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The Work of Art in the Age of Digital Fragility

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The Fragile Digital Record

In 1998 the Museum of Modern Art in New York (MoMA) acquired *Lovers*, an interactive digital art installation created by the Japanese artist Teiji Furuhashi in collaboration with ARTLAB, an experimental laboratory that Canon had established in the early 1990s to explore new ways of art making with digital and virtual-reality technologies.

Lovers (fig. 1) is a poetic exploration of contemporary relationships and romantic love. The artwork is designed as an immersive and interactive installation taking place in an empty room painted with black walls. At the center of the room there is a metal rack equipped with various technological devices, including slide projectors, video projectors, laser-disc players, motion sensors, and robotics software. As visitors enter the room, they are slowly surrounded by a series of spectral real-size dancers emerging onto the black walls. The dancers, some women, some men, move in slow motion, sometimes leaping, sometimes walking, sometimes standing, and sometimes fusing their translucent bodies in a virtual embrace before vanishing again into darkness. Silence is occasionally interrupted by the indistinct murmurs of the dancers and by random crystalline electronic notes, which seem to come simultaneously from nowhere and everywhere. When the room is relatively empty and silent, one of the figures—Furuhashi himself—stops for a moment extending his arms, as if trying to embrace the viewer, but only to embrace himself. When the motion sensors detect someone attempting to approach the walls to touch the images, they create luminous boundaries admonishing the viewer with stern commands projected onto the floor: “Do not cross this line!”; “Don’t fuck with me fella; use your imagination.”

Figure 1 *Lovers*, by Teiji Furuhashi, 1994. Computer-controlled, five-channel laser disc/sound installation with five projectors, two sound systems, two slide projectors, and slides (color, sound).



Lovers was Furuhashi's most ambitious work, and also his final one. The artist died of complications related to HIV in 1995, just a year after completing the work. *Lovers* was also one of the first software-based multimedia artworks to be acquired by MoMA, an acquisition of not merely a captivating commentary of solitude and the search for love in the age of the AIDS epidemic but also a pioneering example of a new form of art.

Unfortunately, and despite its young age—*Lovers* is just over two decades old—this artwork is at risk of being irremediably lost as a result of technological obsolescence. The near tragic fate of *Lovers* reveals one of the most critical and unresolved issues of the nascent digital age. Namely, the fact that an increasingly large part of personal and institutional memories, scientific knowledge, government and corporate data, as well as valuable cultural artifacts are being produced and stored in a medium, the digital, that is inherently fragile and potentially short-lived.

This may sound somewhat paradoxical, especially if we consider that the advent of the digital age has been often hailed as the coming of an age in which the circulation and exchange of information has been finally “disembedded” from material constraints and spatial boundaries. The ability of digital information to operate independently of the particular media on which it is stored, so the story

goes, has transformed the digital into a powerful vector in the construction of a novel cultural logic in which time and information, rather than geography and materiality, have become the crucial organizing factors for cultural, economic, and political processes (e.g., Friedman 2005; Brynjolfsson and McAfee 2014). This “disembedded view,” as one may call it, has dominated popular narratives of the digital thanks to endless metaphors, like the cloud, and visual representations of ones and zeros percolating in the void. These images and narratives have helped further entrench the idea of the digital as a different type of space, an infinitely elastic “virtual” space “that is not truly bound by terrestrial laws” (Schmidt and Cohen 2013: 3) and that is capable of storing all the world’s memories and keeping them just one click away from us.

Over the last two decades, this celebratory embrace of the digital has begun to break as scholars (e.g. Gillespie, Boczkowski, and Foot 2014; Fuller 2005; Parks and Starosielski 2015; Pink, Ardèvol, and Lanzeni 2016; Star 1999; Star and Ruhleder 1996), but most especially institutions, have gradually come to realize some of the shortcomings of this disembedded view. Not least is the failure of these narratives to acknowledge the seemingly banal fact that those “immaterial” and “delocalized” digital flows of ones and zeros never exist by themselves but are always embedded somewhere and in something. In other words: that there is no digital unless there is a hard drive, a USB, a cell phone, a server, a satellite, an undersea cable, or a cell tower, not to mention electricity.

Taking this seemingly banal fact as their point of departure, different scholars have begun to unsettle dominant representations and narratives of the digital by focusing on what Hans Ulrich Gumbrecht and K. Ludwig Pfeiffer (1988: 398) called “the materialities of communication.” This has opened up an exploration of the vast arrays of hardware, platforms, and infrastructures through which digital information exists and circulates (Hu 2015; Blanchette 2011; Bogost and Montfort 2009; Dourish 2017; Gillespie 2010). This exploration has shown that, contrary to established narratives, the digital is localized rather than ubiquitous, since, as it turns out, the geographies of those digital infrastructures tend to be largely built on the same geopolitical structures as previous technologies (Starosielski 2015; Zook et al. 2004; Graham 2012). This exploration has also shown that digital communication is dirty rather than clean, since digital technologies and infrastructures depend on heavily extractive modes of production such as the mining of rare metals and minerals (Parikka 2015), are energy intensive,¹ and are

1. US data centers alone consumed 70 billion kilowatt-hours in 2014, the equivalent to about 6.4 million average American homes, or 8 big nuclear reactors (Shehabi et al. 2016).

also responsible for the increasingly intractable problem of toxic e-waste (Gabrys 2013); and, last but not least, it has also shown that the digital is not automated but labor intensive since, as it happens, the production and circulation of digital data rely on (largely invisible) labor (Irani 2015; Scholz 2013).

Taken together, what these studies have shown is that the digital should not be seen as a technology that is “disembedding” cultural, economic, and political processes from material and spatial constraints, but as a technology that is *re-embedding*, and thus rearticulating, those cultural, economic, and political processes alongside a different set of spaces, materials, and infrastructures.

In this essay we explore this process of re-embedding through what, we claim, is one of the key dimensions of the digital: its fragility.

One of the uncanny ironies lying at the heart of the digital age is that those technologies that were once imagined to usher us into an age of perfect remembering (Mayer-Schönberger 2009) by detaching information from the servitude of aging materials have turned out to be much more unstable, unpredictable, and volatile than the mediums they seek to replace. One of the reasons for this is that digital technologies rely on hardware that has short life expectancy. Much of the optical media on which digital content exists, like CDs and DVDs, lasts between thirty and eighty years (Iraci 2011; NIST 2007). The magnetic hard drives sitting in our computers are extremely unstable and unpredictable, lasting anywhere between four and a hundred years, while the data servers making up the clouds in which much of contemporary digital information is stored have to be updated every four or six years (Rothenberg 1995; Scaramella, Brothers, and Perry 2016). Digital files are routinely corrupted and broken as they are read, transmitted, and processed. Digital data itself is subject to decay as a result of a process known as “bit rot” or “bit flipping,” which occurs when a bit gets displaced by an electric charge and is switched from ones to zeros or zeros to ones (Schwarz et al. 2006), which results in “broken data” that has to be continually fixed (Pink et al. 2018).

