# Aspects of a digital curation agenda for cultural heritage

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*Abstract*—**Digital curation emerged recently as an important concept in the theory and management of cultural heritage information. This paper presents the approach and research agenda adopted by the newly-founded Digital Curation Unit of Athena Research Centre, Greece, and illustrates its relevance to the management and use of cultural heritage digital collections. It highlights the need to tackle the risks of epistemic failure tied with the prospect of long-term access to curated repositories, and presents the case for multidisciplinary research, informed by humanistic and social science as well as computer science perspectives. A multi-tiered research agenda, it argues, would need to resolve problems of representing domain knowledge; developing and maintaining knowledge resources; streamlining the enrichment of these resources from text; automatically generating text from databases; discovering and accessing domain associations; enabling the use of databases containing valuable data over time; conceptualizations of epistemic discourse, and communication genres in specific contexts; grounded research on the motives, activities and contexts of digital resources appraisal, knowledge enhancement and use; and, cost-benefit assessment of preservation policies. These complementary approaches are particularly relevant in the field of cultural heritage, where large-scale digitisation of heritage resources on one hand, and web-based social computing on the other, already create a deluge of un-curated and poorly represented cultural information.**

*Index Terms*—**digital curation; cultural heritage; museums; digital libraries; digital preservation**

## I. Introduction

MORE than forty years have elapsed since databases were first introduced to a handful of American museums, initially as mainframe-based, glorified inventory control systems [1]. The subsequent advent of microcomputers, interactivity and hypermedia, and the web, led to widespread adoption of a broad range of digital technologies in museums and heritage organizations in almost all aspects of curatorship and public communication, promising to "unlock the value" of cultural heritage institutions – museums, libraries and archives – as they adopt technology-based methods and tools to manage their collections and associated knowledge, and interactive media to produce connected, immersive, interactive, virtual cultural experiences [2-4].

Recent large-scale cultural digitization efforts in Europe, North America and elsewhere [5-7], in conjunction with the emergence of distributed, inter-connected structure of cultural information assets, brought about by the Internet and the Web, posed significant challenges of resource discovery and interoperability, producing a need for interdisciplinary, collaborative research agendas and action plans to tackle issues of long-term digital preservation and adequate knowledge representation of cultural information [8, 9]. This was accompanied by the sober realization of additional vexing problems: how to ensure authenticity and integrity of digital cultural assets? what to preserve, in the face of information deluge, and what not? how to ensure usability and accessibility? and, how to ensure the future "fitness for purpose" of born-digital and digitized cultural objects?

Digital curation emerged in the last few years in response to issues such as the above; in this paper, we introduce the concept and practice of digital curation, identify key challenges in curating cultural heritage collections as a knowledge-laden process, and present a conceptualization of digital curation process that allows for a research agenda suitable for meeting these challenges.

## II. From Digital Preservation to Digital Curation

Digital curation is a new interdisciplinary field of enquiry and community of practice, which brings together disciplinary traditions and research interests from disciplines such as computer science, archival science, librarianship and information science, disciplines practicing collections-based or data-intensive research, such as history of art, archaeology, biology, space and earth sciences, and application areas such as e-science repositories, organizational records management, and, last but not least, museums, libraries and archives. The notion of digital curation first appeared in 2001, in a invitational seminar organized in London by the Digital Preservation Coalition and the British National Space Centre, 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" [10]". The last few years saw the crea-

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tion of a Digital Curation Centre in the UK [11], the publication of an *International Journal of Digital Curation* (http://www.ijdc.net), a yearly International Digital Curation Conference (http:///www.dcc.ac.uk/events/dcc-2007/, and a number of academic programmes designed around a digital curation curriculum [12-14]. The scope and digital curation is now discussed widely, both within and outside its original constituency [15-19]; the notion attracted the interest of publications such as *The Guardian* [20] and the *Times Higher Education Supplement* [21], and "Digital curation of cultural heritage" was selected to be the theme of the forthcoming conference of the International Documentation Committee of the International Council of Museums (CIDOC/ICOM, http://www.cidoc2008.gr).

