DIGITISING PHOTOGRAPHIC NEGATIVES AND PRINTS FOR PRESERVATION.

By

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A DISSERTATION PRESENTED TO THE FACULTY OF INFORMATICS AND DESIGN OF THE CAPE PENINSULA UNIVERSITY OF TECHNOLOGY IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MAGISTER TECHNOLOGIAE PHOTOGRAPHY

CAPE PENINSULA UNIVERSITY OF TECHNOLOGY

2013

To my mother, who did not always understand what I was doing and who, at the age of 96 years, lives to see me succeed with my ideals for further study.

ACKNOWLEDGEMENTS

I wish to thank my family and friends who supported me on this long journey and also photographic friends who anxiously waited for the completion of the project and the results.

A special word of appreciation for the Cape Peninsula University of Technology who had the confidence in me to award financial assistance at a time I needed it most to enable me to finish this research.

Thank you to Mr Irvine Meyer, Senior Lecturer of the Photography programme, Media Department at Cape Peninsula University of Technology and supervisor for my project, for years of patience, encouragement and advice.

The National Library of South Africa allowed me to carry on with this project while still fulfilling my daily duties. They also provided much needed financial assistance and allowed me to take appropriate leave to finish this thesis. Their willingness to allow me to attend a number of seminars, workshops and conferences helped me to meet people in the preservation and digitising fields, giving me the opportunity to gather data and information, and is much appreciated.

The following individuals and institutions also deserve special mention and appreciation:

- Mr John Tsebe CEO of the National Library of South Africa and Mr Douwe Drijfhout, Programme manager of Preservations Services at the National Library, for their encouragement over the years that I have been busy with the project.

- Sue-Adrie Jefthas, who helped designing the questionnaires and retrieving the data to make it more easily accessible to me to analyse the findings.

- Don Williams of Image Science Associates in the USA who gave invaluable advice, supplied the scanner test targets, and verified some results from test scans. I appreciate his patience with me as student as there were no local researchers whom I could approach for advice and help. The field was completely new to me with only a handful of reading material at my disposal for getting familiar with the principles and use of targets.

- Hans van Dormolen of the Koninklijke Bibliotheek, Netherlands for answering questions and for the supply of information as well as advice on targets.

- Jay Gatusso of the National Library of New Zealand who allowed me the use of his corrupted files as illustration of bit rot.

- Ria Groenewald of the University of Pretoria, Library Services and head of digitising projects for her encouragement, interest in the project and many discussions we had as well as for the knowledge that she shared freely with me.

- all institutions that were willing to take part in the survey.

- the Photographic Society of South Africa who allowed me to use their website for a survey by their members.

- Deon Kuhn for his valuable advice in terms of the scientific approach and the final editing of the thesis.

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BBC	British Broadcast Corporation.
CENDARI	Collaborative European Digital Archive Infrastructure.
DAC	Department of Arts and Culture.
DISA	Digital Innovation South Africa.
DNG	Digital Negative.
DPI	Dots per inch.
DVD	Digital Versatile Disc.
FADGI	Federal Agencies Digitization Initiative Still Image Working Group.
FEDORA	Flexible Extensible Digital Object Repository Architecture.
ICC	International Colour Consortium.
IFLA	International Federation of Library Associations and Institutions.
ISO	International Standards Organisation.
JISC	Joint Information Systems Committee.
JPEG	Joint Photographic Expert Group.
MTF	Modulation Transfer Function.
NARA	National Archives and Records Administration.
NDR	National Digital Repository.
NLSA	National Library of South Africa.
NRF	National Research Foundation.
OCR	Optical Character Recognition.
OECF	Opto-Electronic Conversion Function.
PDF	Portable Document Format.
PSD	Photoshop Document.
PSSA	Photographic Society of South Africa.

RAW	Unprocessed original captured data.
RGB	Red, Green, Blue.
ROI	Region of Interest.
SFR	Spatial Frequency Response.
TIFF	Tagged Information File Format.
TWAIN	Technology Without An Interesting Name.
UNESCO	United Nations Educational, Scientific and Cultural Organisation.
USA	United States of America.
USD	United States Dollars.
UTT	Universal Test Target.
WDL	World Digital library.

Abstract of dissertation presented to the Faculty of Informatics and Design of the Cape Peninsula University of Technology in fulfilment of the
requirements for the degree of Magister Technologiae: Photography

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September 2013

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This study deals with the pitfalls and standards associated with the digitisation of photographic artefacts in formal collections.

The popularity of the digital medium caused a rapid increase in the demand for converting images into digital files. The need for equipment capable of executing the task successfully, the pressure on collection managers to display their collections to the world and the demand for knowledge needed by managers and operators created pressure to perform optimally and often in great haste.

As a result of the rush to create digital image files to be displayed and to be preserved, the decisions that are being made may be questionable. The best choice of file formats for longevity, setting and maintaining standards to guarantee quality digital files and consultation with experts in the field of digitisation as well as attention to best practices are important aspects which must be considered.

In order to determine the state of affairs in countries with an advanced knowledge and experience in the field of digitisation, a comprehensive literature study was done. It was found that enough information exists to enable collection managers in

South Africa to make well informed decisions to ensure a high quality of digital collection.

By means of questionnaires, a survey was undertaken amongst selected Western Cape image preservation institutions to determine the level of knowledge of the managers who are required to make informed decisions. The questionnaire was designed to give insight into choices being made regarding the technical quality, workflow and best practice aspects of digitisation. Comparing the outcome of the questionnaires with best practices and recommended standards in countries with an advanced level of experience it was found that not enough of this experience and knowledge is used by local collection managers although readily available. In some cases standards are disregarded completely.

The study also investigated by means of questionnaires the perception of the digital preservation of image files by fulltime photographic students and volunteer members of the Photographic Society of South Africa. It was found that uncertainty exist within both groups with regard to file longevity and access to files in five to ten year's time.

Digitisation standards are set and maintained by the use of specially designed targets which enable digitising managers to maintain control over the quality of the digital content as well as monitoring of equipment performance. The use of these targets to set standards were investigated and found to be an accurate and easy method of maintaining control over the standard and quality of digital files.

Suppliers of digitising equipment very often market their equipment as being of a high quality and being able to fulfil the required digitisation tasks. Testing selected

digitising equipment by means of specially designed targets proved however that potential buyers of equipment in the high cost range should be very cautious about suppliers' claims without proof of performance. Using targets to verify performance should be a routine check before any purchase.

The study concludes with recommendations of implementing standards and it points to potential future research.

CHAPTER 1
INTRODUCTION

1.1 Background to the research problem

1.1.1 The importance of the photographic image

Since the first photographic image "View from the Window at Le Gras", made by Joseph Nicéphore Niépce in 1826 (Peres, 2007:135), photography played a major role in shifting the human mind from time to time.

It is argued by Pretorius (2001:3) that:

> "The importance of photographs as sources of information cannot be denied".

