's interpretation.

The timescale of our intervention did not allow for these actions to develop to become *ordinary* practice even within the local community. Yet, we argue that these early signs are suggestive of developmental potential for new interaction between visualization tools, modes of analysis and knowledge production – interactions that are appropriate within the contemporary context of art history as a discipline.

Vorsprung durch Technik[5]

Multi-display learning spaces, built around technological tools, can facilitate forms of complex argumentation well suited to current analytical methods such as visual culture studies and postmodern iconology. The audience can be invited to participate and to construct a shared analytical experience based on valuing and nurturing multiple perspectives. In contrast to Grimm's microscope analogy, multi-display learning spaces are perhaps closer to the spirit of Aby Warburg's *Mnemosyne* picture boards of the 1920s (Warnke and Brink 2000). Inspired by the *skioptikon* and radiographic displays (Hensel 2011: 143–61), Warburg grouped visual evidence according to themes and used relationality as an analytical principle to drill toward what he termed the 'psycho-history' of images. The *Mnemosyne* and multi-display learning spaces share an apparently banal but fundamental concept with visual culture studies and postmodern iconology: that the knowledge to be derived from images studied within relational frameworks is more meaningful than the sum of what could be extrapolated from each image individually. If the relation between tool, analysis and knowledge production can be successfully developed to encapsulate such a fundamental and inescapable tenet, in the process it may offer art-historical methodology an alternative to its reliance on single-path verbal and textual

analyses. Rather than being regarded as threatening to bring forth its obsolescence – as suggested by the title, *Technology and the Death of Art History*, of the conference at which this paper was first presented – technology will have then made yet another core contribution to the discipline.

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NOTES

1. Huang et al. describe how one display ecology supports workplace collaboration between Mars Exploration Rover mission staff at the NASA Jet Propulsion Labs. One difference between this work and our own should be highlighted immediately. Huang et al. describe how different displays serve to *form* an ecology, despite the individual displays not having been *designed* as a unified system. Our own work examines the use of an ecology of displays that are intended to work together and underpinned by a single technical system. Of course, it may be the case that even intentional display ecologies develop to encompass tools unintended by their designers, since other sources of information (such as personal devices) can also form part

of such an ecology in principle, though we do not analyze the use of personal display technologies in this chapter.

2. A Centre for Excellence in Teaching and Learning, funded by the Higher Education Funding Council for England. See http://www.nottingham.ac.uk/visuallearninglab/ for more details.
3. See http://www.youtube.com/watch?v=cn9DasZpdps for a video overview of the Poly-Vision Thunder presentation tool.
4. See http://www.multi-slides.com/. Accessed 30 July 2017.
5. Ger. = 'progress through technology', a slogan of German car maker Audi.

PART III

Virtual Museology

This final section brings together Anna Bentkowska-Kafel's chapter on the virtual museum and Almila Akdag Salah's account of the use of social network analysis to analyze deviantArt, which is an online social network site on which user-generated artworks are shared. As Bentkowska-Kafel observes, Erkki Huhtamo (2002) has remarked on the vagueness of the term virtual museum. The use of digital multimedia and virtual experiences has attracted allegations of edutainment and the diminution of the role of museums. In this regard, the juxtaposition of Akdag Salah's discussion of the deviantArt site with Bentkowska-Kafel's reflections on the impacts on museology and museum practice of networked digital technologies may, at least to some people, be controversial. However, it is that very possibility that points toward the primary reason for linking the two contributions. Bentkowska-Kafel proposes that virtual museology should not develop separately from the best established scholarly practices. The way in which digital technology offers opportunities for an inclusive and collaborative approach to museology does not warrant 'a need for discrete information communication museology and specialist digital preservation'. Akdag Salah discusses social network analysis in her chapter, which is a method that provides the opportunity to better understand the curatorial practices of not only deviantArt, but digital platforms more generally. It has analytical value in illuminating and assessing the museological implications of the adoption of digital techniques and technologies.

Virtual museum: The concept and transformation

Anna Bentkowska-Kafel

In November 2015 an editorial of a popular London newspaper headed, 'Virtual Museum', announced a launch of a website showing the British Museum captured through Google Street View technology (*Evening Standard* 2015: 14). In the same newspaper Blunden (2015: 23) described this new museum as open 'all hours on Google'. Concurrently, the European Commission (2015) opened a Horizon 2020 call for research projects investigating 'Virtual museums and social platform on European digital heritage, memory, identity and cultural interaction'. The term 'virtual museum' is used in the call to foster research supporting European cultural policy of the mid-2010s. The *Evening Standard*'s use of the term 'virtual museum' indicates the apparent colloquialism that does not require explanation, but is that really the case?

The concept of virtual museum is not new. Historically, its meaning has evolved to encompass new intellectual constructs and cultural phenomena, reflecting changes influenced by technological developments in information communication. Some of these historical developments impacted museology and museum practice well before the advent of modern computers and Internet technologies. The reflections on the subject, presented here, stem from the author's interest in historical approaches to documentation and critical visualization of cultural heritage, as well as applications of electronic imaging to recording and study of art and architecture (inter alia 3DVisA 2006–08; COSCH 2012–16). The chapter introduces applied research carried out in this area by the European Virtual Museum Transnational Network of Excellence (V-MusT 2011–15). The focus is on the scholarly methods of creating virtual collections and the pedagogy of virtual museums. How does one teach about virtual museums? Academic curricula are slow in adopting virtual museology and do not yet provide a ready answer.

The question concerning the place of virtual cultural heritage in the modern museum is an important one. Electronic tools for creating virtual collections are now available. World Wide Web repositories make the idea of a universal virtual 'museum

without walls', 'open all hours', to all, one that is particularly attractive. The vision is burdened with cognitive and experiential problems therefore controversial. The newspaper editorial mentioned before describes how, 'Not only will the technology allow 24-hour scrutiny of 4,500 of the [British] museum's holdings in very high definition, it will allow us to see artefacts so precious they are only on display for limited periods, thereby giving the virtual visitor the edge over real ones' (*Evening Standard* 2015: 14). This technological determinism, which equates a digital representation of an object with the object itself, is not uncommon. The present time, marked by enthusiasm toward digital technology, as well as apprehension of its ubiquity, is right to continue the debate on modern museology and its concepts of museum.

Digital media industries are thriving on the demand for experiences that blur the physical and virtual realities. Capitalizing on this trend, many museums are working on an approach to digital simulacra that enhance direct experience of the physical object and preserve its authenticity. Despite notable examples of international collaboration, the coordination of scholarship and practice in this area is insufficient to make a universal virtual museum a reality. Access to specialist digitization know-how, and infrastructure of the required quality, is still beyond the means of many museums. Museum collaboration with commercial partners, such as Google, is a partial solution.

V-MusT: Applied research into virtual museums

A need for interdisciplinary, in-depth research into virtual museums has been recognized by the European Union through funding allocated in 2010 to eighteen European partners to establish the Virtual Museum Transnational Network of Excellence (FP7-6-2009 G.A. 270404). The V-MusT Network (http:// www.v-must.net) was active between 2011 and 2015. Museums and other cultural and academic institutions, as well as media companies in 13 countries, and some 50 associated organizations, undertook an extensive program of theoretical and applied research, and training. V-MusT aimed to enhance virtual museology and digital methods of dissemination of cultural heritage. The work benefited from international, interdisciplinary collaboration and was informed by earlier technical innovation and research, conducted by the V-MusT partners and independently, notably in the United States of America and Canada. A large body of resources is now available for developing and studying virtual museums; it consists of extensive literature, electronic tools and materials, technical standards, legal advice and good practice guides (inter alia Karp 2004; Styliani et al. 2009). Documentation summarizing the V-MusT Network's contribution to the field is available online (V-MusT 2011–15).

V-MusT pedagogy

V-MusT established a program of training in virtual cultural heritage through a series of national and international short-term schools. A great deal of pedagogical, technical and logistic innovation was needed to design and deliver the complex, specialist curricula. The schools enabled scholars, scientists, museum professionals and educators, participating in and affiliated to the Network, to refine and disseminate interdisciplinary theory of virtual museums and applied heritage science.

Virtual Restoration and Reconstruction in a London Charter Framework (V-MusT UK 2012) was the first V-MusT Summer School in the United Kingdom. It was organized by King's Visualisation Lab of the Department of Digital Humanities at King's College London, in collaboration with a number of academic institutions and museums in London. The School's syllabus was concerned with the scholarship, techniques and ethics of historical visualization and drew on the principles of the London Charter for the Computer-based Visualization of Cultural Heritage (Figures 1 and 2). Available in several languages, the London Charter (2006–) promotes critical visualization as a method of historical, scholarly investigation, and calls for its intellectual and visual transparency (Bentkowska-Kafel and Denard 2012).

FIGURE 1: London Charter for the Computer-based Visualisation of Cultural Heritage. Screenshot of the home page, http:// www.londoncharter.org. Accessed 15 February 2016.

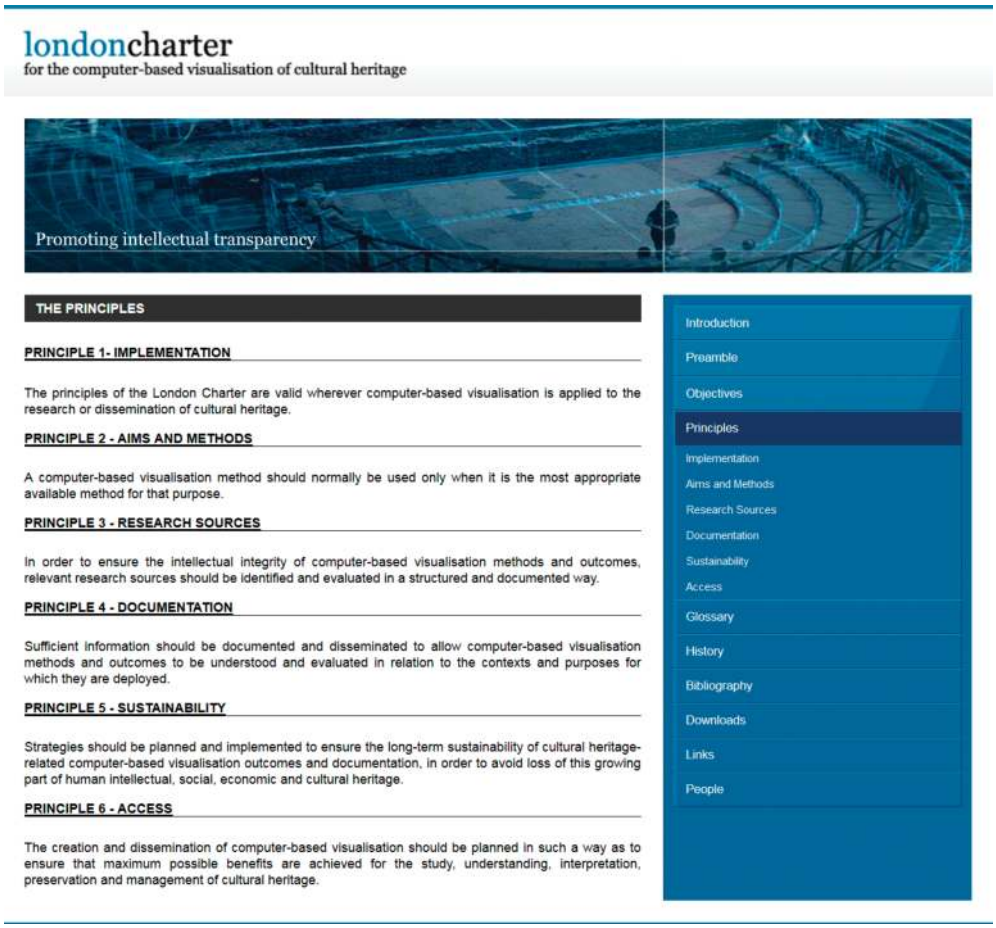

FIGURE 2: Principles of the London Charter for the Computer-based Visualisation of Cultural Heritage, http:// www.londoncharter.org. Accessed 15 February 2016.

