Digital Curation in Architecture Curricula and Vocational Training for Architects

The DEDICATE Framework in Architectural CAD Courses Design

Dr Ian Anderson and Dr Ruggero Lancia
HATII (Humanities Advanced Technology and Information Institute)
University of Glasgow
Glasgow, UK
Ian.G.Anderson@glasgow.ac.uk and Ruggero.Lancia@glasgow.ac.uk

***Abstract*—As the design processes in architectural practices switch toward entirely digital workflows, architects are gradually required, because of their legal and commercial liability, to provide for both a relatively long-term curation of their own digital products and the deposit of authoritative data. But, despite being the sole curation actors for their data, architects receive little education or training in either pertinent competences nor agreed and established procedures to comply with these duties.**

In this paper, the DEDICATE project, an AHRC funded project hosted by the HATII of the University of Glasgow, will be discussed to explain its role in the design of Digital Curation courses within architectural CAD education and architects' vocational training.

***Keywords*—Digital Curation, CAD, CAM, Architectural CAD Education.**

I. CAD/CAM IN PROFESSIONAL PRACTICES AND ARCHITECTURAL EDUCATION

Early computer aided drafting systems started being adopted in Architecture design as soon as the 1970s within large companies and public bodies [1] At the beginning of the 1980s, both the diffusion of personal computing and the releases of CAD software running on microcomputers permitted this phenomenon to expand across smaller businesses. These firsts systems were generally developed as substitute of the conventional drawing board and aimed at augmenting the efficiency of the traditional design process cutting the drafting costs. More elaborated idiosyncratic systems with integrated analytical functions started being developed in the same period within research institutions and large corporations especially to manage statutory requirements of design, such as the energy codes.

In the first two decades of CAD application to Architecture Design, the scarce integration of automated methods in the building industry, the limited diffusion of computer assisted procedures in the day-to-day operations of architects and the still high costs of the CAD procedures management, delayed the development of a specific CAD education in Architecture curricula. Interestingly, in 1980, a review conducted by Patrick Purcell on the CAD syllabuses offered by the architectural schools of the British Isles and other prominent international institutions explained the difficulty of inserting a formal CAD syllabus in the Architecture curriculum, emphasising the lack of architectural competences and research interests among CAD educators, in most of cases coming then from engineering and computer sciences [2].

Between the end of the 1980s and the beginning of the 1990s, CAD applications triggered a switch in the traditional design process introducing 3D modelling and visualisation functions, parametric modifications and semantic modelling with simplified analysis features.

Since the 90s, CAD training has been regularly offered in the majority of the Architecture courses in Developed Countries, more often than not within other disciplines syllabuses and usually without either formal assessments nor graded progression. Because of both this persistent informal approach to CAD education and the diffusion of professional CAD packages running on personal computers, vocational and technical schools CAD courses started acquiring popularity resulting in a new class of specialised draughtsmen lacking any design background [3].

Despite the lack of formal education in these years, the design processes in architectural practices grew predominantly digital, the availability of integrated procedures for the design and production of building elements, such as CNC (Computer Numerical Control) manufacturing, has accelerated practices' switch toward entirely digital workflows often concurrent with other related digital design workflows, such as Engineering Design. Major architecture schools have interpreted and supported this change offering training and post-grad specialist

qualifications in advanced CAD scripting, generative and parametric design.

Despite the thorough understanding of both the processes applied on and the characteristics of digital design data required by these technologies, there are neither Architecture curricula including Digital Curation training nor vocational training for architects on this subject to support the rising need for management of digital data.

Data management constituted a topic of the CAD education at the beginning of the 1980s in the MIT Master of Science course in Computer-aided design and at the Carnegie-Mellon University, in a four-week module in the professional architectural programme [2]. As idiosyncratic CAD systems development was superseded by commercial package solutions, the interest on this topic was exhausted and, to date, there are no evidences of other CAD courses held in Architecture Schools addressing the management of design data.