The first ever photographic image of planet earth from space is a good example. Taken from outer space after the launch of Apollo 8 in 1968, (Yenne, 1988:46) astronaut Bill Anders gave mankind for the first time ever the opportunity to see our complete planet against the universe as backdrop (Panzer, 2005:176). The value of the image is not only the image itself, but the fact that it was taken by man and not a remotely controlled machine in space. Glendinning (1990:191) puts the image and the event in perspective with the following words:

> "On that voyage a small event occurred that proved exceptional in helping modern peoples realise we live on a single, shared-and limited-planet. The first clear photograph of the whole earth was taken. Since then, this image has appeared and reappeared around the world in newspapers, books, websites and films and on television. It is a picture of our home, in its full, vibrant splendor".

In South Africa the well known image taken by Sam Nzima of the shooting of Hector Peterson on 16 June 1976, underlined South Africa's political issues. The photograph appeared in many newspapers worldwide and in the Weekend World which

emphasised the importance of understanding racial issues in South Africa (Tema, 1976:3).

On a personal level, the photographic image plays a major role in the lives of people as observed by Eismann. For example, in the year 2000, a fire swept through Los Alamos, New Mexico. A couple who lived in the same home for 30 years was interviewed and asked if they could save anything in the home.

"All we took were the photographs" (Eismann, 2001:1).

1.1.2 Collection institutions

Considering the importance of the photographic document, it is not uncommon to find photographic artefacts in collections at various collection institutions for example museums, libraries, archives and in special collections even if the primary function of the institution is not the collection of historical photographic material as in the case of the National Library of South Africa.

For example museums, libraries and archives around the world are increasingly considering digitising their collections including their photographic heritage and several policies are in place to facilitate this archiving process. In South Africa, the urgency for archiving in general is emphasised by the introduction of the National Heritage Resources Act, No. 25 of 1999 (South Africa, 1999:1-88).

This legislation defines all material which is considered to be of importance for the South African history. For example as part of the National estate Clause 3.2.i.vii states that moveable objects include:

> "books, records, documents, photographic positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in section 1(xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996)" (South Africa, 1999:14).

1.1.3 Digitisation as medium for preservation

With the advent of digital photography, a new medium for archiving photographic artefacts in digital format became available to collection institutions in contrast to previous approaches of photographically copying the original to produce a surrogate copy for preservation. It is now possible for any institution with a relatively small collection to start with a digitising process. However, in three cases known to the author, Jordaan, (2005), Heese, (2005) and Marais (2006) confirmed that they did not consult any experts or research any literature regarding the digitising process for preservation to establish the current methods used by other countries already in the process of digitising for some years. This is to an extent symptomatic of an uncaring attitude toward the seriousness of digitising photographic collections for future accessibility.

In light of the mentioned cases, Meyer (2004:3) argues:

> "In the South African context, consumers are arguably not as sophisticated or critical as in Europe and the United States of America and are potentially more liable to acceptance of an inferior product".

Mnjama (2005:458) cites Kemoni who identified problems experienced by archival institutions in Africa for example:

> "the inability by researchers to use archival information and the lack of adequate archival training schools".

Institutions whose collections are in a poor condition because of serious deterioration, for example the District Six Museum in Cape Town (Clement, 2005), are usually eager to start digitising immediately because they see digitising as a quick, easy and relatively inexpensive way of preservation and future access to the images.

However, papers delivered at the annual archiving conference of the Society for Imaging Science and Technology in the USA in recent years, indicate a level of

uncertainty about the future of preservation of digital data. Miyata (2004:109) expresses a concern about this uncertainty:

> "There is as yet no history of actual long-term storage using today's digital devices and data formats. In addition, maintenance of digital archiving systems is not easy because rapid updates of software and developments of new hardware occur very fast".

The current situation is partly due to the high number of variables in the digitisation and preservation process. Variables in the archiving process include file formats, computer hardware and software, and techniques used for data capture. Recently accessed web pages on the World Wide Web reflect the same concern expressed by organisations and individuals.

1.1.4 Criteria for digitisation

Criteria for digitisation should be based on all the available knowledge and experience, and should consider factors for example cost and the complex technical nature of digital preservation. Brand (1999:84) for example, warns against the danger of electronic systems evolving to such an extent that the complexity of hardware and software in future may result in the loss and irretrievability of data:

> "Digital files do not degrade gracefully like analogue information for example photographic negatives, prints or slides. When digital files fail, they fail utterly".

It cannot be assumed that commercial companies will always be able to assist in the preservation process of digital data because most companies are market and product driven. There are a number of researchers voicing their concern by suggesting the increase of pressure on software developers to support older file formats and become involved in the digital preservation process and to be co-responsible for preservation and future access of data. Van der Hoeven (2004:5) suggests that:

> "A possible approach is to invent rules which force software developers to support older formats when they introduce new ones. Or offer at least well-tested conversion tools to migrate to newer formats".

To ensure longevity in the collection environment, an ideal situation would be to keep the digitising process in-house. There are several advantages to this, two of which are security and quality control. However, before embarking on the digitising process, curators of institutions should do research and consultation to establish the best methods to ensure the longevity of the data which leads to the statement of the problem.

1.2 Problem statement

Digitisation of photographic collections consisting of negatives, positives and paper based prints is widely adopted as a means of preservation and access of a surrogate copy of the original artefacts. As the process of digitisation is a complex issue with many variables which have an effect on the longevity of the image files, sufficient knowledge is needed to make the best decisions for the digitisation procedure.

1.2.1 Primary research question

What is the level of knowledge and technical skill of collection managers in the Western Cape to guide them in the decision making process when quality and longevity of master image files is crucial to produce good surrogate copies of original photographic images?

1.2.2 Further questions

Further questions to be answered:

- To what extent do custodians of photographic collections use standardised scanning and workflow procedures to ensure optimum image quality?

- What is the level of knowledge when custodians decide on scanning procedures and workflows to establish reasonable file sizes versus quality comparing to recommendations by researchers?
- What are the preferred characteristics of image data files to ensure optimal storage space and longevity of the files?
- To what extent are service providers informed about current practices in order to make recommendations and offer specialist scanning services to collection institutions?
- What is the level of awareness about the complexity of digital preservation at fulltime student level at photographic teaching institutions in the Western Cape?
- What is the perception of fulltime photographic students on the issue of long term preservation of digital files?
- What is the perception of members of PSSA on the long term preservation of digital files?
- How does different scanners perform when targets are measured to establish actual resolution versus selected resolution?

1.3 Global overview

The human's perception of time is often too limited when making decisions affecting preservation of artefacts for future generations.

Brand (1999:84) cites Boulding:

> "A personally experienceable, generations-based period of time reaches from grandparents to grandchildren – people to whom we feel responsible. We should therefore be thinking in terms of a 200-year span – one-hundred years forward and one-hundred years back".

This statement emphasises the importance of proper archiving, whether of artefacts or of data.

