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| RESEARCH REPORT |
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| Understanding Digital Architecture  Stories born in the digital architecture archives |
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# Introduction

As the National Collection for Dutch Architecture and Urban Planning, Het Nieuwe Instituut (HNI) manages one of the largest architecture collections in the world and the largest in the Netherlands. Since 2015, Het Nieuwe Instituut has been developing the plan to expand its collecting capacity with a digital repository, which concluded in July 2021 with an implementation of an Archivematica-based e-depot. Now that the digital preservation infrastructure of Het Nieuwe Instituut is in place and the archives are being processed gradually, questions arise concerning how the relationships and workflows between acquisition, preservation, and access to the born-digital architecture collections should be shaped.

The history of collecting, processing, and providing access to born-digital architecture and design archives is still very recent, and developing ways of dealing with them remains a work in progress for many collecting institutions. Like many other architecture archives, Het Nieuwe Instituut is just beginning to learn how to store, catalogue, and preserve digital design. Even though many institutions are not yet sure how to preserve digital collections or how to make them accessible, they have been collecting born-digital archives and applying a learning-by-doing approach. To develop ways of making born-digital archives more accessible, Het Nieuwe Instituut recognises the need for building a better understanding of the nature of those collections. Are they essentially different from the analogue ones, and if so, in what way? What new stories about the history of architecture can they tell? Do they require a different approach to collecting? Could their intrinsic qualities influence the ways in which they are appraised, preserved, and accessed?

## Goal

The implementation of the digital repository at Het Nieuwe Instituut revealed a need to develop case studies that could address questions specific to born-digital architecture collections. The goal of this research is to sketch out directions for a follow-up study on the relevance of born-digital collections, their uniqueness, the relationship to the ongoing research projects within Het Nieuwe Instituut, and the potential they have for the users. *Understanding Digital Architecture* explores questions that reach beyond the functional preservation of collections, and focuses on exploring how Het Nieuwe Instituut could bring more attention to their born-digital architecture collections and what consequences does collecting and preserving born-digital architecture have for the institute?

## Research questions

The research was structured around the following questions:   
1. How can Het Nieuwe Instituut bring more attention to its born-digital architecture collections? Are they essentially different than analogue collections and if so in what sense?

2. What new stories about architecture can they tell? What could presenting them mean for the future of the collection?   
  
To answer those questions two areas of investigation were considered:

A. Changes in the architectural practice, with the following sub-questions:

* What are the consequences of digitisation for the design practice at large?[[1]](#footnote-1)
* What influence has the use of digital tools had on the work of the architect and the design process?

B. Potential influence on the collecting institution, with the following sub-questions:

* What are the consequences of the digitisation of architectural practice for acquisition?
* How do changes in architectural practice influence the archival practice and what are their consequences for long-term preservation?
* What are the consequences of the digitisation of architectural practice for the access and use of born-digital architecture collections?

## Research Method

This research was conducted through a series of structured conversations with employees of Het Nieuwe Instituut and an extended network of international digital preservation experts working with architecture and design collections, and was supplemented by a limited literature review.[[2]](#footnote-2) Because the primary goal of this research is to sketch out directions, it does not aim to provide a comprehensive answer to the questions stated above. Instead, it aims to describe possible starting points that link considerations on born-digital architecture archives to existing lines of inquiry within Het Nieuwe Instituut and elsewhere. These starting points could form a base for a follow-up case study or a research project that would look more closely into a selected topic.

This report is based on conversations conducted between June and November 2021 with: Curators of Collections at Het Nieuwe Instituut Suzanne Mulder and Ellen Smit; Het Nieuwe Instituut Senior Architecture Researcher Marten Kuijpers and researcher Ludo Groen; Het Nieuwe Instituut’s V-Conservator Eline de Graaf; Artist Donna Verheijden; Professor Theory of Architecture and Digital Culture at the TU Delft Georg Vrachliotis; Senior Curator Design & Digital Corinna Gardner and Curator Nathalie Kane of the Victoria & Albert Museum; Associate Professor in the School of Architecture at Carnegie Mellon University Daniel Cardoso Llach, Assistant Section Head of Technical Services for the Prints & Photographs Division of the Library of Congress Aliza Leventhal, Assistant Professor of Computer Science at California State University Channel Islands Eric Kaltman.

## Acknowledgements

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Due to the conversational character of the inquiry that shaped this research it was not always possible to quote the contributors directly nor, in all cases, to indicate authorship. Therefore, this report should not be read as a text authored by one person, but by all of the above-mentioned contributors.

I am indebted to all the experts who participated in this research. I would like to thank all the participants for their time, kindness, and the willingness to share their knowledge.

## Institutional context

In 2012 Het Nieuwe Instituut published its acquisition policy *Making Choices* (*Keuzes Maken*). The policy indicated a new course focusing on the social innovations within the architectural practice and shifted attention from the single author to networks of actors.

Currently, Het Nieuwe Instituut is expanding this approach with two new areas of focus as a part of its project *Rethinking the Collection: Digital Culture and Architecture,* and *Diversity*. Both will receive more attention in the pro-active acquisition policy of Het Nieuwe Instituut and function as research questions to explore other aspects of heritage and collecting. Advances in digital culture in the Netherlands have significantly influenced developments within the field of architecture since the 70s. As subtopics, *Rethinking the Collection* will focus on the digitisation of the design process (the digital design practice), the changing role of the architect, the entanglement of architecture and other disciplines (new cross-disciplinary practices), and the development of data-based design in the Netherlands.[[3]](#footnote-3)

*Understanding Digital Architecture* aims to draw connections between existing lines of research at Het Nieuwe Instituut such as *Invented from Copies,* the research report on reproduction techniques, the exhibition *MVRDVHNI: The Living Archive of a Studio*, new directions in acquisition policy related to *Rethinking the Collection*, and lessons learned during the process of implementing the digital archive, including earlier research projects such as *Between Creators and Keepers*,[[4]](#footnote-4) making a first inventory of how digitisation influenced the practice of six Dutch architecture offices; the development of the *Preservation Policy*[[5]](#footnote-5) for the Digital Archive, *A preservation policy for the AutoCAD DWG/DXF file format*;[[6]](#footnote-6) a hands-on study *Decoding Complex Architecture Archives* analysing four dossiers within the MVRDV archive and assessing preservation challenges they pose,[[7]](#footnote-7) and *EaaS as a Preservation Strategy for Het Nieuwe Instituut – Research into the feasibility of Emulation as a Service*.[[8]](#footnote-8)

# Unique characteristics of born-digital collections and long-term preservation

Born-digital design and architecture records are still relatively under-researched. Three-dimensional engineering design only appeared on the Digital Preservation Coalition’s list of Digitally Endangered Species in 2017. Het Nieuwe Instituut made its first born-digital acquisition in 2009. It is not yet clear how the unique characteristics of born-digital collections make them different from their analogue counterpart and how those differences influence the ways in which they should be preserved. According to Corrina Gardner, to understand what that difference is, we need to explore whether we can apply best practices in preserving analogue archives to the digital ones, but not unreservedly. Below I outline some of the aspects that characterise a shift in understanding born-digital architecture archives in relation to their analogue counterpart and the challenges it presents for collecting institutions on the level of acquisition, preservation, and access. Even though these three domains are often described separately, they remain strongly connected, and it is sometimes difficult to draw a line between specific types of influence for each one of them.

## Born-digital material is fleeting

One characteristic of digital technology is that it is not made to last. Because of its fast-paced development, the preservation of born-digital archives and collections faces a new level of urgency, where even print material might no longer be reliable for long-term preservation.[[9]](#footnote-9) This fleeting character of born-digital archives poses a question about the level of loss collecting institutions are willing to accept. Firstly, because the scope of born-digital archives is too large to preserve them all, and secondly because it might not be technically feasible. This might be the case with legacy proprietary file formats, but also generative software developed to create dynamic, not replicable versions, which cannot be saved or reconstructed. Yet, these are only two examples of many technical constraints faced by digital archivists in their day-to-day practice. Even if some can be overcome, it is not without a substantial investment in time, effort, and financial resources, which require a serious institutional commitment.

It is undeniable that digital architecture and design archives at least partly comprise material that belongs to endangered species within the heritage world. Even if parts of those archives are relatively easy to preserve (such as JPEGs or PDFs), the more challenging parts comprise files, which can tell us the most about the design process (such as various Adobe CS, CAD, or BIM file formats). Nationally, a Dutch coalition of design heritage organisations, the Network Archives Design and Digital Culture (NADD), warns that important material from the pioneering years of the digital culture and design are already in danger of becoming unusable or lost, and with them important knowledge is at risk of vanishing.[[10]](#footnote-10) Worldwide, the Digital Preservation Coalition (DPC) a UK-based non-profit comprising several global leaders in digital preservation, publishes The Global List of Digitally Endangered Species. In 2021, 3D digital engineering drawings were listed as endangered and tending towards a greater risk. DPC notes that the loss of tools, data, or services within this heritage group would impact many people and sectors, and recommends that in order to safeguard 3D digital drawings, action is needed within three years. The report states that to prevent or reduce losses a major effort is needed, possibly requiring the development of new preservation tools or techniques[[11]](#footnote-11) because almost none of the currently available tools are able to go beyond the identification of files from any of the popular types of CAD software.[[12]](#footnote-12) This purely technical challenge is further amplified by the diversity of software used by designers, the rate of change within both the design software industries and architecture industry, scarce documentation, and the scant time invested in archive-keeping within the architectural practice. Together with the fact that many of the architects and designers who were among the first to use computers and other digital technologies in their practice have already retired or are approaching retirement age, these aspects have greatly affected our ability to both preserve and understand the heritage from the beginnings of digital design. Only through access to the creators’ knowledge can we gain insights invaluable to the understanding of their legacy and preserving it for future generations.

The digital architecture collection of Het Nieuwe Instituut presently contains works of at least several Dutch digital pioneers with very different kinds of practice and use of digital tools. The first digital archive ever acquired by Het Nieuwe Instituut in 2009 belongs to Carel Weeber (1937-). It contains born-digital material dating from 1991 to 2008, mostly from Weeber’s work as part of *Architecten Collectief*. It contains about 300 DRW (Micrografx files) possibly created on an Atari computer between 1991-1994. Weeber is said to have learnt how to use an Atari from his students, and at the time was one of the first ones to do so in the Netherlands. He admitted it only allowed the creation of simple drawings consisting of circles and straight lines, which suited him well as he liked to design simple buildings.[[13]](#footnote-13) In 2015, Het Nieuwe Instituut acquired an extensive archive of MVRDV, an architecture studio that used computers in rather experimental ways including early forms of parametric and data-based architecture and urbanism. Contrary to Weeber’s approach MVRDV used self-developed computer software to embrace a higher complexity of design. In both cases, those early experiments are not accessible because of the lack of legacy software and hardware. Early works such as those of Weeber or MVRDV are invaluable for an understanding of the origins of digital architecture. If the archival practice is to preserve them for future generations, it must act fast. At the same time, it needs to face questions of what exactly to collect, how to appraise the material, and how to provide access to it.

