Digital Fragments and Historiographies

Data Mining the William J Mitchell Archive

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Abstract

The acceleration of digital design and production poses new problems for the architectural archivist, historian and theorist. Architectural history and theory has primarily been constructed on the quotation of fragments from physical archives. But, what can be said about architectural historiography if the quotation or fragment itself is a digital entity? The recently acquired Melbourne University archive of William J Mitchell, one of Melbourne University's most distinguished graduates, poses these questions because the material culture of archive includes a diverse range of digital materials: audio-visual slides, electronic storage media and software. The Mitchell archive contains a number of 3.5 inch floppy disks related to Topdown. Topdown was a parametric program that was intended to create a large knowledge base and library of architectural fragments to be used in CAD. The review of Topdown raises issues about the archival logics and context of digital fragments; as well as, the tantalising fact that those fragments themselves are the result of attempts to codify the architectural fragment into a digital system. At a practical level the shift to digital practices, as exemplified in the Mitchell archive, indicates a need to revise principles governing architectural historiography, hybrid and digital media collections and conservation. This is because the logic of digital archives suggests a different order of so called metadata is needed. As a result, this situation suggests the need for architectural historians to develop new instruments and approaches to both architectural historiography and theory.

Introduction

Writing in 1991 the Introduction to The Electronic Design Studio a book he co- edited William J Mitchell was to proclaim that architects should:

> think of design systems as open, flexible, constantly evolving knowledge-capture devices rather than static collections of familiar tools and dispensers of established wisdom. When we can do this I think we will see the emergence of design systems that do not just mechanically assemble banalities, but that have real style and flair.[1]

The *Electronic Design Studio* represented the proceedings of the CAAD Futures conference held in Cambridge Massachusetts in July 1989 and was published in 1991. It brought together at that point many of the leading proponents of computing in architecture who would go on to significant careers as leaders in the field. It contained contributions from George Stiny, John Gero, Bahrat Dave, Milton Tan, Robert and Rivka Oxman. In the afterword of *Electronic Design Studio* Mitchell railed against the "banal and simplistic conception of CAD functions" in "fourth generation CAD".[2] Arguing for the "wider possibilities" of CAD Mitchell saw hope in the emergence of personal computing and networks linking together a new generation of "workstation network technology" and powered by machines that had advanced graphic capabilities.[3]

At that point as an author Mitchell was well acquainted with and intimately linked to the evolving nature of computer aided design in architecture. The pioneering *Computer-aided architectural design* had been first published in 1977.[4] After this there was a hiatus until the late 80s to early 90s when Mitchell produced a flurry of publications as author. In 1987, in collaboration with Robin S. Liggett and Thomas Kvan, *The Art of Computer Graphics Programming: a structured introduction for architects and designers* was published.[5] Shortly after, *The Poetics of Gardens* with Charles W. Moore was published in 1988.[6] *The Logic of Architecture: design, computation, and cognition* was published in 1990.[7] *Digital Design Media: a handbook for architects and design professionals* with Malcolm McCullough was published in 1991.[8]

William J Mitchell Archive

The recently acquired William J Mitchell archive at Melbourne University enables an insight into this productive period in Mitchell's career as a thinker in relation to the development of Computer Aided Design in architecture as well as the early history of parametric design. In 1986, Mitchell was appointed Professor of Architecture and director of the Master in Design Studies Program at the Harvard Graduate School of Design.[9] An examination of material in the archive relating to the years 1986 to 1990 connects Mitchell to both earlier developments in CAD as well as CAD's future trajectory and Mitchell's later theorization of digital and networked urbanism, in *City of Bits* published in May 1995 by MIT press.[10]

In 2011 the Dean of the Faculty of Architecture, Building and Planning Prof. Tom Kvan organised for William J Mitchell's archive to come to Melbourne University. Professor Kvan, had been a former student and collaborator of Mitchell's. In 2013 Professor Mitchell's personal archive and papers were given to Melbourne University. All of the items were collected by Mitchell's second wife Jane Wolfson. Included in the collection are:

1. Approximately 700 000 slides including images of designs, and of geographical locations
2. Approximately 1700 books, which reflect Mitchell's research and personal reading interests
3. Copies of theses that Mitchell had supervised
4. Boxes of copies of his articles, and research and manuscripts for at least three of his books, *The City of Bits*, *Poetics of Gardens* and *The Logic of Architecture*.