The urgency of preservation worldwide has also been emphasised by the

countries that joined the Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict (Gschwind, 2004:11).

Modern-day examples of threats to cultural property include situations like 11 September 2001 in the USA and the recent Iraq conflict. Organisations are expressing their concern about the war in Iraq where archaeological sites and museums are under constant threat of destruction. The Archaeological Institute of America (AIA) ran a pe tition to bring these dangers of damage to the attention of the authorities. Their open declaration on cultural heritage at risk in Iraq states:

> “The extraordinary global significance of the monuments, museums, and archaeological sites of Iraq (ancient Mesopotamia) imposes an obligation on all peoples and governments to protect them. In any military conflict, that heritage is put at risk, and it appears now to be in grave danger" (AIA, 2010).

In some countries, the preservation process of cultural property became a national policy, for example, Australia implemented the Victorian Electronic Records Strategy (Quenault, 2004:3).

The large number of photographic collections in different countries around the world and the value of these collections necessitate careful planning to safeguard them against natural and manmade disasters, as well as against natural deterioration. Since 2004 the preservation issue is a topic of increasing importance at the annual conferences of the Imaging Science and Technology Society in the USA. For example, Bell (2004:82), Van Horik (2004:128) and Abrams (2006:83).

Some core questions about file formats, computer platforms, software and hardware, for example, at this stage remain unanswered. Choosing the wrong digital format may spell disaster for any institution because file longevity due to file format changes over time as well as operating system changes may become an issue thus

leaving a file inaccessible. These variables are also hardware dependant in the sense that the introduction of new computer hardware may also prevent access to digital data over time. Hodge (2000:1) thus points to the importance of standardisation because:

> "the preservation and archiving process is made more efficient when attention is paid to issues of consistency, format, standardisation and metadata description in the very beginning of the information life cycle".

In a Photoshop newsletter, Schewe (2005:1) similarly emphasises the issue of sustainability:

> "One of the most critical factors regarding the long-term preservation of digital content is the format in which the digital 'objects' are stored. In order to have 'sustainability' you need the ability to maintain a digital object in a technological environment in which users and archiving institutions operate. Sustainability is significant whatever strategy may be adopted as the basis for future preservation actions: migration to new formats, emulation of current software on future computers, or a hybrid approach".

Sustainability of file formats will ensure access in the future in different computer environments. To support sustainability a possible system of file migration may be considered to ensure file readability with future computer operating systems and software. This method could be costly due to the fact that constant attention to digital files is needed, which is labour intensive even years after completing the original digitising process. Emulation on the other hand makes it possible to read any type of file regardless of the system used to produce the original file and could be defined as:

> "emulation is an approach which keeps the source digital object in its original data format but recreates some or all of the processes enabling the performance to be recreated on current computers while migration is the process of converting a digital object from one data format to another" (Wilson, 2005:22-23).

The challenge of both approaches is:

Kuny (1998:10) who refers to the current situation as the digital dark ages,

expresses the concern:

> "We are, to my mind, living in the midst of the digital dark ages: consequently, much as monks of times past, it falls to librarians and archivists to hold to the tradition which reveres history and the published heritage of our times".

The fact that new technology is mostly market driven, and changing rapidly, is causing companies to give less attention to longevity of digital data. The need for preservation for future becomes mostly a concern for organisation whose responsibility is of a historical nature for example museums and libraries therefore the concern for future access to digital files.

Ray (2002:365) emphasises the importance of best decision-making to address some of the concerns for digital preservation:

> "It is clear that for preservation to be successful, we need to pay attention not only to the format of digital objects, but also to the commitment we make to providing long-term access to the information. Thus decisions about digital preservation will involve technical issues as well as economic, legal, social and organisational ones".

The digitisation option and related issues for archival purposes are not new. As early as 1997, Eagleson pointed out the difficulty of choosing storage media and the file format (Eagleson 1997:23).

Rothenburg (1995:2) who also refers to the digital dark ages, warns those who believe in the immortality of new media files:

"Digital information lasts forever – or five years, whichever comes first".

The statement of Rothenburg is now frequently used in literature addressing the archival properties of digital data.

Although digitisation is an option in the process of archiving, Gschwind (2004:11) points out that the process of copying the original always results in a decrease of

quality, therefore preserving the original is important.

The result of spontaneous digitisation is very often wrong decisions which effect the long term preservation of digital images. Krause (2009:2) identify the problems associated with unplanned digitisation:

> "With haste personal computers are now at the centre of common life: replacing analog means of communication, record creation and storage. While these new means of information retrieval are celebrated by the public they are not without flaw: digital records become corrupt or reach obsolescence within a decade, and are accompanied by a great host of silent dangers".

The outcome of poorly planned digitisation projects may be no long-term sustainability. There are at least three known cases in the Western Cape where the lack of proper planning resulted in non sustainable results. Initial research confirmed the lack of attention to sustainable file formats and poor workflow by the University of Stellenbosch archives, the Gribble Collection in Paarl and a photographic collection at the Ou Hawe Museum at Hermanus.

- In the case of the photographic collection of the University of Stellenbosch, the curator stated that a Joint Photographic Expert Group (JPEG) file format is used and images are scanned with a Mustek flatbed scanner. The collection consists of glass plate and cellulose acetate photographic negatives (Heese, 2005).
- The JPEG file format is also used to store files of a small photographic collection which forms part of the Ou Hawe Museum at Hermanus (Marais, 2006).
- The Gribble Collection in Paarl was digitised by copying the negatives with a Nikon Digital Single Lens Reflex camera, fitted with a macro lens on a light table of unknown colour temperature. The file format used for storage is the JPEG type (Jordaan, 2005).

Thus, in all three cases the JPEG format was used as file format, which, as a lossy format, is not the recommended format for achival purposes. In fact, in the above three cases, it was confirmed that no research study had been done before deciding on a file format. The decision was based on general knowledge and advice from

salespersons in photographic retail shops. Factors contributing to the decision were storage space and applications suitable to process JPEG format. The fact that these institutions did not seek advice from experts reveals their assumption that information available to the average consumer and service provider is adequate for making specialised decisions. Recommendations by experts in this field, such as Van Horik (2004:130), show that this may be a short-sighted view:

- Uncompressed file types should be used to minimise the risk of becoming unreadable in the future,
- Standardised file formats should be used which will ensure durability,
- Non-proprietary data-encoding ensures longevity.

The literature indicates that scientists in the field of data preservation do not agree about which method will be the best for future data preservation. Some proposals are as follows:

- the Universal Virtual Computer (van Wijngaarden, 2004:254),
- the Global Digital Format Registry (Abrams, 2004:83),
- Emulation (Verdegem, 2006:56),
- Automated Migration (Abrams, 2006:113),
- Digital to film (Breslawski, 2004:54).