The approach introduced by the UK Digital Curation Centre suggests that "[d]igital curation […] is about maintaining, and adding value to, a trusted body of digital information for current and future use" by adopting a lifecycle approach [22], and by foregrounding the need for "subject description and linkage to discipline-based ontologies […] descriptive information that allows re-analysis of datasets of scientific and scholarly significance", as a prerequisite to ensuring future "fitness for purpose". The research agenda proposed to achieve this goal 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 [11].

Digital preservation is considered to be a necessary condition for achieving the objectives of digital curation [17], and tools for digital curation activities (repository software, preservation metadata and interoperability standards, trusted repository certification, cost models, and information life-cycle conceptualizations) are shared with digital preservation. Yet the need to ensure adequate representation and long-term access to digital information as its context of use changes, and the risk of repositories becoming unfit for use "data mortuaries" [23] introduce important new strategies. These include:

- a lifecycle approach to the representation of curated information objects, allowing "continuous enrichment or updating to keep [them] fit for purpose" [17], as these evolve in interaction with changing designated communities [24];
- event-centric methodologies to represent the structure of digital information "life events", such as those regarding the lifecycle of digital preservation [25] and the epistemic content of scientific information "packages" [26];
- recognition that actors involved in the curation of digital information include not only custodians of preserved assets (such as librarians or data managers), but also those concerned with the production of knowledge (research communities formed around diverse disciplines) and its public communication and user experience [16, 27, 28]; and,
- the need to understand, and account for, differences in digital curation needs between diverse scientific and scholarly disciplines and contexts of use [29, 30]

It was noted recently 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 for information futures [31]. A study of current digital curation research and advocacy suggests that the scope of digital curation work needs to expand significantly, particularly as regards the goal of ensuring epistemic adequacy of information in yet unknown future contexts of use, and advances the view that validity and usefulness of digital information objects for "fitness for purpose" depends, crucially, on adequate knowledge representation [16]. This approach:

- prioritizes the need towards fuller understanding of disciplinary differences, not just 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 [cf. 32, 33];
- foregrounds the necessity of developing not only domain models and formal representations of *epistemic \context,* but also semantic representations of the *epistemic content* of curated information objects at the occurrence (or instance) level, echoing the call for the redefinition of documentation as "knowledge curation" [34];
- argues that in order "to capture the evolving perspectives of use and interpretation […] we may adopt a stepping stones approach, allowing the semantic augmentation of information objects as interpretive communities 'exercise the archive' of digital memory" [16], using insights from ontology evolution and belief change [cf. 24]; and,
- provides arguments toward the adoption of an agency-oriented approach to curation, best served by event-centric methods, such as the application of the ABC ontology to scientific application packages [26], and that of CIDOC CRM [35] to cultural repositories and to the lifecycle of preservation metadata [25, 36].

On this basis, it is suggested that the focus of digital curation activities should be expanded "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*'." [16].

## III. Key Challenges in Curating Cultural Knowledge

Cultural heritage is a collections-driven domain. From an organizational viewpoint, it is based on institutions such as museums, art galleries, special collections, and historical archives, which have emerged in the course of centuries of scholarly traditions. These, in turn, consist of a broad spectrum of disciplines, from philology and hermeneutics to history, anthropology, archaeology and art history. Archaeological sites, historic settlements, artworks and artefacts, memorabilia, textual records of diverse genres and subject-matter, are all part of heritage; but so are also intangibles, such as object his-

tories, narratives, interpretations and contextual knowledge about past societies, cultures and specific situations in which these emerged and developed [37].

Cultural heritage institutions, such as museums, have been central to the development of object-centred disciplines such as archaeology. A shift from objects to object histories – from tangible artefacts to intangible ideas and narratives – is also apparent in recent developments in cultural heritage practice, broadening the traditional museum functions of *collecting, preserving* and *disseminating* to encompass the collecting – or appraisal – of information on objects and object histories; the preservation (and management) of inventories, catalogues, terminologies and other information sources; and, the dissemination (and interpretation) of collections through foregrounding of their cultural, historical and artistic context [38].