The author's experience of directing and teaching the UK V-MusT School seems illustrative of some of the challenges of interdisciplinary training of virtual heritage specialists in general. The international participants – from England, Germany, Italy, the Netherlands and Iran – had different cultural, educational and professional backgrounds, as well as different expectations and ambitions. They were both academics and professionals. The group included Ph.D. students in Classics, Archaeology and Art History. There were also media technology professionals working for a company specializing in commercial visualizations for nuclear industries and urban planning. The doctorate candidates were equipped with specialist historical knowledge but, in some cases, lacked spatial literacy and technical skills required to record a heritage object accurately and model it on a computer. Some Information Technology professionals had poor academic research skills, no previous experience of historic primary sources and were unsure how to interpret

the documentary and material evidence, and assess the historic and artistic qualities of the studied object. All participants had to learn that three-dimensional digital visualization of material cultural heritage requires in-depth knowledge of the subject *and* specialist technical skills, such as precise recording, drawing and modelling. Visualization-based historical research involves archival studies and fieldwork. It is complex, laborious and requires a great deal of advance planning, as well as a good understanding of the purpose of the project and its feasibility. The scholarly objectives of historical visualization, which favors the process of discovery over the final product, were weighed against the pressures of commercial goals. The differences in participants' backgrounds and levels of previous experience, their initial, generally uncritical, view of applications of Virtual Reality (VR) turned out to be advantageous to stirring a wide-ranging discussion. The School offered an intensive program of fieldwork, practical visualization labs, lectures and demonstrations of new technologies applied to heritage studies. A site in Strand Lane, London, known as Roman Bath, was chosen as a subject for a collaborative visualization project, which the students were required to design, carry out and evaluate under the supervision of subject and technology specialists. The students worked in small groups. They kept notes as they surveyed the site, examined material evidence and secondary sources. They discussed the uncertain building history and purpose of the site, aiming for the final 3D visualization to show gaps in knowledge and ambiguity of sources. They sought expert advice.

The School stressed the importance of direct study of cultural heritage. A class at the British Museum was taught in the Parthenon sculptures gallery where the advantages and drawbacks of a typical museum display are evident. Some of the surviving external decoration and fragments from the Athena temple (447–432 BC) on the Acropolis in Athens are displayed either freestanding or on the gallery walls (Figure 3). This is contrary to the original architectural setting. The impression the figures make when positioned so as to face into an interior space and viewed close up, at eye level, is very different from the effect intended by their creators. The display ignores the geospatial and sociocultural contexts of the original architecture. The original painted decoration has not survived, resulting in the modern, incorrect perception of Greek sculpture as white marbles. Accompanying the incomplete and misrepresenting display is a kiosk showing computer visualization of how the structure might have looked originally. The seeming completeness of the virtual object may also be, and often is, misleading – unless proper measures are put in place.

Information on how historical and technical uncertainty has been resolved in the visualization of cultural heritage is a key factor contributing to the scholarly credibility of the method. Paradata, a detailed record of the visualization process, are necessary to enable future revisions of decisions and adopted solutions, if and

FIGURE 3: Participants of the UK V-MusT School in the Parthenon Gallery, British Museum, September 2012. Photo: Martin Blazeby, reproduced by kind permission.

when new evidence becomes available. Graphical representations of the physical object (extant or lost) should not be the sole aim of creating virtual heritage. Visualization may also serve as a graphic interface to comprehensive information about the object *and* its historical, spatial and social contexts. Virtual collections have the potential of addressing the problem of fragmented knowledge promoted by museum exhibits, their detachment from the original function and actual life cycles of the objects. The clarity of virtual visual representation (what is being represented and how) is essential. The V-MusT training aimed to foster such a transparent approach and recognition of its cognitive benefits.

In a seminar 'What is a virtual museum?', held at King's College London, on 11 November 2012, the participants of the UK V-MusT School collectively defined the virtual museum, as 'a computer-based, open-access, comprehensive, remote and interactive collection of 3D representations (or copies) of objects. It is an integrated knowledge platform'. The phrase 'integrated knowledge platform' was used by the author's students to mean not only a multimedia repository of information with open access, but also a virtual environment for communication, collaboration and

dissemination of research. The distinction between 3D representations of objects and copies refers, in this case, to the difference between procedural modelling (e.g. in Autodesk 3ds Max software) as compared to point clouds/polygonal meshes captured through precise, spatial and spectral measurements (e.g. with structured light or laser scanning).

This definition arrived at by the students reflects the group's shared expectations of the new generation of virtual visual collections of historic artefacts. It was informed by many discussions in the course of lectures, visualization labs and museum workshops. At the Petrie Museum of Egyptian Archaeology, University College London (UCL), the V-MusT students experienced first-hand digital 3D technologies and interactive multimedia (Figure 4) employed in educational materials implemented across the UCL Museums and Collections. Augmented Reality (AR) applications supplement the experience of the physical object with computer

FIGURE 4: Participants of the UK V-MusT School at the Petrie Museum of Egyptian Archaeology, University College London, September 2012. Photo: Martin Blazeby, reproduced by kind permission.

imagery and other media. Applications of gesture capture techniques enable the user to virtually handle digital surrogates of the museum objects, compensating to some degree for the fact that the latter must not be touched by visitors and can rarely be looked at all round. The UCL team was at hand to explain the scholarly and educational aims; demonstrate how technology works and present prototype solutions. Virtual objects on show in UCL museums result from the ongoing, inter-departmental collaboration between curators, conservators and scientists in geomatics engineering, photogrammetry and 3D imaging. A notable early collaboration was E-Curator (2007–08): 3D color scans for remote object identification and assessment. The project investigated the potential of e-science technologies (including transfer and storage of large, 3D data sets) in the documentation and conservation of material heritage, for example for monitoring the condition of objects and facilitating their study. A dedicated Internet platform for collaborative research into the acquired object data has been developed. Several museum objects were scanned with an Arius3D scanner. They posed different conservation and digitization challenges. A traceable methodology for post-processing 3D color point clouds was developed to make the repetition of the process and future revisions possible. The precise 3D digital color records of objects in the UCL collections enabled the creation of virtual surrogates. They are being used in educational e-materials available for tablets and other devices both within the museum, often next to the actual object, and remotely. In 2012, 3D Encounters (2009–) applications, developed by UCL in partnership with the media company Íomhánna Éigipteach Teoranta, were also made available at the UCL campus in Qatar. Another interdisciplinary, interdepartmental project, QRator (2011–) is an ongoing program of interactive interventions, available at the UCL Grant Museum of Zoology and London's Museum of Brands, Packaging and Advertising. The QRator iPads, and a dedicated website, invite visitors to engage with the collections through questions about objects on display, the ethics of collecting and display and other topical matters. The QRator activities transform the museum into a place of dialogue.

V-MusT classification of virtual museums

Conceptually and technically more complex than tablet applications are some large-scale, interactive multimedia displays. One such display, the Etruscanning (Hupperetz et al. 2013) was developed for the Allard Pierson Museum in Amsterdam (2011) and has since been made available at the Vatican Museums, Villa Giulia in Rome and the Museum Formello in Veio, Italy. The visitor can interact with virtual objects placed in the virtual representation, projected onto a large screen, of the Etruscan tomb, Regolini-Galassi (Figure 5) in Cerveteri. By stepping on

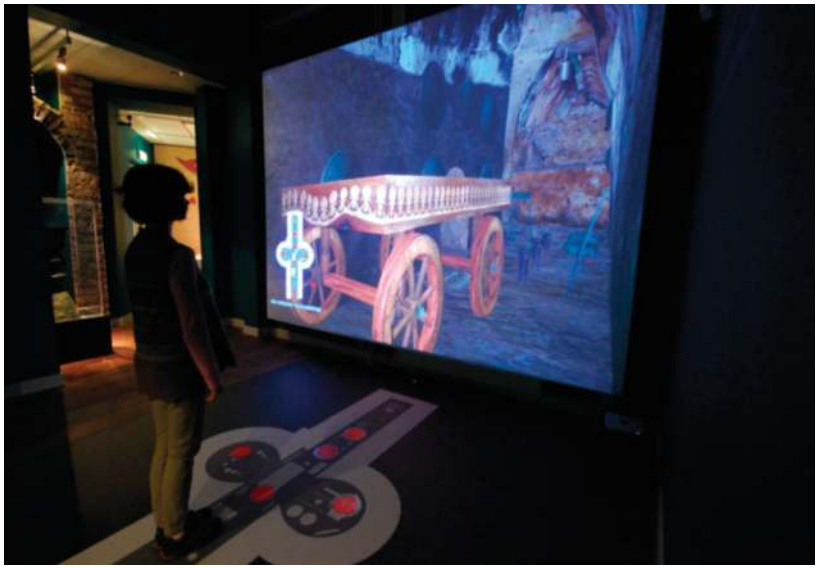

FIGURE 5: Etruscanning. Computer visualization of the Regolini-Galassi tomb developed for the Allard Pierson Museum, the Vatican Museums, the Villa Giulia in Rome and the Museum Formello in Veio, Italy, 2013. Photo: Daniel Pletinckx, reproduced by kind permission.

sensors located in the floor, and moving naturally within this immersive VR environment, different parts of the audio-visual display are activated; objects can be brought closer for detailed, all-round viewing. The commentary, read by actors impersonating Etruscans, changes accordingly and augments the performative effect. Virtual objects are 3D records of actual archaeological finds dispersed in museums in Leida, Amsterdam and the Vatican – virtually reunited through photogrammetry, laser scanning and other technologies.

The Etruscanning is an outcome of interdisciplinary collaboration between subject specialists and technology professionals, some of whom participated in V-MusT. The Etruscanning is one of 58 virtual museums (as of November 2015) included in a list compiled by V-MusT at http://www.v-must.net/virtual-museums/ all (Figure 6). These pages index virtual museums according to a classification developed by V-MusT. The list, which is by no means comprehensive, aims to demonstrate the variety of types and formats of virtual museums. Among the virtual museums listed are: several visualizations of ancient Rome; an interactive computer model of the Cathedral in Santiago de Compostella; and 3D records of capitals in selected Romanesque cloisters of France, Spain and Italy. A virtual museum of Bologna shows domestic interiors in the twentieth century. The Virtual Museum of Iraq consists of 3D digital records of selected objects in the National Museum in Baghdad. It was created in the 2000s by Italian heritage technology specialists to draw attention to the cause of protecting cultural heritage of ancient

FIGURE 6: Virtual museums listed on the Virtual Museum Transnational Network website at http://www.v-must.net/virtual-museums/all. Accessed 12 October 2013.

Mesopotamia, at risk of destruction during the ongoing war. On the list is also the haptic museum (simulating touch) of Pure Form, housed in the Cathedral in Pisa. The last example from the V-MusT list to be mentioned here is the *Locis Imaginis*, a crowd-sourced online platform, supported by the French Ministry of Culture and Communication, where personal photos of a monument can be superimposed onto its 3D model in the national database of national heritage, for interactive study as well as collective memory. The broadness of the term 'virtual museum', applied by V-MusT to a wide range of content and formats, is likely to be questioned. The critique of the V-MusT classification may contribute to the wider debate on what constitutes a virtual museum more generally.

The classification underpinning the V-MusT selection is based on criteria that bridge traditional museology and information communication technologies. V-MusT

defines virtual museums according to the content and subject (e.g. ethnographic museum; museum of the Thermopylae Battle), purpose (e.g. research, an enhanced visitor experience, edutainment), interaction technology (e.g. device-based or natural, gesture-based), level of immersion (low, medium, high), the form of communication (e.g. narration, dramatization), duration (temporary or permanent) and sustainability of digital tools employed (e.g. reusable, archived non-reusable) (Ferdani et al. 2014: 12–25). In the V-MusT typology, virtual archaeological museums include visualizations of historic architecture that has not survived. The traditional roles of the museum are augmented to include provision of entertainment (mainly in the form of serious computer games) and promotion of cultural heritage through advertising.