1.4 Aims and objectives of the study.

Following from the preceding brief literature review, the objectives of the study are specified as follows:

- To give a brief overview of findings of related research in South Africa.
- To investigate a standardised scan and image correction workflow for optimum image quality.
- To test different scanning resolutions to establish a reasonable ratio of files size versus image quality.
- To investigate the plausibility of storing digital files in various file formats other

than Tagged Information File Format in order to reduce storage space and ensure longevity.

- To determine the level of technical advice given by commercial companies to collection centers and museums.

1.5 Research design and methodology

Both quantitative and qualitative research methods were used as listed below.

- A literature study was used to investigate current practices for scanning photographic artefacts. There are different opinions about the best practice in data preservation, scanning and workflow procedures for optimum quality of the final digital image. Gaining a clear understanding of the various approaches may contribute to improving local preservation.

- The literature study included congress proceedings, research papers and reports of technical tests. Investigation of the literature study will attempt establishing if any related research has been done in Southern Africa since the year 2000.

- Quantitative evaluation has been undertaken on different scanning devices. Currently, institutions rely on basic specifications provided by the suppliers of the scanning devices without verified technical specifications, for example true resolution. By testing scanner resolution, it will be possible to establish which type of scanner could give the best possible results for the minimum archival needs of local institutions in the process of digitising or future processes. Scanners to be tested will include:

    - ⌂ Epson A4 V700,
    - ⌂ Epson Expression 1680 Pro A4 flatbed,
    - ⌂ Epson Expression 1640 XL A3 flatbed,
    - ⌂ Epson 10000XL A3 flatbed,
    - ⌂ Zeutschel OS 14000 large format A0 overhead,
    - ⌂ Cruse large format A0 overhead,
    - ⌂ i2S Suprascan Quartz large format A1 overhead.
    - ⌂ Epson V700,
    - ⌂ Nikon ED 9000,
    - ⌂ Flextight Precision III.

    By using suitable devices for example a slant edge target, a measurable method

will be used to test and evaluate manufacturer's claims of resolution.

- Quantitative data were compiled through desktop research. There may be digital file types that will give a high quality image in relation to file size, with minimum risk of becoming unreadable in future. This will increase the longevity of the data

for future access. Desktop research of current practices could be used to determine the life expectancy of current widely used digital file types.

- The data were compiled by means of a questionnaire. Judging from telephonic interviews, local practitioners seem to be ignorant of the danger that digital data may become unreadable over time due to hardware and software outdating or failure.

The questionnaire addressed questions to determine:

- if the company is aware of the vulnerability of digital files,
- which type of digital file do they provide the customer with,
- how many photographic artefacts typically do they handle for a single client,
- what are the typical file sizes and resolution provided for preservation purposes.

Once it is established what level of knowledge the company has, a strategy could be developed to supply practitioners with relevant and most recent research findings and methods to improve longevity of digital files and image quality.

1.6 Delineation of the study

The study is subject to the following delineation:

- The study did not take into consideration public access policy, intellectual property and security of collections.
- Collection policies were not considered.
- Setting up of metadata for identification and cataloguing, security and copyright was not investigated.
- Different types of storage mediums were not investigated, for example hard drive discs, Compact Disc Drives and Digital Video Discs.

1.7 Significance of the study

With the National Heritage Resources Act, No. 25 of 1999 as background, this study will provide a starting point for smaller institutions that wish to digitise their collections of photographic negatives and prints for preservation and public access. The information could be used to make strategic decisions regarding the technical aspects

of scanning and file formats to ensure longevity and readability of data in the future.

The study will focus on creating a master file for preservation purposes according to international best practices and will include reflective and transmission scanners. Additional information will be added to reflect the experience of the author in the past 2 years when the organisation acquired a sophisticated large format A0 overhead digital scanner.

The study will furthermore give a view of the awareness level of 3rd year fulltime photography students at institutions in the Western Cape as well as a sample of members of the Photographic Society of South Africa.

1.8 Expected outcomes, results and contributions of the research

- To establish and provide basic guidelines for the digitising process to ensure optimum quality, and
- To ensure longevity and integrity of digital data.

1.9 Structure of the study

The dissertation is structured as follows:

Chapter 1: Introduction

This chapter gives a general synopsis of the problem. In addition it briefly describes the background, research question, objectives and methodology.

Chapter 2: Overview of literature - the digitising landscape

A review of the current literature presented by various experts and authors in the field of digital preservation and digitising projects from various institutions around the globe. Studies in the fields of the aforementioned to investigate what is current practices in the fast changing preservation field of digitising and long term digital preservation. A

look at standards in terms of archival quality of digital files and practices for safe preservation.

Chapter 3: Research Methodology

This chapter outlines the methodology followed to achieve the outcomes set out in the problem statement.

Chapter 4: Data and findings

The collected data will be analysed and discussed.

Chapter 5: Summary, Conclusions and Recommendations

This chapter summarises the research findings, makes recommendations for future research, and concludes the study.

CHAPTER 2
OVERVIEW OF THE LITERATURE - THE DIGITISING LANDSCAPE

2.1 Introduction

This literature study has a two-fold purpose, namely to serve as background information for the research presentation and analysis presented below in Chapters 4 and 5, but also to provide an overview of the recent development in, and present status of the field of, image digitisation for archiving purposes. In this regard it focuses on important aspects of digitisation such as the identification of collections, the formulation of policies, setting of standards for quality, research best practices and attention to research in the field of data longevity. It gives an overview of research in the field and philosophies regarding digitisation, and points out flaws of the past in terms of these factors.

It should be noted that in some cases reference is made to collections other than photographic. This is due to unreported photographic material which often forms part of digitised collections but as the number of photographic artefacts is very small, it may not be reported as a photographic collections as such. The National Library of South Africa is a case in point, because the primary function of the library is to collect all South African published works as a legal deposit library but they do have a very valuable collection of photographic artefacts such as prints and various types and sizes of negatives.

Attention will be given to aspects such as:

- Threats to collections,
- Digitising policies,
- Current projects,
- Obstacles,
- Standardisation and technical aspects.

- Equipment.

Each aspect will be briefly discussed on a global, African and South African level.

2.2 Background

During the history of time, mankind explored and developed ways of communication. From early rock art to clay tablets (Alford, 2000:Plate 23), the token system (Schmandt-Besserat, 2009:1) to the Egyptian hieroglyphics (Hancock, 1996:147) and the alphabet. At the same time man wanted to retain this information and make it accessible for his culture and future generations. The result is the beginning of libraries, archives and museums in many cities in the world.

