

Dallas, Costis (2007) An agency-oriented approach to digital curation theory and practice. In *International Cultural Heritage Informatics Meeting (ICHIM07): Proceedings*, J. Trant and D. Bearman (eds). Toronto: Archives & Museum Informatics. Published September 30, 2007 at <http://www.archimuse.com/ichim07/papers/dallas/dallas.html>. Author's re-formatted version, August 2008.

An agency-oriented approach to digital curation theory and practice

Costis Dallas[§]

Digital curation emerged as an important new concept in the theory and management of cultural information, not least because of its broad applicability and promise of a universal approach to ensure future “fitness for purpose” of digital information. This paper explores curatorial traditions in the field of museums and cultural heritage, in order to contribute to the active current debate on the nature, scope and methods of digital curation. It uses an approach inspired by cultural-historical activity theory in order, firstly, to understand current digital curation practice, its achievements and limitations; secondly, to explore key activities in the cultural heritage field, i.e., knowledge production in archaeological fieldwork and publication, museum curation, and meaning interaction in exhibition visitor experience. On account of these insights, it concludes that, in order to ensure the declared objective of future “fitness for purpose”, and avoid the risk of epistemic failure, more effort should be dedicated by the digital curation community on developing adequate knowledge representation of digital information in specific epistemic and pragmatic contexts; that an agency-based approach, using event-centric approaches to represent knowledge on the content and context of information, would be particularly useful in some application domains; and that formal methods to curation lifecycle based on belief change and ontology evolution could also be used in modelling the co-evolution of the epistemic content and context of curated knowledge.

Keywords: digital curation; activity theory; museums; material culture; exhibitions; knowledge representation

Introduction

Digital curation emerged in the dawn of the 21st century as an important new concept in the theory and management of information, not least because of its claimed applicability in a broad range of problems and domains, from cultural heritage collections to e-science and the management of organisational records. The creation, in 2004, of a collaborative, multidisciplinary Digital Curation Centre in the United Kingdom (Atkinson et al., 2005), the publication of an electronic *International Journal of Digital Curation* (<http://www.ijdc.net>), the increasing number of research and professional fora where digital curation is discussed, the appearance of digital curation in the curriculum of academic departments across the Atlantic (Lee, Tibbo, & Schaefer, 2007; Moss & Ross, 2007), all bear witness to the growing inter-

[§] c.dallas@panteion.org; Digital Curation Unit, Athena Research Centre & Department of Communication, Media and Culture, Panteion University, Greece

est the concept arouses. Current stakeholders in these developments include, primarily, computer scientists, archivists, librarians and information scientists, as well as managers of digital repositories and digital libraries, cultural heritage informatics specialists, and practising researchers in collection-based scientific fields such as bioinformatics.

Yet a single species appears to be missing from this Noah's ark of survival from digital information deluge: *curators*, those ancient animals whose typical habitat is the museum storeroom and the exhibition gallery. Their absence from the digital curation census is particularly notable in the light of recent large-scale investments in the digitisation of cultural heritage and art collections on the one hand (Zorich, 2003; JISC, 2005; Minerva Editorial Board, 2006), and of the rapid emergence of virtual museums and Web exhibits on the other (Dietz et al., 2004; C. Copeland, 2006; Sumption, 2006). It appears even more remarkable as the lineage of some of the most poignant insights for current digital curation work is to be found in the core of cultural heritage informatics work, especially as regards considerations such as long-term intellectual preservation, resource discovery and metadata, interoperability, authenticity and integrity, and lifecycle management of digital cultural heritage resources (e.g., Bearman, 1996; Trant, 1998; Besser, 2000; Ross, 2000; Geser & Mulrenin, 2002; HATII & NINCH, 2003).

This realisation was our point of departure, raising the issue: how, and to what extent, might the digital curation agenda be relevant to curatorial practice in the field of museums, art and cultural heritage, at a time when collections-based research and public communication depends increasingly on technological remediation? And, conversely: to what extent an understanding of museum and cultural heritage curatorial practices might contribute to better digital curation of cultural heritage materials? While starting from a particular domain-specific (or 'disciplinary', cf. DCC et al., 2005, 14-15) viewpoint – that of museums, art and cultural heritage – this inquiry touches upon broader issues regarding the scope, methods and epistemic nature of digital curation, which are already the object of active discussion within the digital curation community (Giaretta, 2006; Dale, 2007; Day, 2007; Madden, n.d.).

Activity theory

An account of current digital curation practice inspired by cultural-historical activity theory may be helpful in establishing an understanding of the concrete practices related with digital curation. Activity theory, a school of thought and set of principles based on the Russian psychological tradition of Vygotsky and Leont'ev and on further theoretical development in Scandinavia and the English-speaking world, is now advanced as a useful descriptive and formative framework for problems as diverse as developmental research, organisations, work and ergonomics, social aspects of technology, and Human-Computer Interaction (Leont'ev, 1978; Engeström, 1987; Bannon & Bødker, 1991; Nardi, 1996; Engeström, 2000; Kaptelinin & Nardi, 2007).

The key concept is *activity*, understood as "purposeful interaction of a subject with the world". An activity is always directed toward some *object*, a physical or conceptual entity (or entities). This object embodies, also, the fulfilment of some objective or *motive*, which in turn is intended to meet a specific *need* of the subject of the activity. Activity systems are composed as a hierarchy of *activities*, constituted by conscious *actions*, which in turn are constituted by sub-conscious *operations*; actions are designed to meet hierarchically structured goals. Subjects can be individuals, but also *communities* sharing the same needs and

motives. The fundamental notion of *agency*, “the ability and the need to act” defines an activity as an asymmetrical relationship between a motivated *agent*, or *subject*, and a non-motivated object of activity. Purposeful *interaction* between subjects and objects takes place by means of *tool mediation*, whereby tools are meant to include not just physical, but also cognitive, “mediational artefacts” such as methods and procedures, computer programs, languages and signs (Kaptelinin & Nardi, 2007, 29-72).

There are further fundamental concepts within activity theory, such as those regarding the internalisation / externalisation process, the unity between consciousness and activity, and the proximal level of development, which are, however, of less direct concern to our present discussion. Our focus will be to use the notion of concrete *activity* as a conceptual framework, in order to elucidate the interaction between *subjects* (and communities thereof) on the one hand, and the *objects* of their agency (which may also be other *subjects*) on the other, in settings that juxtapose current digital curation work with established curation traditions, in order to understand the relationship between the two domains and evaluate the potential impact of their interaction.

Enter digital curation

A widely accepted definition of digital curation, introduced by the UK Digital Curation Centre, reads as follows:

Digital curation, broadly interpreted, is about maintaining, and adding value to, a trusted body of digital information for current and future use: in other words, it is the active management and appraisal of digital information over its entire life cycle.

(Pennock, 2007)

This definition is here to be interpreted as a descriptive *proviso*, rather than as a definitive statement of identity; indeed, the question of ‘what is digital curation’ occupies several pages of interesting discussion in the “DCC approach to digital curation” evolving wiki document (Giaretta, 2006) and it continues to appear regularly in digital curation conferences and literature. Yet several potentially fruitful questions arise from it: What constitutes a “trusted body of digital information”? Why curation of information, and not of “data” (e.g., as in Macdonald & Lord, 2003), or, conversely, of “knowledge”? What is meant by “adding value”, and what methodological and theoretical presuppositions does answering this question entail? How is “present and [especially] future use” to be understood? Is “active management and appraisal” an appropriate functional scope, to the exclusion of other operations? Does the “entire life cycle” concern the life of the digital surrogate alone, or of its intellectual referent as well? It is useful to reflect briefly on the original circumstances and *motives* which brought this notion to life, and then provide an account of digital curation activities, their subjects, objects and mediating tools, in current practice and in situations of knowledge interaction in cultural heritage, before returning to some of these inter-related questions.