Online access to virtual museums, via desktop and mobile platforms, has become standard, contributing to ever new forms of engagement and collaboration. *Keys to Rome* (2014), an exhibition curated by several V-MusT partners, opened simultaneously in Alexandria, Amsterdam, Rome and Sarajevo. Selected ancient artefacts on show were accompanied by their 3D printed, scaled models. Visitors could interact with these smart objects (fitted with sensors). For example, by employing Natural Interaction AR, one could reveal the colors of original painted decoration that has not survived in the actual historic object on display (Figure 7; *Keys to Rome* video 2014). This kind of curated multimedia, in situ and online, should not be dismissed outright as 'mere', game-like, educational guides for the general public. They challenge the traditional role of the curator and the

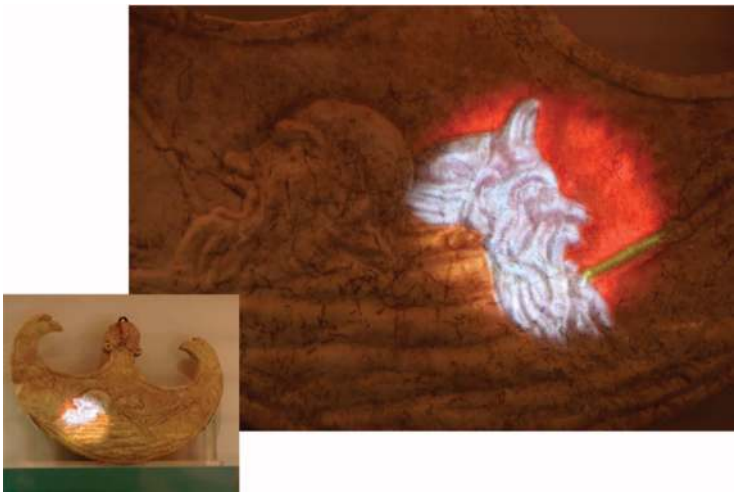

FIGURE 7: Details of an interactive, Augmented Reality computer simulation of the original color scheme of an oscillum, shown in the *Keys to Rome* exhibition, the Allard Pierson Museum, Amsterdam, 2014. Screenshots from the video showing the use of smart objects, http://www.allardpiersonmuseum.nl/en/exhibitions-at-events/keys-to-rome.html. Reproduced by kind permission.

ways in which he or she organizes and contextualizes objects in an exhibition space. Virtual objects are often research tools and means for reviewing earlier scholarship and communicating the latest findings. Therefore, the definition, as agreed by the participants of the UK V-MusT School, of the virtual museum as a complex, computer-based system of knowledge, reflects the developments in museum practice. It involves new forms of engagement with the museum object and its story, and ever-expanding modes of communication, both scholarly and popular, enabled by digital technologies.

The virtual museum: The concept and transformation

'A Museum without Walls. Let's go to explore the city' is a guided tour of Nowa Huta, an exemplar Socialist city of the 1950s, built for the workers of the Lenin Steel Works on the outskirts of Kraków. The tour starts at the Kraków Historical Museum with a talk on Polish Social-Realist architecture and design of the Communist era (Kraków Tours 2012). The Association for Public Art active in Philadelphia, United States of America, offers 'Museum Without Walls Public Art Bike Tours' (2015). The tour is of 65 pieces of public sculpture. Claes Oldenburg's *Clothespin* (1976) expands an everyday object into a soaring, 14-meter steel sculpture. The artist's and local curators' talks, available on the accompanying 'audio program with slides and maps' for smartphones and other devices, reveal the *Clothespin* as two figures kissing.

The concept of museum – broader than a building that houses a collection of historic objects and the institution responsible for their safeguarding – is well established. The phrase 'a museum without walls' is used both in the literary sense and figuratively. Although it does not appear in Malraux's original writings (1947; 1951; 1952–54; 1965a; 1965b), it is often seen as his legacy (inter alia Battro 1999; 2010: 136–47). Edwin Coomasaru (2014) goes as far as inferring 'André Malraux's 1947 plans for a "museum without walls"'. The phrase has persisted since the English edition of Malraux's *Le musée imaginaire*, which first appeared in 1949 in Stuart Gilbert's translation, under the title 'Museum without Walls'. Frequently misinterpreted (cf. discussion in Allan 2010), the phrase narrows Malraux's concept of the imagined museum (*le musée imaginaire*), which is primarily an intellectual and spiritual construct concerned with appreciation of art, based on personal selection of objects. Malraux extends the concept of art museum to include wide-ranging knowledge of artefacts known through photographic prints. Malraux saw in the printing press (*l'imprimerie*) a realization of universal access to world visual arts (Malraux 1947; 1965a: 16). This vision contrasted with, and was arguably in response, to Walter Benjamin. Benjamin's (1969) concerns over the loss of authenticity and aura of art through its

mechanical reproduction were expressed in an essay of 1936, first published in French, that was to become seminal to later debates over print/digital surrogates of art. Malraux's discussion of the subject (1947) is free from a scholarly apparatus and makes no explicit reference to Benjamin's text. There is, however, indirect evidence of communication between the two scholars (Benjamin 1994: 529) also suggested by Malraux's own explicit argument (1965b: 232) on the value of art reproduction, comparable to spiritual intermedium. Famously photographed by Maurice Jarnoux in 1954, with an array of photographic prints of world sculpture arranged on the floor, Malraux challenged and augmented the established, strict canon of western art by noting its relationships to other cultures. Free from constraints that often affect a selection of objects for museum displays, he juxtaposed images of major works of the Italian Renaissance with little known ethnic objects from faraway lands. He crossed artistic genres and media, geographical and chronological boundaries. As observed by Grasskamp (2016: 3), 'Malraux could only so confidently avail himself of these works [sculptures] with the help of photography, which both continues and invalidates the traditions of the museum collection in that reproductions allow objects to be "liberated" from their actual locations and combined at will – which was precisely the point of the *musée imaginaire*'.

Many of Malraux's observations and arguments remain relevant today: real museums (*les vrais musées*), even the largest, such as the Louvre, display only a fraction of their collections. The UCL Petrie Museum, for example, shows approximately 10 percent of its holdings (http://petriecat.museums.ucl.ac.uk/), keeping the rest in store (Gardner 2007). Exhibited objects are, necessarily, dislocated from their original context and the purpose for which they were created. They impose an incomplete and fragmented experience (Keene 2005). A first-hand experience of art and architecture is not always sought or possible. Malraux noted that Charles Baudelaire and other prominent art critics of the twentieth century visited only a handful of museums; some of the most significant and persisting critiques of western art were pronounced based on art reproductions, not direct observation.

In the 1960s, at the time of publication of Malraux's 'Le musée imaginaire' in English (1965) and its American edition (1967), Everett Ellin explored the feasibility of a networked computerized system for museums across the United States of America. Appointed to direct the American Museum Computer Network, he envisaged the system to be used 'to deliver electronically, upon request, museum lectures and simulated exhibitions (in audio/visual form), to a classroom console or even to the home'; and to be capable of answering 'specific questions from amateur and expert alike' (Ellin 1969: 25). Ronald Stenvert (1992: 21) interpreted this innovative proposition as 'worldwide databases', which he termed an 'electronic museum, or a digital virtual museum'. Ellin's concept encompassed more than the virtual counterparts of physical objects in museum collections. Questions concerning the scope and functions of the virtual museum have dominated the debate ever since (Keene 2005: 25).

Examples of noteworthy concepts of virtual museums range from the seventeenth-century paper museum (*museo cartaceo*) of Cassiano dal Pozzo, to the twenty-first century virtual feminist museum proposed by Griselda Pollock (2007) and, questionably, Jonathan Meades's (2012b) idiosyncratic discussion of the spirit of place. Cassiano dal Pozzo (1583–1657) undertook large-scale documentation of heritage, both material and intangible, by commissioning artists to draw and paint in great detail architecture and antiquities, spectacles and religious ceremonies, arms and costumes, flora and fauna, geological specimens and other subjects. Engravers were employed to make prints after these records. After Cassiano's death, his brother Carlo continued the work. The name of paper museum given to this unique collection may be justified owing to the precise, scientific practice of recording and examination of the studied objects; annotation; systematic chronological and subject classifications of the assembled works on paper. Over 7,000 of these records have survived and are dispersed between the British Museum and other collections (MacGregor and Montagu, 1996–).

What is a virtual museum of the digital age? Although Erkki Huhtamo (2002) only looked at museums on the web, he noted the vagueness of the term. Research into media archaeology (Bowen et al. 2005–) has unearthed numerous virtual museums created in 1990s; these examples claimed to be virtual museums by the virtue of disseminating information about heritage in the form of webpages. The Virtual Museum of Computing (1995–), founded by Jonathan Bowen, presents a history of computing and consists of a basic page in HTML with hyperlinks. Numerous similar compilations of information and resources, which may have sizable content despite being often the outcome of a labor of love, have since appeared online. Many virtual museums make reference to Malraux, or an explicit connection between his thought and the Internet (Musée Imaginaire Virtuel 2008?–). Some continue to develop while others have fallen victim to the transience of the web and the notorious, '404 Not Found' error.

Aware of the danger of the virtual museum being 'a buzzword used indiscriminately', Werner Schweibenz (2004: 3) defined the virtual museum as

> a logically related collection of digital objects composed in a variety of media which, because of its capacity to provide connectedness and various points of access, lends itself to transcending traditional methods of communicating and interacting with visitors […]; it has no real place or space, its objects and the related information can be disseminated all over the world.
>
> (cf. earlier versions in Andrews and Schweibenz 1998: 24; Schweibenz 1998: 191)

Schweibenz emphasizes communication and interaction with visitors. The fulfilment by virtual museums of other important roles and characteristics also needs to be considered, starting with the legal status and organizational framework. Whether institutional or deinstitutionalized, these are often difficult to formalize, as the story of the Museo Virtual de Artes (MUVA) demonstrates (Haber 1998; 2001). Opened in 1997, MUVA is believed to be the first entirely synthetic museum: it exists solely online in a purpose designed, seven-story virtual building. Mario Buchichio created an interactive 3D computer model of the museum (MUVA 1997–), based on the architectural plans, drawn by Mezzotoni-Scheck & Partners for a museum proposed for Montevideo that has never been built. The virtual museum houses a collection of images of art by Uruguayan artists. The aim was to compensate for the absence (until 2018) of, in Schweibenz's words, a 'real museum' of contemporary art of Uruguay. Supported and hosted by the newspaper, *El Pais*, the virtual museum is a legal entity and has a board of directors.

With this complexity of virtual museums in mind, the V-MusT Network concluded,

> a virtual museum is a digital entity that draws on the characteristics of a museum, in order to complement, enhance or augment the museum experience through personalization, interactivity, and richness of content. Virtual museums can perform as the digital footprint of a physical museum, or can act independently, while maintaining the authoritative status as bestowed by ICOM [the International Council of Museums] in its definition of a museum. In tandem with the ICOM mission of a physical museum, the virtual museum is also committed to public access; to both the knowledge systems imbedded in the collections and the systematic and coherent organization of their display, as well as to their long-term preservation.
>
> (Hazan et al. 2014: 39)

Virtual museology

The International Council of Museums (ICOM) recognizes that the virtual museum and cyber museums are 'key concepts of museology' as well as 'unusual practices likely to have a considerable impact on the future of museums in the long term' (Desvallées and Mairesse 2010: 19). While recognizing the significance of the virtual museum, ICOM struggles with its ontological status – 'existing in essence but not in fact', 'on the margin of institutional reality' (2010: 44, 59). More recent research, by V-MusT and others, highlights the need for ongoing revision of the

ICOM definitions of the virtual museum and the preferred concepts of 'digital or cyber exhibitions' (2010: 37–38).

