Longevity of Electronic Art

submitted to International Cultural Heritage Informatics Meeting, 2001

written Feb 2001

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This paper explores the problems of maintaining accessibility to electronic works of art over time. It examines the various hardware and software issues surrounding digital longevity, then discusses the special characteristics of electronic art that make it much more problematic to preserve than more conventional types of works. Finally, the author offers up a new paradigm for approaching preservation of these types of works, and suggests some concrete/pragmatic steps that can be taken to preserve this type of material.

Background and Problem of Digital Longevity

In the mid-1990s the library community began to worry about the fragility of works stored in digital form. The Commission on Preservation and Access and the Research Libraries Group formed a task force to explore how significant this problem really was. The Task Force report sounded an alarm "Rapid changes in the means of recording information, in the formats for storage, and in the technologies for use threaten to render the life of information in the digital age as, to borrow a phrase from Hobbes, 'nasty, brutish and short.'" (Task Force 1996). As the problem of digital longevity had repercussions within the arts community as well, the Getty Conservation Institute and Getty Information Institute collaborated with leading technologists to put together a conference and book trying to broadly outline and bring attention to the problem (MacLean and Davis 1998). Both of these seminal works grappled with the broad problem of digital preservation, but neither directly tackled the problem of how to conserve a complex work of art originating in digital form.

Electronic works (such as moving image materials, multimedia, interactive programs, and computer-generated art) have very different characteristics from physical artifacts (such as oil paintings, vases, sculptures, and manuscripts). From a conservation perspective, electronic works have more characteristics in common with performance art, conceptual art, site-specific installations, and experimental art. Like performance art, electronic works are usually difficult to capture, and (as examples later in this article will demonstrate), in many cases it's not even clear what elements ***need*** to be captured. The long-standing preservation techniques developed for physical artifacts do **not** address the problem of preserving electronic works.

Electronic works are encoded and usually stored on a physical storage devices such as a digital or analog tape. The most obvious impediment to electronic longevity is what this author has termed "the viewing problem" (Besser 2000a). While the default for physical artifacts is to persist (or deteriorate in slow increments), the default for electronic objects is to become inaccessible unless someone takes an immediate pro-active role to save them. Thus, we can discover and study 3,000 year old cave paintings and pottery (even though the pottery may be in shards that we need to piece together). But we're unable to even decipher any of the contents of an electronic file on an 8-inch floppy disk from only 20 years ago.

The most obvious problem for preserving electronic information is the obsolescence of physical storage formats. The office world has gone through transitions of digital storage devices from 8-inch floppy disks, to 5.25-inch floppies, to 3-inch diskettes, to CD-ROMs, to DVDs. Digital artists, requiring larger file sizes, have also used a variety of optical storage disks, DAT, Syquest, Zip, CDRW, etc. But these storage devices become obsolete very quickly, and today it's very difficult to find a drive for one of these storage devices that will work with a contemporary computer. For digital works, technologists offer the "solution" that we need

merely copy a file onto a new physical storage medium as the old medium becomes obsolete. (After all, unlike analog technologies, we can recopy a digital file onto a new medium without any of the content deteriorating.)

This concept of *Refreshing* (first outlined in Task Force 1996) involves periodically moving a file from one physical storage medium to another to avoid the physical decay or the obsolescence of that medium. Because physical storage devices (even CD ROMs) decay, and because technological changes make older storage devices (such as 8 inch floppy drives) inaccessible to new computers, some ongoing form of refreshing is likely to be necessary for many years to come (Besser 2000). Besides raising the issue of assuring authenticity (see authenticity discussion below), this suggested approach ignores the even more substantial problem of constantly changing file formats.

Transferring files to new physical storage devices has no impact whatsoever on the rapid obsolescence of file formats. Word processing files (which are primarily ascii text, and thus much simpler formats than images or multimedia) are generally readable for half a dozen years after they are created. But even these word processing formats become inaccessible after a dozen years. Fifteen years ago Wordstar had (by far) the largest market penetration of any word processing program. But few people today can read any of the many millions of Wordstar files, even when those have been transferred onto contemporary computer hard disks. Even today's popular word processing applications (such as Microsoft Word) typically cannot view files created any further back than two previous versions of the same application (and sometimes these still lose important formatting). Image and multimedia formats, lacking an underlying basis of ascii text, pose much greater obsolescence problems, as each format chooses to code image, sound, or control (synching) representation in a different way.

