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Architecture, Design & Engineering – Archiving Digital Assets: Past, Present and Future

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Abstract

For decades, design in the worlds of architecture, design and engineering have been digital and the software tools to support the work operate under a business model of rapid change and proprietary output. This paper reports on the outcome of a two day Summit held at the Library of Congress in November 2017 (Designing the Future Landscape: Digital Architecture, Design & Engineering Assets) bringing together creators, archivists, researchers, project managers, and standards and guidelines developers to illuminate the issues and challenges for preserving and accessing this work product, to explore new research possibilities created by design as data, and to identify initiatives contributing to addressing issues of preservation and access. Like the event itself, this paper hopes to increase awareness of the challenges and issues, and to share and encourage actions and collaborations for preserving this material. An in-depth consolidation of the themes and issues from the Summit can be found in the report written by Aliza Leventhal for the Library of Congress released in March 2018 entitled: Designing the Future Landscape: Digital Architecture, Design & Engineering Assets.

Background

Quantitatively captured in the software/technology surveys conducted by the American Institute of Architects (AIA),[1] which began in 1987 and were most recently conducted in 2016, the AIA surveys indicate that computer aided design (CAD) was rapidly adopted by large and medium sized firms in the 1990s, and by the end of that decade were being utilized in projects beyond experimental exploration. The 1980s and 1990s were an especially experimental time for architects and designers who were testing the limits of design software at their disposal. Partly based upon advancing technological capabilities, like so many software vendors during the 1990s, design software vendors seized the opportunities provided by the available hardware to achieve more of the envisioned and desired potential benefits and functionality that had continued to grow since the early predictions relieving architects of repetitive remedial tasks, supporting time-intensive tasks, and processing significant quantities of data.[2] Digital design became another tool to the designer, and as the functionality of the software developed and designers gained more mastery over them, new possibilities were not only imagined but created.

The broad adoption of computers and design software by the end of the 1990s did not mean that the software was, or is now, being consistently used across the profession, or even within a firm; but rather implies that the foundation for some digital workflows were being more formally developed. This is credited to the acceptance that "designers aren't as methodical as would be ideal to reconcile the processes computers require."[3] The design process is more than its technological parts, and includes the cultural and climatic context of practitioner's workflows, including contract deliverables for construction and facilities maintenance, and following the trends emphasizing innovation in software and its uses.

The contextualization of digital design within the broader evolution of technology was a recurring theme of the Summit. This was explored within the framework of "Product, Data, and Process," which exposes the issues of the past/present and present/future records being clearly divided between preservation and access of legacy data, and the development and adoption of sustainable deliverables within the present and future. The first addresses the backlog of unpredictable digital files and obsolete software that have and are slowly making their way into private or institutional archives; and the second is developing a future world of platform independent file types and record guidelines based on archival standards. The categorizations of past/present and present/future indicates that we are not yet at a place to confidently identify when the shift to less platform-dependent files will be, and as such, must accept this overlap.

Stakeholders

Researchers/Scholars recognize the value of having access to the complete file directory, or comprehensive access to the digital environment in which the design files were created. Examples were offered for how a privileged position of accessing historic records from within the creating design firm was an ideal research environment, especially when comparing with archives that face barriers and limitations to providing similar digital access in their reading rooms.[4] Academics within the architectural history and design disciplines are already exploring digital design records using automation, scripting, artificial intelligence, shape grammar, digital culture, and digital archeology.[5]

Collecting Institutions have experience developing collecting policies for design records and reaching out to design creators. They have a substantial challenge providing technical support and subject expertise for design collections that have

[1] For the most recent of these surveys, https://www.aia.org/resources/6151-firm-survey-report-the-business-of-architectu

[2] Computers in Architecture, Genevieve Greenwald-Katz, AFIPS '76 Proceedings of June 7-10, 1976, national computer conference and exposition, pg. 315-320.

[3] Session 2, Fireside Chat - Data Flow

[4] Session 3, "New Archives: Digital Forensics and Programmatic Methods in Digital Design History," Andrew Witt, Graduate School of Design, Harvard; "Expanded Archives of Digital Culture," Matthew Allen, Harvard University, University of Toronto

[5] Session 3, Access Use Cases

hybrid or entirely digital records. These collections vary in size, but will result eventually in Petabytes of data, and have significant software dependencies that are difficult to acquire and maintain if each institution were to take on this challenge independently.

Software Vendors play a critical role in determining which standards are supported and will require customers to articulate the preservation, interoperability and workflow requirements for their software to respond to. In the absence of an articulated business model, without users asking for long-term accessible files, or providing guidance about features and priorities, vendors do not have incentive to add those features.

Guidelines, and Standards Organizations have made efforts on both national and international stages, and across industries. Their development could benefit from broader inclusion of stakeholders' perspectives and needs. There are reasons to be optimistic about the potential for standards to improve the future of design records, but it became abundantly clear that standards will need to include implementation guidelines and interoperability capabilities in addition to the desired output of a preservation format. There are successful examples of this type of collaboration across interest groups, such as the CAx Implementor's Forum within the aerospace and defense industries.[6] Additionally, there was an expressed need for a tiered approach to preservation, such as those in the Federal Agencies Digital Guidelines Initiative's (FADGI) digital imaging guidelines to ensure best practices are upheld regardless of an institution's available resources.[7]

It is important to note that there was a strong presenter focus in the sessions towards architectural records. However, the issues raised for the records produced by the architecture profession resonate within engineering and other design professions including graphic design, landscape architecture, planning and urban design, archeology, and others.