Some organisations such as the Victoria and Albert Museum (V&A) in London are developing new strategies for collecting digital design. Rapid Response Collecting of the V&A[[14]](#footnote-14) is a strand of their collecting activity, where objects are acquired in response to major moments that touch the world of design and manufacturing.[[15]](#footnote-15) As explained by Corinna Gardner and Nathalie Kane these acquisitions often elude the traditional definition of an object as a completed and unchanging artefact. There is a similarity between the changing notion of the object as in the case of the V&A and the changing notion of the archive in the case of Het Nieuwe Instituut. Whether it is about acquiring an archive after the creator’s death or at the end of their career, or a museum object that is difficult to define in traditional terms, the collecting institutions are incentivised to collect in a more continuous and creative manner. Instead of a complete work or an oeuvre, an archive or a collection becomes a part of a still evolving body of work also often referred to as a living archive, that is a subject to re-use in the creator’s continued practice. Cycles of archival re-use become both an aspect within the design practice of the donor, and a subject of creative re-interpretation by others. As noted by Marten Kuijpers and Ludo Groen, that brings the collecting institutions and the creators into a new relationship and poses questions about the institutional responsibilities and their limits.

## Digital literacy is a prerequisite

The fast-paced and iterative nature of digital design translates directly to the fragmented, layered, and connected nature of born-digital architecture archives. The ease with which files can be multiplied and modified and the interdependencies between files and software makes individual digital objects difficult to appraise. Born-digital architecture archives require more technical skills and knowledge of both archivists and archive visitors. They are more fragile and susceptible to damage than we tend to think. Born-digital material can be damaged by simply being looked at and most of the times we won’t see the damage immediately. Digital tools are necessary for reading and interpreting digital information. Digital archivists cannot even determine whether we are looking at the same file without using a checksum, a unique number generated based on the composition of bits and bytes in a file. And even then, two identical files saved at two different moments (with a different time stamp) will have two different checksums, and would require using another tool to determine digitally whether we are dealing with an identical file.

Digital objects require different logic and skills for appraisal, preservation, and access than analogue material. This specialised knowledge is often referred to as digital literacy. ‘Paper-based drawings require both a technical and visual literacy to appreciate the math and engineering applied to the aesthetic intent of a drawing. This is further complicated with the transition to design software and a computer interface, requiring advanced digital visual literacy in both designers and potential future researchers. Digital visual literacy is the ability to interpret and communicate using a digital interface and visual content, which includes navigating interfaces and understanding the basic logic behind the relationship of commands and mouse clicks to digital drawing.’[[16]](#footnote-16) Next to that, as born-digital architecture records become entangled with media history, we observe a shift­ from an archival object (artefact, collection, archive, database), towards information, where different, previously not recognised elements of the archive, can provide a key to its understanding.[[17]](#footnote-17) In this sense, as Eric Kaltman notes, understanding born-digital archives requires knowledge of the software used within the design process, as well as being able to interpret the hermeneutics of data that constitutes the archive. In other words, both the software in which the born-digital objects were created, and the organisation of data within the archive become an area of study, which exceeds the traditional understanding of design or architecture research and brings it closer to areas of study within human sciences and media studies.

While this feature of born-digital records poses new challenges in relation to building digital literacy among archivists and researchers, it also makes the study of relationships between different elements within and across archives and collections technically possible. While the precise methods to explore those connections and make them visible are yet to be determined, born-digital archives can provide new insights into the design process by using methods such as data mining and visualisation, natural language processing, artificial intelligence, machine learning, or forensic analysis.

## Digital objects and software are intertwined

One of the big challenges of preserving born-digital architecture is how to deal with the need for preserving software and hardware along with it. This is challenging not only from a technical point of view but also because a common understanding regarding the need for it is lacking. It is often not clear internally whether collecting software and hardware is desirable, if so to what extent, and whether it has any meaning for the audiences used to dealing with analogue material. Is it possible to build engaging stories about architecture based on technical aspects such as software or computer code? Is it worth investing the time in saving obsolete computer software such as Adobe Flash, which revolutionised the look and feel of the internet by popularising the use of animation, or FormZ an intuitive programme used by architects for quick form studies, to provide access or migrate the files which were created in this software? And if so, how shall the collecting institutions represent such highly technical material to their visitors in ways that are meaningful?

After all, when answering the above questions, most collecting institutions are reluctant to take on a mission of becoming computer museums or sites of digital archaeology as part of their role. It is often too big of a task that exceeds their institutional capacity. Knowing institutional limits regarding digital preservation is also important for making other choices regarding born-digital records. It is important to know what type of digital objects form the collection, to articulate what parts of it are essential and why, and what software is needed for keeping those essential parts of the collection alive and accessible. The National Library of the Netherlands, the KB, defines such assessment as *kennisniveaus* (knowledge levels) and prefers it to approaches such as defining a preferred format policy. In their view, forming such requirements for institutions with no possibility of requiring donations in specific file formats, which is often the case for architecture and design archives, is not realistic. Rather than moving institutions closer to fulfilling their preservation goals, it moves them further away by creating an illusion of control.[[18]](#footnote-18) Digital officers of the KB state that knowing one’s institutional challenges related to preservation and access to digital collections and facing them leads to better understanding of the preservation possibilities, even if that may mean admitting what one is unable to do.

Next to the above-mentioned acceptable level of loss, institutions may need to define a desired level of satisfaction in terms of how much of the digital collections will be accessible to the public. It is an important consideration related to the use of software for representation and access, but it is also worth considering whether some software might be needed to migrate certain types of files, which is more related their long-term preservation. A similar type of consideration might apply to preserving executables. Most preservation policies advise removing them before ingesting. While often those files should be removed, in some cases they can offer interesting insights into the work of the creator. As mentioned by Eric Kaltman, they might contain old software that is invaluable to preserving legacy data, self-developed scripts, obscure plugins, or cracks. In the long term, access to such historical components might help practitioners better understand the records, or be important for another collecting institution somewhere else. Perhaps such instances should be assessed case by case rather than following a rule of thumb.

On a more systematic level, as noted by Aliza Leventhal, the digital preservation community cannot count on changes within the software industry. Coalitions such as LOTAR[[19]](#footnote-19), which are sometimes referred to as an important benchmark for bundling a coalition around the standardisation of CAD file formats, has merely five main players. The design industry is far more fragmented and less dependent on having future access to their own files. Investing in education and the development of digital literacy seem far more important for the design industry, enabling changes that will facilitate digital preservation in the future.

It is also important to note that, while the digital preservation community is currently mainly working with collections from the 90s and early 00s there are many more challenges to come, including preservation of time-based media, such as simulations and cloud-based and networked software such BIM or any other subscription software that is used by design practices nowadays.

# What collecting born-digital design means for institutions? The acquisition perspective

The use of digital design tools has led to a new design practice, where the traditional understanding of the drawing or the model can no longer apply. It also challenges collecting institutions to rethink the conventions of architectural scholarship such as authorship, originality, style, or period. Facing this change, both architectural historians and archivists need to re-evaluate the relevance of those terms for digital architecture collections and look for new terms that define this practice more accurately. The introduction of software and digital technologies into architectural design changed not only the nature of the design process but also the nature and structure of architecture archives, which in turn has consequences for both archival and research practices. According to Tom Avermaete, Professor of History and Theory of Urban Design at ETH Zürich, practices of design, research and archiving have a more lateral relationship with one another than they did in the past.[[20]](#footnote-20) Philosopher and writer Vilém Flusser describes this change as a part of a shift from what he termed “linear thinking” (based on writing) toward a new form of multidimensional, visual thinking embodied by digital culture.[[21]](#footnote-21)

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[Illustration 1: Diagram as presented by Tom Avermaete during a roundtable ‘The Tools of the Architect in the Archive’ at Het Nieuwe Instituut on the 23rd of November, 2017 redrawn by the author.]

## New and old approaches to acquisition

Collecting born-digital architecture is still experimental and institutions such as Het Nieuwe Instituut and Canadian Centre for Architecture (CCA) stand at the forefront of developments regarding collecting born-digital architecture. As noted by multiple speakers during the interviews, few institutions will ever collect on the level that Het Nieuwe Instituut or CCA do, but as more and more institutions are confronted with digital design archives, questions concerning what it means for collecting institutions to accept or actively acquire born-digital design will start to become more prevalent.

HNI and CCA seem to have a different approach when it comes to acquiring born-digital architecture archives, which allows for comparison. While Het Nieuwe Instituut collects extensive archives that afford insight into the design process on a broader scale, CCA takes a more curated approach by collecting and exhibiting pioneering projects of digital design in architecture. At the same time, both organisations show similarities in their mostly pro-active acquisition approach, focusing on collecting the avant-garde of digital design and, so far, leaving the non-innovative digital architecture largely outside the picture. A pro-active acquisition approach is often based on innovations in the field and focuses on identifying actors who played a crucial role in selected developments. It is a research-based approach that relies on work that precedes acquisition. Conversely, as noted by Ellen Smit, a passive acquisition approach based on donations, allows research to function as a secondary action. In this way, collecting is not based on presumptions and lets the material drive the discovery. Such an approach might be less biased and allow more insights into the craft of everyday practice rather than focus on the minority of the avant-garde.

Both of the above-mentioned approaches represent the so-called custodial approach to archiving. With growing sizes, scopes, and complexities of born-digital records, more and more archivists discuss the possibility of moving towards a so-called post-custodial approach. In his *Glossary of Archival and Records Terminology* Richard Pearce-Moses defines the post-custodial theory of archives as an approach where archivists no longer physically acquire and maintain records, but provide management oversight for records that will remain in the custody of the record creators.[[22]](#footnote-22) Post-custodial as well participatory approaches to archiving propose a shift from the definition of the custodian as an authority operating within an institutional context towards a mediator working closely with the community. Given the networked nature of the architectural practice, a fully post-custodial approach for born-digital architectural records might be very challenging for future access to those records, yet a conceptual shift in the institutional role of the custodian is certainly changing, along with the dynamic nature of the archives and the notions that would traditionally define them. Het Nieuwe Instituut’s projects such as *Architecture of Appropriation*, investigating the practical and ethical possibilities of documenting and archiving the squatting movement in the Netherlands, and *Collecting Otherwise* developing alternative methodologies for the acquisition, classification and distribution of heritage already engage with a form of post-custodial and participatory approach to archiving.

## Changing definition of the object

The digital realm in design makes it more challenging to define what constitutes an object in an archive or a collection. Firstly, there is a difference between the traditionally understood museum object and a digital information object. A digital information object is a unique composition of bit sequences (zeroes and ones), which can be rendered on the screen by an adequate computer software. It cannot be viewed, interpreted, or exhibited without the software. This means that acquisition requires more time as well as technical skills and equipment to view and appraise the digital files, while some of them might be impossible to render, yet still be valuable for acquisition. The uncertainty of the archive's content, the impossibility of comparing and assessing every single file, translates into uncertainty regarding whether these objects are valuable and whether they will ever become accessible to the public. In other words, as noted by Corrina Gardner and Nathalie Kane, in collecting born-digital design there is no guarantee of display.