II. Architects' Commercial and Legal Responsibilities for Digital Curation

There is evidence that statutory project documentation is mainly adapted to be printed and kept in paper archives by architectural practices [4]. But, the request for producing and depositing authoritative digital data is an emerging phenomenon across many international Building Control authorities and Public Investors that are urging architectural practices to implement consistent data management procedures.

For example, in Netherlands, since November 2011, the Rgd BIM Norm obliges design contractors involved in public building projects to produce and deliver their products in Building Information Modelling formats following the policies of the Rgd BIM standard [5]. In the same year, the United Kingdom Cabinet Office announced in the Government's new Construction Strategy that will require on all public works BIM documentation by 2016 [6].

Further, where workflows are entirely digital, the commercial liability of architects extends these requirements for the consistent management of digital data, introducing the need for relatively long periods of reliable data retention. Such as for example, in United Kingdom, the architects' professional liability period amounts to 12 years [7].

Borrowing from the definition of Digital Curation by Neil Beagrie as “the actions needed to maintain digital research data and other digital materials over their entire life-cycle and over time” [8] and combining these data management requirements, it is evident that architects are being given Digital Curation responsibilities over their digital data. In addition, because of the key role of public commissions in the growth of commercially successful practices, a progressive extension of these responsibilities will likely take place as a result of both the technological adaptation of competitors companies aspiring to public clients and the strategic request of public bodies for an increased control over the Built Environment.

So far, the heterogeneity and complexity of architectural digital data, as well as the prevailing role of major repositories in establishing preservation and curation policies, has neglected policies, agreed standards and feasible procedures to be implemented by design professionals.

The workflow ramifications and the still limited legal pressure on architecture practices for both implementing consistent data retention procedures and depositing authoritative data, actually prevent both Digital Curation professional from approaching this field and architects from appealing to their services. As a result, most practices resort to commercial services for data management that do not solve crucial curatorial issues, such as long-term data accessibility and authoritativeness.

III. The DEDICATE Project

The Design's Digital Curation for Architecture (DEDICATE) project is funded by the Arts and Humanities Research Council (with the ref. AH/J008265/1) and is hosted by the Humanities Advanced Technology and Information Institute (HATII) of the University of Glasgow.

This project is aimed at delivering the policies, requirements and procedures to build a sustainable curatorial framework for CAD/CAM assets minimising their loss risks and maximising their reusability and interoperability within their stakeholder community.

In more detail, DEDICATE is aimed at answering these research questions related to the different curatorial stages of CAD/CAM data, as they are categorised by the high-level abstraction of the DCC curation lifecycle model [9]:

1) [Data Pre-production stage] Which capture methods should be preferred for ingesting authoritative data relating to Built Environment? Which modelling tools might be preferred in order to obtain products apt to enter the curation workflow, that is released in durable formats and with a metadata set suitable to record their production process? Which data formats should be adopted to enhance the persistence and the reusability of information? What information should be kept in metadata at this stage and through which technique?

2) [Data Creation stage] How to record the actual use, that is the set of events determining either a modification or the employment, of the digital objects before their ingestion in the repositories?

3) [Data Appraisal stage] What policies should be defined to implement an evaluation method for the appraisal and selection of the digital objects to be collected in repositories? How might be involved actively the stakeholders' expertise in this process?

4) [Data Ingestion stage] Which ingestion processes could be assessed culturally and economically sustainable in this context? Which policies should be adopted to integrate automated procedures and the self-submission of the assets? Which information should be retained at this stage for curation and preservation purposes, and how?

5) [Data Preservation and Storage stage] Which digital asset management architecture should be adopted and how should it be implemented to fit the policies and processes of the researched repository system?

6) [Data Access stage] Which kind of interoperability model should guarantee access to the information? How many of the original functionalities of the digital object should be granted to their users and adopting which methods? How to deal with the intellectual property management of these digital objects considering as well the possibility of deriving new data from those?