5. 125 VHS videos containing, amongst other things, interviews by Bill Mitchell
6. A variety of digital storage media (3.5 inch floppy discs, 8mm data cartridges-D8 format, iomega zip discs, and CD-ROMs).[11]

As a hybrid collection of both physical, digital and multi-media material the above indicates Mitchell was foremostly an architect who had been well trained in his undergraduate degree at Melbourne University with a solid grounding in architectural history and theory. Mitchell's broad intellectual interests and training an investigation of the collection archive gives a glimpse into the history and development of computing in architecture. The perspectives emerging out of this archive encompass the rise of machine computing, distributed computing as well as generative and parametric design in architecture.

Archival Materials

At a practical level the shift to digital practices, as exemplified in the Mitchell archive, indicates a need to revise principles governing museology, collections and conservation. In this context, is it simply a matter of developing new technology based methods and practices to extract historical data? Or does the extant digitisation of an archive shift how fragments emerge and are selected as quotations in historical narratives?

The Mitchell archive has been documented using Forensic Toolkit (FTK). FTK is based on software devised by Access Data a company formed in 1987 with customers primarily in the areas of law enforcement, government and law. FTK is mostly used in digital forensics and law enforcement but can be directly applied to archival contexts. FTK is able to interrogate digital media in order to identify, preserve, recover and analyse digital information.12 In the context of law enforcement the purpose of FTK is to investigate computer crime as well as civil proceedings with an evidence trail. Underscoring the issues involved in digital forensics and archiving FTK enables files, folders and computers to be accessed and evaluated for "evidentiary values". In other words, its primary application in forensics enables it to systematically, track and document a trail of evidence. FTK is therefore an extremely useful tool to image, register and recover data from digital archives by ensuring the digital content recovered has not been altered in any way. FTK can been used to access and image a range of storage data including hard drives, floppy drives, CD's and DVDs and USB's: In effect, it can be used to access and image data from "any common electronic source". Once imaged the data can be easily filtered and searched.

Following this bequest, the Melbourne University archives began to use FTK to register and examine the digital media in the Mitchell collection. A variety of digital storage media were accessed and registered using FTK. The three largest group of data storage items in the Mitchell collection includes: 104 iOmega Zip disks created between 1995-2001. 51 Maxell 8mm HS-8/112 Data Cartridges first released in 1989, as well as 241 3.5 inch floppy discs of various kinds created between 1985 and 1993. Most of these floppy disks were created between 1986 and 1992 and provide a snapshot into Mitchell's most productive period of publication until he took up his post at MIT. It is this latter group of disks that are the subject of this paper. 94 of these disks (numbered DF001-192-01 to DF001-192-94) in the archive exist in a single physical storage box which was easily accessible and is the primary focus of our initial research. The hand-written notes on each disk were recorded and the disk contents were image and transferred to the FTK database. The earliest two 3.5 inch Floppy DS DD disks in this storage box are a disk entitled "Sampler: An intro to Macintosh Applications 1985-1986" (DF001-192-17) and a disk entitled "m master". (DF001-192-34). At the time of writing the files on this latter disk has yet to be examined.

Macintosh Hardware and Software

Mitchell appears to have, as discussed here and below, exclusively used Apple computers in the mid to late 1980s. This is evident from the predominance of Apple titled or orientated disks in the archive in the set of disks discussed here. At that time, the “Classic” Mac Operating system was deployed by Apple in its Macintosh personal computers from 1984 to 2001. The original Apple Macintosh having been released in January of 1984. The main advantage of the apple system over IBM systems at the time appears to be its Graphical User Interface and the use of a mouse an essential part of Apple as a consumer product.