The critical discussion of virtual museums has grown in complexity since Schweibenz (1998: 191) characterized it as having 'no real place or space' and therefore considered the concept to be an oxymoron (1998: 185). ICOM reminds one that '"virtual" is not the opposite of "real"' and criticizes Schweibenz's definition as 'something of a misinterpretation' (Desvallées and Mairesse 2010: 59). The distinction between the virtual and physical realms characterized early experiences of digitized collections but, as evidenced by the examples chosen to illustrate this text, is becoming blurred. The term 'virtual museum' is no longer considered contradictory. This transformation is primarily a result of cognitive and experiential shifts in human perception owing to the acquired or native familiarity with digitized and digital objects. Pervasive computing and a range of simulation technologies (immersive VR, AR, machine haptics, among other technologies) contribute to life-like virtual experiences. Some critics continue to approach such digital multimedia in museum with contempt, irrespective of their quality and scope. These forms of interpretation and communication are sometimes seen as edutainment, even 'disneylandization', degrading the traditional status and mission of western museums (Borusiewicz 2012: 122). Others draw the opposite conclusion from the profusion of virtual simulacra and popularity of virtual worlds. Discussing mobile art apps, Poprzęcka (2013: 29) expresses a concern that is commonly heard: digital surrogates of art, particularly those of the highest quality, becoming substitutes for the experience of material art objects. She hopes, however, that the fascination with the virtual induces longing for 'the actual reality'. Malraux (1965b: 232) would probably have agreed: 'Reproductions but increase our esteem for the work, because we feel a need to rediscover the […] real or imagined soul that belongs only to the original'. The need is, Malraux argued, for the presence of the work of art, its 'voice', the spiritual or even mystical experience. With the advent of the digital image, this view resonates with some scholars in a new way: 'Not unlike the availability of printed copies of works of art, the digital image is a surrogate that attracts rather than repels, that creates interest rather than diminish it' (Hamma 2000: 1). The significant increase in museum visits in the United Kingdom between 2005/06 and 2011/12 (Department for Culture, Media and Sport 2015: 25) may be an indication of benefits drawn, among others, from the ever greater digital presence of museums. While capitalizing on this interest, virtual museology must not develop in isolation from best conventional scholarship and practice.

Digital technology-driven developments in the world of museums and museum studies do not call for another 'new museology' (Vergo 1989; Ross 2004); a separation of critical museology from operational museology (Shelton 2013); the embracement of neuromuseology (Onians 2015); nor do they justify a need for discrete information communication museology and specialist digital preservation.

Digital technology has opened instead unprecedented creative opportunities for an inclusive, collaborative fulfilment of key museum functions by bringing different aspects of their work closer than ever before.

Acknowledgments

This chapter is an updated and expanded version of the paper 'The Virtual Museum – the concept and transformation', presented at the 28th Conference of Computers and the History of Art (CHArt), *Display: Consume: Respond – Digital Engagement with Art,* held on 15 and 16 November 2012 at the Association of Art Historians, London, UK. It was subsequently published in Polish in *Muzealnictwo,* 54 (2013), pp. 159–66 and in parts is reproduced here, in the author's translation, with the kind permission of the publishers, the National Institute for Museums and Public Collections, Poland.

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A field guide for analyzing the curation of online social networks of arts

Almila Akdag Salah

Introduction

DeviantArt (dA) is one of the largest and oldest networks that is devoted to user-generated art. Launched in 2000, dA with a huge image archive of user-generated artworks, and a social structure consisting of 35 million members, offered an alternative art market, presenting a new mode of displaying, evaluating and consuming arts. In that sense, dA generated a platform free of institutional and governmental politics, democratizing the way arts are generated, shared and enjoyed. However, a closer look at dA reveals that a new value system is created through the use of accumulated user statistics, which may be a very familiar pattern for all who follow the rise of the Big Data. Within this evaluation system, some aspects of dA are astonishingly reminiscent of the existing art market, and in this chapter, I like to scrutinize one of these aspects, namely, the birth of curatorial practices.

The dA platform is a very large online social networking site (oSNS) (boyd 2007; boyd and Ellison 2007; Kaufmann et al. 2008; Mayer and Puller 2008). The tools needed to analyze such immense structures are necessarily computer-based, and the most commonly used tool to dissect an oSNS is (social) network analysis. Today, more and more scholars and artists are using network analysis as part of their profession, and we witness a rise in artworks and research (Akdag Salah 2010; Helmreich and Fletcher 2012; Akdag Salah et al. 2013; Pilcher 2013) that are based in social network analysis (SNA). While these studies describe the relevant aspects of network theory in order to report their analysis results, the initial steps and the decisions that are made on the way are either briefly touched upon, or just hinted at. Yet the process of analysis is of value to researchers who would apply similar approaches to other domains. The focus of this chapter is to highlight this process while explaining how the curatorial practices in dA could be analyzed.

This chapter is structured as follows: In the next section, I will explain various services dA offers to its members, and describe how these services create

an evaluation system. How this system affects the power dynamics of dA, and how it triggered the birth of different curatorial practices will be the topic of the second section. After presenting three curatorial practices visible in dA, in the third section, I will focus on SNA, and devise a workflow of how this methodology should be used in order to analyze the differences between these three practices.

Value system of dA

In the naming conventions of dA, the members are called deviants, and the uploaded images are called deviations. The homepage of a deviant is arranged like an overview of a portfolio, as well as a portal to each deviant's activities. The members are relatively free in designing their dA space, but certain links and static information fields are not to be changed. Each homepage has a navigation bar displaying basic statistics, as well as member information (age, country, membership status). The statistics list the number of people who have visited the member's page, how many comments are left and how many artworks the member has. The members do not have a say in the display of statistics; they can neither change, nor conceal this part of their homepage. Inevitably, these statistics build the foundation of a value system, and have an important role in generating a status for each member.

The homepage statistics of each deviant is a very prominent example of this value system, and gives newcomers an intuition about the role of deviants. A deviant with a high number of visits has obviously an impact. If this deviant has a low number of likes, his/her artwork does not accumulate enough interest to leave comments or favorites. Conversely, a lot of comments and favorites imply many admirers for the deviant's artworks or other contributions. In short, the homepage statistics are not only telling in how popular a deviant is, but are also good indicators of what type of a role he/she plays in the dA network.

On top of the homepage statistics, each deviation (i.e. artwork) also has a site on its own, with similar statistics like the ones on the homepage. As in the case of homepages, these statistics cannot be meddled with. Thus, it is possible to judge the 'quality' of a work through its statistics (i.e. the number of pageviews and comments it receives and how many times it is favored and downloaded). It is possible to liken this process to the idea of citation-networks, where each citation in a scientific paper is seen as the building-block of a value system. If a paper receives many citations, it is thought to be an influential paper. The number of pageviews and comments for a deviation can be seen as a similar indicator. Another measure that is used to understand the importance of a paper is 'half life cycle' of its citations

(Burton and Kebler 1960), which describes a common citation pattern (first a gap, then a peak and then a fading out) in any field. Papers that do not follow the expected pattern are either too controversial, or contain break-through research results. Theoretically, like a paper, the half life cycle of a deviation never ends (unless removed by the deviant), since it is accessible at all times. However, a short while after its first upload, the deviation would get its peak of pageviews, downloads and comments. These periods could be influenced by curatorial practices.

Curatorial practices in dA

The birth of curatorial practices can be traced back to the transition from the private Wunderkammers to the establishment of museums in the nineteenth century, at which point the question of 'what to collect' started to be combined with 'what/how to display'. The curator's job definition roughly stretches from 'overseeing and expanding a collection, to preparing exhibitions, educational programs and experiences for the audience' (Boylan 2006).

With the introduction of online art networks, the twenty-first century saw the introduction of a previously unknown possibility, namely, 'collective curating'. In dA, for example, the most direct way of promoting a deviation is called the Daily Deviation (called DDs for short), that is, publishing chosen deviations on the homepage of dA. The way deviations are chosen is the result of a collective effort to which each member of dA can potentially contribute. The second type of promotion is performed by the members themselves. They can publish 'feature' articles (called journals) on their own homepages, as well as news articles, accessible through the main dA page, both of which can promote other works. Finally, a more covert way of promotion is adding the deviation to one's own favorites or collections, and any member can promote a work in this way. These last two promotion types cannot be tagged as 'collective curating', but they are nevertheless very important: they are the emblems of today's online behavior of the masses: in various platforms, many users generate 'new content', from news to do-it-yourself projects, by mainly curating user-generated content of other users. Hence, in this section, we will explain each of these promotion mechanisms in detail.

Official curators of dA

Daily Deviations are a feature of dA since its beginnings. Each day a certain number of deviations are chosen and promoted on the main website of dA. These

deviations naturally receive many visitors due to this promotion. I define the choosing of the DDs as the official curatorial process of dA, and liken it to the position of a curator, responsible of managing the archive of a big museum, designing certain exhibitions and promoting only certain works at any given time.

The selection process of daily deviations is quite elaborate and is not under the direct control or supervision of the website owners. The dA staff actively participate in the online community, and are members of the website. The main team is extended with the recruited volunteers from the community, who moderate galleries and thus play a major role in the decision process of DDs. Every member of dA has the right to suggest deviations for a DD. However, the voting process is not clearly defined and suggesting a work is not as easy as favoring a deviation, which can be accomplished by a single click. Instead, if a member thinks a deviation is worthy of DD, he/she can suggest that piece by getting in contact with the appropriate gallery moderator. Beside these incoming suggestions, a group consisting of staff/volunteers is browsing deviations to select the DDs. The final selections of this group become a part of a list of deviations waiting to be published each day. Thus, the DD awards do not necessarily reflect a selection among the latest submissions to the site, and can include deviations that are already a few years old. Usually around 30 works are published on the main website of dA as DDs, and the previous DDs are stored on separate pages for each day, accessible to all visitors.

DD publications seem to affect citation cycles of deviations. After the announcement of DDs, the selected deviants get mentions, and hence a burst is expected after such promotions. In order to test this idea, in a previous study, we have followed the rise in the number of pageviews, comments and downloads for DDs selected for a random day (Akdag Salah 2010). This sample reflected the heterogeneity of DDs, as the selection included works from different genres, with a balanced distribution of new and old members (who usually have higher number of pageviews/comments). However, the peaks in the statistics for all members were more or less the same, regardless of a member's previous status in dA (Akdag Salah 2010).

Self-acclaimed curators of dA

Since its first launch in dA, certain aspects of the website allowed its members to portray themselves via their artworks and journal entries. The latter are dedicated web pages with text fragments, and can be accessed by a separate journal tab. Some deviants use journal entries as a way to collect other members' artworks, and to publish them in a systematic manner. Such journal entries usually do not

have much written text, and are rather an accumulation of deviations according to certain criteria (e.g. 'best deviations uploaded last week, in a certain category'), and work as a sort of filter in a platform where thousands of artworks are uploaded every day.

The deviants who publish journals to curate others do not necessarily have a collective name, that is, they are not called 'self-acclaimed curators' or anything else (which could have been the case, as dA also contains a section where members register certain information about themselves, and choose a name from a dA-generated list, but 'Curator' is not a title that can be found in this list). In order to find these deviants, network and text analysis tools should be used.

Silent curation

The basic functions of dA are the *gallery* and the *favorites* sections. Every member has these sections on their homepage, and if a member is prolific, only the latest portion of their galleries and favorites are shown via thumbnails. The gallery is an accumulation of deviations the member has uploaded, whereas the favorites is an accumulation of favorite deviations shared by other members. While browsing dA, every member can easily enhance their favorites section by clicking on a deviation, and adding it thus to their favorites. Surfing galleries and favorites sections are the main navigation ways in dA.

A third function, setting up a 'watch', completes the circle of information flow in dA. If a member likes another member's works, then he or she can start 'watch'ing this deviant. Watching another member means getting notifications about their activities. Hence, if a deviant has a lot of watchers, whenever he/she uploads a new artwork, this gets immediate pageviews, comments and likes. Similarly, a well-watched deviant's favorites section promotes other artworks more strongly than other deviants.

We can liken the official curation of the site, the everyday launches of DDs, to broadcasting a news story at 8:00 p.m. news from the main news channels. Self-acclaimed curation would correspond to being published on a local news channel. Silent curation is similar to getting mentioned in a column by a famous columnist, whose views are followed by many people. Unfortunately, the issues of correlation between curatorial practices and statistics have not been studied enough (Akdag Salah 2010) even though one of the strengths of SNA is that it both opens up such matters for inquiry and provides a means of engagement. As of now, without a proper and detailed analysis of dA, what we can do is to speculate about the influence of curatorial practices in the network by generalizing the results of a small sample.

SNA and dA's curators

Today, social networks are analyzed via at least three different mainstream approaches: social network analysis, actor network theory (ANT) and complex network analysis (or Network Science). The main difference between these approaches is in their focus: social network analysis has been developed to chart social ties, and tries to map these ties while discerning 'the deeper organizing principles that generate meaning structures' (Mohr 1998, 2000). ANT, in return, is mainly concerned with the relations of materials/concepts, and tries to capture the transformation of the interactions between these. Complex network analysis has its focus in the structure of the network itself, and investigates the topographical attributes before everything else (Albert and Barabási 2002; Newman 2003). In order to understand the differences between the three curatorial practices of dA, we need to first understand the dA network itself, and then apply SNA. In this section I will shortly touch upon the most important steps of this methodology, starting with the translation stage.