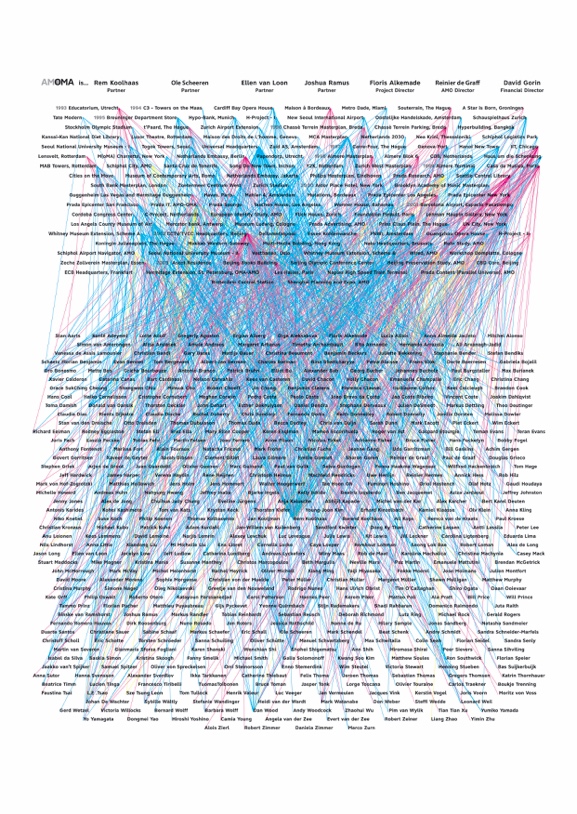
Secondly, the digital design process is more fragmented and iterative than its hand-crafted counterpart. Many digital records are composed of files that are bits and pieces of one process and are intrinsically connected and layered. Records can contain multiple drawings (sometimes embedded into one another via external paths such as xrefs in AutoCAD), elements of drawings (such as blocks), renderings (including background images, filters, light settings, and textures), diagrams and the like. All these information objects stand in relationship to one another. Many of them were not created as a form of presentation but show the so-called work in progress. In such a fragmented and layered design record it is difficult to draw a line where an object begins and ends. Is an object a single layer, a file, a file folder, a project file folder, or a collection of files and folders? When we look at a CAD drawing with lots of layers, some of which are hidden, what constitutes the drawing? Is the drawing composed of the visible layers as last saved in the file, or is it merely the last saved version of the drawing? In digital design it is often a composition of information objects and the relations between them that can tell us more than a single object. If so, can we, and should an archive be defined through objects, and in what way would that still be relevant? Can we say what objects we have in the collection, or would we rather speak of content types, relationships, processes, and software dependencies?

An interesting example to illustrate such shifts, is the process that the Victoria and Albert Museum went through to collect a popular Chinese platform WeChat. To acquire it, they needed to answer the question: ‘What is WeChat?’[[23]](#footnote-23) In their view, the way such a digital object is defined has a direct influence on the acquisition. Would collecting a social media platform mean collecting its code base or the content created by the community using the platform? Should it be collected throughout its entire lifespan or in a specific moment in time? Could a public institution collect the private information of individual users without their consent? Those and other questions helped the V&A to define what the object was in the case of WeChat. But ultimately every acquisition presents a similar set of challenges and questions, which will probably be different every time. The V&A is a museum, which allows it to be more selective in what and how to collect. This reflects an important distinction between a museum and an archival approach to collecting, but the question of the definition of an object in a collection and where its boundaries are, remain similar for both.

The contextual information of the digital object becomes even more important when we focus on questions such as why did an architect create a certain file? What did they want to achieve? What new insights does digital design provide us with for the design process, and does it mean that acquiring large, unstructured architecture archives and dealing with their challenges later might offer more opportunities for future research on the design process than acquiring carefully selected digital objects?

## Changing definition of authorship

The so-called signature has been a mark of originality for hand-drawn architectural drawings both in the literal sense, as the drawings were often signed, and metaphorically, when it could be referred to as an individual drawing style. Even though, to the outside world, architectural practice is still very much focused on the role of the architect as a visionary individual, the actual practice has long been highly collective with a hierarchy flatter than before and offices often functioning as a group of sub-offices (often managed by the partners) and operating under the same brand. In fact, many of the leading architects never or rarely worked digitally as the digital transition caught them mid-career. They preferred to hire young, digitally skilled architects and instruct them to perform computer interactions leading to particular designs and choose the results according to their liking. In the digital drawing the signature is hidden unless we apply digital forensic techniques to research who was involved in the drawing process, for instance based on software licence or system log-ins. Because of the collective nature of the digital architectural drawing, it is difficult to assign authorship to a particular person within the design studio. Many architecture practices did not keep records of who worked on specific projects or tasks. As noted by Georg Vrachliotis, Professor of Theory of Architecture and Digital Culture at the TU Delft, in the digital drawing there is also little to indicate mistakes or imperfections (such as the trembling of the hand, erasure, or hesitation), which could more easily be seen on paper. A way to track back individual contributions could be very challenging, tenuous, and require a lot of technical knowledge. It forces us to think of the creative process in a different socio-technical way, less focused on the vision of a single individual, and more on a complex, digitally enabled collaboration of a collective.



[Illustration 2: A network diagram showing AMO OMA’s management structure, projects between 1993-2003, collaborators, and different relations between them, published in *Content*, Taschen, 2004. Image courtesy OMA.]

What are the new narratives and perspectives offered by such collective digital drawing? Can we see them with the human eye or is a collaboration between the human and the machine indispensable to revealing them? Forensics offer great opportunities for discovering these new perspectives but using forensic tools will always be a highly specialised and technical process. Could collecting institutions facilitate making forensics more available to a larger group of interested enthusiasts within their participatory archival practices? Could the hidden beauty of those technical objects be made more visible during the acquisition process or is acquisition of the born-digital bound to remain at least to some extent ‘blind’?

## Institutional challenges

According to Aliza Leventhal, the idiosyncratic nature of architectural design is both fascinating and frustrating for collecting institutions. One of the major challenges seems to lie in creating a shared understanding between the archive creators and keepers regarding terminology, sense of order, and sensitivity to the fleeting nature of the digital heritage. When it comes to terminology, she notes it is important to build a shared language around preservation issues that can be understood by both sides, designers, and archivists. Currently, it’s very likely that each will understand a term such as ‘file migration’ very differently. There is also a need to build understanding about how architectural archives are constructed and which design processes underly an often-unstructured file system with countless creative ideas for file naming, that tend to lack a system within the same office. It is rather unlikely to expect that offices will standardise their workflows to such an extent that the archive structure and file names will be problem-free for archivists. Archivists can make use of educational material, such as training reels, that help understand internal design processes, and conduct donor interviews, but ultimately it is a learning curve that requires engagement on both sides. While the collecting institutions can expect that the standards won’t change dramatically, they can advocate for design practices to be more mindful of preservation issues. For the time being, it seems that donor interviews (such as the one used by CCA) and recording archive flythroughs, including examples of software use during acquisition, will be essential parts of the archival process of the born-digital collections.

Collecting born-digital archives with such supporting material can play a key role in documenting the digital design process for future generations, but how to appraise and select the archives poses another challenge. Which responsibilities does a collecting institution have regarding preserving born-digital archives? Do institutions need to develop new ways of collecting, preserving, and providing access to born-digital archives? Answering those questions requires institutional innovation. There are few institutions that combine collecting paper as well as born-digital archives and are looking into the possibilities of working with design software within the archival practice. Engaging with born-digital design archives introduces new challenges in the institutional role of the collector. It may have an influence on developing policies to define new ways of collecting and preserving, or on developing new institutional boundaries of what lies beyond the scope of responsibilities of a given organisation. Corrina Gardner and Natalie Kane note that it is not clear whether defining specific acquisition policy for the digital collection is always desirable. The V&A’s current collection policy remains open enough to allow for such acquisitions. While policies should allow for flexibility, institutions ought to monitor and evaluate the direction in which acquisitions are going and be ready to reshape collecting guidelines and requirements periodically.

# What can we learn from born-digital collections? New perspectives on use and access

The questions of accessibility are perhaps most interesting when it comes to born-digital architecture and design archives. In museums such as the V&A, the guarantee of display has always been a fundamentally important aspect regarding collecting. The prerequisite for making a commitment to an object was the guarantee of its publicness. With the digital design, such a guarantee is impossible and, if it were a main prerequisite for collecting, acquiring digital collections at all would be unworkable. Acquiring born-digital design institutions need to think differently about what justifies digital acquisitions beyond the guarantee of publicness. While defining the importance of each element in a digital collection is already challenging, providing access to this material demands even more new approaches, and at the same time opens many new possibilities.

## Make machines allies

“In the future we might rely even more on technology to sort and select, using search engines to make sense of the avalanche of information bequeathed to us.”[[24]](#footnote-24) Artificial intelligence (AI) can not only offer new possibilities for discovery and access to born-digital architecture archives, but may be an indispensable tool to manage the scope of born-digital archives. However, as indicated by designer and programmer Richard Vijgen, while AI offers interesting possibilities, it is never free of bias. Vijgen notes that while for a computer scientist, it comes as no surprise that the training model determines what an AI can recognise, this might not be clear to a regular archive or exhibition visitor. In addition, the more user-friendly the AI interface is, the more obscured the logics of the algorithm will be.[[25]](#footnote-25) That might not only place the user in a passive role, but also create wrong impressions concerning the role of the software. Turning it from a facilitator to an interpreter with a significantly large risk of making mistakes. Working with computer technologies is never neutral, and collecting institutions will always have to keep in mind which perspectives are made possible by using technologies such as AI, and which are obscured.

According to Georg Vrachliotis, the question is not whether we are going to use AI to discover architecture archives, the question is how are we going to do this, and how to do it ethically? Currently, it seems that research around AI has revealed many aspects that advise precaution. Therefore, we seem to know more about what not to do with AI than what we can or should do with it. Hence, it is crucial to investigate positive examples of AI use for born-digital collections that can counterbalance the negative side of it more fully. Professor Vrachliotis' research focuses on using AI and computer vision to annotate digital files, which could offer interesting possibilities of, for instance, enriching the metadata of digital records to make them more easily discoverable. Each file within an archive contains technical metadata about its properties (such as size, file type, creation date) and the descriptive metadata added by archivists to supplement the available information with information about the origin, content of a file or the collection it belongs to. A lot of information that might allow digital archivists and researchers to establish a better understanding of architectural archival records and make new data-based connections between collections or their parts, is already there. We only need to learn how to use the available tools to make the discovery of born-digital architecture archives consisting of ‘messy production data’ more accessible to humans.