7) *[Data Transformation stage] Which kind of transformations could affect the original data in the repositories and following which policies? How to manage the data migration for preservation purposes in order to retain perpetually its contextual functions? Data derived from stored assets might be considered either transformations of the original digital objects or new items, and which metadata set should record these kind of relationships between assets? Which model of rights management would enable the control of diverse typologies of intellectual property?*

In this investigation, the actors of Built Environment modification and management are considered the major and more vulnerable stakeholders of these digital products. Thus, this study is particularly concentrated on architectural practices, engineering consultancies and Building Control bodies.

Given the different results this research aims at accomplishing, a multiplicity of methods is needed to fulfil the tasks that each investigation stage is intended to carry out.

In order to identify the functions and the current use of the CAD/CAM assets as well as the events that modify their consistency and to assess the curatorial management of the digital objects emphasising their correlated risks, this project makes extensive use of audits on project partners, from the selected categories of stakeholders, drawing on the models and tools developed by three outstanding Digital Curation initiatives focusing on specific aspects of digital assets' life-cycle:

1) DAFD (Data Audit Framework Development) which provides an audit methodology and online tools to support and facilitate organisations to establish an overview of their data holdings, policies and practices against best practices and new risks (http://www.data-audit.eu);

2) similarly, DRAMBORA (Digital Repository Audit Method Based on Risk Assessment) which offers an audit methodology, complemented by a computer-aided audit software, addressing the assessment of risks implied by the policies adopted by the repositories;

3) *and finally, Planets (Preservation and Long-term Access through Networked Services) which offers a testbed to experiment the effects of curatorial actions on digital assets.*

To complement the audits' information with statistical results, scripted analyses are run on the partners' data repositories to characterise digital products,that is to record important data characteristics, and measure their distribution.

Thus, the audits consist of both experimental investigation activities resulting in metric findings assessing the digital curation actions held by stakeholders and, on the other, unstructured interviews and reports of unobtrusive observations describing the digital assets, the processes taking place in the data repositories and their agents.

The curatorial framework for CAD/CAM data will result from both the analysis of the context recorded by the audits and the study of the specific digital workflows involved by common procedures within the stakeholder's community against the agreed and general technical and administrative requirements for a consistent data management across the entire digital products lifecycle.

Eventually, the feasibility of this framework will be evaluated by applying the testbeds developed in Planets and CASPAR (Cultural, Artistic and Scientific knowledge for Preservation, Access and Retrieval), specialised in data preservation and in perpetual accessibility of the digital objects and their contextual environment. In doing so, borrowing from the Information Studies both the quantitative and qualitative approach to services evaluation, the audits will triangulate metrics, ethnographic observations and unstructured interviews to assess the implementation of the proposed policies and recommended procedures.

IV. Digital Curation in Architectural CAD Education – the DEDICATE Framework Contribution

The scope of the CAD/CAM data curation involves a wide stakeholder community spanning across different communities of practice and often bears the responsibility for the preservation of information of public interest although not benefiting from statutory archival retention. The three categories of Built Environment actors which have been selected as context for the researched framework constitute a coherent group of stakeholders both cemented by the mutual need for information and data exchange, and sharing responsibilities over their digital assets.

In such context, post-hoc data curation procedures are neither feasible nor effective, instead, as Alistair Miles proposed for the project ImageStore, a DCC SCARP section, curatorial attention when integrated in the very workflows defining the data lifecycle enhances the quality of data and their preservation viability in informal retention contexts [10] Therefore, the researched framework of the DEDICATE project, delivering the policies and procedures to build a sustainable curatorial framework for CAD/CAM assets, is expected to be highly integrated with architectural design procedures and, as a result, tending to substitute the professional digital curators' interventions on this repertory with a competent management by the stakeholders themselves.

From this standpoint, the DEDICATE framework will offer also the knowledge to design specific Digital Curation training for Architecture education and architects' vocational training by contributing technical and managerial competences pertinent to the entire design data lifecycle.