“Acquisition and curation of very large valuable collections of primary data” was advanced, in June 2001, as a key function of e-science information infrastructure in the UK (Taylor, 2001). A few months later, the Digital Preservation Coalition and the British National Space Centre organised in London an invitational seminar on digital curation, aiming “to raise the profile of the Open Archival Information System Reference Model (OAIS) standard in the UK and share practical experience of digital curation in the digital library

sector, archives, and e-sciences" (Digital Preservation Coalition, 2001). Further realisation of the pressing need to deal with the towering accumulation of primary scientific research data and its future use provided the motive for the formation of a Digital Curation Task Force in the UK, which met in London, in November 2002.

As noted in the preamble of the meeting report:

We are entering an era in which digital data resources are becoming a central pillar of scientific research. [...] The data generated in this deluge requires active management to meet basic needs of access and re-use: data needs to be retained so that it survives, so that it can be found and retrieved as appropriate, understood within and across disciplines, and re-use must be possible; this needs to happen efficiently, fairly and affordably in contexts we cannot today predict. But in addition, digital technology may offer opportunities to incorporate such data more valuably into the knowledge base and extend the reach and value of the data. Ambition in this area could be rewarded by substantial and enduring benefit and scientific advance.

(Macdonald & Lord, 2003)

The motive of providing "long term access to [scholarly and scientific] data" is re-iterated by the main stakeholders of the UK Digital Curation Centre, with the added emphasis on the need for "subject description and linkage to discipline-based ontologies [...] descriptive information that allows re-analysis of datasets of scientific and scholarly significance", and "linkage to the two further domains of scholarly communication and e-Learning". The comprehensive research framework proposed to achieve these goals includes data integration and publishing, (scholarly and scientific) annotation, archiving and appraisal, provenance and data quality, metadata extraction, legal issues, networks of trusted repositories, economic cost-benefit analysis, and, performance and optimisation issues (Atkinson et al., 2005).

Digital curation practice

Digital curation practice so far has been cautious. The generality of essential conceptual tools underlying digital curation advocacy – information lifecycle stewardship; multidisciplinary scope including financial, scientific, technical, legal and sociological points of view; primacy of future 'fitness of use' – as well as the perceived need to deal with problems of great magnitude, dependent on universal infrastructures, tools and procedures, and equally applicable to the curation of information resources in diverse fields (e-science repositories, archives, organisational records, digital libraries, cultural heritage digitised resources, e-mail and web archiving, to name but a few) produced a motive to unite in the short term, under the digital curation banner, a broad cross-sectoral and multi-disciplinary community of researchers and practitioners. Consequently, research and policy activities so far focussed on issues of general, rather than domain-specific, validity: including, organisational and technical issues regarding trusted information repositories; preservation metadata; economic models. This is manifested in the articles and refereed papers that have already appeared in the first two volumes of the *International Journal of Digital Curation*, in the first and second international digital curation conferences which took place in Bath (<http://www.dcc.ac.uk/events/dcc-2005/programme/>) and Glasgow (<http://www.dcc.ac.uk/events/dcc-2006/programme/>) respectively, as well as in the existing instalments of the DCC Digital Curation Manual (<http://www.dcc.ac.uk/resource/curation-manual/>).

As is clear from the overlap in research problems addressed, tools - methodologies, vocabulary, systems – invoked, and goals sought, digital curation carries with it the traditions, research subjects, and objects of enquiry of digital preservation; indeed, digital preservation is considered to be a necessary – and immediate – if not sufficient condition for achieving the goals of digital curation (Giaretta, 2006). Most of the objectives posed in the seminal Task Force on Archiving of Digital Information report (Garrett & Waters, 1996), and further developed by initiatives such as the NSF Digital Library Initiative, DELOS, ERPANET, and CASPAR (Hedstrom & Ross, 2003; Ross, 2004; Giaretta, 2007) are still central to the digital curation community; the latter appears to include the most active contributors to digital preservation research and practice, mostly from academic departments of computer science, information and archival science, professional specialties of libraries, archives, institutional and disciplinary digital repositories, and from disciplines engaging in data-intensive research. Equally, most current mediating tools for digital curation activities – such as repository software, preservation metadata and interoperability standards, trusted repository certification, cost models, information life-cycle conceptualisations – are shared with digital preservation.

Beyond digital preservation

Taylor, credited as the godfather of ‘digital curation’, reportedly introduced the term specifically in order “to distinguish the actions involved in caring for digital data beyond its original use, from digital preservation” (Taylor, 2001; Macdonald & Lord, 2003, 5). In fact, the movement towards digital curation could also be seen as a reaction to earlier approaches which, while recognising the urgency of developing solutions to deal with media redundancy, failed to address the need to ensure adequate representation and long-term access to digital information as its context of use changes; on the contrary, digital curation adopts a lifecycle approach, providing for “continuous enrichment or updating to keep [digital information] fit for purpose” (Giaretta, 2006). The goal of ensuring “fitness for purpose” of curated digital information through time makes it necessary to develop not just static, but also dynamic, models of information, as it evolves in relationship with evolving designated communities (Flouris & Meghini, 2007); also, to consider event-centric approaches in representing the structure of digital information “life events”, such as those regarding digital preservation lifecycle (Constantopoulos & Dritsou, 2007), but possibly also extending beyond the preservation domain to the representation of epistemic aspects of scientific information objects (Hunter, 2006).

Another distinctive trait of a digital curation approach is the understanding that actors involved in digital information lifecycles consists of a far broader range of stakeholders than just direct custodians of preserved assets (such as librarians or archivists); in particular, they include those in science involved with “research, creation and publishing of data and outcomes”, whose lack of taking responsibility for the continuing curation of digital information accounts for the reduction of archives into unfit for use “data mortuaries” (Beagrie, 2006, 5).

Buneman identifies, two quite different “cultures of digital curation”, in urgent need of mutual understanding, who engage in different activities with the object of digital information:

An archivist (A) does the digital equivalent of putting documents in boxes. [He] is concerned with: appraisal - the selection of what documents to preserve, in-

dexing and classification - the choice of which document to put into which box, and preservation - ensuring that the documents are preserved for posterity. [...] A scientist (B) does the digital equivalent of publishing a textbook or compendium. [Her] concerns are with organization and integration of data that has been collected from other sources, with the process of annotation of this data and with the publishing and presentation of the data.

(Buneman, 2004)

The motives of the two communities, or “cultures”, are quite different: archivists (or “preservers”) are concerned with long-term archiving and simple access of digital information, while scientists (“publishers”) are more interested in visualization, annotation and contextualisation of data and relevant argument. In the digital curation activity system, cohesion of activities engaging these disparate communities may be achieved through tool mediation: that of database technology, provided that research challenges of data integration, database archiving, annotation and provenance are met (*ibid.*). The digital curation approach makes it possible to extend communities to all classes of people who may interact with digital information through its lifecycle.

As has been noted recently, “the paradoxical case with digital curation” is that while it is a relatively new term, its definition refers to activities that organisations in diverse disciplinary communities have been engaging with already for “around for 30 years or so” – among them, those working with “physical repositories”, such as libraries, archives and museums (Rusbridge, 2007). The DCC, its directors state, will “seek to value and understand the different paradigms and methodologies” across disciplinary boundaries (Atkinson et al., 2005); the emphasis to understand disciplinary differences, witnessed in recent policy papers (DCC et al., 2005; Hockx-Yu, 2007), in the focus of the forthcoming 3rd International Digital Curation Conference on diverse national and scientific disciplinary approaches (<http://www.dcc.ac.uk/events/dcc-2007/programme/>), and, in the SCARP project and its Imagestore bioinformatics video and image digital curation sub-project (<http://www.dcc.ac.uk/scarp>). The motive of these research initiatives is to better understand differences between disciplines in “deposit arrangements and requirements; preservation arrangements; in the use of data and information; observational versus experimental data, and external sources; organisational and institutional; research process and methods; and different levels of workforce skills” (DCC et al., 2005, 14-15).