## New narratives about human-machine interactions

With the rise of digital design tools, architecture and media history become more and more intertwined. The relevance of born-digital architecture archives as data and their role for media studies is still new, but we are bound to see more research that relies on those records. This new type of research might be more connected to the humanities and might not only focus on using computational methods to understand architectural drawings, but also on other aspects such as forms of collaboration between human and machine, or the history of design software development and its use. It is likely to expand the range of questions we will be able to ask about architectural collections. Also, within other disciplines such as game studies, there are interesting developments relevant for research with born-digital architecture. Eric Kaltman’s research on interaction in games investigates the possibilities of citing interactive software experiences in a scholarly context. Asking a question regarding how to quote software use or specific human-machine interactions in an academic context, makes us rethink frameworks for the dissemination of scholarship. If we consider its applicability to architecture, one could imagine inquiries into the use of specific commands to study how an architectural drawing was or is created. This could, for example, provide new ways to understand layered digital drawings or provide instructions on how to study them.

## New perspectives for history of architecture

Looking at stylistic developments within digital architecture, we can clearly see that some of them were enabled by the introduction of computer aided design, but there are also developments that have nothing to do with that. There is no clear line of architecture before and after the computer. The role computation has played in architectural history is still a very new topic that is relatively rarely discussed and researched. A barrier to that is to a large extent the highly specific and technical character of such studies, and it is often unclear how we can get historical information out of digital artifacts. At the same time, there is no doubt that software and digital technologies played an important role in organising labour and communication. According to Daniel Cardoso Llach, to understand the evolution of architecture, labour, and the digital protocols through which the built environment is shaped, we need to look at software and hardware history, and their use as a part of architectural history. It might be too early to understand the long-term influence of digital design, but without understanding this part of history we won’t be able to see the full picture. In the same way that an architectural historian can tell the period in which a drawing was made and possibly even recognise its author, those who understand different software packages can tell which software was used to design a given building. This is a new angle that has not yet been fully discovered. Even the subjects of study are still in formation, and they are only addressed by a small group of researchers. It is a challenge for collecting institutions to understand what and how to collect about those developments, and to find ways to connect their collecting and research initiatives with those taking place outside of their own institution.

## Engaging users and embracing context

Many collecting institutions ask how they can bring digital archives to the attention of audiences that are not native to digital design. What can be done to help them understand digital objects and their context in ways that are engaging and not too technical?

In 2019, the Dutch Digital Heritage Network researched the behaviour of cultural heritage users. Based on this research it defined the following profiles based on what the users were looking for in collections: direct information about the collection (51%), research and discovery (54%), intense experience (59%), creating with objects (13%), creating with datasets (4%), creating with a community (8%), learning (5%), and gaming (5%). The researchers also asked the survey participants to indicate which of the other behaviours interested them. In this latter part, about a quarter expressed an interest in learning and creating with objects more, about fifteen percent was interested in creating with datasets, creating with a community, and in gaming. It seems that, when looking to engage heritage users with digital collections, those types of use have a larger potential than is currently exploited.

Because digital-born architecture collections lend themselves to different types of research that range from highly technical research for digital design natives and architecture historians, to interested laymen, data scientists, media researchers, and artists, we can expect to see different levels of digital literacy and different ways to adapt to the needs of users. They will include more technical approaches and more visual ones and have an influence on the different access methods that Het Nieuwe Instituut can offer in the future.

In the digital preservation community, there is a lot of discussion and research about the differences that users might experience while accessing born-digital archives through software viewers and emulation. Some of those challenges were described in the report of Henk Vanstappen *EaaS as a preservation strategy for Het Nieuwe Instituut*.[[26]](#footnote-26) Emulation brings users closer to the software as a primary source, but it can also present a barrier of literacy. It is therefore important to distinguish what type of access is sufficient or best suited for different purposes and different users. As the design process is structured through the interface, the most effective way to provide access to historical design files would be through the very same interfaces in which they were created. Yet for example, for users conducting visually driven artistic research the added layer of the original interface might not be as important as to those interested in researching the architectural design or the design process. While emulation is considered an important method that creates an opportunity for people to interact with technology in its historical context, it will only be valuable for those users who will be able to see the differences between the different software versions.[[27]](#footnote-27)

That is not to say that emulation can only be valuable for digitally native researchers. There are interesting examples of showing digital environments, which allow contemporary computer users to learn about the past. Between 2017 and 2019, the Andy Warhol Museum displayed *Warhol and the Amiga*. The show included a reconstruction of Andy Warhol’s Amiga 1000, which the artist used to create a portrait in ProPaint.[[28]](#footnote-28) The reconstruction was made based on the original objects found in the museum’s archives. This kind of exhibition allows visitors to experience what it meant to create a digital drawing in the mid-80s, giving many visitors the first opportunity to experience such insights. The records of Carel Weeber, created on an Atari from the digital collection of Het Nieuwe Instituut, offer similar potential.

Reconstruction work of this kind is user-friendly and provides an experience that cannot be captured in writing or through a static image. Such exhibition efforts can also be a great way to expand digital literacy in design software and encourage new audiences to engage with the collection. The overall experience of experts working with digital design collections is, that making the collection visible attracts people to work with it.

One cannot predict all types of use and ideas that people will come up with, but not knowing what people will envision, is also a part of the beauty of the role of the archivist, says Aliza Leventhal. The archivist always does everything in their power to help a visitor find what they need. Among those visitors will be digitally native ‘super-users’ and many other visitors who will require more assistance to understand the digital records. Interestingly, it is important to note that this does not seem to be a merely generational issue. While younger users are more fluent in using current digital technologies, they do not have the same abilities to use older systems, which were less intuitive and user-friendly than those we have now.

## New experiences

Allowing people to interact with the (historical) digital design environments has great potential to help understand them. What new possibilities of presentation and access are there? As already mentioned, reconstructions of influential software in a playful and agile way can be a powerful means to create access. As in the case of the interactive reconstruction of Ivan Sutherland’s Sketchpad by Daniel Cardoso Llach[[29]](#footnote-29), which provides access to the logics and regimes of the programme. Looking at the context of Het Nieuwe Instituut’s own collection, similar approximations of MVRDV’s software experiments could provide an engaging way to understand the design principles of the studio. It could, for example, allow the visitors to reimagine their environment with the help of data-based design. Direct engagement with software creates room to embrace the tactility of the digital tools and how they condition the work of design, even if this might still be a controversial topic for some architects. It also has great value for students to bring them into contact with the history of what they are doing. What were the constraints of digital design at the time, and what are they now?

Naturally, experiencing born-digital architecture can also be done in many other ways including VR, using augmented reality software to show never-realised competition entries in the current context, allowing visitors to create their own versions of buildings, re-mixing archive material, or making their own artist impressions. These are but a few examples to indicate a vast range of possibilities.

## Living archives

Sampling and remixing have always been a part of digital culture. The ease with which digital objects can be manipulated or placed in a different context presents endless possibilities for creative use and re-use of born-digital collections. However, this kind of creative use can also be legally problematic. In contrast with the faster acquisition process described earlier the archival material that ends up in collections such as the one at Het Nieuwe Instituut is often part of an oeuvre of still practicing architects, who make use of those files themselves. How to treat an archive which is still growing and evolving and at the same time make it accessible for creative re-use without violating copyrights is a complex question that goes beyond the scope of this research. However, it is important to note that it places the collecting institution and the donor in a more dynamic relationship. This relationship is often referred to as the ‘living archive’. Living archives refer to “practices and environments that connect organisation, curation and transmission of memory with present-bound creative, performative, and participatory processes”.[[30]](#footnote-30) As in the case of the exhibition *MVRDVHNI: The Living Archive of a Studio* what does it mean to present an archive of a still practicing firm to a board audience? What insights does it provide in their work methods? Are the same levels of interpretation and criticism possible when an exhibition becomes a part of the relationship between the creator and the keeper?

Next to that, there is another dimension of the living archives that is important. It is their more participatory and democratic dimension, which aligns well with experiments already conducted by Het Nieuwe Instituut within research projects such as *Collecting Otherwise* or *Architecture of Appropriation*. How can this approach to archiving be helpful in defining ways in which collections can be more diverse and open? How can they allow new voices from the architectural practice and beyond? While creating novel born-digital stories, could we imagine giving more attention to the role of women, racial and cultural minorities, or interns and ‘CAD monkeys’ in architectural practices as opposed to the stereotype of a white male visionary architect? Perhaps born-digital archives can function as one of the keys that could reveal a more multivocal character of the architectural practice and better understand it’s human and more-than human character.

# New stories – six examples

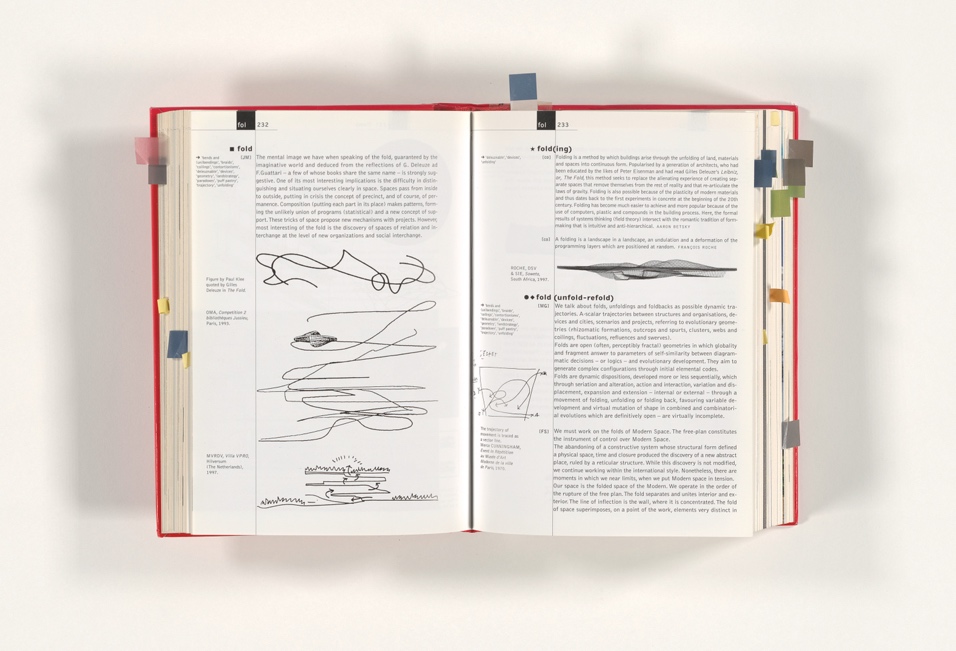
## Three stories about the digitisation of design practice

In about four decades, computers and other digital tools changed the architectural practice in a significant way–technically, but also conceptually. Currently it is not only the creation and documentation of an architectural object that takes place digitally, but more commonly the entire design process becomes digitised, including the fabrication of building components or entire structures.[[31]](#footnote-31) Digitisation has made the architectural design process faster, more complex, democratic, fragmented, dispersed, and difficult to archive.[[32]](#footnote-32) The influence of digital tools on architecture is often associated with new formal languages that they enabled. Undoubtedly, it’s an important part of the history of architecture, but it is also noteworthy that beyond enabling novel geometries with 3D modelling software, digital technologies had other far-reaching consequences for the way architectural offices have worked, grown and internationalised, which are discussed far more rarely.