In particular, the managerial tasks that architects are expected to be able to carry out are:

1) to plan and implement consistent curatorial procedures along the digital design workflows;

2) to formulate data appraisal and selection criteria against a set of economical and professional objectives to formalise information disposal procedures;

3) to manage the ingestion of digital assets according to agreed curatorial policies to ensure data authoritativeness persistence and accessibility;

4) to establish preservation policies according to professional and legal needs to implement preservation procedures on the assets held in the repository;

5) to manage the persistent feasibility of data storage;

6) to monitor and restrict privileges for data access and reuse according to professional and legal requirements;

7) to plan and implement procedures to track the data reuse and transformation according to good practices in IPR management.

The corresponding technical competences expected from the addressees of the course are:

1) expert knowledge of formats, data structure and digital design computing procedures;
2) advanced knowledge of metadata standards and data quality assessment;
3) thorough knowledge of both the purpose and the originating digital work flow of data;
4) understanding of preservation routines function and strategies;
5) knowledge of repository architectures options;
6) understanding of the techniques and procedures for privileges based data access;
7) knowledge of data watermarking, cryptographic techniques options and format migration issues.

Trained architects should be able to understand and promote curatorial framework updates as the technologies and the tools for both curation and design evolve.

Moreover, the dissemination of curatorial competences to students and architects through the CAD training would support the evolution of the architect profession and corroborate the control over the commercial exploitation of digital design products.

The traditional rationale for introducing computer education in architectural schools has predominantly regarded the professional relevance of the presented techniques [2]. With the affirmation of professional software packages, this attitude has determined a simplification of CAD education contents, often reduced to specific packages employment instructions, promoting a substantial loss of control over the digital design process. The integration of Digital Curation competences into CAD education will fit the latest digital design techniques that demand for computing awareness and coding competences.

Further, the affirmation of the digital cultural market and the integration of digital design techniques with manufacturing facilities are urging the redefinition of the role of the architect as a content provider. This renewed scope on the professional services expected from architects demand from them the necessary competences to legally and persistently manage the intellectual property rights (IPR) associated to the design digital products. The Digital Curation module of a CAD training would

offer architects the opportunity to integrate consistent IPR management in the very workflows of the digital design processes and in so doing facilitating the commercial exploitation of their products.

ACKNOWLEDGMENT

The DEDICATE project would not be possible without the generous funding from the Fellowship Scheme for Early Career Researchers of the Arts and Humanities Research Council.

REFERENCES

[1] Bijl, Aart. 1977. "The Automated Architect." *Computer-Aided Design* 9 (4) (October): p.287.

[2] P. Purcell, "Computer education in architecture," *Computer-Aided Design*, vol. 12, no. 5, pp. 239–251, 1980.

[3] G. Vazzana and D. Bachmann, "CAD salary and employment study," *Computer-Aided Design*, vol. 27, no. 11, pp. 795–803, 1995.

[4] R. Lancia, "First Step Award Final Report - project DIDECU (Digital Design Curation)," University of Glasgow, Glasgow, Feb. 2011.

[5] D. Van Rillaer, J. Burger, R. Ploegmakers, and V. Mitossi, "Rgd BIM Standard," Rijksgebouwendienst, Jul. 2012.

[6] Cabinet Office, "Government Construction Strategy," May 2011.

[7] A. Speaight and G. Stone, *Architects Legal Handbook. The Law for Architects*. Oxford, Cambridge, Mass: Architectural Press, 2005.

[8] N. Beagrie, "Digital curation for science, digital libraries, and individuals," *International Journal of Digital Curation*, vol. 1, no. 1, pp. 3–16, 2008.

[9] S. Higgins, "The DCC Curation Lifecycle," *The International Journal of Digital Curation*, vol. 3, no. 1, pp. 134–140, 2008.

[10] A. Miles, "Zoological Case Studies in Digital Curation – DCC SCARP / ImageStore," *Alistair Miles*. [Online]. Available: http://alimanfoo.wordpress.com/2007/06/27/zoological-case-studies-in-digital-curation-dcc-scarp-imagestore/. [Accessed: 21-Jan-2013].