Two key approaches have been proposed to deal with the problem of changing file formats (Task Force 1996): ***migration*** and ***emulation*****.** These are seen as alternatives to one another, but both approaches are supposed to be used in conjunction with ***refreshing*****.**

Migration is an approach that involves periodically moving files from one file encoding format to another that is useable in a more modern computing environment. (An example would be moving a Wordstar file to WordPerfect, then to Word 3.0, then to Word 5.0, then to Word 97.) Migration seeks to limit the problem of files encoded in a wide variety of file formats that have existed over time by gradually bringing all former formats into a limited number of contemporary formats.

Emulation seeks to solve a similar problem that migration addresses, but its approach is to focus on the applications software rather than on the files containing information. Emulation backers want to build software that mimics every type of application that has ever been written for every type of file format, and make them run on whatever the current computing environment is. (So, with the proper emulators, applications like Wordstar and Word 3.0 could effectively run on todayís machines.) Emulation is most closely associated with the writings of Rand scientist Jeff Rothenberg (Rothenberg 1995, 1999, 2000).

Two Problems Particularly Germane to Electronic Art

Two other problems particularly germane to electronic art are what this author has termed "the inter-relational problem" and "the translation problem" (Besser 2000a).

As the WorldWide Web dramatically demonstrates, information is increasingly inter-related to other information. Any given web page typically contains links to numerous other web pages. These links are important to the content, meaning, and contextualization of that web page, yet the pages that are linked to are likely to change their location or content over even a short period of time. According to Internet Archivist Brewster Kahle, in 1997 the average Web document lasted only 75 days (Shenk 1997). (Indeed, the most common message on the WorldWide Web is "404 File Not Found", indicating that the pointed-to file has been moved or removed.) In attempting to preserve a web-based work of art, one may need to capture all

the web pages pointed to by that work at the time of creation (and iteratively, all the pages that those pages point to as well). This task may prove to be huge (and possibly intractable).

This boundary issue even exists within the interlinked pages of a given artist's own website. It is not uncommon for a piece of web art to consist of literally hundreds of web pages all interlinked to one another. Nested works (whole works completely embedded within larger works), overlapping works (with some pages being part of more than one work) and inter-woven works are all forms of web art. In addition, even a web page without user-clickable links can incorporate source material from many different files (with still images, moving images, and animations all coming from different physical files, some of which may be on websites not controlled by the artist). In a profound leap, the re-use and recontextualization of pieces which has been a major theme in 20th century art (from early century collage, to Dada, to Pop, through Postmodernism) has reached a new level on the WorldWide Web where works can actually incorporate other works by linking to them instead of copying them (and the referencing works will instantly incorporate any changes in the works that they reference). Conservators seeking to preserve digital works need to be careful about where the boundaries of those works really are. This is part of the larger issue of what the work really is (discussed below).

Another important issue is how a work translated into new delivery devices changes meaning (the translation problem). While a lay person may occasionally confuse the two, people in the cultural heritage community are clear that a photograph or poster of an oil painting is definitely different than the painting itself. We clearly understand that a reproduction of a work (particularly changing into another format) may convey certain characteristics of that work, but is dramatically different than that work. The faithfulness of the photographic reproduction processes has raised questions about differences between originals and reproductions (Benjamin 1978, Besser 1997), particularly of photographs. But those of us in the cultural heritage community still recognize that a digitized photograph displayed on a screen is quite different from the paper-based photograph it was digitized from, or that a motion picture film converted and shown on a video screen is quite different from the original film.

Today, most electronic works of art (both analog and digital) are displayed on cathode-ray tube screens (CRTs). With the advent of liquid-crystal and other flat-panel display units, a decade from now CRT screens may be as rare as black and white monitors are today. And fifty years from now it is unlikely that one would be able to even find a working CRT screen. For some electronic works (certainly for those that concern themselves with the "look" of a CRT), attempting to display that work on a flat-panel screen would result in something that the artist would regard as poor reproduction of his or her work (perhaps akin to a photograph of an oil painting). For one of his pieces that opened in the new Tate Modern Museum, artist Gary Hill told the museum that they can replace fading CRT screens with other similar-sized CRT screens, but he forbid them from replacing any of them with flat-panel screens (Laurenson 2000).