Design Data Framework

Products are the outputs, the wide range of complex digital objects created by designers and engineers. Preservation of the products includes storage and access. Access to the files can require the original version of the software and the operating system (OS) it was used within in order to be accessed as their creators had previously done. Current work with emulation suggests that it might be possible to create such an environment, but this requires the acquisition of all of those dependent pieces, contextual understanding of how the software and OS were used, and expertise to build and maintain the emulated environments. Such an environment is challenging to recreate, and requires parallel preservation efforts of the digital files, the software, the OS, and sometimes knowledge of how the creators used or modified the software and hardware. Emulation could work despite all of its dependencies for complete success, but the products will still require initial mitigation; and, without proactive intervention of future file types the list of possible products (e.g. file types) will only continue to grow.

Data is at the root of the question "What are we preserving?" Data is the foundational element of all digital records, and the strength of the metadata aggregated across digital files and intentionally included by record creators is critical to the accessibility and interpretability of a project through its digital files. This category is specific but the content is broad reaching, as data pertains to all the pieces of information that influence or support a designer's work, and the functionality of their wide selection of software. This category includes environmental or contextual data such as GIS and energy modeling data, and also refers to the robust data set developed within a Building Information Model (BIM) record. It is critical for designers and records creators to identify what data is important to their work, and indicate how much of the robust data developed are new or evolving attributes of the design process. This type of conversation with creators capturing a narrative will help archivists better understand the developing practices within the design and engineering fields, and better prepare them to ask and categorize the records they accession into their collections.

The **Process** of designers and their work is the most complex element to capture in digital records. Barriers to capturing and collecting records that articulate the design process include technological limitations, lack of documentation by project teams, the use and integration of multiple software tools in contributing to a single document output, an institutions' collection policies, and communication between records creators and institutions receiving their donated materials. Technological limitations include how software varies in their automatic capture of data that would provide insights into identifying who did what work; and the inconsistent availability of versions of software used throughout a designer's career or firm's existence can inhibit access to a collection's materials. There are also potential contextual limitations, as the contextual business records such as the accounting and marketing records about project teams or project pursuits, are not always collected by archives, but could be valuable information depending on a researcher's focus. These challenges are exacerbated by communication issues, which was a concern mentioned several times throughout the Symposium and Workshop. Communication was seen as an area to improve upon by institutions and designers alike, whether records are donated to an archive or kept within a firm. As archivists and facilities managers ask designers to explain and record the phases of a project (Schematic Design, Design Documents, Construction Documents, and Construction Administration) the nuances of the design process will be better captured. This need linked directly to the topic of creating and providing guidelines and standards.

Legacy Issues

It was collectively agreed that legacy records should be accepted as the complicated sets they are and institutions should focus on supporting them in their original environments, or as close to that as possible. The market for design software has continued to grow and change over time, with market winners shifting as innovative software came on the market and changed the way designers created and communicated their designs, often without development for interoperability, or backwards compatibility. A few vendors have maintained their position as market dominators, but these market dominators have not

[6] Session 4, "A Template for Interoperability Testing," Phil Rosché, CAx Implementor Forum, ACCR, https://www.youtube.com/user/LibraryOfCongress, and https://www.cax-if.org/

[7] FADGI's digital imaging guidelines has different levels built in to provide scalable solutions for institutions with varying levels of resources or capacity.

simplified the landscape of design software as they support and use dozens of file formats.[8]

Despite these challenges, progress has been made in exploring both the issues and possible preservation and descriptive practices for digital design records. Ranging from the in-depth effort of the IMLS funded, two part MIT/Harvard FACADE project (2010 & 2013)[9] to the Canadian Centre for Architecture's three-part exhibit (2013-2016), *Archeology of the Digital*[10] it is clear that significant work must still be done to establish best practices for preserving and providing access to these records.

Emulation is one possibility for providing access to files in the digital environment in which they were originally created. While emulation has not yet been widely adopted by the digital preservation community, it is deserving of continued exploration for offering a possible solution for access, curation and description support. Exploring this avenue allows institutions collecting design records to imagine new reference and access models for researchers where they would be able to access a digital collection in its entirety, and also the files in their original program. Yale University, in collaboration with the Software Preservation Network (SPN), has been awarded two $1 million grants from the Alfred P. Sloan Foundation and the Andrew W. Mellon Foundation in 2018 to continue to develop and explore this possible digital access solution.[11] The concept of a consortia-style model for sharing software resources and digital design software expertise has been identified as a possible solution for addressing major barriers of this approach for smaller or less resource-rich collecting institutions.

