TECHNOLOGICAL AND ENVIRONMENTAL IMPACTS ON DETERIORATION OF DIGITAL INFORMATION RESOURCES AND MEASURES OF PRESERVATION

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Abstrak

Sumber-sumber informasi digital yang disediakan perpustakaan-perpustakaan dan pusat-pusat informasi menunjukkan peningkatan yang cukup signifikan. Salah satu tujuan utama digitalisasi adalah untuk meningkatkan akses terhadap sumber-sumber informasi yang dilayankan. Pada saat yang sama, ketika media teknologi informasi berubah dalam tempo yang cukup singkat, digitalisasi sumber-sumber informasi menghadapi tantangan mengenai siklus hidup sumber-sumber tersebut. Situasi ini memicu munculnya pertanyaan tentang apakah bahan-bahan digital tersebut dimungkinkan untuk akses jangka panjang. Dengan demikian, perawatan sumber-sumber digital menjadi salah satu isu paling penting yang dirasakan oleh komunitas perpustakaan karena digitalisasi di satu sisi dapat meningkatkan akses tetapi di sisi lain tidak ada kepastian sampai kapan akses tersebut berlangsung. Tulisan ini mencoba mengekplorasi berbagai kerusakan sumber-sumber informasi digital yang disebabkan oleh teknologi dan lingkungan serta mengungkapkan langkah-langkah pencegahan yang dapat dilakukan untuk mengantisipasi kerusakan-kerusakan yang akan terjadi.

Kata kunci: Digital Information Resources, Preservation, Deterioration, Technological and Environmental Impacts

I. Introduction

There is a rapidly increasing volume of information, which exists in digital form. Whether created as a result of digitizing non-digital collections, created as a digital publication, or created as part of the day-to-day business of an organization,

more and more information is being created digitally and the pace at which it is being created is accelerating. This circumstance is occurring in an environment in which there is a growing awareness of the significant challenges associated with ensuring continued access to these materials, even in the short term. Accordingly, the long-term preservation of digital resources is one of the most important issues facing the library community since digitization alone provides access but no preservation.

In light of the importance of the preservation, Cedars[1] informs that there are two critical reasons why preservation of digital materials has to be paid attention. First, due to their reliance on technology, which is rapidly obsolete, preservation of digital must be considered at time of creation or acquisition to the collection. Preservation decisions for digital items cannot wait until continued utilization has proved their value. Delays in taking preservation decisions can obstruct effective preservation efforts. Second, due to preservation and management of digital materials will prove costly, integration into the everyday management and organization of the library or archive will achieve the most effective economies of scale.

The digitization of library materials results in combination of two factors i.e. challenging and troublesome. On the one hand, there are considerable opportunities offered by digital technology to provide rapid and efficient access to information. On the other hand, there is a very real threat that the digital materials will be created in such a way that not even their short-term viability can be assured, much less the prospect that future generations will also have access to them. The need to create and have widespread access to digital materials has raced ahead of the level of general awareness and understanding of what it takes to manage them effectively.

To prepare how to prevent possible deteriorations on the digital resources, this paper attempts to explore various deteriorations on digital information resources and tells about measures can be done to cope with the damages.

II. Types of Digital Information Sources

Before coming to further explanation of deteriorations on digital information resources, we need to know whichever materials can be categorized as digital information.

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[1] The Cedars Project, *Cedars Guide to Digital Collection Management* (London: The Cedars Project and JISC (2002), pp. 4-5.

Digitized materials may consist of selected articles (conference papers), newspaper articles, pictures/images, multimedia resources, photograph of artifacts (scanned and downloaded from Internet, etc.), manuscripts, personal collection, artworks, examination questions, important information resources for classes not available in the local library, out of print materials, special letter of well-known personality identify, and background sounds and music.

Based on its purpose, the digital information source may be created for some reasons as follows:

- Personalized digital resources for e-learning;
- One-off projects e.g. a legend historic incidence, e-book, a report etc.;
- As and when required e.g. digital document delivery;
- Continuous project e.g. institutional memories;
- Multimedia digital resources e.g. three dimensions' (3D) photographic collection;
- Commercial resource or creating own digital resources;
- Creating in-house e-digital resources;
- Collection of commercial e-digital resources;
- Textual digital resources e.g. collections of articles, table of content.[2]

In the other source, Tedd and Large[3] generally classify digital information into four major groups.