Below I describe some of these changes as proposals for stories about digital architectural design, which could be told anew through the exploration of born-digital architecture archives. The first three stories relate to the changes in design process, thinking about architecture, and office culture. The following three tie directly to the use of specific digital tools. An in-depth study of the topics described below reaches beyond the scope of this preliminary research and would require further investigation to determine specific case studies and further research.

### The pioneers of instability and flux

The emergence of CAD allowed architects to realise architectures that previously remained in the realm of so-called ‘paper architecture’, exemplified by the works of visionaries such as Frederick Kiesler (1890-1965), Cedric Price (1934-2003), or Lebbeus Woods (1940-2012). Before, such designs either geometrically or conceptually exceeded technological possibilities available at the time. New formal and philosophical considerations related to the fluidity of form and mobility of architecture inspired many architects. Throughout the 90s and 00s we saw the emergence of the so-called blobs[[33]](#footnote-33) associated with the fluid form of the building’s envelope, and the folds associated with the influence of the writings of Gilles Deleuze and Felix Guattari[[34]](#footnote-34) and growing interest in spatial flows and continuous tectonics. As described by Greg Lynn in *The Metapolis Dictionary of Advanced Architecture,* one of the most interesting implications of the fold as described by Deleuze & Guattari is “…the difficulty of distinguishing and situating ourselves clearly in space. Spaces pass from inside to outside, putting in crisis the concept of precinct, and of course, of permanence.”[[35]](#footnote-35) In the Netherlands the latter was especially visible in the early work of UNStudio such as the Möbius House (1993-98), and MVRDV’s first realisation Villa VPRO (1997), or OMA’s unrealised competition project for Jussieu Library (1992), or built examples such as Educatorium (1992-1995) and Kunsthal (1987-1992). Next to those formal and philosophical explorations we have seen the rise in the use of audio-visual media, movement and interactivity in architecture exemplified by projects such as Muscle NSA by ONL (Kas Oosterhuis, Ilona Lénárd, 2003-04) or H2O expo by NOX (Lars Spuybroek, 1997). Both belong to some of the first practices that used computers as a design tool to realise their architectural ambitions and anticipated the way this technology could be used, before it was available to all.[[36]](#footnote-36) In parallel, notions of Liquid Architecture and transArchitecture, both coined by American architect and artist Marcos Novak, were strongly related to first digital explorations in architecture. Liquid architecture focused on exploring spatial aspects in cyber space–beyond the physical reality of architectural practice. Those ideas strongly resonated with architects in the Netherlands. In 1998, The Netherlands Architecture Institute (NAi), the predecessor of Het Nieuwe Instituut, organised an exhibition titled *Transarchitectures* and a conference during the DEAF98 festival[[37]](#footnote-37); in 2002, NAi publishers brought out a book titled *Trans-Urbanism* with contributions by, among others, Rem Koolhaas and Lars Spuybroek.[[38]](#footnote-38) This part of architectural history was extensively discussed as it happened, but it was not thoroughly studied later in relation to its technological context, which might offer new perspectives now. The Dutch architecture community can boast of many pioneering practitioners and realisations exploring new formal languages, philosophies, and media. Currently, information on events and discourses relevant for these aspects can be found predominantly in the archive of V2\_Lab for the Unstable Media in Rotterdam.[[39]](#footnote-39) Beyond individual archives of the creators, important archives, related to exhibitions and events, are likely to be held by the Berlage Institute and Het Nieuwe Instituut, but they are not publicly available.



[Illustration 3: Term ‘fold’ as published in *Metapolis Dictionary of Advanced Architecture* accompanied by drawing by Paul Klee referenced by Deleuze and Guattari, OMA’a diagram for the Jussieu Library competition and MVRDV’s Villa VPRO diagram, all showing reinterpretations of the Deleuzian fold in Dutch architecture.]

### Data as the new form

Developments around data-based architecture have become another important shift in how digital software was first used in architecture. MVRDV’s early experiments with software have possibly had one of the largest impacts on the architectural discourse in the Netherlands in that respect. *FARMAX: Excursions on Density*, published in 2006, describes several early experiments including a less well-known software prototype Castle Maker (Ronald Wall and Rafael Siedle, 1995). Castle Maker was a tool to generate optimised buildings within the constraints of light and programme.[[40]](#footnote-40) In KM3, MVRDV published experiments with more well-known software prototypes such as the Climatiser (2003) and the OptiMixer (cThrough, around 2003).[[41]](#footnote-41) Next to those, in various collaborations, MVRDV developed the FunctionMixer (cThrough, 2001-2003), Regionmaker (2004)[[42]](#footnote-42), and Spacefighter (cThrough, 2006)[[43]](#footnote-43). Some of those were actual digital tools and some only conceptual prototypes. Whether working or not, these experiments, along with their 1999 project MetaCity Datatown, were at the core of the development of the so-called datascapes or data-based architecture and urbanism. In *Metapolis Dictionary of Advanced Architecture* Winy Maas explains that ‘…under maximised circumstances, every demand, rule or logic is manifested in pure and unexpected forms that go beyond artistic intuition or known geometry and replace it with “research”. Form becomes the result of such an extrapolation or assumption as ‘datascape’ of the demands behind it.’ According to Maria López Calleja and Rory Stott early datascape designs of MVRDV may be seen as the precursor to today’s more and more commonly used Building Information Modelling (BIM), which as they describe it ‘helps designers to harness data in order to enrich human experience.’[[44]](#footnote-44)

Diagram

Description automatically generated with medium confidence

[Illustration 4: MetaCity Datatown, MVRDV 1999, Collection Het Nieuwe Instituut, archive Metacity / Datatown MVRVTP087. Image courtesy MVRDV.]

Dutch architects rank among the pioneers of digital architecture and their explorations around form, interactivity, data, and media in architecture certainly belong to the world’s avant-garde of the time. Collecting designs from this strand of architectural history can be fascinating but also challenging due to their experimental nature. It may require engaging in software archaeology or reconstruction, and investigations close to those performed by institutions such as Amsterdam-based platform for media art LIMA or CCA during their *Archaeology of the Digital* project. Both legacy software and hardware play an important role in understanding the methods used to write the software that made those experiments possible, as well as understanding projects where such experimental tools were applied.

### From a master to a digital swarm

In 2017, during the research project *Between Creators and Keepers* conducted on behalf of Het Nieuwe Instituut, six Dutch architecture, urban and landscape architecture offices were interviewed on how digitisation has influenced their practice. Many of them reported that the use of digital tools led to speeding up the design process, allowed them to carry out more complex tasks, and made the design process more iterative. As more activities could be conducted in parallel, the design process became more non-linear. The designers could implement adjustments instantly and easily test numerous options, which resulted in the creation of multiple versions of one drawing or model and allowed numerous iterations of those versions in the search for the best possible design. This work, digital, analogue, or hybrid, has often been conducted to fulfil not only aesthetic needs and cater for programmatic solutions, but was often informed by specific parameters, be it the volume of the building envelope, exposure to daylight or something else.[[45]](#footnote-45) The aspect of iterative work and learning by doing became very important in the development of so-called design intelligence, which was extensively discussed in the context of Dutch architecture of the beginning of the 21st century by American architecture critic Michael Speaks.[[46]](#footnote-46) The production of numerous versions of imperfect, adaptable designs, created in a so-called ‘quick and dirty’ way, became a signature design method of many Dutch offices with OMA in the lead.

The number of versions in the individual archives of architecture offices tends to be overwhelming and very difficult to appraise by the human eye, which presents a serious challenge for their preservation. The iteration takes place not only within one project, but also between different projects. The process of recycling ideas became a strategy for survival in the fast-paced new normal of architectural design. See, for instance, OMA’s project for Casa di Musica in Porto, which is a re-use of an earlier design for the house of Fleur Groenendijk. MVRDV goes as far as systematising its own recycling methodology in the book *Copy Paste*, published in 2017. This method of recycling ideas raises interesting questions for the notion of the original and its role in the acquisition process. What can be considered original in the realm of born-digital architecture? How shall we assess the value of the numerous versions? Does the relevance of iterations in the design process call for other forms of research and assessment of their value? And what does it mean for the collecting institutions? Should they become more selective in how they acquire to avoid problems with non-accessible legacy files and numerous duplicates? Or, conversely, less selective to provide more insights into the discovery of the design process itself. The answers to those questions will differ per institution and will depend on their mandate and mission.

Another important aspect of working digitally was that it allowed for a more collaborative design process. Besides a more democratic design process at the studio, it also led to the emergence of new forms of collaboration such as Design–Build (D-B), co-design, and other forms of collaboration. Architects began to work more frequently with many different project partners in different project phases. That had an influence on both the role and the responsibility of the architect, but also on the role of the personal signature. Paradoxically, with the rise of the so-called starchitect, the role of the single individual in the design process becomes less visible. This poses many interesting questions regarding the understanding of authorship and the notion of the signature, which are key in the traditionally understood appraisal of architecture collections.

Thanks to digitisation and the subsequent globalisation of the architectural practice, offices began to work more internationally as they were able to work on multiple large projects at the same time. The development of communication technologies allowed them to operate simultaneously in different places across the globe. OMA opened their first office in New York in 2001, not long after their Beijing office opened for the construction of CCTV, and in 2009 an OMA office opened in Hong Kong. Many other Dutch offices followed suit to set up offices in other countries all over the world. This may be seen as the emergence of the networked office, an office that functions as a dynamic set of networked relations rather than as a team that aims to combine necessary competencies in-house.

Another development related to the internationalising and globalising architecture practice is the changing role of the internship and the emergence of the so-called CAD monkey position. Internships at renowned offices became a necessity for young, ambitious architects. Those young practitioners and students were entering big offices not as much to learn how to design as to deploy their digital design skills. This practice has become a broadly criticised form of exploitation, but also a way of spreading the office’s DNA all over the world. The dispersal of the architecture studio took place not only within their own organisational structure, but also through the fast circulation of young talent, who would continue to develop their work methods and design philosophies, as well as perpetuate their work culture and ethics. The position of intern is by no means new, but the amount and turnover of interns at architecture offices from the 1990s on gained a different dimension. The phenomenon was deftly captured in *Baby Rems*, an article published by Metropolis Magazine in 2011, which referred to the 'Rem effect', and depicted the first and second generation of well-known architects who began their careers at OMA.[[47]](#footnote-47) By now this genealogical tree is much larger.  
  
The perception of an architectural practice as one organised around a master is very misleading, and interestingly, born-digital records can provide more insight into the democratisation processes that occurred within the architecture profession in the last decades. Would it be possible to visualise how many designers and other professionals worked for offices such as OMA or MVRDV over the years? Perhaps such a perspective could offer new, fairer ways to look at the current practice and the role of the (st)architect as a digitally enabled globally dispersed collective rather than a visionary individual.