Developing Sustainable Deliverables

Development around platform-independent file types and established interoperability are occurring, represented in the Architecture, Design & Engineering (ADE) / Architecture, Engineering & Construction (AEC) community through Building Information Modeling (BIM) standards and guidelines, particularly through the adoption of the open IFC file format (ISO 16739:2013).[12] They offer a fundamental approach shift separating the data from the proprietary platforms they were originally created in, and the mapping of that data to an open standard to ensure long-term access to important data about a project, data that has a business importance for construction and maintenance through time, and which also offers both academic and industrial research potential. This last category of data focused on research captures the design process, which is more difficult to prioritize to practitioners who are focused on supporting the practical applications of construction and maintenance of their structures.[13]

The explosion of available software has fostered a culture of experimentation and project files that could be considered digital bricolage when the combination of software used to produce a single file is taken into account. With such a diversity of options it becomes obvious how a standard that separates the file's data from the proprietary software, such as buildingSMART[14], can be a valuable resource for future access and long-term preservation. Additionally, while there are many smaller, customized tools in development, there is also consolidation in the field amongst the largest design software companies.

The IFC standard has been adopted with clear timelines by several nations within the European Union, and several others have developed their own local and national standards that can be rolled up into OpenBIM.[15] The US National BIM Standard is focused on lowering the cost of construction. If these initiatives are followed with increased vendor support of the standard's file type, and including functionality to apply the necessary metadata into a file without adding additional steps to the workflow, the burden on designers to create a preservation record would be significantly reduced.

Despite the clear benefits to complying with standards, the adoption of standards within the design software in the industry has been sluggish. Standards will not be adopted unless they can support and address both the designer's need to feel unbridled during the design process, and the fast-pace of design projects that prioritize efficiency and end product above all else. While this might seem like an insurmountable obstacle, the almost ubiquitous adoption of design software into AEC practice across the United States and world demonstrates that disruptive technology can become the norm.

Collective Impact

Collective Impact is a model for understanding system level change. System level change means working outside the conventions of your community of practice and developing a shared or common information space and opportunities for collaboration. This includes connecting with communities with larger scopes, such as the digital preservation community and the SPN, which are addressing functionality and access issues that the design records community can learn and benefit from. Broadly applicable issues, such as the breakdown of access of software, acknowledges that the issues facing collecting institutions, firms, and researchers are bigger than their special interests, and that the issues of long-term preservation and access of digital design records are at the system level.

For example, the relatively small group of major players in the aerospace and automotive markets not only supports but demands a consolidated set of software[16] and, building on decades of standards collaboration across manufacturing industry sectors, was able to collaborate to develop and adopt Long Term Archiving

[8] Session 1, ADE Formats Primer
[9] http://osc.hul.harvard.edu/liblab/projects/facade2
[10] https://www.cca.qc.ca/en/events/38273/archaeology-of-the-digital-complexity-and-convention
[11] https://news.yale.edu/2018/02/13/project-revives-old-software-preserves-born-digital-data
[12] Session 4, "buildingSMART International and Industry Foundation Classes (IFC): THE solution to A/E/C/O data interoperability," Jeff Ouellette, Assoc. AIA, buildingSMART International - Implementation Support Group; and "Documenting Building Information Requirements," Roger Grant, Program Director, National Institute of Building Sciences
[13] Session 4, What is Happening Now?
[14] https://www.buildingsmart.org/
[15] Session 4, "buildingSMART International and Industry Foundation Classes (IFC): THE solution to A/E/C/O data interoperability," Jeff Ouellette, Assoc. AIA, buildingSMART International - Implementation Support Group
[16] Session 4, "A Template for Interoperability Testing," Phil Rosché, CAx Implementor Forum, ACCR

and Retrieval (LoTAR).[17] As most buildings are not mass-produced in the same way as airplanes and automobiles are, the market and internal industry forces present in the aerospace/automotive industry cannot be easily replicated within the AEC/ADE industries. Nonetheless, the LoTAR model of collaboration and standards implementation offers valuable lessons and models.

These wide-ranging issues can be more effectively addressed through cross-discipline recognition that with a shared, raised awareness, stakeholders can begin testing and exploring potential solutions outside our silos and benefit from collaboration across disciplines.

Author Biography

Kit Arrington and Kate Murray Co-chaired the Summit; Aliza Leventhal authored the report generated by the event upon which this paper is based.

Kit Arrington is a Digital Library Specialist in the Prints & Photographs Division at the Library of Congress where she is a project coordinator for the digitization including the architectural, design and engineering collections. She is a participant in the development of the Library of Congress' Recommended Formats Statement and the FADGI Technical Guidelines for Digitizing Cultural Heritage Materials.

Aliza Leventhal is the librarian and archivist for Sasaki, an interdisciplinary design firm. She is the co-founder and chair of the Society of American Archivist's CAD/BIM Taskforce, through which she leads research and advocacy efforts with fellow archivists around digital design files and software.

Kate Murray, is a Digital Projects Coordinator at the Library of Congress, leads the FADGI Audio-Visual Working Group and the Sustainability of Digital Formats website.

[17] "The objective of LOTAR International is to develop, test, publish and maintain standards for long-term archiving (LTA) of digital data, such as 3D CAD and PDM data." http://www.lotar-international.org/