Curating genes at Ajaxe

Curation is not known only in cultural heritage and museums. In fact, a major field of application, worth examining before we proceed to a discussion of cultural heritage, is curation of genes and proteins in biomedical research, a field that was dramatically transformed in the last decades by advances in bioinformatics. Curation of biological research data was, in fact, the topic of an activity-theoretical analysis by Kaptelinin and Nardi, based on ethnographic observation in the research department of a pharmaceutical company, code-named “Ajaxe” (2007, 155-171).

Initial curation activities, according to this study, consisted of the appraisal of 1-2 genes or proteins per year, out of an infinitely larger data population; genes and proteins selected then became the object of painstaking scientific enquiry, annotation, contextualisation within prior literature findings, scientific interpretation, and impact evaluation from market and humanitarian viewpoints. The curation activity system “permeated the entire sci-

entific exercise at Ajaxe”, and became a ground of contestation between conflicting motives by different communities within the organisation: post-doctoral students, scientists, upper and middle managers.

The selection and knowledge augmentation aspects of curation activities was understood as “the ability to select what others see”: “the idea of curation underscored a scientist’s power to choose the materials to be revealed to other scientists and those to be hidden” (ibid. , 159-160). Diverging motives – the understanding of needs and appropriate responses to them by specific communities – were found to be key factors in determining curation practice. For managers, directions for curation work were determined by perceptions of potential profitability and market direction, intellectual property and clinical considerations; for scientists, primary scientific interest was key; pragmatic considerations (e.g., availability of suitably skilled staff) and humanitarian desires were motives shared by both sides (ibid. , 161-168).

This account provides some interesting insights:

1. Curation activities at Ajaxe, such as the determination and application of criteria for appraisal, or the allocation of effort and resources for further curation of knowledge assets related with one or another gene or protein, involved not just researchers, but also managers of different levels.
2. Activities involved interactions between scientists on the one hand, and gene- or protein-related experimental data and secondary knowledge assets on the other, mediated by a number of tools and leading to the instantiation of knowledge objects that had pragmatic implications for all stakeholders and future evolution of the system.
3. Such activities involved as their *object* not only scientific knowledge produced through the curation process, but also pragmatic knowledge and perceptions about clinical applicability, rights, and market exploitation.

In sum, useful insights emerge from examining curation activities in the setting of biomedical research as manifestations of the *agency* of different communities and their motives. Yet curation becomes relevant to these communities, and becomes a vehicle of “passion and power” relations, primarily on account of the fact that it permeates not only the formal aspects of information lifecycle management, but also the full range of knowledge production, elaboration and use in contexts that start with appraisal and finish with the development, marketing and field record of specific drugs based on curated research.

Meaning interactions in cultural heritage curation

On account of the insights emerging from the Ajaxe study, as well as of the need to provide adequate intellectual preservation for future “fitness of use” for scholarly communication and learning, it is now useful to focus on select activities of meaning production in the field of cultural heritage. Such activities are part of established traditions of curatorship in museums, archaeology and the history of art, and they determine the practice of the whole information lifecycle regarding material culture collections and assemblages, from field research design to documentation, scholarly research, scholarly interpretation and public communication. They are the locus of interactions of communities of agents such as academic researchers in history, archaeology, art history and anthropology, museum curators, collection managers, educators and artists with material artefacts and immaterial objects of knowledge regarding their form, history and content, and they involve mediating tools

such as models for artefact analysis (Mc Clung Fleming, 1974; Pearce, 1994, 109-143), formal approaches to the description and classification of archaeological objects (e.g., Lagrange, 1975; Gardin, 1976; Dallas, 1992) and reasoning (Gardin, 1980; Djindjan, 2002), and exhibition and public communication media (K. Walsh, 1992; Thomas & Mintz, 1998; Davallon, 1999; Smiles & Moser, 2005). Activities we will be concerned are selected to illustrate complementary aspects of knowledge work that contribute to a better understanding of cultural heritage digital curation: the include archaeology, museum research and exhibition creation, and visitor.

Archaeology “from the field to the lab”

Archaeology developed its research methodology in the eighteenth and nineteenth centuries, on the basis of the principles of technology, typology and stratigraphy, allowing “the remains of the past to be organised into an ordered system by means of verifiable procedures of collection and classification” (cf. Trigger, 1989, 73-103; Schnapp, 1996, 321-324). As a discipline based on “the study of material remains from the past, and the conditions of their deposition and subsequent history [it is about] associations of moveable artefacts and immovable features in their archaeological context [...] of space and time[, but ...] also about the people behind the objects: their creators and users.” (Dallas et al., 1993, 118-119). Its practice depends on meticulous survey, excavation and recording of archaeological features and finds, and on the study of museum collections and corpora of objects established through collecting. While prehistoric archaeology often opens up to broader *nomothetic* issues such as demography, social organisation and technology, Classical archaeology is an *idiographic* discipline, summoning the philological study of textual sources to elucidate problems emerging from material things, and sharing methods of art history for the morphological and aesthetic analysis of objects forms (Bianchi Bandinelli & Franchi dell' Orto, 1976).

Ever since the invention of archaeology, interaction of researchers with archaeological reality is supplemented by drawings and engravings in early publications, plans, sections and other site drawings prepared by trained architects for excavation publications, extensive corpora of photographs, of detailed, precise documentation of artefacts in the form of line drawings, typologies and seriations (Trigger, 1989, 196-204; Schnapp, 1996, 238 ff.). The interactive facilities provided by the mediation of technology-supported tools provided by on-line archaeological journals such as *Internet Archaeology* (e.g., manipulation of virtual reality models, GIS visualisation, summarisation of numerical data, etc.) provides new opportunities but also problems of physical and intellectual accessibility (Dallas, 1997).

The predominant activity of archaeological research remains, however, text, either in excavation and artefact collection catalogues, or in monographs and journal articles. In fact, important commonalities can be noted among different archaeological traditions, despite differences in problems foregrounded, methods used, and ontological status attributed to their research outcomes; archaeological knowledge depends, initially, on statements made of material things (archaeological objects, artefacts, features, finds, ecofacts etc.) found in primary archaeological contexts or secondary collections, and on observations on their form and configuration. Description and interpretation of artefacts follows well-established conventions of structure, in argumentation order, and rhetorical form, e.g. in the adoption of a semi-formal, schematised vocabulary specific to a particular epoch or culture.

Nevertheless, the intellectual *content* of archaeological writing is not invariant; the last century saw an explosion of theoretical and methodological perspectives in archaeology, including the impact of Marxism and psychoanalysis, structuralism, semiotics and systems theory; recent trends emphasise the inter-subjective and constructed nature of archaeological knowledge of the past, focussing on the relationship between field, archaeologist and the public, and introducing new modes of approaching the past, such as storytelling, performance and ethnography (Hodder, 1982; Trigger, 1989; Shanks & Tilley, 1992; McDavid, 2002; Hodder, 2003). The meaning of artefacts is increasingly sought not in their morphological traits, typically the stuff of museum catalogues, but in the context of their reception by contemporary societies such as nostalgia, admiration, identity, pride, progress, legitimisation, reassurance/ideology, aura, authenticity/respect, preservation, desecration, disrespect/destruction, physical uses, shelter/stone use, entertainment, play/adventure, 'Denkmal', study, and cosmology (Holtorf, 1998).

As noted by Witmore, the relationship between the primary archaeological "data" and the meaning-laden expressions constituting the stuff of archaeological writing – logbooks, catalogue text, plans, maps, illustrations – is mediated by "multiple fields" of activity, "encompass[ing] everything from funding bodies, sociopolitical alliances, media and materialities [...] Things (our tapes, trowels, theodolites, media, etc.), too, have a stake in our nonlinear and interconnected paths of knowledge production" (Witmore, 2004, 159). In order to bridge the gap between the original sense experience of excavators and the schematisation of knowledge later in the publishing process, the notion of "interpretation at the trowel's edge" is advanced, supported by reflexive, dynamic, consciously interpretative and multivocal Web-based publication of fieldwork at the time it happens (Hodder, 1997).