- Full-text materials that cover e-journal, open access and open archive collections, electronic books, electronic theses and dissertations, and electronic newspapers.
- Metadata sources that cover catalogues, indexes and abstracts, and sources that provide 'information about information'.
- Multimedia materials
- Websites

In light of explanations above, we can say briefly that digital materials range from relatively simple, text-based files (e.g. word processing files), to highly sophisticated web-based resources, which fully exploit the benefits of the technology (e.g. combining sound with images, the ability to link to other resources, the ability to interrogate the data). Any type of digital information sources proposed, as

[2] Shahar Banun Jaafar, *Lecture Notes on Digital Libraries* (Kuala Lumpur: DLIS, 2006), p.1.

[3] L. A. Tedd and A. Large, *Digital Libraries: Principles and Practice in a Global Environment* (Munchen: K.G. Saur, 2005), pp. 51-69.

mentioned above, all of them come with digital signal or code that must be read electronically.

III. Deteriorations on Digital Information Resources

Fire and water are the two great threats to collections and records not only traditional library but also digital library. Many incidents to mention where libraries were demolished because of the two threats. Now they have been joined by other, more insidious, but just as disastrous threats: computer viruses, hackers, file format obsolescence, storage media degradation or obsolescence, platform dependence, catastrophic system failure, natural disasters, terrorist attacks, and simple neglect.[4] These threats are being faced by digital collections and they can bring about deteriorations on digital information sources. For purpose of this paper, elements of deterioration just focus on two issues i.e. technology and environment. This is in line with survey that is conducted by Research Libraries Group (RLG) that "digital materials, regardless of whether they are created initially in digital form or converted to digital form, are threatened by technology obsolescence and physical deterioration."[5]

3.1. Technological Issue

The speed of changes in technology means that the timeframe during which action must be taken is very much shorter than for print materials. Timeframes during which action needs to be taken is measured in a few years, perhaps only 2-5, as opposed to decades or even centuries we associate with the preservation of traditional materials. Technology obsolescence is generally regarded as the greatest technical threat to ensuring continued access to digital material.[6] Since technology will change rapidly so that even if the media is retained in pristine condition, it may still not be possible to access the information it contains. No matter how exemplary the care of the media is, it will not remove the requirement to deal with changes in technology, though responsible care should make it easier to manage technology changes.[7]

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[4] C. Anderson, "Digital Preservation: Will Your Files Stand the Test of Time? *Library Hi Tech News*, Vol. 22, No. 6, 2005, p. 9.

[5] M. Hedstrom and S. Montgomery, *Digital Preservation Needs and Requirements in RLG Member Institutions* (Mountain View, CA: RLG, 1998), p.3.

[6] N Beagrie and M. Jones, *Preservation Management of Digital Materials: A Handbook* (The Digital Preservation Coalition: England, 2006), p. 16.

[7] N Beagrie and M. Jones, *Preservation Management*, p.20.

Based on thoughts stated above, some of the major issues of damage on digital collections caused by technology take in file formats, storage media, and technology infrastructure (including security). The three items are pertaining to the long-term viability of files that are usually handled on the "front lines" by the creators of the digital files and the IT/systems personnel.

3.1.1. File format

One of deterioration on digital information is file formats using proprietary software with closed specification.[8] A proprietary file format is one developed by specific company and protected under intellectual property laws, whether patent or copyright. Most of the files we use and create on daily basis are in a proprietary format, whether it is MS Word, WordPerfect, or PDF[9]. There is one critical difference among the proprietary files of different companies: some, such as Microsoft files, have a closed specification, which means that the company does not share the code that would allow someone to read the file without using their software. You need PowerPoint software to open a PowerPoint presentation.

Other proprietary files, such as Adobe's PDF and TIFF[10] formats, have open specifications, which mean that the company makes their code available to software developers and to their users. This becomes important if a company goes out of business, discontinues a product line, or stops supporting older versions of a file format. If the specification is open, it is still possible to get into the file, extract the information it contains, and move it into a new file format. If a specification is closed, this file is no longer readable or usable, and the information it contains is lost. Those of a certain age will recall WordStar, a popular word processing program in the early days of personal computing. When the company went out of business, there was no longer any support for those files, and soon there was so software available that would open them.

In brief, one of digital information deteriorations regarding file format is because it may be superseded by newer versions, which may no longer be supported by the current vendor or relevant standards body.

Moreover, file deterioration is also caused by density. File compression is danger for preservation, because when files are compressed, some information, bits and bytes, are lost. This is a frequent problem with image files like GIF[11] and

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[8] C. Anderson, "Digital Preservation, p.10.