And it is not simply a problem of unstable hardware and degrading data. The seemingly unremitting digital revolution we are embarked on means that most digital technologies are outdated every few years and replaced by newer versions. Technologies that were ubiquitous barely a decade ago, like floppy disks, now look like archaeological relics. It takes only a few years, if not months, before software environments are replaced by newer versions, often with limited backward compatibility. It is possible to say, without fear of exaggeration, that no other period of human history has experienced the same rate of technological obsolescence than the digital age.

Crucially, this cycle of obsolescence is not simply the result of the inherent

instability of hardware or the “natural” result of the relentless process of technological innovation. We also live in the age of manufactured fragility.

Since the 1930s, when the real estate broker Bernard London (1932) suggested “planned obsolescence” as the way out of the Great Depression, manufactured fragility has become one of the main modes of production to sustain the model of mass conspicuous consumption and profit making that defines contemporary capitalist economies. At the same time, the cult of innovation that fetishizes the new as an absolute value in these economies celebrates technological obsolescence as a sign of progress and as a model for social change (e.g., Fishman, Gandal, and Shy 1993).

Over the last two decades, the advent of digital technologies has brought about a radical acceleration of this logic of manufactured fragility by creating increasingly disposable technologies with increasingly shorter useful lives. It is estimated, for example, that the average life expectancy of consumer electronics today is just five years (Consumer Technology Association 2014). Technological devices are increasingly closed off—both physically (by soldering hard drives and changing ports, or even screws, with each new update) and legally (by enclosing them into patent and copyright laws)—to make sure that no one can extend their life beyond their designated death date and thus sustain the frenetic consumption cycle fueling contemporary economies (Jackson and Kang 2014). At the same time that this is happening, digital objects and services are increasingly ensconced within platforms designed to “lock” users within specific hardware-software environments and force them to continually upgrade their products to avoid losing the digital data contained in them (Parker, Van Alstyne, and Choudary 2016; Srnicek 2016). “You shall upgrade” has become the inescapable eleventh commandment of our digital age. As the media scholar Wendy Chun (2017) has written, today, being means updating. Failing to upgrade means being condemned to a digital oblivion in which your memories and data will become unsupported and irretrievable. Just try to access an old DOS file you stored on a 5¼" floppy disk two decades ago.²

Impermanence and fragility have become defining conditions of the digital age. The radical obsolescence of this new digital register raises a number of important questions. As large swaths of information are moved to this medium via digitization, or are born within it, how are we going to prevent the fragile memories of contemporary digital cultures from receding into oblivion? How, for example, are we going to transform valuable cultural objects, like *Lovers*, into durable parts of our memory?

2. For a taste of the impressive record of some of the dead technologies accumulated over the last decades, you can visit the online Museum of Obsolete Media at www.obsoletemedia.org.

These are some of the questions we address in this article. To do so, we will steer clear of the hyperbolic fatalism about the imminent advent of a “digital dark age” in which all, or most, contemporary digital information will be lost forever.³ The digital does not bring the end of memory. Rather, we argue, the digital opens up a new ontological register, one that makes possible a new kind of object with very specific properties and forms of relation, circulation, and exchange, which require the development of an entirely new infrastructure of memory. An infrastructure that, as we are going to see, involves a transformation of the institutional structures and cultural logics on which we have relied to produce the forms of evidence, truth, meaning, and time that have traditionally constituted the fabric of memory in the analog world.

Now, rather than analyzing this transformation in the abstract, we do so by looking at one of the institutions in which the problems associated with digital fragility are most especially felt: the Museum of Modern Art (MoMA). Museums of contemporary art are particularly interesting places, since they are one of the institutions charged with the task of creating the memory of the present and are thus at one frontline of the challenges created by the digital age. In the exploration that follows, therefore, we do not intend to use the art museum as an emblem of the kinds of transformations created by the irruption of the digital. Rather, our aim is to use the contemporary art museum as a particular example of how the fragility of digital objects wreaks havoc on the guts of one of the paradigmatic machines of modernity. We will do so by focusing on the specific challenges that a museum like MoMA faces when attempting to transform digital objects into durable parts of the narrative and memory of contemporary art.

To explore these challenges, we organize the discussion into what, we argue, are the four main ontological displacements these new digital objects are operating at the heart of the museum. These are (1) a displacement from artworks that exist as stabilized objects to artworks that exist as circulating objects, that is, as objects that must be in perpetual motion to be kept alive; (2) a displacement from artworks that exist as original objects to artworks that exist as multiplying objects that have to be endlessly proliferating; (3) a displacement from artworks that exist as authentic objects to artworks that exist as regenerated objects, that is, as objects that have to be constantly remade; and (4) a displacement from artworks that exist as discrete objects to artworks that exist as distributed objects that are scattered across different spatial, temporal, and property regimes. We empirically show

3. The idea has been around for some time now and has been most recently voiced by Vint Cerf, one of the fathers of the Internet, in his 2015 address to the American Association for the Advancement of Science (Ghosh 2017).

how each of these displacements destabilizes the practices and infrastructures that museums have traditionally relied on to organize and hierarchize these artworks, and to distribute value, meaning, and property rights among them.⁴

Finally, we conclude by exploring some of the consequences of what we have learned about digital fragility in the museum in the wider context of contemporary cultural and knowledge production. We do so by reflecting specifically on some of the issues that emerge when the production of cultural meaning and knowledge becomes dependent on fragile digital objects whose existence and circulation are increasingly ensconced within the proprietary control that defines the corporate structures of contemporary digital culture.

From Stabilized to Circulating Objects

The obsolescence of the technological environments in which digital-based artworks exist is generating an increasingly intractable paradox within art museums: although it is possible to preserve artworks produced centuries or even millennia ago, the preservation of an artwork produced just a few decades ago poses formidable, often insurmountable challenges. Thus, while you can still access a painting like the *Mona Lisa*, which was painted five hundred years ago, you will be hard pressed to access a computer-art piece written in QuickBASIC just thirty years ago.

The practical effect of this paradox is that large swaths of what we could call our recent past are becoming rapidly irretrievable and inaccessible. Over the last few years, museums have tried different strategies to solve the increasingly intractable problem of cultural irretrievability of this register of our recent past. One of the preferred strategies is what is called “migration” in museum parlance. This strategy consists of transferring the contents of media-based artworks from obsolete technologies to new ones—for example, moving a video-art piece originally stored on a LaserDisc in the early 1980s to a brand-new Blu-ray disc.⁵

4. Our analysis is based on participant observation in the media conservation laboratory at the museum. One coauthor, Glenn Wharton, served as media conservator at MoMA for seven years. He established the media conservation lab and oversaw the digitization of analog media collections, creation of a preservation repository for the digital collections, and the development of new policies and procedures for the museum to acquire and manage these fragile new artworks. Fernando Domínguez Rubio is an ethnographer who worked as an intern in the media conservation lab in 2011 and has been performing research on the museum collections since then, conducting more than forty interviews with museum staff members.

5. Another strategy that we will discuss here is “emulation” or running obsolete software (e.g., Windows 95) in new software environments (e.g., Mac OS 10). This is a much less popular strategy since it is logistically more complex and significantly more expensive than migration. Additionally, most of the challenges we will address in this essay for migration are equally applicable for emulation (Rinehart and Ippolito 2014).