In 1986, there were three Apple models available on the market these were the Macintosh Plus, the Macintosh 512Ke, the Macintosh XL (with the operating system derived from the previous Apple operating system Lisa). All of these models were aimed at the consumer and education markets. The Macintosh SE 11 Series servers were not released until early 1987. The previous Apple I, II and III computers employed larger floppy disks rather than the 3.5 inch Sony disks which had been employed by Apple from around 1984 onwards.

Using available software Mitchell was obviously exploring the capabilities of the Apple Macintosh computers in the network he was building at Harvard’s Graduate School of Design (GSD). A number of software applications in the archive that suggests that Mitchell was using Macintosh computers to experiment with Computer Aided Design. These applications included Hypercard a programming tool for Apple Macintosh computers. Hypercard would enable a programmer to develop both applications and databases. It was included with all new Macs sold after 1987. Mitchell also appears to have CricketDraw which is was at that time a vector graphics creation software program designed for use with the Apple Macintosh by Cricket Software. Notably, in the archive there is a disk called Thunderscan, this was program that would turn an Apple ImageWriter printer, with some modifications, into a relatively high resolution scanner. As discussed below Mitchell was using his Apple computer’s in a network as there are a number of disks in the archive that suggest this. Another program in Mitchell’s box of disks was Megamac which was an application to develop applications using the C language.

Topdown Software

The software title that appears to predominate on a number of the disks in the DF001-192 series relates to *Topdown*. This includes disks that were obviously student submissions as part of teaching at Harvard. *Topdown* was Milton Tan’s PhD thesis which Mitchell supervised; thus, developed by Tan, in collaboration with Mitchell and most likely Robin S Liggett. It was intended to be used as a means to create a large knowledge base or library of architectural fragments to be used in CAD. It was a “knowledge based design system” that also employed some parametric functions. [13] Whilst AutoCAD 10 had been released in 1988 *Topdown* was not simply a linear drafting tool drafting tool like AutoCAD. As Mitchell was to liken, it at that time it, most computer drafting systems were seen to “work in a bottom-up fashion”. In other words, they provide ways to be “effective for input and editing” the drawing existing designs and objects. This was usually done by providing a range of graphic instruments such as “vectors, arcs, and splines, together with operators for inserting deleting, combining and transforming instances of these”.[14] As Mitchell and his collaborators conceived it *Topdown* was a piece of software that was an attempt to make a tool inherently parametric. Mitchell contended that a “CAD system should automatically maintain structure as a designer manipulates a geometric model”. [15] However, as Mitchell was to note the real limitations of CAD systems related to their generative abilities. As parametric tool *Topdown* was designed to generate an extended range of geometric shapes. Moreover, Mitchell argued that ambiguity was an important factor in the design process a “a design is not just a description of what is, it is exploration of what might be. Drawings are valuable precisely because they are rich in suggestions of what might be”.[16]

In naming the software *Topdown* Tan and Mitchell set it against what they regarded as more banal and overly rigid CAD representation which to him “impoverish the creative imagination”.[17] “Mitchell was fore mostly an architect, trained in the art history of the styles, and this may be why he used a sketch of an elaboration of a stick figure by Albrecht Durer, as well as drawings of Durand’s development of plan schemata to illustrate how *Topdown* was to work. *Topdown* was a system that was intended to align itself with a design process that went from taxis and schemata to more detailed elaborations of these. Mitchell's work and effort to develop *Topdown* followed on from the shape grammar work of George Stiny. who, presumably Mitchell must have met when he was in California. It was these notions which Mitchell enthusiastically took up and formed the basis of the development and subsequent teaching of the *Topdown* program.