Translation stage

Generally, the basic steps of any computer-based approach to Big Data-driven humanities project involves data collection, cleaning, modeling and analysis. But all such projects need to have a translation stage as well, to convert the arguments and questions into a format where they can be answered or measured via quantitative analysis. To do that, one needs to learn to think in a radically different way when formulating research questions and in this section I would like to stress this difference by an example from dA's curators.

For example, in order to identify a curator of dA, we need to devise a measure, which potentially describes how a self-acclaimed curator behaves in dA. This measure should be based on quantifiable definitions. For instance, instead of saying that a self-acclaimed curator in dA is a member of the network who takes on the role of curating other members' artworks in various ways, we will assume that a self-acclaimed curator is a member who writes more journal entries than uploading artworks. A second condition is that these journal entries should have links to many deviations that do not belong to the curator.

To have a single measure may not be enough, and even multiple measures may be unreliable. Before moving on to the data collection stage, each measure should be tested on a small set of data collected according to set conditions. This test can be done manually as well (e.g. by browsing the site). This small set should be analyzed, and the results should be checked. This small data set is furthermore used as baseline in the next stages of the analysis.

Data collection stage

Different sampling methods are defined and used in statistics, and any population-based study with proper attention to statistical detail needs to minimize sampling biases, that is, to use a sampling strategy that will produce a sample that is representative of the population. Since controlling each and every factor is often practically impossible, assumptions must be made. Probability sampling approaches select items (or subjects) according to estimated probabilities, and include methods like random sampling and stratified sampling. Non-probability sampling approaches structure the sampling in a certain way, and do not rely on probability estimates. Convenience sampling (to take what is available) and snowball sampling (using the already selected items select more items) are examples of the latter.

In order to compare official, self-acclaimed and silent curators, we need a network that would reflect the category distribution of dA, as well as the distribution of active and non-active members. Among the sampling methods we mentioned, stratified sampling would be the best method to use. In stratified sampling, the members of the population are first divided into strata, and each stratum is used to sample a portion of the data. From Akdag Salah et al. (2012) we have an overview of the distribution of categories (i.e. how many members are active in each category), and as strata we can take these categories to randomly sample from each category proportionally. We furthermore have site-demographics (age and country of origin), and we can use these as secondary filters.

While it is very important to use the right sampling method, it is equally important to know what to collect. The profile of a dA member stores a wealth of data, and not all of this information is necessary for the research. To try to get all the information from each profile will prolong the data collection stage, and negatively affect the cleaning and analysis stages. Figure 1 gives a schematic display of available information for each deviant, and for each deviation, and shows communication channels between members.

For our case study on curatorial practices, we need site statistics, friendship information, galleries and journal entries. Site statistics are crucial in measuring the effects of curatorial promotions. Friendship information is needed in order to build the network of social interactions. Galleries of members are useful especially for the silent curation, through which we can extract the information of which member favors which deviation. By analyzing the text of journal entries, we can locate self-acclaimed curators.

Once the sampling method and the features are selected, the data collection and cleaning stage can begin. The conversion of the collected data from its natural format into a database is done in this stage. After this, building and analyzing the network is the next stage in the workflow.

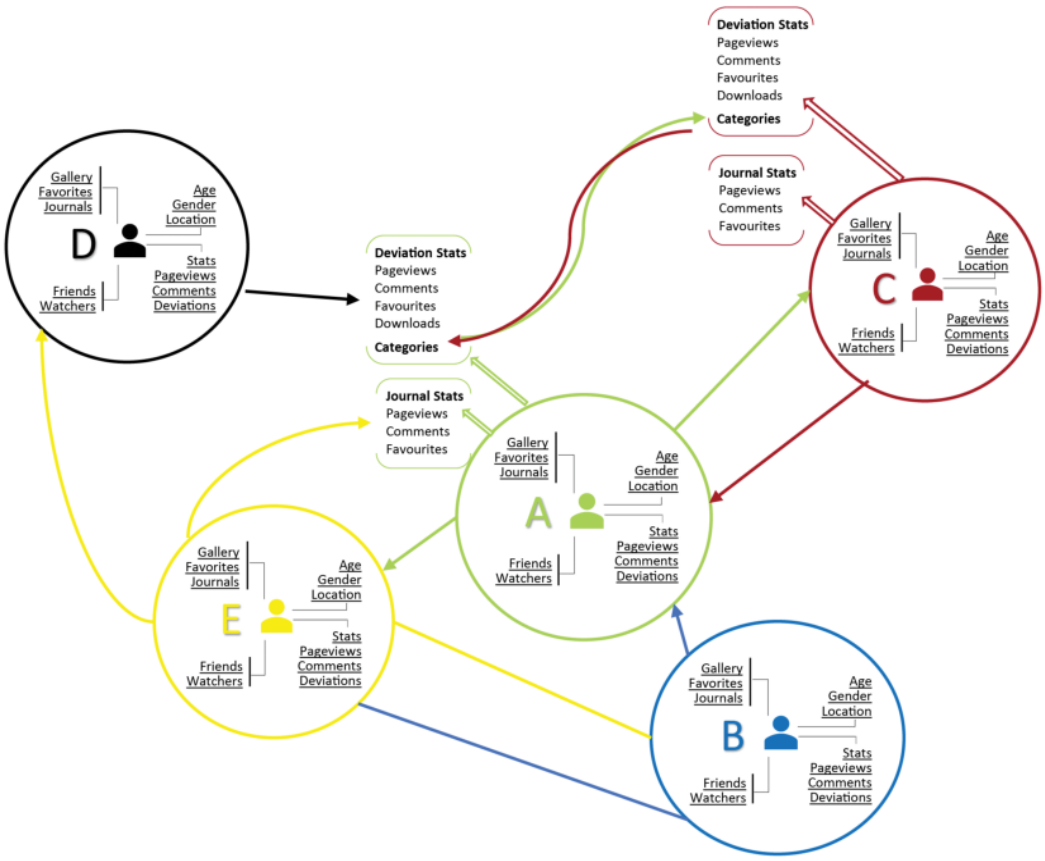

FIGURE 1: A schematic analysis of a deviant, and the available social data for building a network structure.

Modeling and finding communities

The topology of networks is studied to understand and explain them in general terms. To this effect, different real-life networks are studied extensively. Network science, as a field that studies complex networks, relies on work in graph modeling, and goes back to 1960s. Social networks, when represented as graphs in which nodes represent people and arcs represent social connections, exhibit certain properties. Mathematical modeling of random graphs established ways of measuring such properties, and once measured, they can be used to predict how messages will be dissipated in the network.

In an earlier study, we have established that the dA network is a small world (SW)-network (Akdag Salah et al. 2012), meaning that dA has strong community structures, characterized by a high clustering coefficient (i.e. if two persons A and B are connected individually to a third person C, it is highly probable that A and B are also connected to each other directly) and a small average path length

(i.e. it is possible to reach a person from any given person with a small number of hops along the network). These networks are de-centralized, which means there are no central nodes that are more important than all others. dA is perhaps better viewed as a multigraph, that is, as a number of graphs superposed in each other, including connections between artworks and people, between artworks and artworks or between people and people. Furthermore, people can have multiple types of relations to each other (e.g. watcher, watched, favorited, commented, friend, etc.). Figure 1 shows a hypothetical sample of relations between a few members: for example, deviant A, watches deviant E, but is not watched by her in return. Deviant E, however, leaves comments about the journals deviant A is publishing. Deviant B is also watching Deviant D, and has a bidirectional relationship with Deviant B; they share the same geographic location. Deviant D is only connected to Deviant A, and this is a weak connection: she has favorited one of the deviations of A. Deviant C is a friend of Deviant A, and this is a mutual relation. They furthermore publish deviations under the same category. The figure stands for a schematic explanation between five members. If we take into account that each deviant has around 50 watchers, and a similar number of friends, it will be obvious that without using SNA it is impossible to follow even one deviant's interactions in a detailed way, let alone to capture the information flow between a small group of 30 to 40 members. If one would investigate and visualize interactions between the millions of members of the site, automatic analysis tools are indispensable.

Seen as a graph, we have different measures giving us information in dA. The degree of a node tells us the popularity (or extraversion) of a member, and the average degree of the community shows how densely connected the communities are. We can use the degree to check whether self-acclaimed curators are more connected than average members. Communities can be detected by finding clusters of nodes with high numbers of intra-cluster connections and lower numbers of inter-cluster connections. We also observe the classical power law distributions all over the dA network, for example in the degree distributions of the nodes: there are few nodes with very high degrees of connections, and many nodes with very few connections. These properties and our rough analysis of the network and community structures can shape our questions about curatorial practices: Do self-acclaimed curators have communities on their own? Are they well-connected due to their special role in dA? Do influential silent-curators play key roles in their communities, that is, are they bridges between communities, or influential nodes to say the very least? How does novel ideas travel and spread in such a network? We do not answer these questions in this chapter, but some of these issues (e.g. how ideas spread through the network) are addressed in the past (Akdag Salah and Salah 2013).

Conclusion

The amount of visual digital objects around each of us increases with a breathtaking pace: there are millions of digitized objects from museums and shared images of cultural artefacts in platforms such as Europeana, Flickr or Instagram. Such collections contain a wealth of explicit and implicit patterns and knowledge. While explicit value systems (such as in-site analytics) are easily amenable to quantification, implicit ways of valorization need a closer study of the underlying social network and its dynamics. Only the combination of explicit and implicit patterns gives us the full picture of any given social network.

This chapter discussed SNA as a methodology to analyze such platforms, using the dA website as a case study. Especially for digital platforms based on social networks, SNA is a necessity, and not just one of the many available methodologies, but the main starting point. SNA helps one to understand what the norms of a given platform are, and describes the social hierarchy of the platform. It allows the researcher to see who is connected to whom, but also who is in a status to withhold or distribute information to other groups and subcommunities. In other words, SNA bares the social connections, and connections show us the paths of influence and the flow of ideas. SNA metrics describe whether subcommunities are loosely or tightly woven, and allow a bird's eye view on the cultural and social atmosphere of the platform. Furthermore, the social transactions become quantifiable, which means the dynamics of the platform is also measurable to some extent. Behaviors exhibited by the members of an online platform are formed largely through a social understanding between the members, either implicit in the community, or imposed by the design of the medium, both of which can be analyzed with SNA.

It is crucial for the future of digital art historians to understand the capabilities and shortcomings of SNA. From a methodological point of view, it should be obvious that the analysis cannot be purely based on collection and crunching of statistical information, but it should be informed by the culture of the platform, by its everyday practices, by its social dynamics and its history. The role of network analysis may not be central, yet it is essential for a complete understanding of the platform and its practices. The meticulous analysis of a social scientist into the personal history of its subject and its social connections has been partly transformed by the new media that makes social ties much more tangible. Furthermore, a set of useful concepts defined over social networks can now be added to the conceptual toolbox of the social scientist.

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The hyperimage: Toward a theory of expanded photography

Alfredo Cramerotti

Photography, expanded

Photography is better discussed not as a set of activities or practices for specific purpose, but rather as a type of language that travels across borders and idioms, and becomes itself an agent of translation, that is, a way to transfer information and ideas from one context to another (i.e. from industry to art to science to economics to personal to military). The established categories in which photography was once subdivided, practiced, understood and discussed have been reconfigured. A contemporary, expanded photography functions as a macro-genre where there is no longer a separation between the different functions of photography (artistic, personal, scientific, military, etc.); and there is no longer the camera itself, as it becomes increasingly hybridized with information and communication devices (mobile phones, tablets, glasses, game consoles, 3D scanners and so on).

Everyone can testify, in his or her own daily activities, that photography has dissolved into a magma of images; in other words, it is losing its historical and medium specificity, and expanding its scope. It is our daily fare. How many photos have we been included in, have we absorbed, triggered or generated today? We are all, more than ever, 'implicated' in photography whether we like it or not. We 'make' ourselves both as individuals and communities via this visual alphabet and visual database, a language that is neither written nor verbal, but visual and, importantly, digital.