Interestingly, this practice of migration is not without historical precedent. Over the seventeenth and eighteenth centuries, conservators developed a technique called “transfer,” which consisted of physically detaching paintings from decaying supports, like wood panels or wall frescoes, and placing them in more stable ones—for example, Raphael’s *Madonna di Foligno* (1511), now in the Vatican museum, was transferred from wood to canvas in 1801. One could be tempted to think that, unlike the labor-intensive and very risky operation of transferring paintings, the process of digital migration is a hassle-free operation since it is “just” about moving information with a few mouse clicks. This, however, is far from being the case.

One of the difficulties in the process of digital migration has to do with the fact that digital content is inherently relational. Digital content always exists within a particular platform composed of many different “layers” that include, among other things, software, hardware, programming languages, and algorithms (Bogost and Montfort 2009; Dourish 2016; Konzack 2002). These platforms provide the particular ecology of relations within which digital content can exist, be accessed, and be executed. What makes digital migration complex is that it is never a question of simply transferring ones and zeros in the void of digital space, but a question of transferring information between two platforms, that is, between two different ecologies of relations. This can be complicated because not all platforms operate according to the same ontologies or have the same properties. For example, a platform running on a thirty-two-bit environment does not have the same properties as one running on a sixty-four-bit environment. Migrating an object between platforms with the different properties can easily render the object dysfunctional or can even kill it—hence the infamous “Can’t read from the source file or disk” error that ruins our lives every now and then.

What follows from the above is that digital migration not only requires moving digital content but also requires sustaining the platforms that make possible the relations through which that content exists and can remain operational. At MoMA, this takes place in the media workstation. “The belly of the monster,” as we dubbed it, is equipped with different analog and digital playback devices ranging from the bulky 1970s U-Matic playdecks at the bottom to the contemporary slim Blu-ray decks at the top (fig. 2). In a way, we could say that the stack resembles a geological section comprising the different “technological strata” accumulated over the last four decades. Like a geological section, the technological strata of the rack are always changing. As new technologies emerge, the stack keeps on adding new technological strata on top so that artworks can continue to move over time and remain up-to-date.

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The function of the media workstation is to work as a time machine of sorts that allows conservators to prevent artworks based on old platforms from becoming irretrievable by moving them to newer technological environments. At first sight, one may think that the “time travel” afforded by the media workstation overcomes the problem of material obsolescence these digital artworks face, much like the old transfer technique solved the problem for aging paintings. Yet a deeper look reveals that rather than solving this problem, it merely displaces it.

The reason for this is to be found, again, in the intrinsic obsolescence of these technologies. Unlike those transferred paintings, migrated digital artworks cannot



Figure 2 Media workstation at MoMA, aka the “Belly of the Monster.”

sit on their new supports for decades, let alone centuries. Their fate is that they will be superseded by the development of newer technologies within a few years. As a matter of fact, most best practice guidelines advise to migrate digital content every eight years. In practical terms this means that there is no final resting point for digital artworks, since there is no technological environment in which they can be finally stabilized and saved from becoming irretrievable. The result is that digital objects are embedded in a technological environment that condemns them to a Sisyphean logic of enforced circulation from which there is no escape. Failing to migrate these artworks is tantamount to sentencing them to an almost certain death.

This process of enforced circulation is particularly problematic for the museum. For one, it upends the traditional memory-making logic of museums. Traditionally, museums work to produce objects of memory through the physical stabilization of artworks. Your ability to see the *Mona Lisa* depends on the museum's capacity to maintain the physical and environmental conditions under which this fragile piece of poplar wood can be stabilized (Domínguez Rubio 2016). In the case of digital objects, however, any attempt to stabilize them within a given platform would actually condemn them to a sure death. They can only survive as long as they are kept "on the move" circulating across environments and technologies. Or put differently, their ability to survive depends on the museum's capacity to sustain them as eternally circulating objects.

The production of these circulating objects leads us to another paradoxical result that has to do with the temporal structure of the memories and narratives created by the museum.

To survive, these digital objects have to be continually migrated to contemporary platforms. In other words, they have to be constantly brought into the present. Take, for example, the case of Joan Jonas's *Mirage*. Initially made in 1976, *Mirage* consisted of a series of video performances made at the Anthology Film Archives. When MoMA acquired *Mirage* in 2005, the original analog videos were obsolete and almost impossible to reproduce in current display devices and had to be migrated into adequate digital forms.

The result of this migration is an object that relates to time differently. *Mirage* is not anchored to one point in time in the same way that, say, Édouard Manet's *Le déjeuner sur l'herbe* is anchored to 1863. As a circulating object, *Mirage* belongs to more than one historical moment simultaneously: it is both past and present. What results from this process of enforced circulation, therefore, are not objects fixed at one point in time but what art historians Alexander Nagel and Christopher S. Wood (2010) call "anachronic objects," that is, objects that implode the distinction between past and present and flatten time, and therefore cannot

support the kind of linear chronologies that museums have typically relied on to produce memory. The museum cannot sustain the claim that the *Mirage* we see now is something that was made in 1976, which is why the museum had to give *Mirage* two official dates, 1976 and 2005. The question then is, What kind of memories and narratives of the past can we produce with objects that need to remain contemporary?

From Original to Multiplying Objects

One of the defining properties of the modern category of art is the distinction between the original and the copy. Over the last century, the art world has been successful in enforcing this distinction through a myriad of mechanisms, from copyright law to authentication and provenance research, which have operated to prevent the reproduction of the artwork and thus ensure the uniqueness of the original. Yet as we shall see in this section, these mechanisms do not work very well in the digital realm, where the boundary between copy and original becomes insidiously elusive.

To explore why this is the case, let us ask you to follow a hypothetical story. Let's imagine that you are a curator at MoMA. One day, in one of your expeditions to scout new art, you see a piece of digital video art in a gallery that you would like to acquire for the museum. After finalizing the purchase, you talk to the artist about moving the artwork to the museum. She then tells you that what you saw at the gallery was just an "exhibition copy," and that she has the master in her studio. This, your media conservator argues, is a bit problematic, since MoMA, like any other museum, requires securing exclusive rights to publicly display uneditioned works on acquisition. This means that those exhibition copies should be either destroyed or transferred to the museum to prevent anyone else from displaying the artwork.⁶

After some negotiation, the artist accedes to give you the master as well as the exhibition copies. When the lot finally arrives at the museum, you realize that the artist has sent you all the materials in compressed files (e.g., AVI files). You know that these compressed files are a preservation nightmare, not only because the compression algorithms through which these files are generated lose a lot of information—which can significantly alter the contents of the artwork and compromise future

6. Many artists are exceedingly knowledgeable about the technical specificities of digital-based artworks and often use many of the properties of this medium as part of their aesthetic practice and meaning. However, for the purposes of the example, we will assume an artist that is not very familiar with technical details—something that is not necessarily a rare occurrence.

migration—but also because most of them tend to be extremely short-lived, as they are tied to very specific hardware-software environments (Sterne 2012). Thus you require the artist to send the master in an uncompressed file format (e.g., a RAW file). These uncompressed files do not suffer from information loss, since their data is not processed by an algorithm and thus remains “raw”; this makes them “archivable,” since the information they contain has a better chance of being kept alive as compression algorithms and technologies change over time.