Whilst there were other earlier pioneers who were ciphers for the advancement of computing technology in architecture, such as Negroponte and Christopher Alexander, in the early 1970s it was Stiny who advanced theoretical notions of shape grammars and parametric design in a series of papers. Mitchell was an editor of the *Journal Environment and Planning B* which published a number of Stiny's papers in mid to late 1970s. Drawing on notions of structuralism, especially the formal syntactics of Chomsky amongst others, Stiny's initial work in 1971, with James Gips of the Computer Science Department at Stanford, developed a theory of shape grammars. Stiny and Gips linked their conception of shape grammars to traditions of non-representation and geometric art.[18] Whereas Stiny saw the link between shape grammars and abstract art, Mitchell saw the link between shape grammars and the games and systems inherent to classicism in architecture. This is obvious in the publication in 1990 of *The Logic of Architecture: Design, Computation and Cognition.*[19] As Stiny was to note after Mitchells' untimely death, "If he hadn't been there to inaugurate computer-aided architectural design, architects would probably still not be doing it".[20]

In using *Topdown* in his teaching, *Topdown* appeared to allow Mitchell's students to replicate the generative exploration and selective decisions of classical architecture. However, the classical orders were no longer drawn but selected and elaborated via graphical user interface using a Macintosh personal computer. In many respects the systematic and layered nature of classicism was replicated in *Topdown* itself. Mitchell and his collaborators described *Topdown's* operation as working "at a number of levels". At the programmer level the task was to:

> … capture and encode knowledge of shapes and sizes of elements and subsystems, and of how to put them together. In other words, the programmer must encode the vocabulary and syntactic rules of a parametric shape grammar for the type of artefact that is to be designed.[21]

The role of the programmer is to also create a data structure that to organises designs as hierarchies of sub shapes within sub shapes and require the programmer to predefine this hierarchical structure. For the designer, the system was designed to allow the designer to work, and easily move between, a number of different "levels of abstraction" or scales.[22] A designer is able to work with two graphic screens. One screen or window shows the current state of the design whilst the other screen is the screen via which the designer can interact with the drawing object. As they noted, "this freedom to move freely between and work at different levels of abstraction is not provided either by physical media or by traditional CAD systems". [23]

Topdown was intended to be used as a plug-in to a CAD system as what they'd described as a "content rich special purpose tool. "The point of the *Topdown* knowledge base library is not to replace the skill and judgement of the designer, but to speed the process of design exploration by providing a wide variety of specialised tools for swift development, in alternative ways, of aspects of a design". *Topdown* was developed in Lightspeed Pascal for the Macintosh and in Microsoft Pascal under Microsoft Windows for the IBM P5/2. But in 1989 the system was not yet able to utilise object-orientated programming. This did not stop Mitchell and his colleagues from effectively using *Topdown* in teaching at the Harvard GSD and the UCLA Graduate School of Architecture and Urban Planning.

Harvard Network 1989

At Harvard Mitchell was instrumental in the incremental development of a CAD network at Harvard Graduate School of Design. He published details of this network in 1989.[24] Both the floppy disks in the archive from around this time and his comments about this network begin to build up a picture of the means by which Mitchell sought to bridge the gap between architectural design and distributed computing. Mitchell saw *Topdown* as being one component of this network and saw the function of the network as an entity that supported teaching and research across architecture urban design and planning. He also envisaged that this CAD network not be to a singular or monolithic regime revolving around particular hardware or singular applications. He hinted at the organic nature of this network in a way that seem to presage his later discussions of urbanism *in City of Bits* (1995). He proclaimed that the Harvard network would "grow over time", "become increasingly integral to the design professions', "support a heterogeneous mix of technologies and products" and "allow for the smooth integration of new technologies as they emerge". Arguing against so called "specialized CAD laboratories" Mitchell stressed the need to "deliver technology to designers where they need it", in workplaces and firms, and for this reason workstations were distributed thought GSD.