In particular, the digital aspect of the photographic code has started dismantling and disrupting the linguistic features and reference points of society. The effect is that of an invasion in the field of attention: first, it has produced a 'familiarization' of space, reproducing on a human scale both the immeasurably 'big' and the infinitesimally 'small'; then, of place, being ubiquitous and multiple at the same time; lastly, of time, being in real time and simultaneous with whatever lived. Digital photography then causes the perception of an expanded time.

It elides the capability of putting in perspective the thickness of facts. It reveals the abstraction of the traditional categories through which we used to classify event – geographically, historically and economically.

It is as though reality has removed itself from the visible realm and has 'imploded' in the microchip circuits of digital technology. We are within it, not external to it, but it feels bigger, not smaller. The digital visual language has brought everything to the surface and has thus made it available for rearrangement.

But if this is a language, how do we learn it? We know how to speak English, or Thai or use Sign Language, because someone put us, or we put ourselves through education, formally or informally. In terms of visual education, this is something usually not 'structured' academically, and yet we are immersed in images and image-making processes 24/7, and we partake in the labor of imaging. We are a segment of the sequence of knowledge that is generated and used everyday, which in turn produces effects on the economical, scientific, political and social fields – just to name some areas where images have powerful implications. We embody the much-hyped term of prosumers – defined as those users that produce content by circulating and recontextualizing what they receive, mainly through the web. Under this light, we are learning by doing. We become participants of the filtering, curatorial and interpretative processes that occur every day.

I use here the term 'curatorial' with some insight. In my work as a curator of modern and contemporary art, I try not to impose any existing theory on whatever theme I address or investigate through an exhibition, but rather I try to work out a ground theory from the bottom up every time, through the artist's work. This, in turn, shapes the research and the choice of the exhibition formats, and makes enquiries possible further afield. Following the same methodology, as a prosumer and maker of visual narratives, I select information, place it in sequence and address the subject matter from different angles.

Attempting to map how this photographic moment in the history of image-making, distribution, staging and consumption is changing the approach to visual cultural production and distribution, the questions we may pose to ourselves concern two complementary aspects of the notion of expanded photography:

1. How artists' and cultural producers' inquiries, values and justifications are being reconfigured through hyperimage? How do contemporary artists act as translators for such enquiries from one context to another, rather than representing them in a singular context?
2. Conversely, how does an overall 'media age' which almost doesn't recognize different visual practices and approaches, inform cultural production including curating, exhibition making and displaying?

The hyperimage

I address photography in the current form(s) as a double model; first, through its relation to the digital age, as an investigative model for curatorial and artistic practices. Second, using these very practices as research methodology for the concept of hyperimage, which I unravel below, and the field of expanded photography.

Digital images have increasingly become floating signifiers, a commodity exchangeable with items or services. The idea of expanded photography typifies a situation in which we don't actually choose to use photography but we are rather immersed in it. I am attempting to map this realm through a curatorial approach, that is, the activity of creating a narrative through other people's work, in the attempt to give sense to this flux by retaining some information and rejecting others.

In Internet-connected societies, we refer to images (and image-making) in order to act politically, socially and culturally. Expanded photography is now the set of conditions that facilitates our awareness of such interconnected layers – a visual system that searches, finds and acts out meaning as it constitutes it, with or without camera. Our brain processes recollected, imagined or existing photographs, which in turn contribute to our knowledge and perception of the world and of ourselves. Expanded photography passes through different stages, different signs and formats. Like the film and video practices of expanded cinema, it alters the so-called 'architecture of reception', transcending the historical, geographical and cultural experience of the viewer. It also embodies the generative aspects of image-making itself, where photographic practice is transformed into something heterogeneous, performative, seamless and infinite. This is more than simply taking a picture or inventing an image; as outlined above, it is about constituting the self visually.

It's as though our society has freed image-making from previously articulated specific applications, blurring the boundaries between genres and functions, and rendering the photographic image as a free-floating subject on its own, detached from any relation specific to its origins; what we may term as 'hyperimage'. Photography now functions as hyperimage, translating and transcoding (visual) information from one format to another. The definition of hyperimage goes beyond the pure realm of photography. Hyperimage in the digital land is the equivalent of words in a dictionary.

Hyperimage within the digital field is recreating the multidimensional orientation of the 'primitive' (McLuhan 1972; see also McLuhan and Quentin 1967). Primitive and pre-alphabet people interpreted time and space as one and lived in an acoustic, horizon-less, boundless space. We are moving into a world of total involvement in which everybody is involved with everybody else. Time has

ceased, or changed. Space has vanished, or changed, too. McLuhan has famously summarized this by saying that we live in a global village, a simultaneous happening. We are 'global wanderers, but information gatherers rather than food gatherers' (McLuhan 1998). We consume, deal and act through images in relation to everything else. If the digital has contributed, on one side, to the fragmentation of the world, on the other it has nurtured the classificatory tendency of the human brain by making available an infinite amount of new documents and existing visions to reorganize, rearrange, act upon and exercise. The gargantuan quantity of images produced daily and circulated has developed a spectrum of new attitudes; we have become professional seers and visualizers. As the visual automatic writing envelopes us, we unconsciously apply comparison techniques that bring us to disavow yesterday's fashions. And so, after the initial 'congestion' and sense of overwhelm caused by photography in its first hundred years, now its expansion through hyperimage offers a de-congestion of our gaze, and takes upon the task of unravelling our lives, 'translating' rather than merely representing them.

Since hyperimage is more a 'formation' than an information tool, its true function is that of being an 'experience shaper'. The digital realm allows a constant adjustment of the perception of one's presence and position, and simultaneously makes possible the participation in the development of the seeing. In the modern age, there were attempts to order our world and information by classified patterns, subjects and schedules (much like any nineteenth-century factory setup with its inventory and assembly lines). The continuum was the organizing principle of life. Rationality and logic came to depend on the presentation of connected and sequential facts and concepts. Since then, space and time have shifted from linear and perspective to the discontinued and multidimensional, and we are more sensitive to the unrepeatability of events, while meanings, especially in visual language, emerge as more opaque because of the distance between sign and meaning and the shift from representation to operation.

The technological unconscious

Franco Vaccari, an Italian predigital artist[1] whose writing has not being yet translated into English, put forward the idea of a shift from constant references to the individual to a focus on the tool, which must be seen as 'having the capacity to organize images autonomously into forms that are already symbolically structured, independently from the intervention of the individual' (Vaccari 1979: 18–19) – basically, bypassing the role of the artist.

Fotografia e Inconscio Tecnologico (Photography and Technological Unconscious) is a 1979 text where he articulates that the camera has an autonomous

system of signifiers and an independent, static unconscious. Vaccari summarizes the technological unconscious as the 'autonomous capacity of technological tools to produce sense' (Campanelli 2016)[2]; an 'independent centre of productive activity that gives structure and form to the inarticulate elements crossing it' (Vaccari 1979). He defines the human unconscious as 'plastic' and states that, alongside it, there exists another type of unconscious, the technological one. It can be seen at work when human beings delegate activities to machines and instruments: 'every machine follows rules, or conventions, that shape up its production and such rules work just like the unconscious, although on a static and incredibly rudimentary level' (Vaccari 1979).

Accordingly, if and when we accept McLuhan's view of media as extension and improvement of our human capabilities, then the unconscious is also projected outside, toward the exterior, and its activities are autonomous in two ways: they are unconscious, and they are also entrusted to external tools. The problem is that we might not be ready to propose an alternative to these activities delegated to, and delivered by, tools; we cannot deny some form of autonomous action because it is too incorporated in our everyday.

Vaccari's vision of the unconscious is that of a 'social unconscious' that works autonomously and gives (symbolical) shape to human action. Considering photography and its expansion, while an accepted definition of photography has been the photomechanical depiction of reality, for Vaccari this is a process that is already in itself 'structured' and does not require the intervention of the individual (Campanelli 2016). As such, the very human activity of attempting to give meaning or value to an image is none other than a 'photographic misunderstanding' (Campanelli 2016) and the negation of its deepest reality, which in true is autonomously structured by the technological unconscious.

These reflections, formed in a predigital age, bring to mind that during the modernist period, a shift in cultural production from 'work' to 'situation' and 'action' occurred. Furthermore, it shifted from 'individual' to 'collective experience', accelerated by the digital, with the tendency of eliding the difference between artist and public, producer and consumer; culminating in the prosumer idea – at least on a conceptual level. The public now has a meaningful and active role. The audience is a creative, participating force, but it is still limited by yesterday's answers to today's questions. We have become irrevocably involved with, and responsible for, each other. Vaccari's writings (1979–94) offer stimulating theoretical elaboration, centered on the theme of a civilization – ours – based on goods, communication and wrapped up in images.

In this context, photography has changed its skin to become hyperimage, an indispensable element of interaction; no longer as a representational form, but as a form of relation, experience and translation of the social and the private. The

digital in photography allows for the disruption of rules, habits and behaviors, almost allowing for the production of work autonomous from the intentions and skills of the operator, which is increasingly a process, function or system rather than a 'someone'.

Artistic and curatorial practice

From my position as curator, working daily with artists and visual arts professionals, I can assess the impact of 'expanded photography' in shaping contemporary art and culture-making, exhibiting and displaying, interpreting and mediating to a public and on our capacity to bring together meaningful narratives and specific contexts from the constant flow of data.

There is a sort of parallel between the work of the artist and art curator and the approach of the viewer as a digital native (or 'advanced' digital user) with her or his own rendition of visual life. For a start, there are many aspects of expanded photography impacting an artist's and curator's work in the digital age that really transform not only the artistic agency and the way things are done, but also the conception of the work itself. I have articulated this in a few points below.

a. For a start, artists are not immune to the use of commercial web platforms in order to realize and distribute their work. At some point, there is the need to stick with the surface of the digital and less with its core possibilities, in order to keep the flow and actually produce work rather than spending time trying to keep updated with the operating system. Productive working time has to be assessed on an ongoing basis, and that implies letting go a part of the artistic agency in order to be more productive. Artists use their peers' networks (other artists, galleries, curators, educators, producers, collectors) to gain specialized knowledge such as coding and 3D rendering, and advance their work without necessarily having to master the basics.
b. Visual literacy is something powerful within a digital economy; people are navigating their own identities and beings – the social use of photography through online networks, and the creation of alterimages of themselves, is a clear example of this. The social capital handed over to multinational providers of online platforms is a trade-off for curating their lives and their interests – often with a professional goal in mind. Trading details about work, interests and friendships (and a good deal of self-publicity) with the possibility of constructing a curated narrative of one's own life through a selection of visual markers, is something to be evaluated and in most cases, accepted. Digital natives and advanced digital users construct their image through the media; they don't

watch, they 'search for', saving the results in compilations and preference lists to share with friends and colleagues, contributing to their self-establishment of what others perceive about them. The activity of curating addresses how these life narratives come together and what impact they have on society by means of multidisciplinary investigation; for instance, bringing together, in an art project, videogame aesthetics, participatory initiatives and activism.

c. Hyperimage is also one of the striking examples of disruptive innovation. Unlike sciences that have always worked with the features of the digital embedded in the mechanisms (the research setting, the team approach, the peer-review principle; things at the basis of the algorithms governing search engines), in the arts this is almost missing; it is difficult, if not impossible, to measure the value of the process. The dynamic of sharing is extrinsic to the very idea of it. The unit – the artistic outcome – is still the focus and the measurable thing, but if we contextualize hyperimage within cultural forms such as music, dance, oral history or cooking throughout the centuries and millennia, we can see that, with the digital era, there is no real shift of paradigm. There is no break in human culture about this provisionality of cultural products because we are at the tail end of a short blip in human history that has put a lot of emphasis on the idea of fixity. The work of art in terms of analogue, itemized product (the printed photograph, the celluloid film, the vinyl record, the printed book) has eschewed the provisionality that was mainstream before that. After the Enlightenment and the Industrial Revolution, the anxiety of the 'definitive work of art' is continuously decreasing with and through the digital; we are realigning with what happened before. In fact, just because artistic and curatorial practices have started to shift to now include participatory projects and 'useful' outcomes, that is, artistic projects in the forms of urban gardening, bicycle fixing and recycling or collective dance classes, doesn't mean that artistic structures have. These structures of making, sharing and presenting ultimately shape human culture and take time to change. It is important to try to identify the approaches that somehow transform the settings through implicit feedback mechanisms. Hyperimage helps coming to terms with the implications of the continuity of the sense of human art history and culture.

d. Through collective input (sharing from an individual and pooling from a multiplicity), the digitalization of photography and of imaging in many cases de-centralizes the subject of the story; now, constant feedback and further distribution provide a sort of textuality through which the subject becomes fixed in the collective consciousness – no longer presented by a mainstream narrative. It de-centralizes the position of the artist and producer. There are more strategies to deal with the subject matter, and its value is shifting into new forms of communication. The curatorial approach becomes less of a selection of

whatever results found through the research process packaged in a 'closed' visual statement, and more of a meaningful aggregation of some aspects of the subject matter, left open, linked and expanded by other people further down the line. It is as if the cultural producer is able to make sense, and claim some sort of ownership, not of the content but, of the space between the individual and the social.

e. A more social aspect about the digital realm is that producers (curators and artists alike) think strongly that one of the values of embracing the digital is the learning-by-doing attitude, which so much typifies our information age. This, in turn, fosters research and innovation, since in the digital culture the gatekeeper is no longer the institution that holds the know-how but one's own access to the peer network and the willingness to experiment. It is also relevant to the idea of inclusion, to change how we see expertise and how we define the value of a work in terms of history and subject relevance. Photography is an apt terrain to test the shift in attitude; from mastering the medium to actually using it as a visual vocabulary to compose messages that deliver content and meaning; now starting from a pattern-recognition approach which then generates an idea, a specific narrative, rather than starting with the idea and then doing the research.