[9] PDF (Portable Document Format) is a page description language developed by Adobe Corporation to store and render images of pages.

[10] TIFF (Tagged Image File Format)

[11] GIF (Graphics Interchange Format) is a format for storing compressed images.

JPEG[12]. Master image files should always be stored in a lossless format such as TIFF. Beagrie and Jones[13] assert that file compression algorithms can substantially reduce file sizes and have been widely used in document or image transmission. Compression can be either lossless or loss (with data loss but often higher levels of compression). Although appropriate in many cases for access and user copies, compression adds additional complexity to the preservation process.

3.1.2. Storage media

Storage media and networks/infrastructure are vulnerable to instability, obsolescence, security breaches, viruses, and malfunction. When we decide to buy storage media in low quality, information saved into the media will not function for long-term usage. If we restore information using cheap CDs or DVDs, the storage mediums can be only used for short term.

There is some hope that electronic technologies will prove a more stable storage for older materials. However, Evans and Zarnosky[14] remind that little testing has been done for their longevity. Even though we can afford the best storage media, there still serious concern the long-term value of digitization of print materials. For example, they reveal that current estimates regarding the storage media will have a 30-year longest life but this is no guarantee. In this regard, it is still possibility that the storage media cannot be read if we do not periodically check and restore it as necessary.

Furthermore, storage medium may be superseded by newer and denser versions of that medium, or by new types of media—smaller, denser, faster, and easier to read. As a result, the device needed to read a storage medium might no longer be manufactured. This causes that some digital information has problem to read. Because digital material is machine dependent, it is not possible to access the information unless there is appropriate hardware, and associated software, which will make it intelligible.[15]

3.1.3. Technology infrastructure

The ease with which changes can be made and the need to make some changes in order to manage the material means are challenges associated with ensuring the continued integrity, authenticity, and history of digital materials.[16] This

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[12] JPEG (Joint Photographic Expert Group) is a format for storing compressed images.

[13] N Beagrie and M. Jones, *Preservation Management,* p.129.

[14] G. E. Evans, and M. R. Zarnosky, *Developing Library and Information Center Collection* (Greenwood Village, Colorado: Libraries Unlimited, 2000), p.503.

[15] N Beagrie and M. Jones, *Preservation Management,* p.21.

[16] N Beagrie and M. Jones, *Preservation Management,* p.18.

comes to us because information technology changes continuously. We cannot avoid the changes since market forces encourage change, and today's hot technology is tomorrow's useless doorstop. The problem is compounded by the lack of standards for storage media and by the fact that there is no equivalent to the "open access" or non-proprietary software. We are at the mercy of the hardware manufacturers. Just pick up a simple example, in 1990's we use a 5 and a half inch floppy disk to save our files. Now, how difficult to find equipment to read the floppy.

In this regard, Su-Shing Chen[17] points out that software and hardware product are being updated and upgraded roughly every eighteen months. Companies in the information technology sector have reported that the majority of products and services they offer did not exist five years ago. Consider, for example, a conversion project in which documents are converted to some digital format. If the chosen format is part of a proprietary system, viewable only through a proprietary interface, when the company that markets the interface no longer supports the system and format, the digitized documents are all but lost.

3.2. Environmental Issue

Improper environmental conditions can result in decreasing the longevity of digital storage media and speed up damage to a data resource or its documentation. This is because digital media is fragile.[18] The media digital materials are stored on inherently unstable and without suitable storage conditions and management can deteriorate very quickly even though it may not appear to be damaged externally. This proves that digital resources are in danger when they are laid down in an inappropriate environment.

Some elements of deterioration of digital information resources resulted in environmental conditions are detailed as follows:

3.2.1. Temperature

Most experts agree that large fluctuations in temperature and humidity are more damaging than having slightly higher than ideal temperature and Relative Humidity (RH).[19] The storage environment is critical. When we have a video or

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[17] Su-Shing Chen, "Digital Preservation and Workflow Process", In Zhaoneng Chen, Hsinchun Chen, Qihao Miao, Yuxi Fu, Edward Fox, and Ee-peng Lim (Eds.), *Digital Libraries: International Collaboration and Cross-fertilization* (China.: sn, 2004), p.1.

[18] N Beagrie and M. Jones, *Preservation Management,* p.17.

[19] N Beagrie and M. Jones, *Preservation Management,* p.82.

cassette in a hot temperature, it will be damage or at least cannot be used for long term. The same thing can happen to our storage media. The worst environment is danger for digital collections especially when we do not keep the temperature and humidity instable. It means that fluctuations are the most damaging to digital materials.