Once you have agreed with the artist about the need to send an uncompressed format, you move on to discuss the file format. At this point the artist may, rightly, start to lose her cool about what seems to be splitting hairs. However, you argue, the choice of file type is far from trivial. These files have become the basic units of memory in the digital age. Although we tend to take them for granted, they perform important “memory work,” not only because they contain most of our memories but also because they specify the invisible architectures through which those memories exist.

Each format has a particular architecture that stores data and, crucially, metadata differently. What kind of metadata is stored and how it is stored is particularly important, since each format entails what is called in technical parlance a particular “metadata ontology,” that is, a particular way of describing digital objects and their properties as well as relations between them (fig. 3). This is crucial to determine, for example, how the file was created (e.g., its version and the software environment in which it runs), as well as all the information that can anchor the file to a specific point in time and to a specific person. If you are a police digital forensic scientist, this structure is crucial to establish evidence of authorship of a crime. And if you are a museum conservator, this structure is crucial to establish artistic authorship, authenticity, and rights, as well as what can and cannot be done to the artwork without altering it. This “metadata ontology,” as it is called in technical jargon, is also crucial because it is what provides the interface that enables communication between machines and humans. In other words, even if the raw data remains unscathed, this metadata ontology is what determines how (or if) the file will be read by another machine in the future, and how (or if) a human will be able to be authenticate it.

So although we tend to think of file types as interchangeable, the reality is that they are not. For far from being mere neutral placeholders, the kinds of information, properties, and relations described in these machine protocols shape how we can build human concepts such as truth, authenticity, authorship, and property into the digital world.

Finally, after some negotiation, the artist sends in the uncompressed master

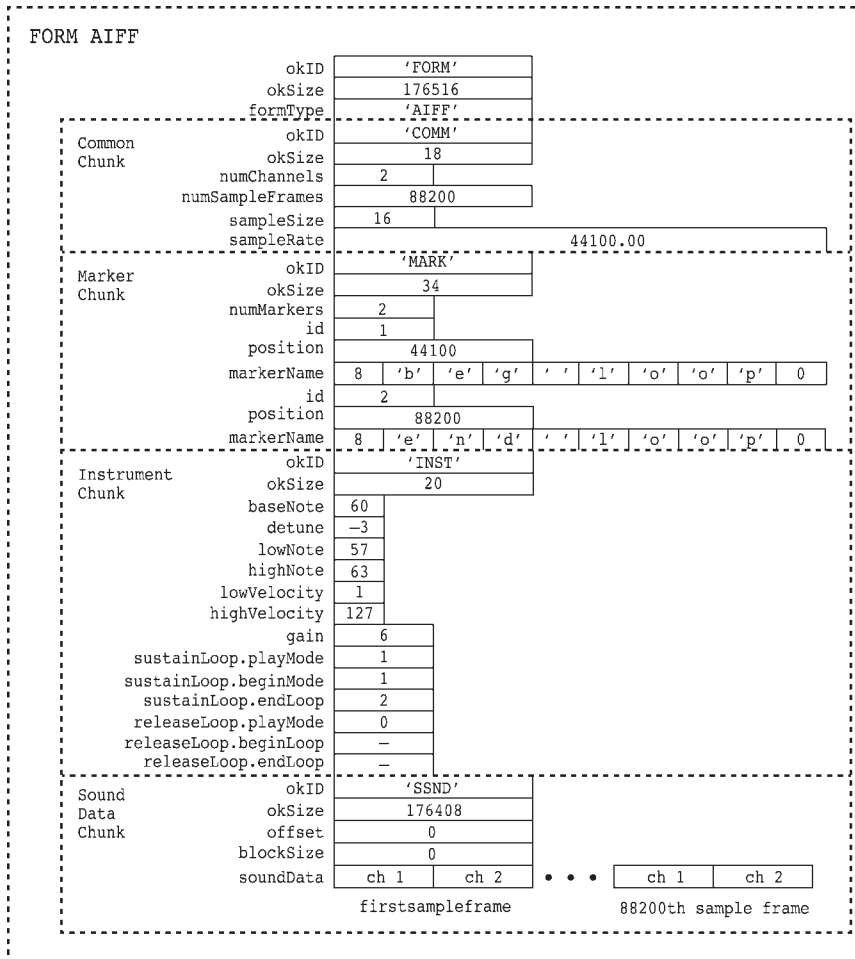


Figure 3 Example of an AIFF file data and metadata architecture.

in the agreed-on file media carrier. Now, while you are glad about it, you are also fully aware that this is not the end of the process. For one, you know that uncompressed masters are extremely fragile, and that they can be easily damaged when you run them through playback equipment. You most certainly do not want to have a six-figure artwork in an easily scratchable piece of plastic, like a Blu-ray disc. This is why you decide that it is wise to create a digital master, a sub-master, and a dub-master. The master and sub-master will be stored on a safe server and backed up off-site, and the dub-master will be used as the work copy for the museum. Thus every time the work is requested to be on view for an exhibition,

or someone requests it for a loan to exhibit it in another museum or gallery, you will be able to use only this dub-master to create a compressed exhibition copy for each occasion.

Now, if we pause here for a second and look back at our story, we will notice that something strange has happened: the original artwork we bought from the gallery has suddenly multiplied. That unique original artwork now exists in multiple forms: as a tape master, a digital master, a sub-master, a dub-master, and multiple exhibition copies in different formats. So it is as though we had bought Picasso's *Demoiselles d'Avignon* and all of a sudden we had five or six iterations of it.

While it may be initially shocking to realize that we have been indeed copying the artwork, we may find solace thinking that this is not entirely new in the art world. After all, museums have been grappling with the problem of "multiple" artworks for a long time in the form of engravings, castings, or photography produced in edition. Besides, the production of multiples has become a common art practice since the late 1950s, be it in the form of series, like Joseph Beuys's *Capri Battery*, which exists in an edition of two hundred multiples, or in the form of endlessly reproducible artworks, like Félix González-Torres's replenishable stacks of papers or candy spills.

Yet while these examples may offer some initial comfort, you soon realize that in the case of digital objects we are not dealing with the same problem. The problem here is not so much that the initial artwork has multiplied, or that it can multiply further, but the fact that it must keep multiplying. Sooner, rather than later, the obsolescence of digital technologies means that the system of master, sub-masters, and exhibition copies through which the artwork currently exists will need to be migrated onto a new environment, thus generating a second iteration of this system . . . and then a third . . . and then a fourth . . . and so on . . . until you end up with a diagram like the one below (fig. 4), which represents the real case of how a single artwork exists at the Tate Modern in London.

As one can imagine, a diagram like this is particularly problematic for an institution like a museum that is in the business of unique artifacts and that has traditionally relied on a firm distinction between original and copy to assign cultural and economic value as well as to establish property rights among these objects. The problem the museum faces here is that, just as it cannot stop the process of circulation we saw in the previous section, it cannot stop this process of endless multiplication and dissemination. Multiplication and dissemination is how digital objects exist.