As noted by Trant, "museums differ from libraries and archives […] in their active, programmatic use of the content in their collections"; 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" [34]. The emphasis on *knowledge* (rather than data, or information) *curation*, has far reaching implications for professional practice in museums, and permeates the entire lifecycle of museum curatorial activity, from fieldwork and object acquisition to documentation, scholarly research, interpretation and public communication through exhibition, educational programmes, publication and outreach [16].

The cultural heritage information universe consists of representations of actual cultural objects (literary texts, artworks, artefacts, historical records, and the like), their histories, persons and organisations operating on such objects, and their relationships. It also encompasses theories, interpretations and opinions about such objects – i.e., knowledge, that is the outcome of curation activities. The constitution of such knowledge is characterised by disciplinary diversity, representational complexity and heterogeneity, historical orientation, textual bias and cumulative character. This follows from generic traits of research in the human sciences: hermeneutic and intertextual, rather than experimental; narrative – textual, rhetorical, often judgmental – rather than formal or "scientific"; idiographic rather than nomothetic; and, conformant to a realist rather than positivist account of *episteme* [39].

The curatorial use of this cultural information universe is dominated by the need to support sophisticated knowledge-based access. Different disciplinary traditions bring about overlapping, often inconsistent terminologies. Given the narrative, textual and rhetorical aspects of cultural heritage research, language itself becomes an additional, important layer of representation. And, rather than being "unstructured", artefacts as well as intangible cultural objects such as iconographies, the results of archaeological excavation, or historical narratives, tend on the contrary to be complex: to represent material culture objects, such as artworks or archaeological artefacts, one has to deal with a combination of multiple specialisation/generalisation, part aggregation, temporal, spatial and conceptual context-dependency, frequency of partial or missing information, and subjectivity/multivocality [38].

In addition, the meaning of cultural objects is increasingly sought not in their intrinsics, but in their reception by contemporary societies and audiences, through different semantic dimensions such as nostalgia, admiration, identity, pride, progress, legitimation, reassurance/ideology, aura, authenticity/respect, and play/adventure [40]. Material culture objects are seen as active objects endowed with agency [41], and as biographical objects endowed, through a process of individualisation, with personal life histories [42]. The production of meaning can be seen, in this light, as a correlate of a lifecycle bridging different contexts or 'fields', from archaeological excavation and fieldwork to the organisation and classification of objects in a museum collection, scholarly research, and interpretation, selection and contextualisation through *spatialisation* as in a museum gallery, or *virtualisation* as in online exhibitions, mediated and co-produced by visitor and user experience [43].

## IV. A Process View on Digital Curation

From an information lifecycle perspective [cf. 44], digital curation encompasses a number of processes geared to achieving (a) trustworthiness of digital resources, (b) organization, archiving and long-term preservation, and (c) added-value services and new uses for the resources. These processes, depicted in Fig. 1, include:

**Appraisal**: Appraisal involves the process of developing criteria and selecting resources that may become part of subsequent curation processes; these resources are drawn from a source domain, where they appear in digital or physical form, and their identification and selection is based on information (data and text) mining operations, and on pre-existing wide-range resource discovery resources.

**Ingesting**: Ingesting digital resources may involve digital recording of image, sound, text and data; digitizing of analog recordings on various physical carriers; and importing digital resources from other sources, including repositories. From the point of view of the entity collecting and managing the digital resources, the ingesting process yields primary material.

**Classification, indexing and cataloguing**: This process not only produces the logical indexes required for information management purposes, but, most importantly, subject indexes and indexes related to the intended or possible uses of the digital resources. This semantic indexing is context -dependent and the outcome of domain-specific scientific interpretation. Thus it carries an inevitable epistemic bias which raises an issue with regard to the re-use of the resources in different contexts. The indexes themselves can be considered as secondary, autonomous digital resources, though related to the primary material. They can be produced during the indexing process, or they can be imported resources.