Mitchell's network at GSD was also built to allow for the flux of future software development and disruption. In 1989, the network had a Sun 386i server at its heart connected to a range of workstations and personal computers in the network that included Sun, IBM and Apple Machines. This gave the network the range to perform both simple and more complex tasks. Notably, Mitchell was extremely interested in visual digitisation noting that one Macintosh II in the network was "configured with slide scanner, flatbed scanner and a digital film recorder. This is perhaps reflected in the range of materials in the archive. Mitchell's diagram of this network indicates his desire to provide students and researchers with a range of software. This was in order to allow them "the capacity to evaluate tools and technologies critically" Interestingly, in Mitchell's diagram of the system *Topdown* was seen as a 2D drawing program whereas AutoCAD was seen as a drafting tool. For Modelling the system used Computervision and AES at the "higher end" and AutoCAD or Modelshop at the "lower end".

Discussion

In his 1977 book Computer Aided Architectural Design William J Mitchell sets out a brief prehistory of the field's development. Mitchell sketches out a global early history of Computer Aided Design in architecture from the early 1960s and briefly summarised developments in the Americas, England Europe, Denmark, Eastern Europe, Japan and Australia. He cites the work of numerous figures such as Dawson (1961), Eberhard (1962), Souder and Clark (1963). These figures all appear to be on the fringes of avant-garde architecture and primarily wrote about computers from a utilitarian and engineering methods perspective. Mitchell notes that it was probably not until the work of Christopher Alexander was 1964 and the Boston Architectural Centre that architectural competing began to explore "graphics and computer aided design systems". [25]Towards the end of the 1980s the application of CAD in allied engineering professions was becoming commonplace. AutoCAD version 1.0 was released in 1982 and by 1988 AutoCAD 10.0 had been released.

Mitchell bemoaned the fact that in architecture CAD "lagged" behind its implementation as compared to the engineering professions. For Mitchell, milestones in the development of CAD include Sutherland's Sketchpad system present in 1963 and IBM's Design Augmented by Computer system. This latter system was developed for General Motors in order to design automobiles and aerospace applications. In these industries, by the late 1960s CAD technologies were already well entrenched. He argued that the primary reason for this was architects lacked the intensive capital, readily available to aerospace and automobile firms, needed to develop CAD system. But he also suggested that there were also cultural reasons for this situation. In Computer Aided Architectural Design Mitchell argued that the slow take-up of CAD in architecture was as a result of "hostility" to the idea amongst architects and "ignorance" of CAD and computing's "potential".[26]

Mitchell's endeavors in the years 1986 to the publication of also came at time when personal computing and the software associated it emerged out of technical laboratories into the realm of consumer products. Given this context Mitchell's thinking superseded the work of an earlier generation of computer aided design pioneers such as Christopher Alexander, Nicholas Negroponte and The Architecture Machine Group at MIT who alongside architects like Cedric Price advanced cybernetic notions in architectural discourse.[27] As Stiny was to remark in his generous obituary that Mitchell was deeply concerned with the linking "computation with visual and spatial design". [28] For Mitchell, the innovations in distributed networks and personal computing was more than simply thinking about how the ordinary architect might efficiently use these new products. Mitchell's thought was not simply about the pleasure of efficiency gains. His thought was more disruptive than this. Mitchell arguably bypassed the early experiments and development of computing in architecture in order to link the history, canon, language, norms and practices of architectural design to emerging innovations in personal and distributed computing. In Mitchell's Mitchell appears not to have shied away from thinking about the direct confrontation between an older order of architectural practice and a new world of technology. A world of technology that was, by the late 80s, more real, immediate and readily available than the architectural theorists and technologists and seers of the 1960s and 70s had experienced. Arguably, it was the gap between his first publication on Computer Aided Design in 1977 and the flurry of publications 10 years or so later that enabled Mitchell's be a powerful advocate of architectural design in the face of disruptive digital innovation.