One of the obvious practical challenges the museum faces here is how to

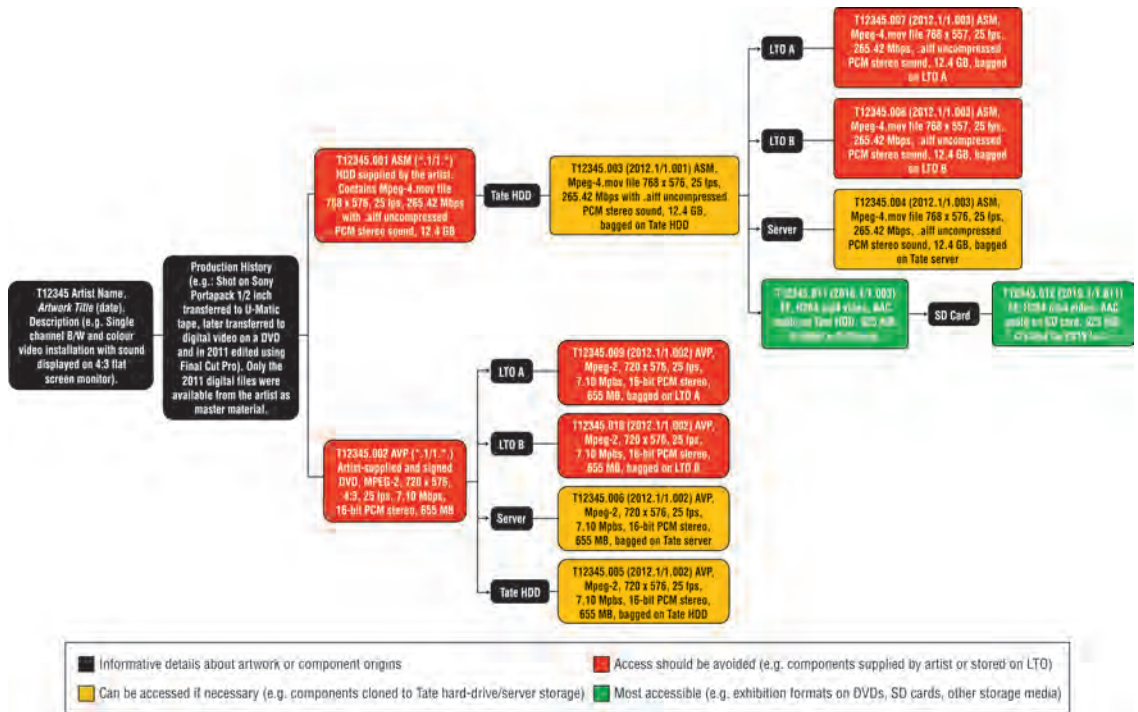


Figure 4 Media component diagram for one artwork at the Tate Modern.

enforce the distinction between original and copy in the face of inherently multiplying and disseminating artworks, not least because the original may not be playable anymore—that 1980s DOS file on a 5¼" floppy is probably dead by now. An additional, and equally serious, practical problem is how to prevent these multiplying artworks from escaping the institutional and proprietary control of the museum. After all, we should remember that artworks can be rather expensive commodities. Not to mention that the museum, both as an institution and as a business model, would be very much pointless if artworks could be endlessly and freely replicated and disseminated.

The problem, therefore, is not just how to distinguish between original and copies but how to keep the semblance of uniqueness in a medium that requires the endless multiplication of the artwork. Hence desperate measures to control this dissemination, such as the increasingly common practice in loan agreements to request visual proof that the loaned exhibition copy has been physically destroyed—a truly interesting example of organized institutional iconoclasm. Or the requests museums now often make to artists on acquiring one of their digital

artworks to make them into limited editions. Or the elaborate attempt to create the mirage of uniqueness by prohibiting digital artworks to be exhibited at more than one location at the same time (Domínguez Rubio and Silva 2013).

So here we are, in an environment that forces the museum to deal with artworks that exist not as unique and stable objects but as endlessly circulating and proliferating ones and that, as a result, not only blur the distinction between past and present but also that between original and copy. This, as it happens, is not even the biggest problem the museum faces with digital objects.

From Authentic to Regenerated Objects

The transformation from unique and stable art objects into circulating and disseminating ones would not be that problematic if digital artworks could at least maintain a stable identity through these processes. That is, if we could say that, despite its multiple migrations and multiplications, we are nonetheless seeing the same artwork. If that were the case, it would be “simply” a problem of how to keep these artworks alive by copying them, but at least their status as authentic artworks would not be compromised. One could think that the ability of digital information to replicate endlessly would make it possible to create a perfect copy, a repetition without a difference. Unfortunately, digital environments also short-circuit this possibility, for they require a change not only in the physical container of these artworks (laser-disc, WAV file, etc.) but also in their content, that is, the very aesthetic structure and appearance of the artwork.

To illustrate this, let us go back to the artwork with which we started this essay: *Lovers*. In 2016, after conservators sounded the alarm that *Lovers* was rapidly becoming irretrievable, MoMA decided to migrate it. The project demanded a vast collective effort that included MoMA’s time-based media conservators, consulting engineers, graduate students from New York University, as well as members of Furuhashi’s art collective from Tokyo.⁷ With scant documentation, the team began with a technical assessment to understand the technology that drove all of the moving parts. They learned that the custom-built robotics software was installed on old IBM computers running Windows 95, and that the obsolete LCD video projectors, monitors, computers, and other hardware all had to be replaced to make the work run. After analyzing the “score” that drove the sequencing of sounds and images that flashed on the gallery walls, they designed an entirely new system to control interactivity and image playback.

7. We thank MoMA’s conservator Ben Fino-Radin for providing details of the conservation project.

Despite the acknowledgment that the project was a temporary fix, since new technologies will eventually supersede these technical upgrades, the financial- and labor-intensive effort was deemed successful in that *Lovers* was revived from near death. Some, however, may challenge the museum's decisions on aesthetic grounds. The migration not only implied changing the inner structure of the work, the invisible code, but also its external form. Replacing the bulky and rough aesthetic of the original equipment on the rack with the sleek and slim aesthetics of today's technologies not only implies a noticeable departure from the original form, but it may also generate an entirely different reading of the artwork. And this is not the only, or even the main, problem.

In addition to changing the physical hardware of the artwork, the audio and video formats were also changed. The issue here is that each platform produces different types of objects, with different kinds of properties, different ways of establishing relations between them, as well as different ways of producing form, color, and sound. A WAV file, for example, handles sound differently than an LPCM file, just like a VGA monitor displays color differently than an ultra-high-definition monitor. Think, for example, how the same movie changes color when shown in the United States, which uses NTSC colorimetry, and in Europe, which uses PAL colorimetry—or the kind of changes that occur when old films are remastered, or the problems of pixelation or interlacing that alter digitized images.

Thus when an artwork is migrated to a new digital environment, we are not moving the same object across different platforms: we are actually regenerating this object within each new environment. In other words, we are not talking about variations, repetitions, or reproductions of the same object. We are talking about different objects with different properties: an MP3 object is not the same as an MP4 object, much like a cardboard object will never be the same as an iron object. So it is as though in migrating a painting like *Demoiselles d'Avignon* we were not simply moving the painting from one canvas to another—as was the case with the old transfer techniques—but we were in fact painting it anew each time with a different set of pigments and paint brushes, and on canvases of varying sizes and textures.