Diagram

Description automatically generated

[Illustration 5: Baby Rems infographic showing two generations of ‘OMA’s offspring’. The diagram accompanied an article with the same title by Paul Makovsky published by Metropolis Magazine in 2011.]

## Three stories about the use of digital tools

Between 1975 and 1977 at MIT’s School of Architecture and Planning, Architecture Machine Group led by Leon Grossier and Nicolas Negroponte worked on developing the first ideas about architecture software. The computer they envisioned would be architect’s equal partner. It was meant to listen, talk, and even worry about design problems.[[48]](#footnote-48) Their dream never came true. Instead of this ideal software, many architects had to work with what was available. They used software originating in aerospace engineering (CATIA, CADAM), automotive design, general engineering (Autodesk AutoCAD) and the film industries (MAGI, Maya) and slowly adapted them to their needs. The 2017 research *Between Creators and Keepers* has shown that Dutch architecture firms use a vast diversity of software, and they have also done so in the past. While AutoCAD is the dominant programme used for drafting and it is (and was) used by most of the interviewed offices the firms always have used other software next to it.[[49]](#footnote-49)

In *Between the Creators and Keepers*, I described three major levels of influence and four different categories of tools used by the interviewed architecture firms. The levels of influence describe different ways in which design practices have embraced the digitisation of the design process. I distinguish between the digitisation of the design (exemplified by the use of drafting CAD software), the digitisation of the design process (exemplified by complex design process management and the use of software such as BIM) and the digitisation of fabrication processes (that involves parametric design combined with rapid prototyping and digital fabrication). The tools I described were categorised into drafting 2D and 3D software, visualisation software, graphic design (raster and vector) software, and office management software. However helpful, these categorisations are ambivalent and can be described differently.

In the book *The Architecture Machine. The Role of Computers in Architecture*[[50]](#footnote-50) the authors describe four major roles that the computer has played in design: drawing machine, computer-aided design tool, medium for storytelling, interactive platform.[[51]](#footnote-51) To define them the authors state that the drawing machine has helped architects perform tiresome and repetitive drawing and calculating tasks. The role of computer-aided design focuses on the assistance of software in architectural explorations of new geometries. Storytelling focuses on digital forms of representation such as rendering and animation. And the interactive platform focuses on the potentials of interaction and democratisation enabled by developments such as VR and web 2.0.

While the distinctions used by Fankhänel and Lapik differ from those defined in my earlier research there is a significant overlap in the general logic and observations that can be made based on those distinctions. There is one important difference, however, which I would like to note. While *Between Creators and Keepers* analysed the changes in the use of visualisation and animation software by architects it did not distinguish this aspect as a separate part of the design process, but as inherent to it. However, it is worth noting that forms of representation in architecture have gone through several transformations. Some of them have been further highlighted in this research report as a potential study case.

Below I describe the three stories that emerged from the conversations conducted within this research project and that could help understand digital architecture based on interactions between the architect and the computer.

### Reproduction and iteration as core of the design practice

In the research paper on applyingrecycling principles in design and architecture practice (*Invented from Copies*)[[52]](#footnote-52) Het Nieuwe Instituut’s Curator of Collections Ellen Smit stresses the growing importance of exploring not only what architects designed, but how they did it. In her research, she studies how architects, who did not have access to digital tools, developed design-oriented reproduction techniques with a logic that is closer to the digital design processes developed later than to the traditionally understood architectural craft. According to Smit architectural history knows very little about the ways in which architects worked with reproduction techniques and how they invented new ones*.* How architects used analogue and digital techniques of reproduction, repetition, and iteration becomes an interesting research question that spans the realms of analogue, born-digital and hybrid archives. There is a fascinating relationship between the early adopters of digital design and those who thought digitally and worked in an analogue way. *Between Creators and Keepers* has shown that the opposite was also true. Not all architects who used digital tools did so with a digital mindset. Some directly translated their analogue design processes to the digital realm and used analogue logic in a digital environment.

Diagram

Description automatically generated

[Illustration 6: In this composite visualization of De Flint theatre, industrial techniques have almost entirely replaced the drawing (ca. 1975). The document consists of glued-on and hand-drawn interior designs on tracing paper cut from an earlier drawing. We also see self-adhesive colored plastic films and heat-resistant rub-down lettering from a Letraset in Helvetica Medium font. This visualization is to be considered as an analogue ‘masterfile’: it has been made for reproduction and appears in this dossier in smaller variants and varying contexts. Collection Het Nieuwe Instituut, archive O. Greiner, GREO85203t2]

With the rise of digital tools, many architects started to experiment by mixing analogue and digital forms of iteration such as printing floorplans and assembling them as models, for example to study circulation flows within a building as seen below in the photograph of a sketch model of the Jussieu Library (1992), by OMA. Quick mass studies combining digital sketches in CAD and physical sketches in blue foam are another example. Another similar such quick design method was based on photographing a blue foam sketch model, printing it out and sketching changes onto it by hand. This quick way of versioning is characteristic of OMA’s way of working, which has also been adopted by many other Dutch offices, including MVRDV.

A model of a building

Description automatically generated with low confidence

[Illustration 7: Office for Metropolitan Architecture (OMA). Jussieu Library, design model, 1992. Collection Het Nieuwe Instituut/ MAQV, 912.12. Model from a series of thirty-three design models in a wooden box. The models were made to develop the Jussieu library plan and they demonstrate how the various floors are linked together like a ‘boulevard’. All models were made at a scale of 1:500.]

With its design-by-doing methodology OMA cut itself off from the traditional image of a visionary architect who creates perfect designs instantly. Their design process becomes driven by the endless reproduction and testing of versions. The difference between the realm of instantly perfect ideas and the realm of tirelessly searching for options was eloquently expressed by Fenna Haakma Wagenaar in *Content*. While describing the collaboration between OMA and Herzog & de Mueron, she said: “Rem accepts no assumptions. […] Jacques needs instant perfection”.[[53]](#footnote-53) This sea of blue foam becomes a signature of Dutch architecture, well represented by the Dutch Pavilion at the Venice Architecture Biennale in 2010 with an exhibition titled Vacant NL. Although the exhibition presents the volumetric blue foam models in a different context, as a plea to design less and make more use of the existing vacant buildings, of which the Netherlands had an abundance back then, the image of endless, simple, blue volumes could well be an image from almost any Dutch architecture office at the time.

Rows of blue chairs in a room

Description automatically generated with low confidence

[Illustration 8: Vacant NL, installation by RAAAF presented at the Dutch Pavilion during Venice Architecture Biennale 2010. Photo by Rob ‘t Hart. Image courtesy RAAAF.

Naturally, the blue foam phenomenon, however important, is only a part of the broader development related to iteration and versioning, which has a strong connection to the digitisation of design. What role does repetition play within the design process and the development of design practice over time, and where is the line between the copy and the original? Those questions around the appraisal of versions and the possible methods of understanding their value and meaning for the history of architecture remain open and worth exploring.

### The software is an architect

The digital tools led to the creation of new architectural forms and fuelled new design methodologies, but to what extent do the tools themselves determine the outcome of the design? What is leading: the vision of the designer or the capabilities of the software?

New media theorist Lev Manovich goes so far as to propose that software as a digital medium may have eclipsed the message. As he describes, current film editing software, for example, has capacities that surpass the output of the avant-garde auteurs. Film software such as Apple’s Final Cut Pro or Adobe’s After Effects is not only able to combine thousands of separate tracks into a single movie, but also set various relationships between them, develop an idea of a film as an abstract visual score to its logical end, and beyond.[[54]](#footnote-54) Observations posed by Manovich in relation to film are certainly equally relevant to architecture, especially when it comes to parametric design software. To what extent has CAD software determined digital architectural design as an enabler and as a limiter? Does the catalogue of tools that architects use shape the way they design, and if so, how? Can born-digital archives provide insights into those questions and reflect on the development of the architect’s digital workstation and its output?

Since the perfect architecture software has never come to life, the ways in which architects used software has always been highly creative, but also full of obstacles and peculiar workflows that are rather difficult to understand for archivists. In fact, jumping between different software packages often determines the workflow in a design process more than a design phase does. This results in a tendency to archive architecture design files per software package, as this is the most logical way to retrieve the input and output file formats needed to juggle between software and hardware incompatibilities and their affordances.

Throughout their careers, most architects have likely used many different versions of each software, which were substantially different than those we use today. They not only had different interfaces, but also functionalities. Some of them used customised instances of software enhanced with plugins and scripts to accommodate specific workflows. How can such customisations and experiences be preserved? Is there a way of capturing that in an archive? The fact that architects have been working with incompatible software tools for decades is in fact an important part of their work. With growing software monopolies represented by giants such as Autodesk, architecture firms are often locked into the systems they bought into.[[55]](#footnote-55) In 2019 several prominent architecture offices signed an open letter directed to Autodesk urging the company to introduce necessary changes to one of their most important products – Revit. As described by Daniel Davis for the Architect Magazine ‘The open letter was but one of many recent attempts by the architectural community to get Autodesk’s attention on issues of software pricing, performance, and functionality. In the past year alone, one technology leader—who asked not to be named for fear of jeopardising their relationship with Autodesk—had been invited to sign two letters and participate in one public forum, all aimed at collectively calling for action from the software developer. Up until five years ago, they had felt like Autodesk’s partner. Now when they talk to the company, they say it seems “surprised by what we want and dismissive”.’ [[56]](#footnote-56) The aspects of software incompatibilities and ways that architects have dealt with them, is one of the aspects that determine the way in which born-digital archives have been saved and will most likely be the way in which they will be preserved. Can we better understand the workflows and how the software was used by understanding software incompatibilities? The difficulty here is the predominantly proprietary nature of design software, which creates a new type of dependency and relationship between software vendors and collecting institutions. The history of software is undoubtedly entangled with the history of design. Despite some of the shortcomings of this entanglement, there are also positive aspects that have been relevant for the development of architectural practice. For example, the fact that design software has become increasingly collaboration-oriented has been enabled by cloud-based solutions.

There are many interesting areas of study within the design software development itself. On the one hand we see a growing split between hyper-specialised software and more holistic software. While on the other, interoperability through APIs (Application Programming Interfaces) and plugins has become all-pervasive. For the archiving practice it is an interesting area to watch as software vendors are ‘both curating the software ecosystem and responding to their user needs’.[[57]](#footnote-57) As Teresa Fränknel writes: ‘…we must study the programs with which architecture was made, their underlying design philosophies, their tools, and limitations. Unlike pencil on paper, software is not a neutral means of working. It was often built to deal with specific problems such as solid modelling, ray tracing, or animating and it became imbued with its creator’s understanding of design.’[[58]](#footnote-58) What narratives within software development and related technologies should collecting institutions be watching to provide better insights into their collections is still an open and under-researched question. Yet, big, unstructured archives such as the one of MVRDV can provide invaluable insights in such processes.