This account sheds light on archaeological knowledge production work as curation of a broad spectrum of textual and non-textual information objects and structures. This curation activity spans different settings – excavation, field survey, museum, published catalogue; it involves complementary agents within an evolving designated community – the excavator who produces evidence, the researcher of a later point in time who may reinterpret and re-contextualise evidence, the student who may incorporate contemporary accounts of the original evidence in a canonical view of the past; and it depends on changing mediation tools – exhibition and publication *genres*, alternative conceptual frameworks, new vocabularies and substantive research concerns.

Curatorial agency in museum practice

Practical models of approaching, analysing and understanding artefacts, typically based on a stepwise process and emphasising the constructed, activity-based production of meaning from the interaction between curator and artefact have been introduced by material culture studies. A typical lifecycle of the artefact description activity may follow the following steps: a) examination of physical form, b) comparison with a peer group of similar objects and establishing a classification, c) setting artefacts in their (syntagmatic) relationship with other artefacts, d) definition of the socio-cultural context of technology, function, and use e) consideration of meaning relating to the non-morphological, non-functional properties of objects, f) setting in the context of contemporary understandings and interests, and g) interpretation (Mc Clung Fleming, 1974; Pearce, 1994, 109-143)

The account of artefact analysis is typical of museum-based curatorial work, spanning across diverse types of collections, and across the activities of documentation and research.

Contextualisation and collocation by virtue of morphological similarity is an essential tool for such activity, apparent in actions resulting to bringing together fragments or distributed assemblages of objects:

Quite frequently a scholar might find a fragment of a sculpture or vase in one museum that joins to a similar piece in another museum. Dyfri Williams has done just that with an Archaic Greek vase fragment, in the Ure Museum (inv. 26.2.1), that joins a dinos (bowl) attributed to the painter, Sophilos, which is housed in the British Museum (inv B601.26 or B100: Williams, 1983). [...] The same Archaic fragment is also part of several distributed assemblages of objects. For example, someone interested in the works of Sophilos would wish to consult all of the 91 works attributed to or signed by that artist: the single fragment on the Ure DB, and the more impressive objects in the British Museum, Greece's National Museums, and elsewhere. [...] One might also be interested in studying the other vases and vase fragments that, like our Sophilos dinos, were found at the great Archaic Greek trading post, at Naucratis, in Egypt.

(Fuchs, Isaksen, & Smith, 2005)

This passage demonstrates quite aptly the type of mental operations that may take place in the interaction of scholars, and museum curators, with objects in a collection. In fact, engaging in and supporting the process of research activity in a museum context is an important aspect of curatorial work; maintaining and processing prior knowledge on objects and their contexts bridges the realm of research with that of documentation and collections management. Context-dependent artefact meanings, it has been argued, manifest themselves "through repeated re-documentation whenever a work is included in an exhibition, published in a book or article, or hung in a gallery, or otherwise engaged in the service of the museum's educational or research mission". A historical account of documentation, and information systems, in museums demonstrates the relevance of this, supposedly specialist and technical work, on meaning production practices and evolution of missions in museums, and vice-versa (Trant, 2007).

The traditional triad of museum functions – collect, preserve, disseminate – has been extended to incorporate, apart from the obvious activities related to tangible things in the museum, to collecting, preserving and disseminating *knowledge* relevant to the collection; even the physical arrangements of "collections [...] may] represent [...] cultural classifications of artefacts" (Dallas, 1994). Curators impart museum objects with meaning since the first moment of object accessioning; the contextualisation processes related to creating exhibitions storyline is inextricably linked with artefact categorisation; the "sense of order" imparted in a collection constrains, and also enables, the generation of alternative interpretations (Dallas, forthcoming).

Museum displays or exhibitions, on the other hand, may be regarded as *spatialisations* of knowledge through the arrangement of objects and associated information (Hooper-Greenhill, 1992, 90), i.e., "the mapping of conceptual relationships underlying the intrinsic and extrinsic properties of artefacts (e.g., a typological order, a historic sequence) onto exhibit arrangements in gallery space" (Dallas, forthcoming). As was found by an ethnographic study of curatorial work in the Science and Industry Museum of Manchester, "the practiced eye of the curator can 'see' how the material could be potentially re-organised as a display item [...] The sorting and the classifying of the material is done with an eye to the story that can be told" (Hemmings et al., 1997). The motive for exhibition curation is ex-

actly to tell these “stories”, and the narrative implicit in the content, structure and visual-spatial rhetoric of an exhibition becomes an important vehicle of meaning production.

Actually, the shift away from objects, and their intrinsic morphological ‘information content’, towards object histories, and their functional and interpretative contexts, is a fundamental trait of recent material culture theory and museum practice, not unrelated to the extension of curatorial functions to encompass the collection, preservation and dissemination of knowledge (Dallas, 1994, 251-252). It evokes the notion of biographical objects, endowed, through a process of individualisation, with personal ‘life histories’, and privileges aspects of object meaning that relate to original object life events, interpretative contexts of exhibition poetics, and cultural representation of contemporary source communities (Kopytoff, 1986; Karp & Lavine, 1991; Karp, Kreamer, & Lavine, 1992; Kavanagh, 1996). Curators thus produce exhibitions through *tool mediation*: not only of physical artefacts, but also of a thickly inter-connected web of conceptual objects, representing knowledge on object histories. Exhibition, in that sense, presents not just objects, but an “origin”, an act, something that has taken place (Davallon, 1999, 193); there is, here, an underlying notion of a primacy of the function of museum objects as historical evidence, shifting the ground from intrinsic information content to evidential context (Kavanagh, 1989; cf. Cook, 2001 for a relevant debate in archival science).

Yet the shift towards object histories is not universally shared, especially in the case of art museums and galleries. Many art curators, it has been found out, still “resist the introduction of objects that might inhibit an ‘unmediated encounter’ between a painting – a work of art – and a viewer [while] most academic art historians [... feel] that both a greater understanding of issues addressed by the work and an appreciation and enjoyment of a painting would follow from a planned accompanying presentation of the cultural and historical milieu within which the work was produced” (Millon, 1999, 219-220), reception. Indeed, besides contextual exhibition practice, witnessed in *narrative, commodified* and *celebratory* displays, *aesthetic exhibitions*, whereby objects are de-contextualised and set apart to be viewed as contemplative exhibits (Shanks & Tilley, 1992, 69-72), and “re-contextualised in the spaces of the museum according to an externally generated syntax” of remembering and time (Crang, 2003), remain relevant.

Curatorial *agency* in museum practice thus takes place in a complex interaction mediated by physical artifacts, contextual knowledge, and also, last but not least, gallery space and media, and the construction of meaning through museum-based research and exhibition cannot be divorced from theoretical presuppositions on issues such as aesthetic experience, scholarly knowledge on objects and their cultures, and documentation practice. Far from supporting a relativist (or naively constructivist), approach to museum, this fact establishes the case for museum curation as a practice whereby issues of provenance, and evidence, should be taken seriously into account – as seriously, in fact, as in archival science and records management (Bearman & Lytle, 1985-1986; Cook, 1997, 2001), reclaiming notions of authenticity and quality of information as distinctive traits of museum knowledge production and communication (Trant, 1998). These are related not to invariant “truth values” of implicit or explicit statements on objects and their life events, but to *activities* mediated by domain knowledge, research questions, and epistemic frameworks motivating object and exhibition curation.

Visitor agency in exhibition experience

Viewed as a social practice, the museum exhibition visit constitutes a knowledge-laden activity: “exhibition presents a unique arena for new meanings to be generated, as each visitor may represent a new instance of social action.” (Bauer, 2002, 43). This view recognises the socially constituted nature of knowledge production through interaction with objects, as they appear within an interpretive context:

Visitors demand a chance to pick and choose from a range of possibilities, a chance to explore and make up their own minds, to test their own interpretations against the experts, and an insight into the disagreements and conflicts between experts. If visitors are offered the evidence from which to draw conclusions, given access to data, including previous and conflictual interpretations of the data, they are able to adopt a problem-solving approach to learning. Demonstrating ways of analysing artefacts, of decoding silver-marks, or assessing stylistic detail, or of comparing one painting with another, opens up opportunities of increasing deductive thinking, of developing distinctions, of stimulating an interest. New narratives are likely to be less complete, more fragmentary, and to consist of the elements of many narratives which can be combined in a range of ways, rather than to be the complete finished story. Opportunities for testing the validity of constructed narratives will also be needed.