Toward a theory of expanded photography

I start this proposition with an anecdote: François Arago,[3] who supported and advocated the work of Louis-Jacques Daguerre, gave a speech on the occasion of the award to Daguerre for the invention of photography. The announcement already bears witness to a total awareness of the nature of the new medium, and its potential. Arago concluded with, more or less, these words (the translation is mine):

> It seems vital that the Government should compensates Mr. Daguerre directly and that France should nobly gift to the world this discovery, which could provide an enormous contribution to the progress of arts and sciences.

This was delivered around 1830. Reading those lines, there is the sense of disproportion between the perspectives and the potential opened up by the new invention and whatever pretention of its management and control by individuals or nations. It seems to say that it is not photography which is given to the world, but rather it is the world that is offered, or assigned, to photography.

Drawing a parallel with, yet taking a specific character from, the abovementioned notion of expanded cinema, and the writing of predigital thinkers like Franco Vaccari, Vilém Flusser and Marshall McLuhan, this way of reasoning

implicates photography as a multifaceted, expanded feature of our living that cross-references societal fields. Its result, hyperimage, is a whole body of experience that embraces (and is mediated by) a great variety of relations, interests and possibilities to become the principal manifestation and constitutive element of our human condition in the twenty-first century. This process is not only taking place in but also through the public realm. The visualization of our acts, stories and indeed our thoughts is what now constitutes the main discourse of the public realm. There is no public sphere without the sharing of experiences and opinions, and in our age what we share most are images. They have become a commodity. We trade our existence in images, and we shape us through them, creating alter-images of ourselves in the process.

Flusser, for instance, echoes this when he writes that images replace events and translate them into scenes; that is to say, images are needed to make the world comprehensible, since it is not immediately accessible to them. But as soon as images appear, they come between the world and human beings. They are supposed to be maps, but they turn out to be screens (Flusser 1983). The world is 'given' to photography in the sense that human beings forget that they created the images in order to orientate themselves in the world, and since they are no longer able to decode them (and that is the case of the digital field, and the 'unconsciousness' of it), their lives become a function of their own images.

Digital images are really metacodes of images, texts and concepts. They represent even more abstract complexes of symbols than traditional images, and they signify texts (instructions, basically), not the world. The imagination that produces them involves the ability to transcode concepts from texts to images; when we observe them, we see concepts of the world, encoded in a new way (Flusser 1983). A photograph is an image of a concept, or many concepts, according to a program, an image whose function is to inform but for which reality is information, not the significance of that information. All the elements of a photograph (like colors, for instance) represent transcoded concepts, not reflections of the world into the image. The programmed concepts would have to be decoded to reveal that one is dealing with discourses, instructions, scientific texts re-encoded into a symbolic state of things. That is why we are no longer able to decode images directly. And the more people take or create photographs, the more difficult it becomes to decode them.

In traditional images like a painting (an example that Flusser put forward), if one wishes to decode the image, then one has to decode the encoding that took place 'in the head' of the painter. The digital field instead translates scientific statements and equations into states of things, that is, images. There is almost no resistance to the force of digital images. There is very little artistic, scientific, political and everyday activity that does not aspire to be photographed, filmed, videoed or

shared with many. Almost all physical events are transformed into digital states of things, turning them into floating signifiers.

Every photographic image is part of a linguistic system, and since language (and visual language) predates our coming into the world, images always produce a meaning, even in the absence of a conscious subject. What is obtained is already codified (not only digitally, but socially too) and expresses a preexisting judgment – it does not need human intervention in order to transform itself into a meaningful sign or symbol. With the digital, the visual practice of photography has turned into a sort of visual automatic writing, where the images produced are elements of a collective, technological unconscious. In previous ages, the distance between a sign and its meaning was rather minimal. The spatial organization of images was charged with temporal, symbolic and narrative values. There was time to 'read' them, to unravel their stratifications and so to obtain instruction and meaning; the whole process was relatively straightforward because of the minimal distance. Now, the exchanges that take place see the relationship between these elements becoming increasingly complex, to the point of being impossible to track. The intention of what Flusser calls 'apparatuses' (the result of industry; a thing, a program that lies in wait or readiness for something, i.e. a setup, an industry, the socio-economic structures and policies that govern that industry, etc.), or what Vaccari calls 'unconscious' is not to change the world, but rather the meaning of the world.[4] Now the work-programming and work-controlling apparatuses (programs and instructions) are at the center of our life. In cultural analyses, which is what I am undertaking here, the category 'work' can be replaced with the category 'information'.

Photography has multiplied the amount of attention points and has satisfied visual hunger. Reality, writes Vaccari, has become the anticipation of the picture desired. Also, by passing from one context to another, by translating so perfectly through the digital code, that is, gynecological and pornographic imagery that can be swapped smoothly, photographs can exchange roles and so, fill meanings for other contexts. A particular photograph can slip over from one 'channel' (i.e. scientific-indicative, political-imperative, optative-artistic, etc.) to another, the essential thing being that the photograph, with each switchover, takes on a new significance, a new encoding. What renders a picture pornographic is less its form (the representation) than its use (the operation). Hyperimage does not only register but acts upon the real, it determines it, modifies it and implies a preventive action.

The image-making process is always the 'maker of meaning' and necessarily so. The process continually melds past, present and future, cognition and emotion. Expanded photography requires the photographical element to enter a mutual relationship with other economies including art, mass media, architecture, science, law, etc., all the while constantly shifting society's perception of itself through

non-photographic disciplines. Its vehicles of communication are curatorial practice, education, media and publishing, but concern projects that are 'implicitly' rather than 'explicitly' photographic. When artists, editors, producers, cultural mediators and curators open up a space to cross boundaries with other realms of society, an uncharted terrain suddenly materializes. In fact, producers and consumers alike become active participants of the process, since they become a part of the information chain. Inscribing oneself into the image and image-making process is the only way left to participate in life; moving into the interior of the image, into the work and the discourse that lies behind the image, becoming part of it, and the medium.

The status of photography is then less about producing a certain outcome and having a certain position in culture, and more about setting the scene and embodying the development. It is about enabling a certain mutuality. It is as if photography in the digital age is less about the work and more about the making of the work. Expanded photography is, thus, about experiential truth.

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NOTES

1. Franco Vaccari was born in 1936 in Modena, where he still lives.
2. Campanelli reports that Vaccari described the technological unconscious in this way during a talk given at the *Accademia di Belle Arti* in Naples on 8 October 2014.
3. Arago was a French mathematician, physicist, astronomer, politician and member of the French Academy of Sciences.
4. On the relation between Franco Vaccari and Vilém Flusser I have also drawn from *Che cosa legittima la fotografia? La produzione di un incontro tra Vilém Flusser e Franco Vaccari* ('What makes photography legitimate? The production of a meeting between Flusser and Vaccari'), a paper by Valentina Bonizzi published in *Flusser Studies*, 19, May 2015, http://www.flusserstudies.net/person/valentina-bonizzi. Accessed 10 July 2016.

Conclusion: Technology | technique | transformation

Jeremy Pilcher

In bringing this book to a conclusion no definitive diagnoses for culture and society are offered on the impact of the reciprocal relationships between visual culture and technologies used in the creation of knowledge and its communication. Instead, framed by the contributions gathered together in this book, some broad observations are set out about matters that may impact on the speed and scope of the transformative changes that may be expected from the ongoing technological developments. In structuring the volume around the three themes of data generation; knowledge presentation and visualization; and virtual museology a choice had to be made to delineate certain themes more boldly than others. These aspects may be identified both within the contributions taken individually, and also from various interweaving threads that may be traced between them. However, even if the order created for this book has helped to tease out certain strands, it has by no means exhausted the varied interconnections that may be found between the chapters. In the first section, for example, the contributions from Luengo and Eastaugh were linked together in terms of the way that analytical techniques may impact on knowledge about cultural heritage by generating data that may otherwise not be available. Yet, these contributions may also be read as having provided insights into why, as discussed in the opening chapter by Larkin, technological developments may affect disciplines in widely divergent ways and at varying speeds. Modifications in the methodologies and techniques deployed by disciplines cannot be expected to follow inevitably simply because new technologies provide new affordances. As Luengo observes in concluding his account of the potentialities of the techniques of light analysis, photogrammetry and the application of a Big Data extractor, there are practical limitations such as cost, which must be taken into account. In his discussion of imaging techniques that move beyond existing traditional methods of analysis, Eastaugh brings his chapter to a close by observing that the importance of new capabilities *may* be such that they will generate sufficient impetus for existing difficulties to be overcome. In other

words, the integration of new technologies within disciplines depends on a range of factors including, among other things, wider financial and institutional support.

In broad terms, a range of material conditions and attitudes frame the introduction of new techniques of knowledge creation and these will have an impact on their adoption. The contribution by Bligh and Lorenz in the second section discusses the importance of physical space in the use of technology-rich multi-display learning spaces. Their chapter provides an illustration of how a spatial environment may affect the recursive relationship between a complex display ecology and the production of knowledge by supporting the performance of analysis and interpretation in a presentation. Yet, although the available space encouraged the creation of the desired learning environment, as they observe 'student reticence had not disappeared overnight'. Even if there is a supportive wider environment, the time-frame in which the adoption of new technologies takes place will be affected by a wide range of different possible inclinations, reactions and motivations on the part of those involved in using the technologies. As Boyd Davis observes in his discussion of visualizations of chronology, although there has been a resurgence in historical visualization with the growth of the digital humanities, there has been a 'relative lack of critical debate around temporal mapping'. In casting the debate about the role and impact of digitization in an historical perspective, he identified that the 'application of mechanism or of computing to any task habitually prioritizes those things that are easiest to do'. Approached in these terms, the multiplicity of reasons for the uneven rhythms in the way technologies impact on disciplines may be understood, at least in part, in terms of the broader development and acquisition of preexisting attitudes and skills.

These issues may be expected to be highly significant if, as Eastaugh suggests, it is not the underlying technologies that 'ultimately have the greatest impact, but what is done with the data'. Manovich has identified there are a range of skills that would facilitate the analysis of large data sets, which are yet to be widely deployed in the visual humanities (Manovich 2015: 14). In the final section, Akdag Salah discusses the value of social network analysis as a methodology to explore large online social networking sites such as deviantArt. As she observes, it involves the collection and analysis of data collection although such an evaluation, 'cannot be purely based on collection and crunching of statistical information, but it should be informed by the culture of the platform, by its everyday practices, by its social dynamics, and its history'. The use of both quantitative and qualitative methods of analysis may provide powerful insights. In terms of the issues explored in this book, the combination may provide a means to engage with attitudes such as those revealed by Bentkowska-Kafel's observation that the use of digital technologies in museums is regarded by some critics with 'contempt, irrespective of their quality and scope'. A general illustration of the potential for large data sets

to provide better understanding of cultural institutions and their practices is the access provided in 2018 by the Metropolitan Museum of Art to its data. Among the experiments this enabled was an 'examination of the history of collecting at The Met, and how collecting practices have evolved throughout The Met's history' (Tallon 2018). As observed by Akdag Salah, using social network analysis may reveal the 'the social connections, and the connections show us the paths of influence and the flow of ideas'. In turn this may facilitate a critical engagement with the creation and perpetuation of the very value systems by which the inclusion of digital multimedia in museums is dismissed as 'edutainment, even disneylandization'.