One cannot underestimate the value of the photographic image as a historical record. The photographic image can be used for example to recreate some aspect of the past as in the case of the Italian composer Giacomo Puccini. This interview by a South African Broadcasting Corporation reporter:

> "Levarsi un fil di fumo", and smoke bubbles out appears in one of the arias in Puccini's Madam Butterfly. This refers to the volcano Fuji in Japan where the story of Madam Butterfly takes place. Giacomo Puccini was so impressed with this volcano that he had a pipe made of cherry wood from Japan. The head of the volcano was hand carved on the front of the pipe known in Afrikaans as 'die oond - the oven'. When Puccini who was a cigar smoker, smoked his much loved pipe, bystanders were always ready with the quote from the opera "Levarsi un fil di fumo", and smoke bubbles out'. The well known historical pipe disappeared after his death in 1924. Luckily the only photo on which Puccini appears smoking his pipe was in safe keeping. The pipe club of Salamaso used the photograph and had a replica made of the pipe which will be exhibited during the next production of the opera in Lucca, the birth town of Puccini, situated close to Pisa. They have done this as a tribute to the 100th anniversary of Madam Butterfly and the 150th anniversary of the birth of Puccini in 2008. The pipe will also be exhibited at Torre del lago for the Puccini festival the following year. And of course a brass plate with the inscription '"Levarsi un fil di fumo", and smoke bubble out' will be part of the exhibition. (Lochner: 2007).

Collections of historical value such as photographic material, manuscripts, books, rare books, maps and audiovisual material are always under threat in some part of the world. It could be a manmade disaster like conflict or a natural disaster such as a tsunami, water, fire or earthquake. In order to try and limit damage of man-made origin, the urgency of preservation worldwide has been emphasised by the countries that joined the “Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict” (Gschwind, 2004:11). However, it is difficult to protect full scale collections against all possible disasters.

A good example of near perfect storage conditions including high security, is the Corbis-Bettmann Archive Photography Collection in the United States of America. This collection of more than 13 million black and white and colour photographs is stored underground in sub-zero cold storage in a former limestone mine about an hour's drive to the northeast of Pittsburgh, Pennsylvania. The underground storage rooms also contain a fully equipped scanning facility adjacent to the main vault to enable scanning of material without the need for leaving the vault. (Wilhelm, 2004:122). The ultimate goal of this company is to make money with their digitised collection which means that the preservation of originals and digital data will need equal attention for long term preservation if additional cost in future is to be avoided (Frey, 1999: 8).

2.2.1 Development of the personal computer

Although the first functional electronic computer was developed as early as 1938 by Konrad Zuse in Germany (Allan, 2001:1/4), it was during the 1970's through 80's that computer technology progressed progressively with advances in transistors, integrated circuits, memory, storage space, processing times, computer languages, software and

hardware development drawing much attention.

Although the first 180 personal computers were developed and for sale as early as 1957 at a price of $55,000 by IBM, it was not until the late 1970's that the personal computer became an affordable part of the average consumer's life (Allan, 2001:1/15-1/16). Similar to Kodak's well-known slogan, "You push the button and we do the rest" (Peres, 2007: xxiv), Microsoft promoted the concept of "A computer on every desk and in every home" as early as 1985 (Allan, 2001:12/6).

The rapid design progress in electronics and computers gave rise to the concept of Moore's Law:

> "The concept of this law was described by Gordon Moore in an article entitled "Cramming More Components onto Integrated Circuits" in the April 1965 issue of *Electronics* magazine. Moore's law initially stated that the number of transistors on a semiconductor chip would keep doubling every year. This was later changed to every 18 to 24 months. This "law" has held up remarkably well since 1965 and has had a profound effect on computer technology" (Alan, 2001:3/5).

2.2.2 Functions of the personal computer

Since the development of the computer, the definition of a computer changes as its function shifted from being mainly a calculator to an apparatus which can do more than just arithmetic. For example the 1972 Supplement to the Oxford English Dictionary defines the computer as:

> "A calculating-machine especially an automatic electronic device for performing mathematical or logical operations frequently with defining word prefixed, as analogue, digital electronic computer. At present a computer can read, remember, do arithmetic, make elementary decisions and print its answers" (*Supplement to the English Dictionary,* 1972:601).

> A 1993 version of the Chambers Dictionary defines a computer as:

> "A machine or apparatus, mechanical, electric or electronic, for carrying out (especially complex) calculations, dealing with numerical data or with stored items of other information, also used for controlling manufacturing

processes, or coordinating parts of a large organisation" (*The Chambers Dictionary,* 1993:353).

The shift away from a computer which only functions as a calculator, to an apparatus which can do other actions with data, and make the results available in a user accessible format is clear in the second definition.

Over time the computer became an integral piece of hardware in the digitising process of images by allowing all forms of historic photographic material to be converted into digital information which can be viewed, manipulated, saved and accessed.

The rapid developments in personal computers, the use of the internet as connecting device and the World Wide Web to facilitate the organising of information, created pressure on organisations such as libraries, museums and archives to meet expectations from the public to access images of collections.

2.2.3 The quest for information access

The possibility to reformat photographic prints, slides and negatives to a digital artefact has attracted attention worldwide due to the development of the personal computer, the Internet and the World Wide Web. Reformatting as digital content fulfil dual roles: as a medium for preservation as well as for access. It therefore became common practice in most of the collecting institutions worldwide to digitise their photographic collections.

2.2.4 Public perception of digital image preservation

What does the public expect of digital preservation? Users visiting libraries are increasingly expecting books, manuscripts, rare books, photographic and other collections to be available in digital format and to have access to it. Digital information is

easy to access on the institution's premises if it is not open to the public on the WWW. The expectation of the public is that the material they want to access is already digitised and available on-line. This view is mainly the result of the rapid progress in the WWW and the increasing volume of digitised collections available for access oftentimes reported by the press. As more and more organisations claim that they are in the process of digitising their collections, the greater the expectations for access of the material by the public. An example of increased availability of digitised collections is the World Digital Library (WDL).

The recent conflict in Timbuktu, Mali, again placed the emphasis on digitisation for two reasons. Firstly the vulnerability of the material which is very old and not completely digitised, and secondly anybody who needs information on Timbuktu can access the WDL and find very old digitised manuscripts on the site, albeit not all of the material at this stage due to an unfinished digitisation project.

Public ignorance of long term preservation is of great concern when considering the many personal records generated by users of Facebook, Twitter and Flickr and other social media. For example, a personal photograph published on these media platforms, may be the only copy that will ever exist and which may permanently disappear when the platform changes or collapse over time or when the creator or publisher decides to delete the photograph. Apart from the aforementioned, other dangers also exist such as hacking of social media platforms.

2.2.5 Aspects about digitising projects

The UNESCO guidelines document puts the concept of digitising in context and it is important to have a clear understanding of digitising objectives:

> "Digitisation is not preservation: digitisation is not cheaper, safer or more reliable than microfilming. Unlike a frame of high quality microfilm, a digital image is not a preservation master. The only way that digital reformatting contributes positively to preservation is when the digital surrogate reduces physical wear and tear on the original, or when the files are written to computer output microfilm that meets preservation standards for quality and longevity. A digitisation project is therefore no replacement for a preservation programme based on reformatting on microfilm (or on deacidification, conservation treatment or improved storage conditions). This is in general true. But there may be specific circumstances, for example in developing countries, that can turn this notion on its head. If an institution with no experience nor facilities for preservation at all, wants to preserve a specific collection, it may decide to invest in digital instead of microfilming equipment, thus avoiding the high expenditure on microfilming cameras and processors and realizing that this digital equipment and the developed staff skills will serve other purposes as well. Digital technologies offer a new preservation paradigm and offer the opportunity of preserving the original by providing access to the digital surrogate; of separating the informational content from the degradation of the physical medium (Unesco Working Group, 2002:8).