(Hooper-Greenhill, 2000, 30-31)

As Baxandall puts it, “there is no exhibition without construction”, but construction does not end on opening day. Exhibition, he suggests, can be understood as a *field* - we might argue, an *activity* - with three distinct subjects at play: the users, the exhibition makers and the viewers (Baxandall, 1991). But, typically, the original users are *subjects* only figuratively, by proxy of exhibition objects or testimonies acting as “inscribed memories” (Rowlands, 1993) of their original agency. The activity of exhibition as meaning construction can be understood as taking place in a two-step process, *expert* construction, as determined by the curatorial script, and *public* construction, as manifested in the experience of empirical visitors (cf. T. Copeland, 2004, 134-137), corresponding to activity theory notions of object construction and object instantiation. It may also be understood as *conversational elaboration*, an iterative and complex interaction or “explanatory engagement” between visitors and the exhibition (curated artefacts, documentation, exhibition structure and setting), mediated by prior knowledge and beliefs (Leinhardt & Crowley, 1998; Leinhardt & Knutson, 2004, 18-19).

The empowerment of communities in issues regarding cultural representation and public taste subverts the “unassailable voice” of museums; interactive media and the Web play a significant part in mediating this shift (P. Walsh, 1997). This trend calls into question the uni-directional, transmitter-receiver, model of museum communication, raising the issue of multivocality and empowerment of different *interpretive communities*, inside and outside the museum proper (Hooper-Greenhill, 2000; Trant, 2007).

Accounts of learning in a museum exhibition setting identify visitors as active *subjects* of knowledge construction, made possible through the manipulation of both objects and knowledge about their form, function and meaning. The step-wise, conversational nature of how visitors constitute meaning in their interaction with exhibition, the primacy of objects and information available at-hand, but also the importance of prior knowledge, skills and presuppositions on how visitors eventually use exhibitions appear as three inter-

related aspects of the exhibition experience. Unlike the artefactual, static nature of the exhibition as a manifestation of “inscribed memory”, exhibition visit experience constitutes an active practice of “incorporated memory” (Rowlands, 1993) which is transient, experiential, unstable and difficult to encapsulate in a fixed record. It thus raises additional issues of curation and preservation, which are, also, to be found in documenting and accounting for variable, procedural and performance-based contemporary art (Depocas, Ippolito, & Jones, 2003; Depocas, 2004).

Agency in digital curation: cultural heritage and beyond

An examination of knowledge-laden activities from the field of biological, archaeological, museum and exhibition curation, using an activity theory approach, throws an interesting light on digital curation. It provides an opportunity, in particular, to examine some questions regarding the nature, scope, methods and objectives of digital curation work while avoiding both a top-down prescriptive viewpoint, driven, for instance, by sectoral policy or technological research agendas, and a purely descriptive, bottom-up one, merely summarising the situation “as is” and as it represents the current configuration of stakeholders. By attempting to provide a structural account of specific activities, selected on account of their recognised importance within pragmatic domains of use, it helps elucidate the purposeful interaction between communities of subjects or *agents* (such as managers, field archaeologists, exhibition curators, artists, or museum visitors) and *objects* (such as collections, or other communities), as this is made possible through conceptual and physical *mediating tools* (such as domain knowledge, information systems, vocabularies, exhibition media etc.). The analysis makes it possible to reflect, now, on pertinent aspects of digital curation work, listed above, both in the context of cultural heritage and as regards digital curation in general.

As noted by Trant, “museums differ from libraries and archives [...] in their active, programmatic use of the content in their collections”; they are not, and should not be, neutral third parties in the *activities* that produce cultural meaning and fulfil their institutional missions; being, at the same time, curators of material collections and curators of immaterial knowledge, museums are called to re-conceptualise their documentation practices as “active curation of collections knowledge” (Trant, 2007). The emphasis on *knowledge* (rather than data, or information) *curation*, has far reaching implications for professional practice in museums, and settles the point regarding requirements for digital curation *within* the cultural heritage domain.

It is true that the role of interpretive, knowledge-laden, traditions such as found in museum curatorship and material culture disciplinary research on digital curation has been limited so far, not least due to the domination of archival and information service traditions of libraries and archives, and information management concerns of e-science data on its practice and theoretical concerns so far. However, curatorial traditions may provide useful conceptual tools to support a major objective for digital curation regardless of application domain, namely, to allow “fitness for purpose” of digital information objects for the production of future knowledge; as noted by the Polar Bear Expedition project team, “facilitating reuse of digital objects[...] is] the least explored [aspect of digital curation, one that ...] relates more to the definition of a curator in the museum sense; that is, a person who interprets and contextualizes objects for the public.” (Yakel, Reynolds, & Shaw, 2007).

Our review of current digital curation practice, our examination of knowledge-related activities in biological curation as well as in three cultural heritage contexts, namely, archaeological fieldwork and publication, museum curation, and visitor experience in museum exhibitions, leads to initial conclusions that, apart from their potential theoretical interest, have, if accepted, domain-independent implications on digital curation research agenda and practice:

1. The complexity, heterogeneity and knowledge-laden nature of fundamental curation activities reinforce the concerns expressed by McCarthy (2007, 246) that epistemic failure – the inability to account for diverse theoretical, substantive and methodological perspectives in particular disciplinary traditions which require access to digital resources – is an important risk. The validity and usefulness of digital information objects for “fitness for purpose” in knowledge work depends, thus, on adequate knowledge representation of their *content*; digital curation might be re-conceptualised not just as curation of digital information objects, but as curation of their conceptual content as well.
2. The importance of curating *knowledge* aspects of digital cultural objects confirms the need to focus, as a matter of priority, on fuller understanding of disciplinary differences. Research needed should not be limited to investigating just – or predominantly – differences between disciplines as regards patterns of information use and services, but also in the methods, middle range theories, rhetorical and argumentation structure constituting their body of knowledge (Mann & Thompson, 1987; Shum, Domingue, & Motta, 2000). Dealing adequately with this issue requires a radical re-examination of current notions of *context*, which, in present digital curation practice, tend to be limited to the realm of preservation lifecycle of information objects, so that it encompasses the structure and evolution of the pragmatic referents of such objects in the real world (i.e., empirical and actual realities within specific epistemic domains).
3. Work in this area may make it necessary to develop not only domain models and formal representations of *epistemic context* (McCarthy, 2007), i.e., domain knowledge, but also semantic representations of the *epistemic content* of curated information objects at the occurrence (or instance) level, as hinted by the call for the redefinition of documentation as “knowledge curation” (Trant, 2007). For semantic future-proofing of digital curation assets, it may not be adequate to depend on the application of semantic intelligence (reasoning, ontologies capturing domain knowledge) on static information objects invariant through time (what we may call a “sealed vault” approach to digital preservation and curation), but that it may be necessary to account for dynamically evolving semantic representations of “things in the world” at the instance (occurrence) level as well. This argument casts doubts on the appropriateness of current approaches in information system scope, conceptual model and architectures, separating instance-level “data” from context or domain “semantics” and calls for further research on notions of object identity, boundaries and encapsulation of digital information objects for curation purposes.
4. Subjects or *agents* of curation activities appear to include a wide variety of interpretive communities, overlapping with one another, and participating in a densely connected web of relationships through concrete knowledge-laden ac-

tivities, relevant not just to the internal processes of knowledge interaction but also to the pragmatic realm of social, economic and symbolic use in society. This account mitigates the cohesiveness of the two broad abstractions of “preservers” and “publishers” (Buneman, 2004), in favour of a more nuanced view, open to broader and more diffuse constituencies, and providing grounds for overcoming the apparent confrontation between these two “cultures”.