3.2.2. Fume, Smoke, Food, and Drink

The environment that is not protected from fumes, smoke, food and drink will bring about deterioration on digital information sources. If contaminated operating conditions and environments will increase the scope for damage to media and devices. The high density of storage and the close proximity of device heads to the media mean even small particles such as smoke or other debris can lead to data loss.[20]

3.2.3. Sunlight

Sunlight also enables to lose data stored in optical storage media. Optical storage media such as CD-ROM (Compact Disc-Read Only Memory), CD-R (Compact Disc-Recordable), and DVD-ROM (Digital Versatile Disc-Read Only Memory) use laser light to read from a data layer. In CD-ROM, this data layer consists of a series of pits and plateaux in a metallic coating over a plastic disk. A clear acrylic coating is applied to the metallic layer to protect it from scratches and corrosion. CD-R employs a dye layer that is light sensitive as the data layer. Data is written to and read back using laser light. The use of light sensitive dyes means CD-Rs are less stable than CD-ROMs and more concerns have been raised over their use as archival media.[21]

Byers[22] states that CD-R, CD-RW, DVD-R, DVD+R, DVD-RW, DVD+RW, and DVD-RAM disc become unusable in matter of days. If such a disc is left in an environment that allows direct sunlight and extreme heat buildup, the organic dye or phase-changing film that holds the data will degrade quickly, causing the disc to become unreadable.

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[20] N Beagrie and M. Jones, *Preservation Management,* p.126.

[21] S. Ross, & A.Gow, *Digital Archaeology: Rescuing Neglected and Damaged Data Resources*, (London: The British Library, 1999). Retrieved August 10, 2006 from http://www.hatii.arts.gla.ac.uk/research/BrLibrary/rosgowrt.pdf

[22] F. M. Byers, *Information Technology: Care and Handling CDs and DVDs: A Guide for Librarians and Archivists* (National Institute of Standards and Technology: Maryland; Council on Library and Information Resources: Washington, 2003), p.26.

3.2.4. Magnetic Fields

Storage media is very sensitive in magnetic fields. Magnetic media consist of a variety of magnetic media and containers including a range of magnetic tapes (e.g. reels, cartridges, and cassettes) and disks (e.g. hard disks, floppy disks). They all utilize the magnetic properties of metallic materials suspended in a non-magnetic mixture on a substrate or backing material.

This provides a versatile and cheap storage medium and both the storage capacity and the ability to retain the magnetic charges holding the data have increased substantially in recent years. The method of construction and storing the data also point to potential weaknesses of magnetic media.[23] In this regard, if we lay down storage medium close to strong magnetic fields, these may alter the media and lead to data loss (e.g. electrical equipment and motors).

IV. Measures of Preservation on Digital Information Resources

The long-term preservation of those resources is one of the most important issues facing the library community. In light of the importance of the preservation, Cedars[24] insists that there are two critical reasons why preservation of materials has to be paid attention. First, reliance of digital materials on specific technology, which is rapidly obsolete, delays in taking preservation decisions so it can obstruct effective preservation. Second, integration of preservation into the everyday management and organization of the library will achieve the most effective economies of scale. Accordingly, the long-term preservation of digital resources is one of the most important issues facing the library community. In particular, a preservation strategy for digital objects, since digitization alone provides access but no preservation.

The long-term preservation of digital resources is one of the most important issues facing the library community. In particular, libraries need a preservation strategy for digital objects, since digitization alone provides access but not preservation. Anderson reminded us the importance of the preservation in which he said, "maintenance is always cheaper than recovery or re-creation, so it makes good business sense to plan for and fund preservation".[25] Likewise, the Public Record Office (PRO) also suggests that digital resources need to be actively managed according to established procedures, to ensure that they retain qualities

[23] N Beagrie and M. Jones, *Preservation Management,* p.125.
[24] The Cedars Project, *Cedars Guide to Digital*, p.5.
[25] C. Anderson, "Digital Preservation, p.9.

of integrity, authenticity, and reliability.[26]

4.1. Measures of Preservation on Deterioration Caused by Technology

The Preservation on damage of digital collections caused by technology in terms of file formats, storage media, and technology infrastructure (including security) is that nothing can be done without support at the highest levels such as organization stability, financial sustainability, and administration and accountability. Digital collections deal with digital objects and we have to make sure that they remain available and readable over time. The best we can do is to educate the higher levels of management about the necessity of maintaining these files, and the resources and funding required doing so. In addition, precautions can, and should be taken, which will greatly reduce the risk of inadvertently losing access to a resource because of changes in technology.[27] (Beagrie & Jones, 2006, p.21). These include using standard file and media formats, as recommended by reputable sources and providing detailed documentation to enable both contexts to be determined and to facilitate successful management.