### Perspective on digital representation

The introduction of digital tools to architectural design brought significant changes to the long history of architectural drawing and architectural representation. As noted by Aliza Leventhal the aesthetics of the drawing became more technical; one could say less poetic. To many, the neon lines of AutoCAD won’t be as visually attractive as a hand-drawn plan. At the same time, with the development of rendering techniques, architects driven by the commercial need for more photorealistic, alluring forms of representation, have replaced the artistic qualities of the coloured perspective drawing with more commercial ones.

As Sam Jacob points out in his essay *Architecture Enters the Age of Post-Digital Drawing*: ‘These tools—drawing packages and supersophisticated renderware—have narrowed the scope of architectural drawing even as they have exponentially increased its precision. Just think of how these kinds of applications frame not just the drawing but how we draw. They position us within a predetermined idea of space, an array of pre- programmed presets rather than an ambiguous possibility that can be constructed. In these types of space the act of drawing is a Cartesian given.’[[59]](#footnote-59) The early use of Adobe Photoshop and renderware, however, was far from sophisticated. Early collages of the Dutch Pavilion for the Expo 2000 in Hannover from the MVRDV archive in Het Nieuwe Instituut’s collection show that to create the visuals architects first printed out basic renderings of a 3D model and embellished them with physical silhouette cut-outs from printed publications. These images precede the emergence of internet image libraries, which made such workflows unnecessary within a couple of years. It is also interesting to see how in the times of limited internet access these cut-out libraries travelled from one office to another. This rough visual language was very popular and could even be seen as a signature for some offices. Similar quick ‘photoshopped’ collages are also present in the in the work of Crimson on *Wimby!* where simple collages of possible urban designs were used for consultations with the inhabitants.

A picture containing tree, outdoor, yellow, sunset

Description automatically generatedA picture containing text, outdoor, people

Description automatically generated

[Illustration 9a,9b: Collages found during research of the physical media donated as a part of the MVRDV digital archive. Both collages show different stages of the creation process of the Dutch Pavilion for Expo 2000 in Hannover. The left one has been digitally created, while the right one printed, enriched with cut-out silhouettes, and scanned.

MVRDV physical media archive Expo Hannover MVRVTP065, left to right zip drive MVRDV 10.10.97 WXPO – perspecitieven, boszaal.tif (5.11.1997); tif (1.-3.) collages Expo 2000 6705, scan-4.TIF (19.01.1998).]



[Illustration 10: LOGICA, Urban design guidelines for Hoogvliet by MAXWAN, 2002. The image shows a spread presenting the plan and a series if design sketches from *Wimby! Hoogvliet: Future, Past and Present of a New Town* by Felix Rottenberg, 2007. Collection Het Nieuwe Instituut, WiMBY! ! programme archive. Accession code: CRIM. File name: Wimby! 0425\_TD\_part2.]

With the development of both software and skills, rendering started to become a separate profession, and the digital collage was replaced by a photo realistic rendering. Within less than a decade, this transition was condemned by both architects and architecture critics. In 2010 MVRDV and The Why Factory commented on the use of exaggerated photorealistic renderings in their ‘Reality Filter’ and ‘Happiness Filter’ pastiche published in *L’Architecture d’Aujourd’hui* #378. At about the same time a discussion emerged around the realisation of Bosco Verticale, a high-rise residential project by Stefano Boeri in Milan[[60]](#footnote-60), with large trees planted on the balconies. According to the project’s critics its reality failed to live up to the expectations of the glossy renderings. Paradoxically, not long after MVRDV’s own pastiche was published, the office faced fierce criticism sharply worded by Mark Minkjan in the essay *What this MVRDV Rendering Says About Architecture and The Media*, which was awarded the Geert Bekaert Prize for architectural criticism in 2016.[[61]](#footnote-61)

A high angle view of a building

Description automatically generated with low confidence

[Illustration 11: Rendering of Valley, a housing project in Amsterdam designed by MVRDV. The image was used by Mark Minkjan in his prize-winning essay *What this MVRDV Rendering Says About Architecture and The Media* to formulate general criticism on the role of distorted photo-reality in shaping perceptions of architecture. Image courtesy MVRDV and VERO.]

In creating alluring images, the architectural rendering language went to such extremes that it produced a distorted version of reality. As Jacob argues: ‘Renderings assume the language of photography—so much so that in more advanced rendering packages you even design a digital simulation of the camera—and in doing so present us with an apparently “real” image of the world. Yet it’s exactly this fait accompli idea of reality that the return of the drawing seems to challenge.’[[62]](#footnote-62) Nowadays, we see a new wave of architecture practitioners that refrains from photorealistic imagery. The style used by FAT in their work on *WiMBY!* already shows explorations in a different direction. For FAT it was ‘the super-collage possibilities of Photoshop and the extreme flatness of Illustrator that established a different kind of image discourse: one that considered other types of digital space, other forms of graphic quality, and simultaneously a set of alternative architectural propositions.’ In this specific case, Adobe Illustrator as a vector-based illustration software became a vehicle for the critique of dominant forms of architectural practice and Photoshop as the software this type of practice would use. As noted before, it is not the style of the drawing that matters but the software in which it is made, where the software is not only a tool, but also a statement.

Diagram

Description automatically generated with medium confidence

[Illustration 12: The Heerlijkheid Hoogvleit, design proposal by FAT made as a part of the WiMBY! Project. Collection Het Nieuwe Instituut, WiMBy! programme archive. Accession code: CRIM. File name: siteview.tif.]

The development of the aesthetics of architectural representation as well as the design process is a very interesting and relatively rarely discussed area of study. The ‘roughness’ of the early images can definitely be linked to the lack of precision of the digital tools available at the time. Making Photoshop cut-outs used to be a tenuous and time-consuming process, which in the current version of the software can be done much more precisely and within seconds. Could one study the development of aesthetics in relation to specific tools and the use of specific tools as a conscious design choice? Furthermore, what historical value can be found in auxiliary design tools such as image or texture libraries? Is this an element that a collecting institution would want to keep or display? What elements do they contain and where do they come from?

Studying the development of digital representation aesthetics along with the software can allow us to share new narratives that combine the use of the architectural instrumentarium, the development of digital culture, and architectural criticism. Young architects tend to step away from the refined aesthetic of an architectural rendering. They associate it with purely commercial practice and consider it ill-suited for artistic expression. According to Eric Kaltman a similar trend is observed in game design. More and more young game designers reach out to the aesthetics of the early internet and tend to create games that can be easily distinguished from the commercial ones by the way they look. They tend to place more emphasis on the logic of the game rather than immerse the player in a seductive 3D environment. Studies looking at combined developments within various digitally driven disciplines such as architecture and game design, for example, are not common, while it seems that they may be more closely related than we think. For Het Nieuwe Instituut as a place that brings architecture, design, and e-culture together, such lines of inquiry can provide new ways of engaging different audiences in a discourse that concerns them all.

# Conclusions

When it comes to born-digital architecture archives, everywhere we look, there seem to be both challenges and opportunities. Of which the level of digital literacy of both archivists and audiences is a good example. On the one hand it can be an important limitation, and on the other it presents opportunities for creating new educational, engaging forms of access to born-digital architecture collections, which can be refreshing and stimulating. Similarly, changing notions of the traditional understanding of the object, authorship and originality can shake up institutional frameworks, and at the same time provide new perspectives on the history of architecture and design practice. As more challenges are yet to confront the archival practice with more recent developments, such as BIM and cloud computing, learning from each other remains an important task. That concerns institutional context, but also the exchange between creators and keepers. The development of a shared language between archivists and architects is key to enabling the preservation of more contemporary records in the near future. Another crucial question is how to create ethical forms of collaboration between humans and machines on the level of acquisition, preservation, and access that will allow for appraisal, description, and discovery for users with various levels of digital literacy. To face all these challenges, learning by doing seems inevitable. Making mistakes will surely be part of this process, but without such experimentation we might never be able to make sense of born-digital architecture records. Understanding them is only possible through attempts to make them accessible through exhibitions, reconstructions, creating on-site research stations, open online archives, education, artistic re-use, publications, or other new forms we are yet to discover. Finally, born-digital design records offer a chance to rethink both the design practice as well as its archive as a more multivocal and dynamic collaboration between humans and machines.

1. To answer this question the research draws from the research report *Between Curators and Keepers* and the results of the survey conducted among six Dutch architecture offices as a part of that project between 2017-2018. [↑](#footnote-ref-1)
2. Due to the preliminary character of the research project, with its main goal to identify potential study cases no in-depth literature review has been conducted. [↑](#footnote-ref-2)
3. The description of the new attention areas of Rethinking the Collection has been translated from Dutch and can be accessed in original at the website of Het Nieuwe Instituut: <https://collectie.hetnieuweinstituut.nl/bewaren/rethinking-collection-nieuwe-aandachtsgebieden-verzamelbeleid> [↑](#footnote-ref-3)
4. Ania Molenda, *Between Creators and Keepers*, iPRES 2018, available online at: <https://collectie.hetnieuweinstituut.nl/sites/default/files/between_creators_and_keepers_final.pdf> [↑](#footnote-ref-4)
5. Marcel Ras, *Preservation Policy, Het Nieuwe Instituut*, 2018, available online at: <https://collectie.hetnieuweinstituut.nl/sites/default/files/preservation_policy_erfgoed_nl29nov.pdf> [↑](#footnote-ref-5)
6. Henk​ Vanstappen, (DATABLE), *A preservation policy for the AutoCAD DWG/DXF file format*, Het Nieuwe Instituut, 2019, available online at: <https://collectie.hetnieuweinstituut.nl/sites/default/files/pida_24072020.pdf> [↑](#footnote-ref-6)
7. Ania Molenda, *Decoding Complex Architecture Archives* (internal report), Het Nieuwe Instituut, 2020 [↑](#footnote-ref-7)
8. Henk​Vanstappen, (DATABLE), *EaaS as a Preservation Strategy for Het Nieuwe Instituut – Research into the feasibility of Emulation as a Service*, Het Nieuwe Instituut, 2020, available online at: <https://collectie.hetnieuweinstituut.nl/sites/default/files/eaas_24072020.pdf> [↑](#footnote-ref-8)
9. The quality of contemporary digital print technologies and ink used for digital print is prone to fading and does not have the same longevity as other types of print or older printing techniques. [↑](#footnote-ref-9)
10. Read more on the website of NADD, available online at: <https://nadd.hetnieuweinstituut.nl/en> [↑](#footnote-ref-10)
11. Digital Preservation Coalition, The Global List of Digitally Endangered Species 2021, available online at: <https://www.dpconline.org/docs/miscellaneous/advocacy/wdpd/2521-bitlist2021/file>, p. 30 [↑](#footnote-ref-11)
12. Many tools such as, for example DROID can identify many, even quite rare design file formats based on the PRONOM registry. However, there are no preservation tools currently available, that can validate any of such files, extract metadata, or migrate to more sustainable file formats. There are also no open standards for design file formats that are suitable for long-term preservation. All of the major file formats used in design practice are currently subject to technology watch, which means that digital preservation professionals are waiting for new technologies to emerge that will allow to better preservation of such digital objects. [↑](#footnote-ref-12)
13. Recording of a conversation between Dirk van dan Heuvel and Carel Weeber during a special session held around a pop-up exhibition and a conference Between Paper and Pixels organised by Jaap Bakema Study Centre, Het Nieuwe Instituut in 2016, available online at: <https://soundcloud.com/hetnieuweinstituut/collecting-paper-and-pixels-session-with-carel-weeber> [↑](#footnote-ref-13)
14. Video introduction to Rapid Response Collecting on the website of the Victoria and Albert Museum, available online at: <https://www.vam.ac.uk/articles/rapid-response-collecting-an-introduction> [↑](#footnote-ref-14)
15. Find more information on the V&A’s Rapid Response Collecting on the museum’s blog: <https://www.vam.ac.uk/blog/tag/rapid-response-collecting> [↑](#footnote-ref-15)
16. Eric Baldwin, "It's Both Subtle and Monumental": Reimagining Digital Design and Literacy at The Library of Congress, ArchDaily, 2021. Available online at:

    <https://www.archdaily.com/960724/its-both-subtle-and-monumental-reimagining-digital-literacy-at-the-library-of-congress> [↑](#footnote-ref-16)
17. Rolf Hughes, The Art of Displacement: Designing Experiential Systems and Transverse Epistemologies as Conceptual Criticism, Footprint 4, Spring 2009, p. 54 [↑](#footnote-ref-17)
18. Marian Hellema and Ania Molenda, Van voorkeursformaten naar kennisniveaus. Het denken over bestandsformaten bij de Koninklijke Bibliotheek, in: 5 best practices vanuit het Netwerk Digitaal Erfgoed over het gebruik van preserveringstools, Netwerk Digitaal Erfgoed, 2021. Available online at: <https://zenodo.org/record/5181674#.YoJs_C8RqgQ>. [↑](#footnote-ref-18)
19. LOTAR is an international consortium of Aerospace manufacturers, jointly facilitated by AIA, ASD-Stan, AFNeT, prostep ivip and PDES, Inc. Its prime objective is the creation and deployment of a series of standards for long-term archiving and retrieval of digital data, based on standardised approaches and solutions. LOTAR is often referred to as best practice that should be followed by the architecture industry. Read more about LOTAR online at: <https://lotar-international.org>. [↑](#footnote-ref-19)
20. Tom Avermaete, Round Table ‘The Tools of the Architect in the Archive’, Het Nieuwe Instituut, 23 November 2017. [↑](#footnote-ref-20)
21. Andreas Ströhl (ed), Vilém Flusser Writings, University of Minnesota Press, 2004. [↑](#footnote-ref-21)
22. Richard Pearce-Moses, *A Glossary of Archival and Records Terminology*, The Society of American Archivists, 2005, p.101. Available online at: <https://files.archivists.org/pubs/free/SAA-Glossary-2005.pdf> [↑](#footnote-ref-22)
23. Brendan Cormier, Hoe We Collected WeChat, V&A blog, 2017, available online at: <https://www.vam.ac.uk/blog/international-initiatives/how-we-collected-wechat> [↑](#footnote-ref-23)
24. Teresa Fankhänel and Andres Lapik (eds.), *The Architecture Machine. The Role of Computers in Architecture*, Brikhäuser, Basel, 2020, p.15 [↑](#footnote-ref-24)
25. The Archive of the Future, Network Archives Design and Digital Culture, Het Nieuwe Instituut, available online at:

    <https://nadd.hetnieuweinstituut.nl/en/articles/archive-future>. [↑](#footnote-ref-25)
26. Henk Vanstappen, Ibid. [↑](#footnote-ref-26)
27. Read more on EAAS: Archive of Interfaces: Exploring the Potential of Emulation for Software Research, Pedagogy, and Design online at: <https://dl.acm.org/doi/10.1145/3476035> [↑](#footnote-ref-27)
28. Read more on Warhol and the Amiga exhibition at The Andy Warhol Museum in 2019 online at: <https://www.warhol.org/exhibition/warhol-and-the-amiga/> [↑](#footnote-ref-28)
29. Read more on Sketchpad reconstruction on Scott Donaldson’s website: <https://scottland.cc/projects/sketchpad/> [↑](#footnote-ref-29)
30. Amalia G. Sabiescu, Living Archives and The Social Transmission of Memory, in: *Curator: The Museum Journal* Volume 63, Issue 4, 2020, p. 497. Available online at: <https://doi.org/10.1111/cura.12384>

    [↑](#footnote-ref-30)
31. Ania Molenda, Between Creators and Keepers, iPRES 2018, 2018 [↑](#footnote-ref-31)
32. Ania Molenda, Ibid. [↑](#footnote-ref-32)
33. As stated in the definition of a blob in *The Metapolis Dictionary of Advanced Architecture* the conventional geometrical forms did not seem to offer relevant language to contemporary dynamic in the design field defined by flux and complexity: “Unlike a conventional geometric primitive such as a sphere, these objects are defined with a centre, a surface area, a mass relative to other objects and importantly by two types of fields of influence. These meta-ball primitives are surrounded by halos of influence.” [↑](#footnote-ref-33)
34. Discussed for example during this lecture at the Architecture Association in London on the 14th of June 1993 by Andrew Benjamin and Greg Lynn: <https://www.youtube.com/watch?v=dXHw2WTweO4>, in the same year Lynn published his keynote essay ‘Folding in Architecture’ in AD Profile 102, available online: <https://onlinelibrary.wiley.com/doi/10.1002/9781118795811.ch2>. [↑](#footnote-ref-34)
35. Manuel Gausa, Vicente Guallart, Willy Muller, Federico Soriano, Fernando Porras, José Morales, *Metapolis Dictionary of Advanced Architecture*, Actar Publishers, Barcelona, 2008, p. 232 [↑](#footnote-ref-35)
36. Both projects have been a part of the ‘Archaeology of the Digital’ of the Canadian Centre for Art and Architecture curated by Greg Lynn in 2013, since then they have been a part of CCA’s born-digital architecture collection. Read more on the project on CCA’s website: <https://www.cca.qc.ca/en/events/3425/archaeology-of-the-digital-media-and-machines> [↑](#footnote-ref-36)
37. Read more on TransArchitectures event in the V2 online archive: <https://v2.nl/events/transarchitectures> [↑](#footnote-ref-37)
38. Find the TransUrbanism publication in the V2 online archive: <https://v2.nl/publishing/transurbanism> [↑](#footnote-ref-38)
39. The V2 online archive is available online at: <https://v2.nl/archive> [↑](#footnote-ref-39)
40. Maas et al., *FARMAX: Excursions on Density*, 010 Publishers, 2006, p. 232 [↑](#footnote-ref-40)
41. Daniel Dekkers, OptiMixer2\_14, available online at: <http://www.cthrough.nl/OptiMixer/OptiMixer2_14.pdf> [↑](#footnote-ref-41)
42. The Region Maker has also been published as a book in 2004 by Hatje Cantz titled *The Regionmaker RheinRuhrCity*, <https://www.hatjecantz.de/rheinruhrcity---die-unentdeckte-metropole-1177-1.html> [↑](#footnote-ref-42)
43. MVRDV, Delft School of Design, *Space Fighter: The Evolutionary City (Game)*, MIT and cThrough, Actar, Barcelona, 2007 [↑](#footnote-ref-43)
44. Maria López Calleja and Rory Stott, MVRDV'S Datascapes were a Precursor to BIM Techniques, 2020, available online at: <https://www.mvrdv.nl/stack-magazine/2588/mvrdvs-datascapes-were-a-precursor-to-bim-techniques> [↑](#footnote-ref-44)
45. Ania Molenda, Ibid. [↑](#footnote-ref-45)
46. At the end of the 1990s Michael Speaks curated an exhibition at the Storefront for Art and Architecture, a gallery in New York, under the title *Big Soft Orange* showcasing emergent Dutch practices at the time. It described three conditions of globalising neoliberalism that were shaping Dutch and world architecture. ‘Big’ stood for quantity, ‘Soft’ for managerial practices necessary to manage the former, and ‘Orange’ for the increasing dominance of the market, and the way in which the Dutch in particular were responding to it. He also framed Dutch architecture practices as representative of a shift from design ideologies to design intelligence. [↑](#footnote-ref-46)
47. Paul Makovsky, Baby Rems, Metropolis Magazine, 2011. Available online at: <https://metropolismag.com/projects/baby-rems/?utm_medium=website&utm_source=archdaily.com>. The chart is no longer available with the article, but it can be found online at the following address: <https://rasmusbroennum.files.wordpress.com/2012/03/baby_rems.pdf>. [↑](#footnote-ref-47)
48. Teresa Fankhänel and Andres Lapik (eds.), *The Architecture Machine. The Role of Computers in Architecture*, Brikhäuser, Basel, 2020, p. 15 [↑](#footnote-ref-48)
49. Ania Molenda, Ibid. [↑](#footnote-ref-49)
50. Teresa Fankhänel and Andres Lapik (eds.), Ibid [↑](#footnote-ref-50)
51. The four roles also constitute the structure of the book as each one of them is explored in a separate chapter. [↑](#footnote-ref-51)
52. Read more on Invented from Copies on the website of Het Nieuwe Instituut: https://invented-from-copies.hetnieuweinstituut.nl/en [↑](#footnote-ref-52)
53. Fenna Haakma Wagenaar, 'Astrology: Protect us from what we want', in: *Content*, Taschen, 2004. [↑](#footnote-ref-53)
54. Lev Manovich, ‘New Media from Borges to HTML’, in *The New Media Reader*, ed. by Noah Wardrip-Fruin and Nick Montfort (Cambridge, Mass.: MIT Press, 2003), p.15. [↑](#footnote-ref-54)
55. Next to many negative examples of monopolising practices, there are also positive examples of collaboration between design software developers and architects. One such example is RhinoCentre, a knowledge centre and network of Dutch and European users of Rhinoceros. RhinoCentre works closely with its users to monitor their needs and translate them to software adjustments. Rhinoceros is a commercial 3D computer graphics and computer-aided design application software developed by Robert McNeel & Associates. [↑](#footnote-ref-55)
56. Daniel Davis, Architects Versus Autodesk, Architect Magazine, 2020, available online at: <https://www.architectmagazine.com/technology/architects-versus-autodesk_o> [↑](#footnote-ref-56)
57. Matthew Allen, Tell me about a Rhino command. Software and Architectural History, Exhibition at Harvard Graduate School of Design, 2016. Read more online at: <https://www.academia.edu/24720335/Exhibition_Tell_me_about_a_Rhino_command_Software_and_Architectural_History_Harvard_GSD_April_2016> [↑](#footnote-ref-57)
58. Teresa Fankhänel and Andres Lapik (eds.), Ibid, p. 14 [↑](#footnote-ref-58)
59. Sam Jacob, Architecture Enters the Age of Post-Digital Drawing, Metropolis Magazine, 2017. Available online at: <https://www.metropolismag.com/architecture/architecture-enters-age-post-digital-drawing/>. [↑](#footnote-ref-59)
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