5. A key challenge is to capture the evolving perspectives of use and interpretation, applicable to digital information now appraised and curated for future “fitness for purpose”. To ensure longevity of knowledge use through digital curation, we may adopt a stepping stones approach, allowing the semantic augmentation of information objects as interpretive communities “exercise the archive” of digital memory. A promising approach relevant to this goal, based on insights from ontology evolution and belief change, has been advanced as a building block for a formal theory of preservation (Flouris & Meghini, 2007) and could be useful in capturing valid co-evolving representations of domain and occurrence-based knowledge through a process of active ‘questioning’ of systems by future communities of use.
6. Last, but not least, digital curation in a wide spectrum of disciplinary traditions may be better served by adopting an agency-based perspective, i.e., one that departs from a view of “knowledge in the world” as composed of static information objects, in favour of one based on the primacy of activities linking subjects with objects in (technical, spatial, temporal etc.) context. This conclusion supports the validity of applying event-centric methods, such as the application of the ABC ontology to scientific application packages (Hunter, 2006), and that of the CIDOC Conceptual Reference Model to cultural repositories and to the lifecycle of preservation metadata (Bekiari, Constantopoulos, & Doerr, 2006; Constantopoulos & Dritsou, 2007). Similar approaches could be applied usefully for the development of domain specific representations of substantive knowledge in particular domains, contributing to present and future “fitness for purpose”.

In view of these conclusions, a different formulation of the accepted definition of digital curation may be in order. Clearly, “maintaining, and adding value to, a trusted body of digital information for current and future use [through] the active management and appraisal of digital information over its entire life cycle” (Pennock, 2007) remains a necessary objective for the digital curation endeavour. To achieve the ambitious goal of future “fitness for purpose”, in the context of yet unknown epistemic and pragmatic contexts of use, it may be useful, however, to consider expanding explicitly the focus of digital curation activities, so that they include, also, ‘maintaining and adding value to a trusted body of digital information for current and future use, through *the active ‘questioning’, dynamic co-evolution and adequate representation of its epistemic/pragmatic content and context*’.

Digital curation is a community, a set of practices, and a field of theoretical and policy concern still in its infancy. Its radical programmatic objectives provide an excellent ground in order to re-open issues and to re-evaluate ‘good tricks’ that have, so far, been drowned within organisational and disciplinary silos. Our goal was to illustrate the potential usefulness of viewpoints and experiences derived from curatorial work in cultural heritage disciplines. Further work, and, in particular, reflection on the intellectual foundations and practical exigencies of digital curation, on specific disciplinary traditions and technology

solutions, on institutional frameworks and policies, may verify or refute these initial findings. Developments in digital curation will undoubtedly impact on almost all areas of knowledge work and technology-mediated communication within the multidisciplinary purview of cultural heritage informatics. Our community should welcome this active, 'questioning', dynamic process.

References

- Atkinson, M., Buneman, P., Burnhill, P., Giaretta, D., Lyon, L., Ross, S., et al. (2005). The Digital Curation Centre: A vision for digital curation. Paper presented at the *From Local to Global: Data Interoperability - Challenges and Technologies*. Consulted August 26, 2007. http://www.dcc.ac.uk/docs/publications/DCC_Sardinia_paper_final.pdf.
- Bannon, L. J., & Bødker, S. (1991). Beyond the interface: encountering artifacts in use. In J. Carroll (Ed.), *Designing interaction: psychology at the human-computer interface*. Cambridge & New York: Cambridge University Press
- Bauer, A. (2002). Is what you see all you get?: Recognizing meaning in archaeology. *Journal of Social Archaeology*, 2(1), 37-52.
- Baxandall. (1991). Display of culturally purposeful objects. In I. Karp & S. Lavine (Eds.), *Exhibiting cultures: The poetics and politics of museum display*. Washington DC, London: Smithsonian Institution Press, 33-41
- Beagrie, N. (2006). Digital curation for science, digital libraries, and individuals [Electronic Version]. *International Journal of Digital Curation*, 1, 3-16. Consulted July 14, 2007. <http://www.ijdc.net/ijdc/article/download/6/49>.
- Bearman, D. (Ed.). (1996). *Research agenda for networked cultural heritage*. Santa Monica, CA: Getty Art History Information Program.
- Bearman, D., & Lytle, R. (1985-1986). The power of the principle of provenance. *Archivaria*, 21, 14-27.
- Bekiari, C., Constantopoulos, P., & Doerr, M. (2006). Information patterns for digital cultural repositories [Electronic Version]. *ERCIM News*, 66. Consulted September 22, 2007. <http://eprints.sics.se/300/01/bekiari.html>.
- Besser, H. (2000). Digital longevity. In M. Sitts (Ed.), *Handbook for digital projects: a management tool for preservation and access*. Andover, Mass.: Northeast Document Conservation Center, 155-166
- Bianchi Bandinelli, R., & Franchi dell' Orto, L. (1976). *Introduzione all'archeologia*. Rome; Bari: Universale Laterza.
- Buneman, P. (2004). The two cultures of digital curation. Paper presented at the *16th International Conference on Scientific and Statistical Database Management (SSDBM'04)*. Consulted June 20, 2007. <http://csdl2.computer.org/comp/proceedings/ssdbm/2004/2146/00/21460007.pdf>.
- Constantopoulos, P., & Dritsou, V. (2007). An ontological model for digital preservation. Paper presented at the *DigCCurr 2007: an international symposium in digital curation*. Consulted August 30, 2007. http://www.ils.unc.edu/digccurr2007/papers/constantopoulos_paper_6-4.pdf.
- Cook, T. (1997). The Impact of David Bearman on modern archival thinking: an essay of personal reflection and critique. *Archives and Museum Informatics*, 11, 15-37.

- Cook, T. (2001). Archival science and postmodernism: new formulations for old concepts. *Archival Science*, 2001, 3–24.
- Copeland, C. (2006). Out of our mines! A retrospective look at on-line museum collections-based learning and instruction (1997-2006). In J. Trant & D. Bearman (Eds.), *Museums and the Web 2006: Proceedings*. Toronto: Archives & Museum Informatics. Consulted July 23, 2007. <http://www.archimuse.com/mw2006/papers/copeland/copeland.html>
- Copeland, T. (2004). Presenting archaeology to the public. In N. Merriman (Ed.), *Public archaeology*. London; New York: Routledge, 132-144
- Crang, M. (2003). On display: the poetics, politics and interpretation of exhibitions. In M. Ogborn, A. Blunt, P. Gurfudd, J. May & D. Pinder (Eds.), *Cultural geography in practice*. 255-268
- Dale, R. L. (2007). Digital curators: who, what, and how: a perspective from OCLC programs and research [Powerpoint presentation]. Consulted September 22, 2007. http://www.ils.unc.edu/digccurr2007/slides/dale_slides_3-3.pdf.
- Dallas, C. (1992). Syntax and semantics of figurative art: a formal approach. In P. Reilly & S. P. Q. Rahtz (Eds.), *Archaeology and the information age: a global perspective*. London: Routledge, 230-275
- Dallas, C. (1994). A new agenda for museum information systems. Paper presented at the *Problems and Potentials of Electronic Information in Archaeology seminar: pre-circulated papers.*, London: British Library, 251-264.
- Dallas, C. (1997). A step beyond reading in archaeological publication: *Internet Archaeology*, issue 1. *Archives and Museum Informatics*, 11, 55-64.
- Dallas, C. (forthcoming). Archaeological knowledge, virtual exhibitions and the social construction of meaning. *Archeologia e Calcolatori*, 18.
- Dallas, C., Smith, P., Lock, G. R., Cornforth, J., & Davidson, C. (1993). Digital multimedia and Classical culture: the Sacred Way perspective. In D. A. Roberts (Ed.), *European museum documentation: strategies and standards*. Cambridge: Museum Documentation Association, 117-130
- Davallon, J. (1999). *L'exposition à l'oeuvre : stratégies de communication et médiation symbolique*. Paris: L'Harmattan.
- Day, M. (2007). Report from the DigCCurr 2007 International Symposium on Digital Curation, Chapel Hill, NC, April 18-20, 2007 [Electronic Version]. *International Journal of Digital Curation*, 2, 102-111. Consulted September 1, 2007. <http://www.ijdc.net/ijdc/article/view/28/31>.
- DCC, JISC, CCLRC, & British Library. (2005). *Digital curation and preservation: defining the research agenda for the next decade. Report of the Warwick Workshop - 7 & 8 November 2005*: DCC, JISC, CCLRC & British Library. Consulted August 26, 2007. http://www.dcc.ac.uk/events/warwick_2005/Warwick_Workshop_report.pdf.
- Depocas, A. (2004). Variable and unstable: preserving and documenting our digital art heritage [Electronic Version]. *Horizon Zero*, 18:ghost: archive, evolution, entropy. Consulted August 2, 2007. <http://www.horizonzero.ca/textsite/ghost.php?is=18&file=7&tlang=0>.
- Depocas, A., Ippolito, J., & Jones, C. (Eds.). (2003). *Permanence through change: the variable media approach*. New York & Montreal: Guggenheim Museum Publications & The Danel Langlois Foundation for Art, Science and Technology.