4.1.1. File formats

To cope with deterioration related to file format, we are supposed to choose proprietary software with open specification. If we must use a proprietary format, prefer one with open specifications. If they are widely implemented, like PDF and TIFF (which is often treated as a standard for image files), they become a de facto standard, and we can be relatively certain that we will be able to read them five years from now.

Another solution is use standard file formats are certified by the ISO[28] or another standard-making body. These files are platform and software independent; they do not require a certain brand of software or a particular operating system to be usable. ASCII[29] text, XML[30], and SGML[31] are examples of standard

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[26] Public Record Office (PRO). *Guidelines on the Management, Appraisal, and P reservation of Electronic Records* (Public Record Office: Kew, 1999). Retrieved August 10, 2006 from http://www.pro.gov.uk/recordsmanagement/eros/guidelines

[27] N Beagrie and M. Jones, *Preservation Management,* p.21.

[28] ISO (International Organization for Standardization)

[29] ASCII (American Standard Code for Information Interchange) is a coding that represents individual characters as seven or eight bits; printable ASCII is a subset of ASCII.

[30] XML (eXtensible Markup Language) is a simplified version of SGML intended for use with online information.

[31] SGML (Standard Generalized Markup Language) is a system for creating markup languages that represent the structure of a document.

file formats. Work is underway to develop a standard for PDF files. When choosing a file format, the safest choice for preservation purposes is a standard. While there are no absolute guarantees – bits and bytes can degrade over time – standards are the best insurance we have.

For any proprietary file, make sure that our file does not fall more than two versions behind the current software. Files created with version 5 of software X should be updated when version 7 is complete. Software manufacturers do not always make new versions backward compatible with files created with older versions of the software for the simple economic reason that they want users to upgrade. When we have word processing files that we want to keep but do not want to update when new versions are released, consider saving them as ASCII text. We will lose the formatting but we will still have our content. With other proprietary files, try to eliminate the macros, animation, etc. and keep the file as plain as possible.

Some of the first techniques that we can do to cope with deterioration upon file formats, as stated by Anderson[32] are:

- Inventory all files and make a list of format.
- Convert older materials to newer versions (word processing files, spreadsheets, etc.).
- Try to limit the number of file formats you support.
- Watch the technology market for news affecting file formats (new standards, product updates).

4.1.2. Storage media

To avoid deterioration for storage media, we must take into account the best we can afford. It is true what Anderson reminds, "this is not the place to pinch pennies...you get what you pay for, so buy the very best you can afford whether you are purchasing CDs or security software."[33]

Types of storage media include hard disks, tape, and optical media. Hard disk is convenient and high capacity. Nevertheless, it will last only about five years. If we choose tape for backup, we go with high-density tapes like DLT, which have proved to be the most reliable. Gold CDs are the best choice among optical media, and have a shelf life of five to ten years. DVDs have a higher capacity (sometimes it is only possible to get one TIFF file on a CD) but have not yet been proved dependable for long-term storage. We cannot rely on our backups to cheap CDs

[32] C. Anderson, "Digital Preservation, p.10.

[33] *I b i d*

or DVDs. How we store the media is as important as the media we choose. The storage environment is critical. The same thing can happen to your storage media. The optimum environment for long-term storage is 688F with 40 percent humidity. The most important thing is to keep the temperature and relative humidity stable. The storage area should be protected from dust, magnetic fields, fumes, smoke, food, and drink. We have to treat our storage media as if it were a rare manuscript, as in many ways it is.

Moreover, another way to preserve our storage medium that will help significantly to reduce the danger of loss and include:

- storing in a stable, controlled environment;
- implementing regular refreshment cycles copy onto newer media;
- making preservation copies (assuming licensing/copyright permission);
- implementing appropriate handling procedures; and
- transferring to "standard" storage media.[34]

4.1.3. Technology infrastructure

The changes in information technology can be solved if we have good planning for it. Since only protection we have is planning, we have to develop an overall digital preservation plan and find the funding to support it. A digital preservation plan should include scheduled migration of materials to new media, offsite backup, a disaster recovery plan and scheduled regular testing of media and backups. Offsite back is important in case of a disaster that destroys our entire facility. A number of research libraries participate in a program called LOCKSS (Lot of Copies Keeps Stuff Safe) to backup their digital collections. Perhaps we can work out a similar arrangement with another institution in our region.[35]