Historically, the display of a work of art was closely tied to the medium that artist used to construct it. Display conditions have traditionally been fairly predictable , with viewing conditions varying primarily due to effects such as different lighting. Even with the advent of non-installation video art (which functionally separated the display [CRT] from the work [on tape]), that artist could still expect that any display device would have a very limited set of predictable characteristics (a tube/CRT). The separation of a work from its display is a key part of the digital revolution, and future non-installation digital works will likely be able to be displayed on a wide array of devices that will emerge in the coming years. Museum curators and conservators will need to struggle with deciding when a particular display device is an important characteristic of a work, and when a particular form of playback may be intrinsic to the work. (As will be noted below, this is one of several arguments for involving the artist in decision-making that will become important to digital conservation activities.) Curators will also need to make plans of how to preserve the appropriate device, as well as how to indicate to future museum staff that they need to display this work on a particular type of device.

Conservation Challenges: Special Charactistics of Electronic Art

Electronic Art poses enormous challenges for conservators. Some of the problems are endemic to all electronic works, while others are specific to electronic works of art. As a number of other pieces have examined longevity challenges for works outside the art world (Besser 2000a, Besser forthcoming, Rothenberg 1999, Lyman & Besser 1998, Russell 1999, Sanders 1997, Task Force 1996, Van der Werf 1999), this paper will put more emphasis on problems posed by electronic works of art. In this section we will briefly describe a handful of these challenges. Not all of these challenges are posed by all types of electronic art (some are confined only to digital works, others are confined to web-based art, and some are confined to just particular works and not to every work of a particular type). Wherever possible, we will try to indicate which classes of works this applies to.

Electronic works **lack fixity**. As mentioned in the "translation problem" discussion (above), non-installation electronic art is independent of the device that is used to view it. The work is stored on analog tapes or a set of digital files which may be reproduced (or even mass-produced). The likely inability to distinguish between an "original" and a "copy" will have a profound effect on museums, one rivaling the effect that photographic reproduction had on art (Benjamin 1978, Besser 1987, Besser 1997). This will cause a paradigm shift in how a museum views its holdings (as relatively unique original objects) and how the museum certifies their authenticity (see below). Conservationists will also have to shift from the paradigm of repairing and saving a physical object to that of maintaining a set of disembodied artistic content over time.

Web-based works are often **dynamic**; pieces of a work may be constantly changing, either because the art is a "work in progress" that an artist may want to alter periodically over some period of time, or because the artist wants a completed work to periodically change over time due to the actions of others. Artists sometimes purposely inject elements of controlled chance into web-based art by making their work point to web pages that may be periodically changed by others. Both these strains of dynamism pose serious challenges to a conservator trying to preserve such a work. Conservation approaches to previous types of dynamic works can provide helpful insight, but are by themselves inadequate for dealing with this problem. (For example, the dynamism associated with a John Cage piece can be captured by a combination of a rigid formula coupled with examples. With a Cage piece, the conservator's knowledge of the artist's intentions permits the adequate capture of the work as the artist intended it. Few creators of web-based works offer the level of explanation of their intentions that Cage does.)

As we have seen in the discussion of "the inter-relational problem' (above), web-based works pose significant questions as to **what is the boundary of a work**. Pieces that link to other pieces, and may lead a viewer from one website to another pose problems for anyone trying to capture and preserve a work. Anyone who has tried to download a complex web-based work onto a laptop to show that work without an Internet connection can attest to the difficulties in making sure that everything necessary was downloaded properly. Conservators face a real challenge in assessing the proper boundaries in trying to capture a web-based work.

As we have seen from the discussion of "the translation problem" (above), we can expect that today's electronic art will be viewed on very different systems in the future. Conservators need to work with curators and artists to be aware of certain critical **formal elements** of the work (pacing, color, aspect ratio, format, etc.) that may need to be resurrected in any future viewing situation. Some such elements may be so intrinsic to the work that the artist would deny authorship of a preserved work having one of these elements changed. For example, at the Getty's Time & Bits Conference (MacLean and Davis 1998), Jaron Lanier recounted the story of a cult of kids who had constructed an emulator to run one of his earliest computer games. When Lanier went to visit and watch them playing it, he contended that this was not the game as he had designed it. Contemporary computer processors made the game run much faster, and that faster pacing transformed the piece into something he refused to accept as his work.