To succeed with a digitisation project for preservation, well considered decisions should be made and tested best practices, procedures and workflows should be used to ensure quality, security and longevity of master files. For example one important decision to make is the issue of file formats that should be used as master files and surrogate copies for access and viewing.

In three cases known to the author, Jordaan, as service provider / scanning bereau for the Stellenbosch University Archive (Jordaan, 2005), Heese as curator of the Stellenbosch University Archive, (Heese, 2005) and Marais as service provider for the Hermanus De Wet Photomuseum (Marais, 2006), confirmed that they did not consult any experts in the field of preservation, nor did they research any literature regarding the digitising process for preservation to implement any standards or recommendations used by other institutions locally or abroad. This to an extent reflects an uncaring attitude toward the seriousness of digitising photographic collections for future

accessibility and preservation. Meyer (2004:3) argues that in South Africa we are less critical when crucial decisions need to be made:

> "In the South African context, consumers are arguably not as sophisticated or critical as in Europe and the United States of America and are potentially more liable to acceptance of an inferior product".

In order to address the issue of quality reformatting of photographic material and file longevity for preservation, it would be a good start to use a process of foresight as defined by Horton (1999:5):

> "Foresight is the process of developing a range of views on possible ways the future could develop, and understanding these sufficiently well to be able to decide what decisions can be taken today in order to create the best possible tomorrow".

Papers presented at the annual archiving conference of the Society for Imaging Science and Technology in the USA between the period 2004 to 2012; indicate a level of uncertainty about the future preservation of digital data. Miyata (2004:109) expresses a concern about this uncertainty:

> "There is as yet no history of actual long-term storage using today's digital devices and data formats. In addition, maintenance of digital archiving systems is not easy because rapid updates of software and developments of new hardware occur very fast".

The current situation is partly due to the high number of variables in the digitisation and preservation process. Variables that include file formats, computer hardware and software, and techniques used for capturing data.

To make well informed decisions about digitising projects and the digitising process, it is important to build a sound background knowledge of the world view and practices in this field.

2.3 Threats of collections

Threats could be divided into direct threats of the original artefacts on site and

the direct threats of the digital data as preservation medium. The outcome of any threat to collections may result in partial or total data loss.

In the case of direct threats to the original artefacts, Deegan reminds us that:

> "recorded information and knowledge resources are at constant risk from natural disaster and human mediated destruction. The loss of archives include examples such as the Catholic University of Louvain, Belgium, which burned down in both 1914 and 1940 due to wartime bombing, destroying 230 000 books, 800 of them incunabula printed before the year 1500, and 900 manuscripts." (Deegan, 2006:3).

Direct threats to digital data and the possible loss include factors for example:

- loss of passwords,
- hardware and software obsolescence,
- lack of steps to ensure long-term preservation,
- loss of critical metadata,
- the physical loss of hard disk drives or magnetic tapes or other media types used for backups,
- file format type,
- bit rot.

Brand describe these threats in no uncertain terms:

> "….digital files do not degrade gracefully like analog audio tapes. When they fail, they fail utterly. You can't open them. They have one-tenth the readable life span of acid-laced newsprint" (Brandt, 1999:84).

2.3.1 Global

Modern-day examples of threats to cultural property include situations such as the attack on the World Trade Centre on 11 September 2001 in the USA and the resulting 2003 Iraq conflict. Organisations expressed their concern about the war in Iraq where archaeological sites and museums were under constant threat of destruction. The Archaeological Institute of America (AIA) ran a petition to bring these dangers of damage to the attention of the authorities. Their open declaration on cultural heritage at risk in Iraq states:

> “The extraordinary global significance of the monuments, museums, and archaeological sites of Iraq (ancient Mesopotamia) imposes an obligation on all peoples and governments to protect them. In any military conflict, that heritage is put at risk, and it appears now to be in grave danger". (Archaeological Institute of America, 2010).

Loss of digital data can be just as devastating as the loss of physical artefacts. A major data loss can be a total loss of all artefacts at once with no chance of any data surviving.

2.3.1.1 Loss of passwords

Lost passwords could render a complete database inaccessible as illustrated by the Norwegian 'Ivar Aasen Centre of Language and Culture' case (Rosenthaler, 2006:74). In this case the programmer of the database which consisted of 11,000 titles suddenly died without sharing the password with colleagues. The centre was not able to recover the password themselves but after international appeals to computer hackers, one hacker recover the password in about 4 hours which restored 4 years of work that would otherwise have been lost. Rosenthaler concluded:

> "Probably there are many more failures which are not known to the public or which did not yet emerge. Hopefully the future will bring established procedures so that the *Digital Dark Ages* will not become a reality".

2.3.1.2 Hardware failure

A well known, often quoted and well documented data loss case due to hardware obsolescence often used to illustrate the vulnerability of systems is the Domesday project in England. Kriegsman argues that:

> "Preservation is going to cost money. It is far less expensive to do it today than it is to do it in the future. If preservation is ignored now, digital archaeologists will be required to undo the damage from neglect" (Kriegsman, 2004:23).

This project involves contributions from BBC staff, communities and school

children. The aim was to replicate and honor the 900th anniversary of the Domesday Book. The book was commissioned by King William I (William The Conqueror) in 1086 and the goal was to collect still images, maps, statistics and text of how Britain looked in 1986. The information were recorded on video disc but due to short lifespan of the media it nearly became inaccessible by the year 2002 and had to be reverse engineered to access the data which were only a mere 26 years old.

Harvey (2008:1-2) questions the real danger of data loss by suggesting that there is not enough proof that data were really totally lost, but argues they were just not accessible and new methods were developed to retrieve the so-called lost data. Harvey refers to the literature:

> "From the literature it is only possible to conclude that the evidence of digital data loss is, overall, anecdotal, and that data can be recovered, albeit at considerable expense. The digital preservation community's inability to bring firm evidence to bear in support of its contentions about data loss, coupled with the alarmist rhetoric of terms such as digital dark ages and digital black hole, leave us exposed. Our efforts and our calls for resourcing can readily be ignored. We need to document more examples of data loss to supplement the largely anecdotal examples that are commonly provided. Some examples are probably present in unpublished reports or business cases, but the publicly-accessible literature contains few of these".

Although Harvey (2008:1-2) questions the validity of claims of data loss, the case of the Toy Story 2 data loss, is a reality that could have ended in a total data loss due to the failure of proper data backups and the fact that the production team was not aware of the backup problems. Pinola (2013:92) reported:

> "Animation studio Pixar almost lost a year's worth of work on Toy Story 2 when someone mistakenly entered a Linux command (rm*) that wiped away the files in seconds. The company checked its backups only to discover that they had failed. Luckily, Pixar's technical director had been working from home, so the company was able to salvage the data from her personal computer".