**Knowledge enhancement**: Scientific research and professional practice incrementally generate further knowledge about the real-world entities, situations and events represented by digital resources, about their wider context and domain, or

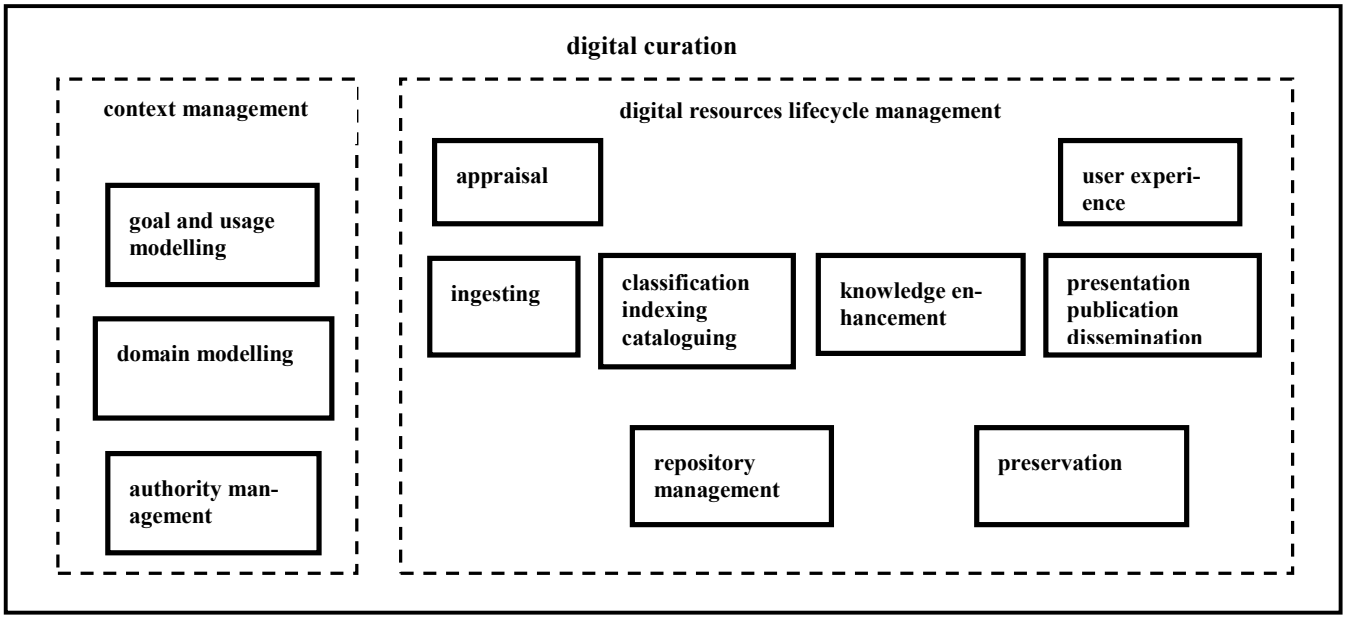


Figure 1. Digital curation processes

even about digital resources themselves. Knowledge enhancement is the process of adding knowledge on top of an existing repository of digital resources and its related knowledge base. Each knowledge addition is related to a different view, angle of interpretation, or application, thus representing a new way of looking at or combining the primary resources and prior knowledge, and can itself evolve. Like indexing, knowledge enhancement is context-dependent and produces secondary, autonomous digital resources.

**Presentation, publication and dissemination**: This is the process of generating new artefacts (scientific, scholarly, artistic, etc.) from existing primary or secondary digital resources. Presentation introduces the notion of *genre,* and also that of pragmatic context (environment, session, etc.). On the other hand, it can be thought of as producing tertiary, autonomous digital resources related to primary and secondary ones.

**User experience:** This is the process related to resource use, interaction between users and resources in a functional context (i.e., a session) mediated by a specific presentation or publication artefact, and the effects of this interaction on both resources and users. User experience is visible in session logs, observational data, and in traces produced by interaction with resources, e.g., social tags, annotations, and similar Web 2.0 artefacts; also, in social interaction mediated by resources, as, for example, in the creation of virtual communities and social networks.

**Repository management**: All digital resources are stored, organized and managed in a repository. This may be actual (centralized or distributed) or virtual. The latter is the case of Web-based, peer-to-peer and grid systems aimed at implementing community- or practice-specific systems. Repository management includes access mechanisms.