Conservators need to not only note which of the formal elements are important to a work, but they may then need to work with technologists to make sure that they maintain the data necessary in order to resurrect these formal elements.

Electronic works pose a serious challenge of guaranteeing **authenticity** over time. Traditionally, our method of guaranteeing authenticity was through the custodialship of an artifact. Ancillary documentation was occasionally used to support provenance disputes, but authenticity was primarily based upon a chain of custody from one trusted owner to another. But because the physical strata for an electronic work has such a short life, our conception of an electronic work is no longer embodied in a physical artifact, but instead in a stream of analog or digital data. For preserving digital works, we have shifted our conservation practices away from the physical artifact (through periodic refreshing). But we have not yet developed sophisticated approaches for assuring the authenticity of a work. The lack of fixity means that there could be many different copies of a work, and if these differ from one another, which is the "real" work? Even though it is not likely to occur frequently, refreshing might occasionally alter a work. And the **malleability** of a digital work means that someone could easily re-edit or eliminate material in a copy and pass this off as the original. A more detailed discussion of authenticity issues is available in (Council 2000).

Perhaps the most important challenge facing those trying to preserve an electronic artwork is "**What really is the work?**" This can be a much larger problem than the fixity, dynamic, boundary, and formal issues raised above (and includes the interplay between these, as well as other problems). This question has been raised by other forms of contemporary art as well. For many types of Conceptual Art, the importance lies more in the ideas than in the physically executed objects. The actual "work" may not be embedded within the object itself, but rather may lie in the signs and information used to construct it. What is a work by Dan Flavin or Sol LeWitt -- the installation or the instructions for the installation? What is the definitive "work" in a performance piece that might be different each time it is performed? In some cases saving a video of such a piece may be less faithful to "the work" than preserving scripts and notes. And with a John Cage piece, a formula and directions may be a much more faithful rendition of "the work" than an audio recording of a performance. If the observations for these types of works is accurate, it argues for a deconstructive approach to preserving the essence of a work, and the importance of theories like semiology in understanding it.

Other electronic art is so situational that it eludes real capture. For example, for their 1980 piece "Hole in Space" the Electronic Café set up video projection screens and hidden microphones in storefront windows in Los Angeles and New York, hooked these together via satellite, and waited to see how long it would take people to notice that they could communicate with people across the country, and how they would choose to use this (see illustration). People just stumbled upon this in surprise, and word spread quickly. Crowds played games, explored stereotypes between Californians and New Yorkers, and some even called relatives and arranged meeting times to give them their first look at their grandchildren . In a piece like this, what is the work? The video feeds from the NYC projection? The Video feeds from the LA projection? The plans for the installation? Interviews with people in the crowd? It's not easy to define even what the piece is, let alone what about it needs to be saved.

This question of what really needs to be saved is a huge issue, worthy of an entire paper, so here we will only point to a few brief questions particularly focused on electronic art. In an age of interactivity doesn't each viewer see a different piece in a dynamic work that keeps changing? If we can only make sure that certain elements of a piece persist over time, how do we decide which elements to make persist? For a work that references and incorporates large parts of the Web, should we try to save those parts that it references and incorporates? Is the technological environment that a work is embedded in an important part of that work and worth trying to save? (If so, what about the social, cultural, and political environment?) Are some interactive pieces so embedded in a larger environment that we might consider the task of really saving them an impossible one? In the following section we begin to grapple with approaches to the questions posed here.

How Can We Approach the Preservation of Electronic Works?

The conventional paradigm that has shaped conservation efforts for centuries is focused on "preserving the artifact." It is clear that that approach will not be effective for electronic works of art. Here we propose a more viable approach involving: trying to ascertain what the work really is, trying to make the critical portions of it persist over time, and saving ancillary materials that become critical to understanding that work (and may be the only evidence of the work that we can confidently make persist over time).

What is the Work?

The most critical element to saving a work of electronic art is first determining what that work really is, how far it extends, what its boundaries are, under what technical environments it should be shown etc. This is an activity that must be undertaken jointly between a curator and conservator, and is likely to involve the artist as well.