Emulation

Further research into the archive will allow for the emulation of the *Topdown* program itself. Emulation is the concept that a computer program in one digital device can imitate or mimic another program or device without needing the original hardware. Removing the dependency on hardware allows the original computing environment to be preserved alongside the digital entities or fragments. This is a critical function in archival research where an archive consists of digital materials, electronic research data or fragments. In other words, digital entities or fragments produced on earlier machines can be emulated on later platforms allowing them to be viewed as if they were running on the original system. In this way, their visual presence can be apprehended directly. In this instance our further research will be focused on the emulation of the *Topdown* system as well as many of the other files in the Mitchell archive. This means that architectural historians and the archivist need to be aware of the history of computing. But moreover, as suggested by the dynamics of the digital forensics workflow, there are new layers of metadata that need to be understood. Metadata needs to account for and describe a range of items such as image archives that contain disk images of operating systems, object archives such as CDROMs or floppy's, as well as a directory of environment descriptions which describe the platforms and networks that digital fragment may have operated within. In addition, Metadata and information is also required about the environment or system in which the emulation is taking place. Work to provide emulation as service to archives and libraries has been undertaken through the Emulation as a Service project at the Albert-Ludwigs-Universität Freiburg. We are implementing a cloud-based emulation service to allow web-based delivery of legacy computing environments; allowing digital entities and fragments such as Mitchell's to be viewed in their original context.

William J Mitchell archive suggests the need for architectural historians to develop new methods of archival research. As digital fragments start to predominate in the archive of architecture it is clear that architectural historiography must account for a broad range of technological developments and layers. The development of emulation services suggest that architectural historians must also have a knowledge of computer languages, hardware, networks, storage and memory capacities, graphics, user interfaces, display technology, as well as regimes of application and software development and individual applications. Given the history of incremental and disruptive innovation in computing the architectural historian and digital archivist must recognise this state of flux. The history of the digital model in architecture is only a partial history if it does not position the fragment into its appropriate technological context. But not all future archives will be purely digital. The Mitchell archive which contains a rage of different materials and media, suggests that it is the hybrid archive that will predominate in the future. One that includes both digital and physical material, as well as the interactions and connections between them.

This archive suggests that architectural theory itself should adopt an approach cognizant of socio-material practices.[29] The structuring of technology, architectural work and organisations is now blurred in as archives contain more and more digital materials. Ethnographic approaches cannot obviously be suitable when faced with historical digital archives. These approaches are only useful to interrogate socio-material practices in the present. Nonetheless an archive such as this points to the necessity for architectural historians and theorists to reconsider the primacy of materiality and the isolation of architectural aesthetics and language. This would suggest the need for a socio-material approach that accounts for the materiality of technology and its interconnection with architecture. In some ways architecture, its canon, norms and histories is now a creature that has become a cyborg.

Conclusion

Historiographical theories and methods can no longer rely on the taxonomies of physical media based on the verities of chronology, style, and type. Arguably, in the future knowing the software version and the output of architectural practices will be stored as digital information and data. In the past the chronology, architectural type, authorship, and indications of the techniques of drawing and reprographics structured the archive. In hybrid archives, some of these categories may still apply in relation to issues of storage, registration, categorisation, taxonomic structure and access. A physical drawing, print or model is easily seen. In contrast a script or software program or digital model may only exist in of files, or lines of coded, or as a visualisation that can only be accessed, or emulated, using a particular platform. Because the personal computer is now so ubiquitous future architectural historiography must account for not only technology cycles and patterns of technology innovation but also product lifecycles of consumer goods.

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Endnotes

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[9] Mitchell died on June 11 2010 at the age of 65. He joined MIT in 1992 and remained there until his death in 2010. He had also served as Dean of the school MIT, a position he held until 2003. From that time, he led the Smart Cities research group at the M.I.T. Media Lab as well as being a Professor of Architecture and media arts and sciences. He also acted as architectural advisor to MIT and 'played a pivotal role' in the $1 billion expansion of the campus between 2004 and 2010.
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