- Dietz, S., Besser, H., Borda, A., & Lévy, P. (2004). *Virtual Museum (of Canada): The Next Generation*: Canadian Heritage Information Network. Consulted February 1, 2007. http://www.chin.gc.ca/English/Pdf/Members/Next_Generation/vm_tng.pdf.
- Digital Preservation Coalition. (2001). Digital curation: digital archives, libraries and e-science. *DPC Forums/Meetings*. Consulted September 22, 2007. <http://www.dpconline.org/graphics/events/digitalarchives.html>
- Djindjan, F. (2002). Pour une theorie generale de la connaissance en archeologie. *Archeologia e Calcolatori*, 13, 101-117.
- Engeström, Y. (1987). *Learning by expanding: an activity theoretical approach to developmental research*. Helsinki: Orienta-Konsultit.
- Engeström, Y. (2000). Activity theory as a framework for analyzing and redesigning work. *Ergonomics*, 43(7), 960-974.
- Flouris, G., & Meghini, C. (2007). Some preliminary ideas towards a theory of digital preservation. Paper presented at the *1st International Workshop on Digital Libraries Foundations*, Vancouver, BC. Consulted September 2, 2007. <http://www.ics.forth.gr/isl/publications/paperlink/DLF107.pdf>.
- Fuchs, B., Isaksen, L., & Smith, A. (2005). The virtual lightbox for museums and archives: a portlet solution for structured data reuse across distributed visual resources. In J. Trant & D. Bearman (Eds.), *Museums and the Web 2005: Proceedings*. Toronto: Archives and Museum Informatics Last updated March 31, 2005. Consulted July 22, 2007. <http://www.archimuse.com/mw2005/papers/fuchs/fuchs.html>
- Gardin, J. C. (1976). *Code pour l'analyse des formes de poteries*. Paris: Centre national de la recherche scientifique.
- Gardin, J. C. (1980). *Archaeological constructs : an aspect of theoretical archaeology*. Cambridge [Eng.] ; New York: Cambridge University Press.
- Garrett, J., & Waters, D. (1996). *Preserving digital information: report of the Task Force on Archiving of Digital Information*: The Commission on Preservation and Access & The Research Libraries Group. Consulted September 2, 2007. <http://www.rlg.org/legacy/ftpd/pub/archtf/final-report.pdf>.
- Geser, G., & Mulrenin, A. (2002). *The DigiCULreport. technological landscapes for tomorrow's cultural economy - unlocking the value of cultural heritage*. Luxembourg: Office for Official Publications of the European Commuities.
- Giaretta, D. (2006). DCC approach to digital curation - under development. *DCC development website*. Last updated August 4, 2006 Consulted September 10, 2007. <http://twiki.dcc.rl.ac.uk/bin/view/Main/DCCApproachToCuration>
- Giaretta, D. (2007). The CASPAR Approach to Digital Preservation [Electronic Version]. *International Journal of Digital Curation*, 2, 112-121. Consulted September 5, 2007. <http://www.ijdc.net/ijdc/article/view/29/32>.
- HATII, & NINCH. (2003). *The NINCH Guide to good practice in the digital representation and ,management of cultural heritage materials* Humanities Advanced Technology and Information Institute, University of Glasgow; National Initiative for a Networked Cultural Heritage. Consulted September 3, 2007. <http://www.nyu.edu/its/humanities/ninchguide/>.
- Hedstrom, M., & Ross, S. (2003). *Invest to save: report and recommendations of the NSF-DELOS Working Group on Digital Archiving and Preservation*: National Science Foundation's (NSF) Digital Library Initiative & The European Union under the Fifth

- Framework Programme by the Network of Excellence for Digital Libraries (DELOS). Consulted July 15, 2007. <http://delos-noe.iei.pi.cnr.it/activities/internationalforum/Joint-WGs/digitalarchiving/Digitalarchiving.pdf>.
- Hemmings, T., Randall, D., Francis, D., Marr, L., Divall, C., & Porter, G. (1997). Situated knowledge and the Virtual Science and Industry Museum: problems in the social-technical interface. *Archives and Museum Informatics*, 11(2), 147-164.
- Hockx-Yu, H. (2007). Digital Curation Centre - Phase Two [Electronic Version]. *International Journal of Digital Curation*, 1, 122-127. Consulted September 15, 2007. <http://www.ijdc.net/ijdc/article/download/30/126>.
- Hodder, I. (1997). 'Always momentary, fluid and flexible': towards a reflexive excavation methodology. *Antiquity*, 71(273), 691-700.
- Hodder, I. (2003). Archaeological reflexivity and the "local" voice. *Anthropological Quarterly*, 76(1, Winter 2003), 55-69.
- Hodder, I. (Ed.). (1982). *Symbolic and structural archaeology*: Cambridge University Press New York, NY.
- Holtorf, C. J. (1998, 2006). The monumental past: the life-histories of megalithic monuments in Mecklenburg-Vorpommern (Germany). *A living text based on a doctoral dissertation submitted to the University of Wales (Lampeter) in 1998*. Consulted 10 March 2006. <https://tspace.library.utoronto.ca/citd/holtorf/0.1.html>
- Hooper-Greenhill, E. (1992). *Museums and the shaping of knowledge*. London ; New York: Routledge.
- Hooper-Greenhill, E. (2000). Changing Values in the Art Museum: rethinking communication and learning. *International Journal of Heritage Studies*, 6(1), 9-31.
- Hunter, J. (2006). Scientific publication packages - a selective approach to communication and archival of scientific output [Electronic Version]. *International Journal of Digital Curation*, 1, 33-52. Consulted September 2, 2007. <http://www.ijdc.net/ijdc/article/view/8/7>.
- JISC. (2005). *Digitisation in the UK – the case for a UK Framework. A report based on the Loughborough University study on Digitised Content in the UK Research Libraries and Archives Sector commissioned by JISC and the Consortium of Research Libraries (CURL)*: JISC.Last updated November 2005. Consulted August 3, 2007. <http://www.jisc.ac.uk/media/documents/programmes/digitisation/jisc-digi-in-uk-v1-07.pdf>.
- Kaptelinin, V., & Nardi, B. A. (2007). *Acting with technology: activity theory and interaction design*. Cambridge, MA & London: MIT Press.
- Karp, I., Kreamer, C. M., & Lavine, S. (1992). *Museums and communities : the politics of public culture*. Washington: Smithsonian Institution Press.
- Karp, I., & Lavine, S. (1991). *Exhibiting cultures : the poetics and politics of museum display*. Washington: Smithsonian Institution Press.
- Kavanagh, G. (1989). Objects as evidence, or not? In S. M. Pearce (Ed.), *Museum studies in material culture*. Leicester, London & Washington D.C.: Leicester University Press & Smithsonian Institution Press, 125-137
- Kavanagh, G. (1996). *Making histories in museums*. London: Leicester University Press.