While some curators may maintain that the artist's role is creation and the curator's role is interpretation of that creation, that view is certainly changing. In the latter part of the 20th century, artists increasingly became involved in planning museum installations of their works. Though the idea of artist participation may have initially been jarring to conventional museum practice, it eventually became commonplace for contemporary exhibitions. Artist participation in conservation activities (that today appear jarring to traditional museum culture) may eventually likewise become accepted (and even commonplace) practices.

There is a growing movement in this direction among contemporary art museums. An international conference on this subject was held in the Netherlands in 1999 (Artists Interviews 1999). It recently became standard procedure for the Tate Modern's conservator to interview the artist for each newly acquired electronic work (Laurenson 2000). Guggenheim Museum Assistant Curator Jon Ippolito (himself an electronic artist) has advocated collaborative involvement between artists and museum staff over how their works should be shown and maintained over time (Ippolito 1998).

Some postmodernists may argue that, because a work's value lies in its interpretation, the intention of the artist is only of minimal importance. But most of these critics should agree that the artist's own description of his/her work is still important to historical and curatorial interpretation, and hence is an important historical record to preserve. And the artist's intentions can be critical to future curatorial decisions about how to appropriately display or contextualize the work (particularly in eras when the initial display equipment may be unobtainable). Capturing an artist's intentions (as well as capturing a curator's interpretation of a work's significance) need to become important parts of museum records. These records will need to be examined by both conservators and curators, and hence need to be mainstreamed within the registration process.

The museum community needs to develop standards for capturing these descriptions and intentions in ways that are fairly consistent from institution to institution. (Standards are important for a wide variety of reasons, from handling traveling exhibitions, to sharing records [or exhibition planning] for similar works residing in different institutions, to creating a multi-institution market for collection management systems so that vendors will incorporate these features into their systems, rather than as expensive individualized system extensions.) Recording precise records are important if we want that information to be accessible beyond the life of the curator and conservator present when the work was acquired.

Though eventually these standards may consist of a number of fixed fields each centered around a precise attribute (importance of color within a particular part of the piece, importance of pacing within a given section of the piece) and controlled set of values, for each attribute we do not yet know enough about the attributes that we will need to capture. It might be wise to follow the path recently adopted by the group designing Technical Imaging Standards for the National Information Standards Organization (Bearman 1999). After struggling to precisely articulate all the technical variables that might be involved in making a faithful digital copy of a photograph, this group settled upon several precisely defined fields as well as a fairly open field to express "reformatting intentions" in plain language. As that community gains experience in describing contents for that open field, it is expected that more precise describable attributes will emerge, become standardized, and be split off into their own fields (where they will be more consistent and easier to manage).

Descriptions and intentions of a work are not only rich information for museum staff, but these can also be extremely useful to the scholar and the general public. Care must be taken to identify which parts of that information should be restricted to museum personnel, which should be accessible for public viewing, and which might be subject to gate-keeping or periodic review of restrictions.

Strategies for making portions of a Work persist over time

As we have described above, many electronic works have variant forms; in fact a single piece of Web art can look different when viewed simultaneously on Web browsers having different settings. In this respect electronic works are similar to forms of performance art. For more traditional forms of performance art, a common practice has been to save a canonical form of the work (the written play for a dramatic work, the score for a musical piece) as well as some audio/visual recordings as examples of particular performance interpretations. Conservationists may well consider capturing a canonical form of an electronic work alongside views of different instantiations of that work, as well as various forms of evidence about that work.

Though traditional forms of theater and music have well-developed approaches to finding a canonical form that forms the basis of most instanciations (performances) of that work, more contemporary art forms have not yet explored how they can create a canonical form. With many contemporary works, canonical forms can be more effectively sought for groups of works sharing common approaches (rather than by general form or genre). For example, the canonical form of groups of works by John Cage, Sol LeWitt, and Dan Flavin may be a set of formulas and instructions for each work, and each performance, piece or installation might be

a variant form of a given work. As we being to understand more about contemporary forms of electronic art, the application of semiological analysis to groups of works may lead to the development of ways of expressing canonical forms for subgenres of electronic art. On a lower-order level, much progress has been made in addressing the construction of canonical forms for digital files (such as determining that the Microsoft Word version of a document may be a variant form of the pdf, html, and sgml versions) (Lynch 1999).