2.3.1.3 Lack of long-term preservation strategies

Ensuring long-term preservation of digital content or files is not only about the quality of the image files but having proper software tools and a proper information technology support system which is in the end the most crucial link in the preservation chain. Literature provides little reference to effective proven long-term storage but rather report on experimental projects. However developments in Poland are discussed by Mazurek (2012:77) who reported that the SYNAT project proved the:

> "need for the reliable, extendible and efficient software solution is a must in terms of long-term accessibility of the digital content".

A newly developed prototype tool resulted in the dArceo software package which does not focus on storage and replication issues but rather on long-term preservation including format migration and monitoring. Mazurek (2012:77).

The information technology aspect of digital preservation such as the necessity for proper provision for servers as storage media is seldom found to be specifically part of the digital preservation literature. It is no surprise that Palm (2006:14) warns us of the dangers of lack of commitment for long-term preservation:

> "Whatever strategy one chooses to follow, the essential point to consider before undertaking large-scale digitization is the level of long-term financial commitment that can realistically be secured and to develop a preservation strategy accordingly. Estimations of costs that cover all aspects should be part of the planning process to limit the risk that a project ends up as yet another digital black hole, as so many others have done".

Cirinnà (2009:19) is in agreement with the critical issue of long-term preservation:

> "Most current digital repositories and most databases and collections used to help curate scientific data do not have specific mandates for long term preservation, nor do they have necessary long-term budgets. Instead they are mandated to support access and re-use in the near-term future. Long term preservation may be one of their aims, or at least hopes and wishes, but it is not (yet) a responsibility".

Also in the South African context very little literature could be found which refers to specific IT costs in terms of capacity, access servers for users access or preservation servers for master files. Liebetrau mentions the issue of master files (Liebetrau, 2010:27), software (Liebetrau, 2010:27) and metadata (Liebetrau, 2010:30) but no indication of direct costs or maintenance costs is indicated. Long-term preservation seems to be an evasive topic not often discussed even in most recent times of research.

The possibility of cloud storage is fast becoming an option for long-term storage as it can provide a cost saving to companies

Clarke (2011:14) reports that the forecast of Cloud Archiving revenue will grow between 28 to 36% per year, which makes it the fastest growing service segment after basic cloud storage services which is at 38%. The Medical image Archive will probably become one of the drivers of Cloud Archiving while the consumer segment for archiving digital assets such as photos, video and personal data will also be targeted by Cloud Archive vendors.

However, Cloud Storage and Archiving is not risk free.

Wooley (2011:14) cites Talbot:

> "Cloud computing actually poses several separate but related security risks. Not only could stored data be stolen by hackers or lost to breakdowns, but a cloud provider might mishandle data - or be forced to give it up in response to a subpoena".

Storage in the cloud is subject to risk management programmes like any other digital data and includes identifying, assessing and taking steps to prevent disaster. However, risk management of cloud computing is not a mature science. Wooley, (2011:14) cites Mather:

> “Risk management in cloud computing is an evolving area, and standards are being debated by the community”.

Clarke (2011:15) lists 4 cloud issues:

- No standard for data validation and audit,
- Long-term relationship between customer and vendor,
- Data migration between vendors could be difficult without standardised interfaces,
- Regulatory and compliance issues may complicate the use of public clouds for data archiving.

2.3.1.4 Loss of metadata

Metadata is critical for long term preservation of image files and as much information as possible about the image should be captured. Metadata should be preserved along with the image. Kriegsman explained three typical sets of metadata, namely administrative, descriptive and structural. If metadata is lost in a large collection it may become irretrievable because it cannot be identified or located (Kriegsman, 2004:35).

According to DeRidder (2011:71) digital files must be easily associated with metadata:

> "If the archival digital files cannot be easily and readily associated with the metadata that provides their context, and if the files themselves are not organized in a fashion that makes their relationships transparent, reconstruction of delivery at some future point is seriously in question".

DeRidder (2011:72) comments on the cost of migration and the role of metadata as support of the file content. To mitigate the high cost DeRidder suggests that one allow the content to become obsolete but to support sufficient metadata and contextual information enabling the resurrection and access of data again in the future.

2.3.1.5 Physical media failure

Digital data cannot exist without recording and storage media. Over time the type

of recording media available changes regularly as technology progresses. Some of the media include punched streamers, punch cards, magnetic tape, floppy discs, hard disk drives, optical discs and, more recently media such as flash drives.

However Conway (1996) describes the dilemma of the modern media by illustrating graphically in his unnumbered figure (here reproduced as Figure 2.1) the relationship between information density and life expectancy. It illustrates the price we pay in terms of data longevity with the increasing demand and availability of greater capacity.

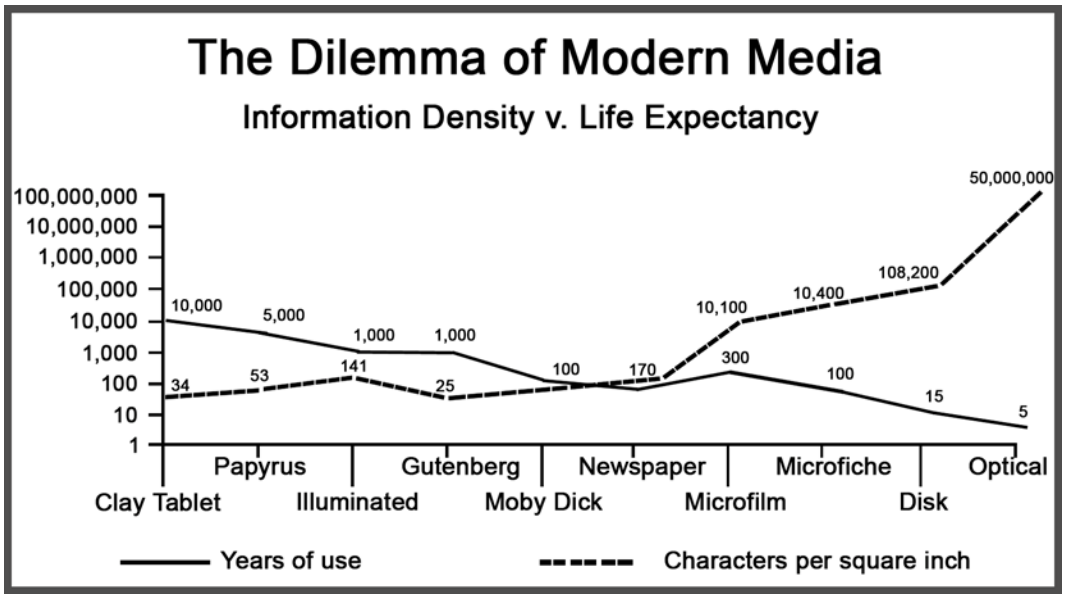


Figure 2.1 The Dilemma of Modern storage Media. (Conway, 1996)

For example, the clay tablet only contains 34 characters per square inch and has a life expectancy of 10 000 years and each year archaeologists unearth more of this recording medium.