The result of this regeneration, therefore, is not one object existing across different platforms but multiple objects in different platforms. This multiplicity is problematic, since it disrupts the traditional understanding of authenticity on which the museum and, by extension, the art world has been predicated. Authenticity has traditionally operated under the logic of identity. That is, we say an artwork is “authentic” if what you see is the same thing that was originally produced. For example, we say that the looted Parthenon marbles we can see at the British

Museum today are authentic because they are in fact the actual marbles that sat in the Athenian Parthenon in the fifth century BC. This logic, however, cannot work in a medium in which we deal with regenerated objects. In this case, authenticity is possible only under the logic of equivalence. The question is not that a PDF file is the same as a Word file—obviously it is not—but whether the PDF file can be seen as equivalent to the Word file. The key in the digital domain, therefore, is how to produce equivalence in this chain of multiple regenerated objects.

To deal with this problem, MoMA, alongside other museums, has been developing over the last decade a complex process involving technologies, standardization processes, and collective judgment in which conservators, curators, audiovisual technicians, and sometimes the artist tweak and tinker with these digitally regenerated objects in an attempt to keep them as close as possible to their original form (fig. 5).

The problem of equivalence takes us straight to the famous Theseus's ship paradox, based on the ship in which the victorious Theseus returned to Athens and which was preserved in the harbor for several centuries to commemorate Theseus's victories. As Plutarch tells us (2001: 1–25), the preservation of the ship took place by gradually replacing decaying wood planks for new ones until the ship was eventually made anew. The question that has amused philosophers for centuries is whether it is possible to consider the materially regenerated ship as the original and authentic Theseus's ship, or whether it should be considered as a fundamentally different object, a mere copy or a replica. This is the same question the museum has to answer in relation to these digitally migrated and regenerated art objects. Should these regenerated objects be understood as authentic art objects? Or are they mere copies, versions, replicas, or perhaps even fakes?

For MoMA this question became vivid in December 2010, when the exhibition *Andy Warhol: Motion Pictures* opened its doors at the museum (fig. 6). This show was MoMA's first attempt to create a full-scale exhibition based on migrated objects featuring digitized copies of the "cinematic portraits" that Warhol had shot during the 1960s and which consisted of portraits shot in 16mm films. These digital copies were the result of a concerted effort to preserve Warhol's legacy by MoMA and the Andy Warhol Foundation, which had donated in 1997 four thousand reels to the museum. Migrating these films to a digital medium was seen as the only alternative to salvage this important body of work, given the short life expectancy and vulnerability of the 16mm films and the obsolescent technological equipment required to display these artworks.

The critical reception of the show reveals some of the fault lines that digital technologies are creating at the heart of the art world. For critics, it was not



Figure 5 Coauthor Glenn Wharton works with colleagues to produce equivalence at MoMA.

entirely clear what kind of objects these films were, or what position they could occupy in the art world. The only thing that was clear was that the films on display were not the originals made by Warhol, and they were not the typical copies the art world has dismissed as forgeries or falsifications. The critics still operating within the analog logic of modernity fiercely criticized the exhibition, claiming that these regenerated digital objects had not only lost the original grain of the 16-mm films and thus had lost “the mystery of presence” but were also betraying “the medium specificity” undergirding the modernist faith (Taubin 2011). Others, like the *New York Times* critic Ken Johnson (2010), were mystified by what appeared to be a new kind of object that elided the very categories on which the art world has been operating: “Are they authentic artworks, reproductions, documents, or some kind of in-between hybrid?”

But be that as it may, the example of the Warhol films reveals the Faustian bargain that digital offers to the museum: either we let these artworks die, or we keep them alive, but at the cost of embedding artworks in an environment in which the modernist binary logic of either/or does not apply, an environment in which artworks can exist as both copies and originals, regenerated and authentic, past and present.

If this has not complicated enough the traditional notion of the artwork, we still



Figure 6 View of *Andy Warhol: Motion Pictures* at MoMA. December 2010–March 2011.

have one more displacement to make. To explore this last displacement, we examine the case of the acquisition of *I Want You to Want Me* (henceforth IWYTWIM), an interactive software-based artwork created by the artists and computer scientists Jonathan Harris and Sep Kamvar.

From Discrete to Distributed Objects

Like Furuhashi's *Lovers*, IWYTWIM is also a piece about love, although of a different kind (fig. 7). IWYTWIM is an exploration of the search for love and of the self in the world of online dating. IWYTWIM is an interactive artwork based in a large (fifty-six-inch), customized touch-screen monitor equipped with a powerful hard drive. In the monitor, visitors can see, drag, and prick hundreds of pink and blue floating balloons, with each balloon containing the real user profiles that artists harvested from twelve online dating sites. The artwork is organized around a series of different screens, or "movements," chronicling the different phases of digital romance, from the initial search for love to final breakdown. For example, in the screen of the first movement, titled "I Want," which chronicled the opening stages of the search for love in online dating sites, the audience could prick balloons to see the sentences that users wrote in their online dating profiles starting with "I want . . ." (e.g., "I want sex," "I want a friend").

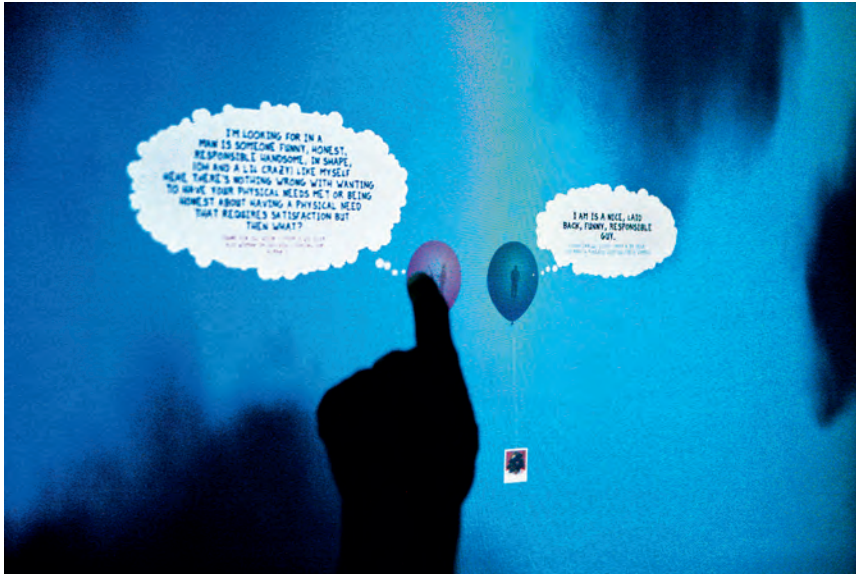


Figure 7 *I Want You to Want Me*, by Jonathan Harris and Sep Kamvar, on view at MoMA.