As was acknowledged in the Introduction, there is no guarantee that the development of new technologies will have a particular disruptive impact on well-established categories or methodologies and values that are used to analyze images and organize culture. The contributions from Eastaugh and Boyd Davis may respectively be understood as indicative of the way new techniques might have conservative rather than transformative disciplinary impacts. Eastaugh's discussion of the importance of the technologies used in verifying and authenticating artworks could be approached in terms of the value they have for reiterating established art-historical knowledge and values rather than because data generated might bring into question existing categorizations and frameworks. In his chapter, Boyd Davis observes that even today chronographies are created in such a way that the fiction that, 'our data are sure, precise and uncontested' is graphically perpetuated. Nevertheless, it seems difficult to imagine that networked digital technologies will not have significant and disruptive sociocultural impacts. In the concluding chapter, Cramerotti speculates as to how expanded photography will impact on the way in which the world is lived. He describes it as a 'language that is neither written nor verbal, but visual and, importantly, digital'. This may be contextualized by John Berger's diagnosis that modern methods of reproduction mean that 'images of art have become ephemeral, ubiquitous, insubstantial, available, valueless, free. They surround us in the same way as a language surrounds us. They have entered the mainstream of life over which they no longer, in themselves, have power' (Berger 1972: 32). But, crucially, with expanded photography what is now required is not only an account of the reproduction of individual images and the ways that knowledge *about* visual works is created and circulated but an engagement with the implications of the replication, circulation and storage of the data by which the image itself is comprised.

While Cramerotti describes photography having 'dissolved into a magma of images' he puts beside that the way in which the digital has 'nurtured the classificatory tendency of the human brain by making available an infinite amount

of new documents and existing visions to reorganize, rearrange, act upon and exercise'. The implications of any such developments may be approached in terms of the way that digital technologies have impacted on the 'technical structure of the archiving archive' and in the process affected 'not just our understanding of and access to the past, but also our relation to the future by choosing the legacies that are available to us and to future generations' (Gere 2004: 5). The meaning and sense that may be obtained from the contents of an archive are a function of the technological capacity of the archive. Technology does not simply affect the way knowledge is stored; it informs what is known. The significance of this should not be underestimated when considered in terms of Derrida's argument that changes made possible by digital technologies, which impact on the preservation and dissemination of culture, are also simultaneously altering what is to come: 'archivization produces as much as it records the event' (Derrida 1998: 16–17). Archival developments provide a means to engage with the way that the tensions and fractures introduced into the recursive interrelationships between processes, techniques and knowledge by new technologies do not simply have an impact on the representation of knowledge but also a performative effect on the world (Gere 2004: 5; Preziosi 2009: 491). It is implicit in the contributions from Bentkowska-Kafel and Akdag Salah that museums do not exist discretely from the technical means by which memories are structured (Gere 2004: 4). The potential transformative effects this will have on societies may be glimpsed from the historical impact the museum has had as 'an indispensable component of statehood and of national and ethnic identity and heritage in every corner of the world' (Preziosi 2009: 490). Approached in these terms, the work in this volume may indicate the prospect of the disruption of established disciplinary parameters and norms but also, perhaps more fundamentally, it gestures toward transformations of the cultural legacies on which constructions of the future will have been founded.

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Brett Bligh is a lecturer in the Department of Educational Research, Lancaster University, UK, and co-Director of the Centre for Technology Enhanced

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Stephen Boyd Davis is professor of design research at the Royal College of Art, London. His background is as a practising designer. His research is focused on visual representation, especially on the visualisation of historical time in a digital humanities context. This includes investigating past innovations in chronographics, particularly from the eighteenth century, and the development of new practice using digital methods. His work is widely published within the fields of design, history, digital humanities and human computer interaction. His innovation projects involve collaborations with major archives and collections, seeking new ways to make sense of historic data and to enable the creation of new knowledge. He is particularly concerned with visual representations that are capable of representing subtlety, complexity and controversy. His research has been funded by Leverhulme, AHRC and EPSRC. His other roles include research evaluation, as a panellist for the UK Research Excellence Framework and for the Hong Kong Research Assessment Exercise, and reviewing for leading journals and UKRI Research Councils.

Alfredo Cramerotti is director of MOSTYN Wales; head curator of APT Global–Artist Pension Trust; Associate Curator of CCANW–Centre for Contemporary Art and the Natural World; Advisor to the British Council Visual Arts Acquisition Committee and the Art Institutions of the 21st Century Foundation; Vice-President and Executive Committee Member of AICA–International Association of Art Critics; Member of the IKT–International Association of Curators of Contemporary Art and CIMAM–International Committee for Museums and Collections of Modern Art, part of ICOM.

He complements his institutional role with active participation in the visual art world. In recent years this has included curating the ongoing exhibition project *Ideal-Types* (Amsterdam 2018, Venice 2019); *Sean Scully: Standing on the Edge of the World* at the Hong Kong Arts Centre (2018); *Shezad Dawood: Leviathan* with the Fondazione Querini Stampalia in conjunction with the 57th Venice Biennale (2017); *EXPO VIDEO* Chicago (2015); three national pavilions at the Venice Biennale (Mauritius in 2015, Wales and Maldives in 2013); and the biennials *Sequences* VII in Iceland (2015) and *Manifesta 8* in Spain (2010). Cramerotti is editor of the *Critical Photography* book series; his own publications include *Forewords: Hyperimages and Hyperimaging* (2018), *Unmapping the City:*

Perspectives of Flatness (2010) and *Aesthetic Journalism: How to Inform without Informing* (2009).

Nicholas Eastaugh originally trained as a physicist before going on to study conservation and art history at the Courtauld Institute of Art, London, where he completed a Ph.D. in scientific analysis and documentary research of historical pigments in 1988. Since 1989 he has been a consultant in the scientific and art technological study of paint and paintings. A frequent lecturer, he has also been for some years a visiting research fellow at the University of Oxford. In 1999 he co-founded the Pigmentum Project, an interdisciplinary research group developing comprehensive high-quality documentary and analytical data on historical pigments and other artists' materials. This led to the publication of *The Pigment Compendium* in 2004, which quickly became a standard reference text in the field and has remained in print since. He is also founder and chief scientist at Art Analysis and Research Inc., a company specialising in the study of the material structure of art for a wide range of public and private clients. Eastaugh has extensive research and publication interests, including developing chronologies of historical materials and the history of technology as applicable to art materials as well as analytical and documentation standards, databases and novel imaging

Catherine Larkin is an associate professor at Long Island University (LIU), Brookville, New York, US, where she serves as Head of Digital Initiatives, oversees the William Randolph Hearst Archive at LIU and teaches in Honors College and the Art History Program. She received a Master of Arts in Medieval Art History from The City University of New York, Queens College (1997) and was awarded a Doctor of Philosophy from the College of Information and Computer Science, the Palmer School of Library and Information Science (2010). Her dissertation research was focused on image and text retrieval in the visual arts and her findings have been presented and published nationally and internationally. Currently, Larkin's research is concentrated on the life and art collecting of William Randolph Hearst, a topic that has generated a number of scholarly accomplishments including presentations, exhibitions and publications. In 2016, Larkin received The Worldwide Books Award for Publications for her article, 'Art collecting on a global scale: Non-European objects from the William Randolph Hearst archive', *Visual Resources: An International Journal of Documentation* (2014). She has recently published a new article titled, 'The William Hearst archive at Long Island University: A resource for provenance research', *Art Documentation* (2019). The article addresses a variety of Hearst's purchases during the Nazi Era (1933–45). Since 2014, Larkin has served as co-coordinator of the

Provenance Special Interest Group, (Art Libraries Society of North America, ARLIS/NA). This association drives her current research agenda. During her sabbatical leave (Fall 2019) Larkin will continue her work on the provenance of Hearst's art acquisitions.

Katharina Lorenz is professor of classical archaeology in the Insitute of Classical Studies at Justus-Liebig-University Giessen and director of the ancient art collection and the Living Lab for Digital Cultural Practices. Her main research interest is in the methodologies for the study of classical art and their implications for historical understanding. She is the author of *Bilder machen Räume. Mythenbilder in pompeianischen Häusern* (Berlin 2008) and *Ancient Mythological Images and their Interpretation* (Cambridge University Press 2016); she has published widely on Greek and Roman visual narrative, Roman painting and the domestic context, art historiography and intellectual history and digital heritage engagement.

Pedro Luengo is presently associate professor of the History of Art Department in the Universidad de Sevilla. He received his Ph.D. in history of art from this institution with his work *Intramuros: Arquitectura en Manila, 1739–1788*. He has been a visiting academic at different international institutions, such as San Agustin Museum (Manila), Instituto de Investigaciones Estéticas (Mexico), European University Institute (Florence), King´s College London and Oxford University. He has taken part in several international research projects, being the principal investigator of one on Xiyanglou buildings in the Yuanming Yuan Garden in Beijing. He has published several papers in both national and international journals. Luengo is the author of *Intramuros: Arquitectura en Manila, 1739–1762* (Fundación Universitaria Española 2012); *Manila, plaza fuerte. Ingenieros militares entre Europa, América y Asia* (CSIC-Ministerio de Defensa 2013) and *The Convents of Manila: Globalized Architecture during the Iberian Union* (Ateneo University Press 2017).

Michael Takeo Magruder | Cover Image (US/UK, http://www.takeo.org) is a visual artist and researcher who works with new media including real-time data, digital archives, immersive environments, mobile devices and virtual worlds. His practice explores concepts ranging from media criticism and aesthetic journalism to digital formalism and computational aesthetics, deploying Information Age technologies and systems to examine our networked, media-rich world. In the last 20 years, his projects have been showcased in over 290 exhibitions in 35 countries, and his art has been widely supported by numerous funding bodies and public galleries within the UK, US and EU.

Jeremy Pilcher is a lecturer in law at Birkbeck Law School, University of London. His research explores intersections between art and law. This includes examining the scope art provides to critically engage with the impacts of legal systems on societies and cultural sites and institutions. Pilcher's research builds on academic qualifications in cultural research, art law and art history as well as his professional experience as a lawyer and fraud investigator. He began his legal career in New Zealand as a criminal prosecutor before working in commercial litigation. After moving to England, he qualified as a solicitor and worked in both the public and private sectors investigating fraud in companies. Pilcher's work is published within the fields of law, digital arts and humanities and intangible cultural heritage. His other roles have included reviewing for journals in museum studies and organisation theory. He is a member of the Advisory Group of the Art/Law Network and he is on the Programme Committee of the Electronic Visualisation and the Arts (London) conference, which is organised through the Computer Arts Society.

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CULTURE, TECHNOLOGY & THE IMAGE

TECHNIQUES OF ENGAGING WITH VISUAL CULTURE

Culture, Technology and the Image explores the technologies deployed when images are archived, accessed, and distributed. The chapters discuss the ways in which habits and techniques used in learning and communicating knowledge about images are affected by technological developments. The volume discusses a wide range of issues, including access and participation; research, pedagogy and teaching; curation and documentation; circulation and re-use; and conservation and preservation.

The book illustrates how knowledge about images is intertwined with the methods that are used to store, retrieve, and analyse those images and the information associated with them. Focusing on the implications of technology for processes and practices brings into view the permeable nature of boundaries between such disciplines as art history, media studies, museum studies, and archiving. As such, this text will appeal to a broad academic audience, including art historians interested in the digital; media studies scholars; digital humanities scholars interested in expanding beyond textual scholarship; as well as new students in any of these fields.

Jeremy Pilcher is a lecturer of law at the School of Law at Birkbeck, University of London. His research engages with the intersections of art and law.

ISBN 978-1-78938-111-5

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