**Preservation**: Digital resources face a range of perils related either to physical causes or to technological evolution. Physical perils include various damages of storage media and catastrophic environmental incidents, e.g. fire, flooding, earthquake, etc. Preservation policies to safeguard against such perils include copying and distributing copies in different locations. Technical perils include the various kinds of difficulty or inability to access and use data due to the technical evolution of hardware and software. Preservation policies against technical perils employ techniques that fall in nine main classes: migration of digital content, technology emulation, technology preservation, dedication to standards, backward compatibility, encapsulation, permanent identifiers, transformation to non-digital form and digital archaeology. Recommended preservation policies have been developed by various national and international bodies and their implementation invariably relies on the use of appropriate metadata.

The above "action line" processes of digital resources lifecycle management rely on three supporting processes, namely, goal and usage modelling, domain modelling and authority management. These processes effectively capture the context of digital curation and produce valuable resources which can themselves be seen as curated digital assets. The utility of the outcome of these processes spans different instances of digital resource lifecycle management, and is necessary to ensure epistemic adequacy for future "fitness for purpose". In fact, goal and usage models, domain models and authorities provide the conceptual "glue" between different curated resources.

**Goal and usage modelling**: Goal modelling tries to capture the intentions of the creators and the users of a given class of digital resources, while usage modelling tries to capture the patterns of use of the resources. Such models provide representations of human agency within which the basic goals of digital curation must be attained.

**Domain modelling**: This process produces or refines representations of expert knowledge about a domain of interest, in the form of ontologies and conceptual models. Several scientific and professional communities have developed or are developing ontologies thus promoting information sharing and actionability, initially through human-understandable, and recently through machine-understandable, semantics. Ontologies have even become the object of standardization, a development that marks the economic evolution and globalization of the respective domains, qualified by the penetration of information technology. Digital curation is conjoint with the emergence of such conditions, therefore relies heavily on the existence and maintenance of domain models.

**Authority management**: While domain models deal with the definitions of concepts, properties, relations and rules in a domain, a good part of the expert knowledge about the domain is captured in the controlled vocabularies (e.g. geographic names, historical periods, chemical molecules, biological species, etc.) used by convention to denote those concepts, properties and relations, or their instances, known as *authorities*. Authorities, and even domain models, are bound to evolve as significant changes to the body of domain knowledge occur. Their maintenance must be undertaken according to specific procedures, so as to safeguard qualities such as coverage, specificity, coherence, consistency and parsimony.

With the above view on digital curation, the DCU has set an agenda of addressing the entire set of processes with a multidisciplinary approach. We expect this to help us deal with problems of epistemic bias and achieve methodological enrichment and refinement. Specific lines of work include:

- modelling digital curation processes;
- problems of representing domain knowledge in the form of ontologies and reference models;
- developing and maintaining knowledge resources and knowledge organization systems;
- streamlining the enrichment of these resources from text by extracting relevant entities and relations;
- ontology-driven search and fact discovery;
- automatically generating text from databases as a more human-oriented form of information, to be considered for preservation purposes in addition to communication;
- ensuring the ability to discover and access inter- and intra- domain associations and to overlay context-dependent interpretations;
- preserving contextual, schema and operational information in conjunction with primary data, so as to enable the use of databases containing valuable data over time;
- user community modeling and social tagging;
- conceptualizations of epistemic discourse and communication genres (i.e. rhetorical structure) in specific disciplinary and pragmatic contexts;
- grounded research on the motives, activities and contexts of appraisal, knowledge enhancement and use of digital resources by diverse interpretive communities;
- and, cost-benefit assessment of preservation policies.

Interestingly, the field of cultural information presents itself as a privileged domain for digital curation. There is a relatively long history of developing library systems and museum systems, along with recent intense activity on cultural information systems, culminating in two important developments: the emergence of the CIDOC CRM (ISO 21127) standard ontology for cultural documentation [35]; and the movement for convergence of museum, library and archive systems, one manifestation of which is the new, CIDOC CRM compatible FRBR-oo model. In Greece, in particular, projects on building a comprehensive national monuments record system, massive cultural assets digitization, and developing relevant standards and guidelines to ensure interoperability and relatively uniform documentation practice [45], have set the stage for curation of digital cultural resources. Thus the domain of cultural information is a domain of choice for the Digital Curation Unit, both at the research and application levels.

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