IWYTWIM was hung in the museum on Valentine's Day and rapidly became one of the main attractions of the *Design and the Elastic Mind* exhibition, providing the audience with the rare voyeuristic pleasure of witnessing the intimate unfoldings of people's digital love lives. After the exhibition ended, curators decided to acquire the artwork for the museum's permanent collection.

Initially, the acquisition of IWYTWIM followed the standard route museums use to acquire any other artwork. Once the legal paperwork was completed, the museum sent some "preparators"—the museum personnel specialized in moving artworks—to the artists' studio to collect the custom-made monitor. After the monitor arrived at the museum, it underwent a routine condition assessment to determine whether there was any physical damage in it prior to being sent to its final destination in the museum's storage facility in Queens.

This time, however, the routine inspection could not be completed. Despite their best efforts, the museum staff could not get the artwork to run on the monitor. No matter how hard they tried, the hard drive attached to the monitor did not produce any data from dating websites. It was only after several attempts that they finally realized that the problem was in fact not technical—since both the monitor and the hard drive were working perfectly—but, alas, ontological. In other words, the problem was not that the museum had acquired a malfunctioning object but that it had acquired a different *kind* of object. More specifically, the museum had acquired a "distributed object."

Public Culture

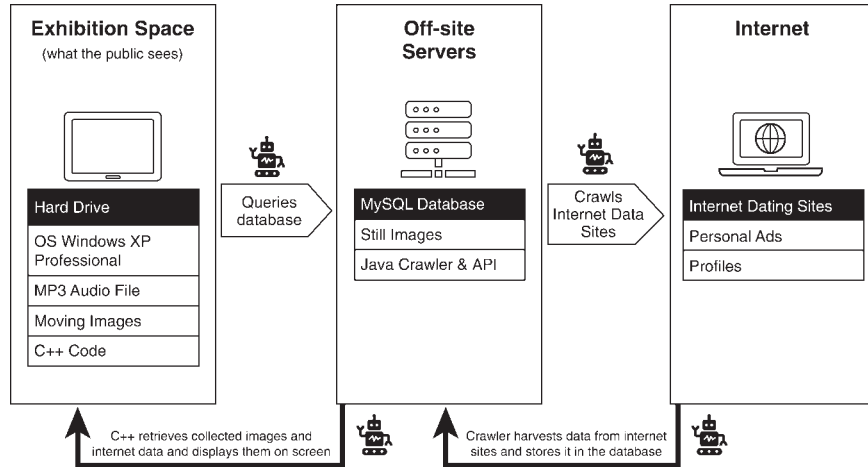


Figure 8 Original working logic of IWYTW.

Distributed objects are those objects whose identities are not contained within any single thing, or series of things, but exist distributed across parts and components. In computer science, distributed objects refer to those objects whose operating mechanisms are distributed in different parts of a computer or across multiple computers. A simpler example is to think of the identity of a tea set, which is not contained in any single piece of the set but exists as the sum of its parts (Gell 1998: 221–23). In art, installations are good examples of distributed objects. IWYTW is another case in point. This artwork is not contained within any single artifact but exists distributed among a large network of components that include, among other things, thousands upon thousands of electronic files containing images, video, music, and metadata; a database; the compiled code; as well as a number of software programs.

What makes IWYTW more problematic than a typical installation is that it is not only distributed structurally but also spatially (fig. 8). While the images, music, and animations are stored in the hard drive attached to the screen, the dating profiles harvested from Internet sites are stored on servers in California.

The distributed nature of IWYTW helps explain why the museum staff could not get it to work when it arrived at the museum: the monitor that they had acquired was not “the artwork,” just one of its many components. Once they realized the ontological nature of the problem, the first task for the museum was to map the logical structure of the artwork to see what was needed to “complete” IWYTW and have a fully working art object. This, however, turned out to be easier said than done.

The problem was not so much localizing the missing components but the dif-

ficuity in actually owning them. Up until the emergence of digital artworks, the discrete nature of most artworks enabled museums to operate under a straightforward copyright regime. Thus when museums acquired a sculpture or a photograph, they signed a contract with its author or rightful owner that made it possible to physically transfer the artwork to the museum and secure full ownership over it, typically including the monopoly over its display, circulation, and reproduction.

Digital artworks, however, do not lend themselves to the same process of appropriation. The reason for this is that these artworks are the products of a system of “nested authorships.” What this means is that the components that make up these artworks are not the results of any single author but of multiple ones nested at different levels. Take, for example, IWYTW. Although Kamvar and Harris wrote the source code for the artwork, the music running in the background was produced by a Canadian band; the data filling the balloons was produced by anonymous users in online dating sites; the touch screen was made by a private company; while the operating system and software on which the artwork runs were produced by different companies.

The issue here is not so much that different components have been produced by different authors, but the fact that each of these authorships is embedded within different property regimes, each allowing for different forms of appropriation and ownership rights. For example, some of the software on which IWYTW runs, like the MySQL database, is protected by a general public license that prevents any individual from having exclusive rights to it, while other components, such as Windows XP or the touch screen, are proprietary software for which the museum can purchase a copy only through an end-user license agreement. The data generated by the users on the dating sites from which IWYTW harvests is subject to a privacy contract and is protected by US privacy and data security laws. And while the Canadian band may have sold certain rights to the artists for use on the artwork, they retain moral rights—under Canadian law—over any future alteration that may occur during the conservation of the artwork.

Thus what we have is an artwork that exists as a multiple object of property. IWYTW is, at the same time, a proprietary object, an open source object, as well as a copyrightable object. So IWYTW is not only distributed logically and spatially but also legally, since it is an object that sits across different property regimes and that cannot be reduced to, or be forced to operate within, any single one of them.

The upshot for MoMA is that, in practice, there is not much more the museum can actually acquire to own IWYTW, since most of the missing components are enshrined in property regimes that prevent their full appropriation by the museum.

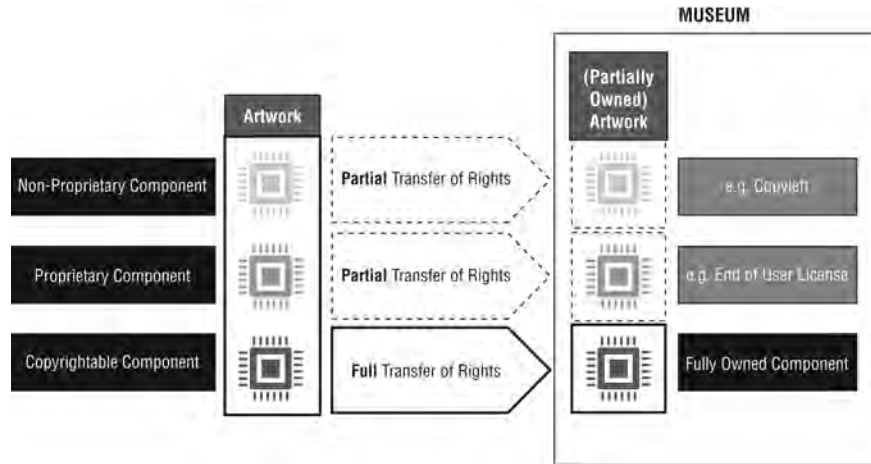


Figure 9 Acquiring a digital object as a partial possession.