- Kopytoff, I. (1986). The cultural biography of things. In A. Appadurai (Ed.), *The social life of things: commodities in cultural perspective*. Cambridge: Cambridge University Press, 64–91
- Lagrange, M. S. (1975). *Code pour l'analyse des monuments civils*. Paris: Éditions du Centre national de la recherche scientifique.
- Lee, C. A., Tibbo, H. R., & Schaefer, J. C. (2007). Defining what digital curators do and what they need to know: the DigCCurr project. Paper presented at the *Proceedings of the 2007 conference on Digital libraries*, Vancouver, BC, Canada: ACM Press, 49-50.
- Leinhardt, G., & Crowley, K. (1998). *Museum learning as conversational elaboration: a proposal to capture, code, and analyze talk in museums* (No. #MLC-01). Consulted September 17, 2005. <http://mlc.lrdc.pitt.edu/mlc>.
- Leinhardt, G., & Knutson, K. (2004). *Listening in on museum conversations*. Walnut Creek: Altamira Press.
- Leont'ev, A. N. (1978). *Activity, consciousness and personality*. Consulted May 5, 2007. <http://lchc.ucsd.edu/MCA/Paper/leontev/index.html>.
- Macdonald, A., & Lord, P. (2003). *Digital Data Curation Task Force: Report of the Task Force Strategy Discussion Day, Tuesday, 26th November 2002, Centre Point, London WC1*. Twickenham: The Digital Archiving Consultancy. Last updated January 2003. Consulted September 3, 2007. http://www.jisc.ac.uk/uploaded_documents/CurationTaskForceFinal1.pdf.
- Madden, L. (n.d.). *Digital Curation at the Library of Congress: Lessons Learned from American Memory and the Archive Ingest and Handling Test*. Washington, DC: Library of Congress. Consulted September 16, 2007. http://www.digitalpreservation.gov/digital_curation.html.
- Mann, W. C., & Thompson, S. A. (1987). *Rhetorical structure theory : a theory of text organization*. Marina del Rey: University of Southern California, Information Sciences Institute.
- Mc Clung Fleming, E. (1974). Artifact study: a proposed model. *Winterthur Portfolio*, 9, 153-173.
- McCarthy, G. (2007). Finding a future for digital cultural heritage information resources using contextual information frameworks. In F. Cameron & S. Kenderdine (Eds.), *Theorizing digital cultural heritage: A critical discourse*. Cambridge, MA: MIT Press, 245-260
- McDavid, C. (2002). Archaeologies that hurt; descendants that matter: a pragmatic approach to collaboration in the public interpretation of African-American archaeology. *World Archaeology*, 34(2, Community archaeology), 303-314.
- Millon, H. A. (1999). Art and architectural history in the twentieth century. In A. G. Beam (Ed.), *Useful knowledge: the American Philosophical Society millennium program*. Darby, PA: Diane Publishing Co., 199-221
- Minerva Editorial Board. (2006). Coordinating digitisation in Europe. Progress report of the National Representatives Group: coordination mechanisms for digitisation policies and programmes 2006. Consulted September 2, 2007. <http://www.minervaeurope.org/publications/globalreport/globalrep2006.htm>
- Moss, M., & Ross, S. (2007). Educating information management professionals - the Glasgow perspective. Paper presented at the *DigCCurr 2007: an international symposium in*

- digital curation*. Consulted August 24, 2007. http://www.ils.unc.edu/digcurr2007/papers/rossMoss_paper_6-1.pdf.
- Nardi, B. A. (Ed.). (1996). *Context and consciousness: activity theory and Human Computer Interaction*. Cambridge, MA: MIT Press.
- Pearce, S. M. (Ed.). (1994). *Interpreting objects and collections*. London ; New York: Routledge.
- Pennock, M. (2007). 'Digital curation: a life-cycle approach to managing and preserving usable digital information. *Library and Archives Journal*, 1.
- Ross, S. (2000). *Changing trains at Wigan: Digital preservation and the future of scholarship*: National Preservation Office. Consulted July 16, 2007. http://eprints.erpanet.org/45/01/seamusross_wigan_paper.pdf.
- Ross, S. (2004). The role of ERPANET in supporting digital curation and preservation in Europe [Electronic Version]. *D-Lib Magazine*, 10. Consulted July 18, 2007. <http://www.dlib.org/dlib/july04/ross/07ross.html>.
- Rowlands, M. (1993). The role of memory in the transmission of culture. *World archaeology*, 25(2), 141-151.
- Rusbridge, C. (2007, June 14). Building expertise in digital curation and preservation. *Digital curation blog: blog inspired by the Digital Curation Centre to discuss issues relating to the curation and long term preservation of digital science and research data*. Consulted September 27, 2007. <http://digitalcuration.blogspot.com/2007/06/building-expertise-in-digital-curation.html>
- Schnapp, A. (1996). *The discovery of the past: the origins of archaeology*: British Museum.
- Shanks, M., & Tilley, C. Y. (1992). *Re-constructing archaeology : theory and practice* (2nd ed.). London ; New York: Routledge.
- Shum, S. B., Domingue, J., & Motta, E. (2000). Scholarly Discourse as Computable Structure. Paper presented at the *Lecture Notes in Computer Science : Open Hypermedia Systems and Structural Computing: 6th International Workshop, OHS-6, 2nd International Workshop, SC-2, San Antonio, Texas, USA, May 30 - June 4, 2000. Proceedings*120-128. <http://www.springerlink.com/content/wm1qd0e0vjkqtuxe>
- Smiles, S., & Moser, S. (Eds.). (2005). *Envisioning the past : archaeology and the image*. Malden, MA ; Oxford: Blackwell.
- Sumption, K. (2006). In search of the ubiquitous digital museum: reflections of ten years of Museums and the Web. In D. Bearman & J. Trant (Eds.), *Museums and the Web 2006: Proceedings*. Toronto: Archives and Museum Informatics <http://www.archimuse.com/mw2006/papers/sumption/sumption.html>
- Taylor, J. M. (2001). The UK e-science programme [Powerpoint presentation]. Paper presented at the *E-Science London Meeting*. Consulted September 22, 2007. <http://www.rcuk.ac.uk/cmsweb/downloads/rcuk/research/esci/jtaylor.pdf>.
- Thomas, S., & Mintz, A. (1998). *The virtual and the real : media in the museum*. Washington, DC: American Association of Museums.
- Trant, J. (1998). When all You've Got is "The Real Thing": Museums and Authenticity in the Networked World. *Archives and Museum Informatics*, 12, 107-125.
- Trant, J. (2007). Curating collections knowledge: museums on the cyberinfrastructure. In P. F. Marty & B. K. Jones (Eds.), *Museum informatics: people, information, and technology in museums*. New York & London: Routledge, 275-292

- Trigger, B. G. (1989). *A history of archaeological thought*. Cambridge [Cambridgeshire] ; New York: Cambridge University Press.
- Walsh, K. (1992). *The representation of the past : museums and heritage in the post-modern world*. London ; New York: Routledge.
- Walsh, P. (1997). The Web and the Unassailable Voice. *Archives and Museum Informatics: Cultural Heritage Quarterly*, 11(2), 77-85.
- Witmore, C. L. (2004). On multiple fields. Between the material world and media: two cases from the Peloponnesus, Greece. *Archaeological Dialogues*, 11(2), 133-164.
- Yakel, E., Reynolds, P., & Shaw, S. E. (2007). Polar Bear Expedition Digital Collections: Enhancing Online Use through Digital Curation. Paper presented at the *DigCCurr 2007: an international symposium in digital curation*. Consulted August 24, 2007. http://www.ils.unc.edu/digccurr2007/pspers/yakel_paper_4-4.pdf.
- Zorich, D. M. (2003). *A survey of digital cultural heritage initiatives and their sustainability concerns: managing economic challenges*. Washington, DC: CLIR.