In trying to capture views of different instantiations of a work, one might first try to capture the electronic files and try to make these persist over time (using strategies such as migration or emulation). For web-based works, this might involve not just saving the artist-constructed files, but also saving the web browsing software available to users to view these as they were displayed when the work was created. For digital works that change over time, this might involve capturing files at regular intervals, forming snapshots of what the work looked like at any given point. For highly interactive works, this could also involve videotaping users and displays during various types of interactions.

Ancillary materials

As we begin to recognize that we may not be able to save the work in the form that it was originally expressed (and may not be able to save it at all), ancillary materials that explain and contextualize the work become more important to save. These materials may serve as forensic evidence for a work that effectively no longer exists.

Sketches, drawings, and plans for a work can be important in understanding both the work itself and the artist's intentions. Proposals written by the artist, as well as correspondence with technicians, helpers, and curators can also help explain the work. A whole host of archival material can serve as evidence of the work, and help people in the future to understand what the work looked like as well as to contextualize it.

Interviews with people after they have seen or interacted with a work can help future scholars and viewers to understand the impact and importance of that work, as well as what the work actually looked like. Particularly for works that involve interactivity or some other experiential component, interviews can be important in contextualizing and understanding the work. For example, in trying to explain the Electronic Café's "Hole in Space," videotaped interviews with people immediately after experiencing the piece have been highly effective in both describing the piece and in situating it and its importance.

In a sense, conservators of electronic works may need to become more like both archivists and cultural anthropologists. As archivists they may need to save all kinds of ancillary materials, and may also need to intervene to help save records usually relegated to the realm of the Registrar. As cultural anthropologists, they may need to interview artists, curators, and museum-goers to help record the meaning and context for a work.

Standards

Because formats for storing works (as well as for storing records about works) are so rapidly changing and outdated, conservators may need to involve themselves in standardization processes (Besser 2000a, Lyman & Besser 1998). Encoding files and records in widely-adopted standard formats acts as a hedge against rapidly changing software -- the more people who are using a standard for encoding, the more likely that new formats will recognize that encoding standard. A wide variety of standards may be useful for electronic art.

High-order multimedia encoding standards (like SMIL and MPEG-4) may make digital art less fragile and subject to changes in application software such as Director, Acrobat, and Flash. Standards are also needed for synchronization units used for timing between multiple image and sound projections within multimedia installations. Without such standards it will be difficult (if not impossible) to reconstruct installations years after a brand of synch unit is discontinued.

And though in recent years much effort has been made at standardization of museum collection management records (through projects such as CIMI), more work needs to be done in the area of standards for conservation records. As we have mentioned above, there is ongoing work in standardizing artists intentions. Other productive areas of standardization may include standards for condition reporting, particularly for annotation of digital images within condition reports.

It is really critical that we develop standards that will persist beyond the life of today's museum staff, or the even shorter life of hardware or software.

Conclusion

We have seen how electronic art is fragile and difficult to conserve. The artifactual value of electronic art is much different than the artifactual value of more conventional art forms. Because of changing technologies, electronic art originals can only be accessed/viewed/played for a very short time period. Though the original artifacts (such as tapes or disks) may have a great deal of value to a very limited number of connoisseurs, these people will not be able to view or use them for more than a few years.

In considering the longevity of electronic art, we need to move beyond the paradigm of conserving an artifact. We need to ask what that work really is, and have both curatorial and artistic input as to what parts of the work are most important to save (and in what fashion). We then need to employ relatively long-lasting encoding standards to try to preserve important functionality of that work. And we need to save a variety of ancillary materials which may be important in understanding the work.

In the coming years, we're likely to see a dramatic shift in the role of conservation. Conservationists involved with electronic art may take on roles similar to archivists and cultural anthropologists, as well as that of standards professionals.

Acknowledgements

Portions of the content of this paper were originally presented in two talks to the American Institute for Conservation in Philadelphia in June 2000 (Besser 2000b, Besser 2000c). Conversations with other presenters at that conference (particularly Pip Laurenson and Jill Sterrett) contributed to the author's evolving ideas on this subject. The author is particularly indebted to electronic artists Kit Galloway and Sherrie Rabinowitz of the Electronic Café International; discussions with them and ongoing work with over 20 years of their archival material has led to many of the ideas presented in this paper.

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