This has huge practical implications for the museums, since it means that an artwork like IWTWM is, and can only be, a partial possession: it can never be fully appropriated, fully owned, or fully integrated into the museum (fig. 9). So if we were to draw an analogy, we could say that it is as though the museum had acquired a Monet but was able to own only the blues of the canvas, could only obtain a temporal license to display the reds, and could not show the yellows of the painting because the rights belonged to some private corporation.

The paradox of these partial possessions is that even if the museum could one day access components that are currently protected by copyright, it would still need to find parts no longer commercially available and, perhaps more importantly, locate people with knowledge and expertise to keep the technologies alive. A tall order indeed, since finding someone who can repair a U-Matic player today can be much more difficult than finding an actual working U-Matic player.

This raises the question, How can the museum preserve an object that is not only constantly circulating, multiplying, and regenerating but also that cannot be fully owned? And perhaps more importantly, what kind of memories and narratives, and what kind of cultural registry of the present, can be built with these fragmented and incomplete objects?

The Form of the Memory to Come

We have now entered an age in which bronze, paper, wood, stone, or iron are no longer the main mediums in which to cast our memories, meanings, relations, and imaginations. The digital has become the new vernacular of our age. In this essay

we provided a sketch of the anatomy of this emerging vernacular by exploring the fragility of the digital record that hides under the illusion of perfect memory produced by the massive digital archives of the present.

By focusing on art, we explored how the fragility of digital objects wreaks havoc on the guts of one of the paradigmatic memory machines of modernity. In so doing, we showed that digital technologies do not simply offer a new technological means but entail a different ontology, one that operates in a very different regime of objecthood, that is, a different way of producing objects and relations between them. Specifically, we showed how this digital ontology does not support the kind of unique, singular, and authentic objects on which the museum has traditionally relied, producing instead endlessly circulating, disseminating, regenerating, and distributed objects. These are objects that can be simultaneously past and present, originals and copies, unique and multiple, owned and nonowned—and that, as such, cannot support the same forms of authenticity, temporality, and ownership that have traditionally anchored the modern narrative of art. Yet as we hope it has become clear, the emergence of digital objects does not announce the end of these concepts. Rather, we argued, these digital objects require diverse and new infrastructures of memory organized around a different set of memory practices as well as a cultural logic in which categories such as authenticity, temporality, and ownership cannot be constructed in the same way, or do not necessarily mean the same thing.

The irruption of these digital objects alters not only how museums produce the memory and narrative of art but also how art itself is done by reconfiguring the very ontology of the contemporary art object. The affordances of this new ontological register are reshaping artistic practices by enabling artists to produce art objects that are circulated, disseminated, and regenerated, as well as spatially and temporally distributed. In some cases, these affordances are being deployed to circumvent or resist existing institutional structures by creating objects that cannot be incorporated into the property regimes and logics of commodification that organize the contemporary museum and the art market, or by experimenting with new forms of participation that are redefining the traditional relation between the audience and the artwork. This is the case, for example, of those artists using open-source platforms to create modular, distributed, and interactive artworks. In these cases, the digital is being used as a vector to redescribe, or even move beyond, the modern categories and institutional logics on which modern art has been premised (Chayka 2016; Groys 2016; McQuire and Radywyl 2010; Medosch 2016). However, in other cases, these very same affordances are being used to further entrench existing modern categories and institutional logics. The ability

to reproduce, disseminate, and distribute artworks has been appropriated by many market-savvy artists as a way to multiply their profit by selling multiple editions of the same artwork or by creating artworks that can be exhibited simultaneously at different venues. In these cases, the digital is actually working as a vector in the expansion of the logic of commodification that feeds contemporary art markets (Chierico 2017; Domínguez Rubio and Silva 2013).

Needless to say, many of the things what we discussed in this essay are specific to art. After all, the art world operates under a very narrow regime of objecthood, one in which even a small variation can be sufficient to call into question the value or meaning of a given object. Things like the presence or absence of grain, or the subtle difference in color rendering between different software environments, may not be problematic for other practices. And yet, the fragility of these new digital cultural objects raises questions that go well beyond the world of art.

These fragile, circulating, disseminating, regenerating, and distributed objects are now increasingly central parts of the fabric through which contemporary institutions operate. The problems of how to build durable forms of evidence with these fragile digital objects, how to sustain the difference between original and copy, or how to anchor them in time to produce a clear distinction between past and present are ones that most contemporary institutions face today. The National Aeronautics and Space Administration (NASA) needs to keep running obsolete digital infrastructures and software to keep space missions and satellites launched decades ago (Cohn 2016). Scientists have to hire digital curators to ensure the authenticity of digital objects in the massive digital databanks containing DNA records, astronomical data, or climate-modeling records, and as a result, the kind of truth-claims that they can make about them (Peng et al. 2015). Likewise, the juridical system and law enforcement have to figure out new ways of producing evidence in the digital realm (Gates 2016; Blanchette 2012); libraries have to create new infrastructures to cope with contemporary knowledge practices that are increasingly produced within this digital medium; while states (and corporations) have to figure out ways of managing and preserving the ever-growing volumes of digital datasets that mediate and define contemporary forms of citizenship (Isin and Ruppert 2015).

These are just some examples of how the irruption of these digital objects is redescribing existing cultural logics and institutional structures. What we argue is that the fragility of the digital is at the heart of these reconfigurations. This fragility becomes particularly critical if we consider one of the defining features of contemporary culture: its proprietary form. Never before have the basic technologies and infrastructures required to produce and transmit cultural meaning and knowledge been so firmly entrenched under proprietary control and have been

made so dependent on corporate structures for which fragility is more an asset than a problem—a dependency that is only set to increase as a result of massive migration of data to the corporate infrastructure of the cloud.

The last decade witnessed the emergence of open-source collectives that tried to address the fragility of the digital by disembedding these digital objects from the proprietary software and hardware infrastructures in which they are locked, and by creating open-software and open-hardware platforms around repair and fixer collectives. In the case of art, this effort has materialized in the emergence of different communities of practice and platforms devoted to developing tools aimed at sustaining the migration and emulation of digital artworks. Even MoMA now relies on open-source platforms to run its digital art vaults.⁸ Yet while promising, these new forms face different practical problems, such as how to sustain these communities of practice over time (Kelty 2008) and, perhaps more importantly, how to address the asymmetry of power against an industry that needs to lock these objects into increasingly tight software, hardware, and legal enclosures to sustain the logic of profit making—a logic that, as we know, does not necessarily have unprofitable ideas such as public interest, common good, or collective memory at its core.

The result of this asymmetrical tug-of-war between those trying to open up these increasingly closed-off digital objects and the corporate attempt to enclose them further is what will determine the shape of the memory to come. And how (or if) that hauntingly beautiful commentary about solitude and love that *Lovers* is will survive beyond the fragile digital infrastructure in which it was born.

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8. And so are most important scientific institutions, like NASA, as well as most major libraries and archives, which are creating coalitions such as the Open Preservation Foundation, or the Digital Preservation Coalition, devoted to creating and sustaining open-source infrastructures.

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