Migration, as part of a digital preservation plan mentioned above, is one of strategies how to preserve digital resources because it is a means of overcoming technological obsolescence by transferring digital resources from one hardware/ software generation to the next. The purpose of migration is to preserve the intellectual content of digital objects and to retain the ability for clients to retrieve, display, and otherwise use them in the face of constantly changing technology. Migration differs from the refreshing of storage media in that it is not always possible to make an exact digital copy or replicate original features and appearance and still maintain the compatibility of the resource with the new generation of

[34] N Beagrie and M. Jones, *Preservation Management,* p.20.

[35] C. Anderson, "Digital Preservation, p.10.

technology.[36]

If the worst happens, having a disaster recovery plan in place will make all the difference in the outcome. This plan should be part of our library's overall disaster plan. We have to know where to turn for experts that specialize in data recovery. OCLC and Amigos Library Services both provide guidance in this area.

Regarding technology infrastructure, Feeney[37] suggests three approaches how to preserve digital resources.

- Preserve the original software (and possible hardware) that was used to create and access the information. This is known as the technology preservation strategy. It also involves preserving both the original operating system and hardware on which to run it.
- Program future powerful computer systems to emulate older, obsolete computer platforms and operating systems as required. This is the technology emulation strategy.
- Ensure that the digital information is re-encoded in new formats before the old format becomes obsolete. This is the digital information migration strategy.

4.2. Measures of Preservation on Deterioration Caused by Environment

There are some measures how to preserve digital collections' deterioration caused by environmental factors as follows:

4.2.1. Temperature

- Moisture content of the air and the temperature are important.
- If they are too high, they speed up the rate at which chemical reactions take place and the rate of deterioration is increased.
- When the temperature and the relative humidity are too high, the two acts together encourage the growth of biological agents.
- A general guideline – the lower the storage temperature is better.
- According to The British Standard, *Recommendations for Storage and Exhibition of Archival Documents,* materials other than paper should be generally stored at 13-16 deg C and a relative humidity of 50-60%.
- From another sources, digital information resources should be kept in consistent temperature – 20 deg C and relative humidity around 40%.
- Avoid large and rapid fluctuations in temperature and humidity.

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[36] N Beagrie and M. Jones, *Preservation Management,* p.94.

[37] M. Feeney (ed.), *Digital Culture: Maximizing the Nation's Investment* (The National Preservation Office: London, 1999), p.41.

- Ensure good air circulation by appropriate use of fans and windows.
- Use of dehumidifiers to reduce humidity in badly affected areas.
- Ensure buildings are properly maintained to keep out dampness during rainy periods.
- Allow media to acclimate to new temperature and humidity before using.

4.2.2. Fume, Smoke, Food, and Drink

- The environment that is not protected from fumes, smoke, food and drink will bring the deterioration on digital information resources.
- To avoid from the deterioration, the digital information resources should be kept from the exposure to the fumes.
- Sensor and alarm system can detect and report the presence of fume and smoke.
- Establish no food, drink or smoking policy in digital information resources storage areas.

4.2.3. Sunlight

- Optical storage media become unusable if it is left in an environment that allows direct sunlight and extreme heat buildup.
- To preserve the optical storage media, it can be done by minimizing the exposure to sunlight and UV from light fixtures.
- In order to limit the exposure to light, curtains and blinds that appropriate with the climate are important to be used.
- Use of insulation methods to reduce heat gain.

4.2.4. Fire and Flood

- Fire and flood can cause deterioration on storage media physically.
- Electrical wiring and electrical services ducting should not pass through storage areas.
- The materials and equipment should be non-flammable.
- Regular checking and maintenance.
- Building maintenance – floor drains, gutters and down pipes need to be kept clear.
- The damage of sensitive media and equipment can be minimized by putting the materials in the waterproof storage.

V. Conclusion

Based on explanations mentioned above, there are some points to conclude.

- Protecting the digital resources requires vigilance, education, and planning.
- The libraries and information centers should be aware of the causes that bring to the deterioration of digital information resources and avoid those elements growth.
- Every staff who is in charge of the collection preservation should be educated and informed about the elements of deterioration as well as measures of preservation on digital information resources.
- Every staff and library user should give their cooperation to overcome problems of the deterioration of digital information resources.
- Digital information resources have to preserve for purpose of providing knowledge and accessible by our next generations.

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