The papyrus contains about 53 characters per square inch and has a life expectancy of about 5 000 years. Compare these media with today's optical disk containing about 50 000 000 characters per square inch but with a life expectancy of

only 5 years.

Conway (1996:6) comments as follows:

> "The newest recording medium--optical disk--may indeed have a longer life than the digital recording surfaces that have gone before. It is likely, however, that today's optical storage media may long outlast the life of the computer system that created the information in the first place".

Two examples of physical media failure observed by the author are shown below. In figure 2.2 an example of delamination is presented. This is a TDK disc of which the layers started to separate before actual use of the disc.

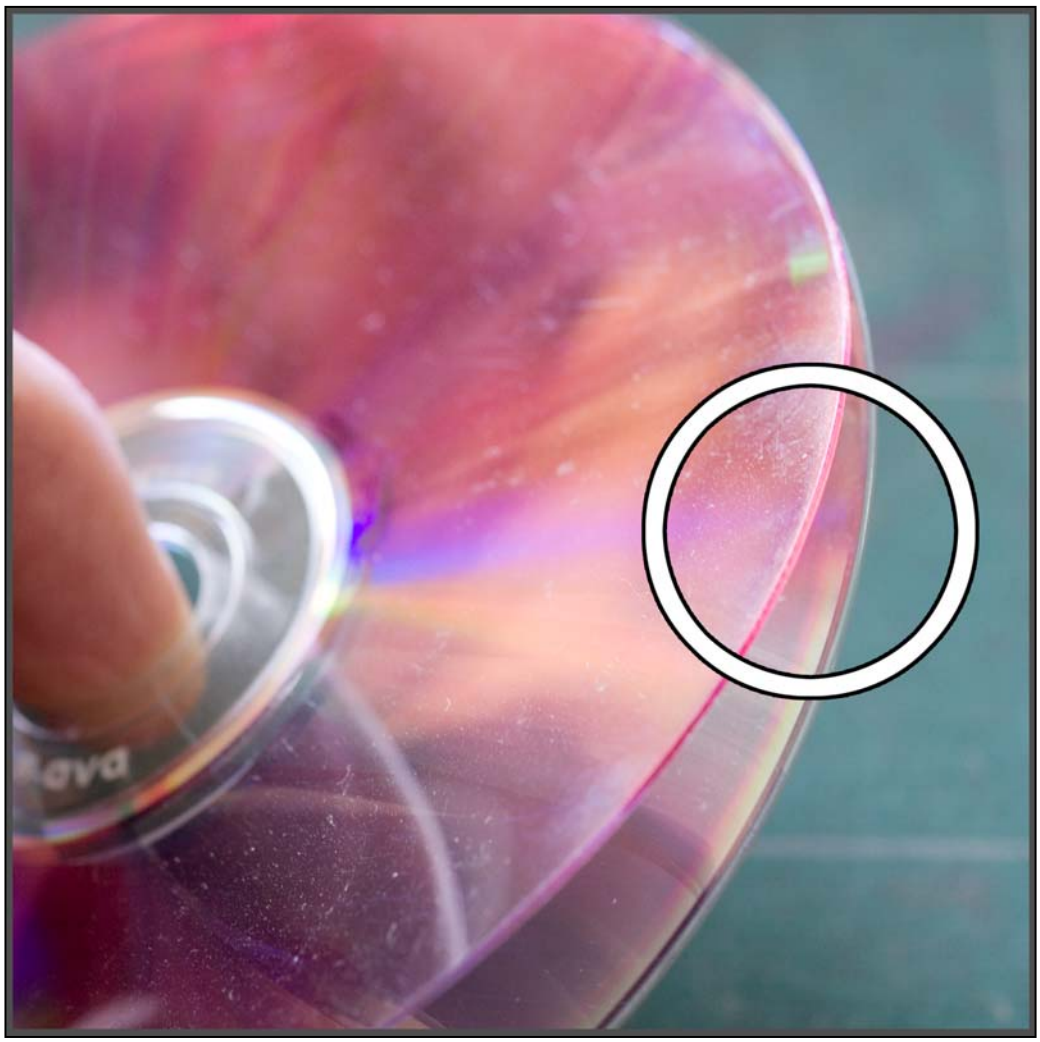


Figure 2.2 Failure of a DVD disc (delamination).

Figure 2.3 indicates an unknown fault on a Verbatim DVD observed after recording. It was subsequently decided to take the disc out of circulation to prevent any possible data loss and it was replaced with another disc.

Figure 2.3 Unknown fault on a DVD.

The physical loss of data as a result of a hard drive failure is a realistic expectation and care should be taken to have more backup copies than needed. According to Rosenthal a hard drive is limited in usage and its preservation properties.

> "The ideal preservation medium would be write-once, last forever and need no power. Hard disks have none of these characteristics. They are inherently writable, they last about 5 years in service, and they need power" (Rosenthal, 2004:250).

However there are alternative findings to hard disk drive reliability but on condition that it is stored safely after data has been written to it as reported by Williams:

> "Analysis of data from an accelerated life test predicts that, if data is written to a 160GB RDX removable hard drive cartridges based on 2.5 inch laptop disk technology, and the cartridges are then stored in realistic

> conditions for 30 years, more than 99% of the drives will then read their entire contents with no errors. A small sample of 3.5 inch CSS drives included in the test demonstrated much lower data retention" (Williams, 2008:188).

Rosenthal considered Sun's claim that their hard disk drive, the ST5800 had a mean time to data loss (MTTDL) of $2.4x10^6$ years but asks the question if we should believe them.

> "Sun did not guarantee that data in the ST5800 would last 2.4×10^6 years. Sun's terms and conditions explicitly disclaimed any liability whatsoever for loss of, or damage to, the data the ST5800 stores whenever it occurs. All that Sun was saying was that if you watched a large number of ST5800 systems for a long time, recorded the time at which each of them first suffered a data loss, and then averaged these times, the result would be 2.4×10^6 years" (Rosenthal, 2010:1).

Rosenthal argues that according to Sun's claim, 30 percent of data loss within the first year of storage is not acceptable:

> "Suppose Sun watched 10 ST5800s and noticed that three of them lost data during the first year, four of them lost data after 2.4×10^6 years, and the remaining three lost data after 4.8×10^6 years; Sun would be correct that the MTTDL was 2.4×10^6 years. But we would not consider that a system with a 30 percent chance of data loss in the first year was adequate to keep a petabyte safe for a century" (Rosenthal, 2010:2).

Alternative electronic recording media for digital information has been researched and suggested, but over time radical changes in recording medium have been slow. An example of an alternative analogue medium is the Rosetta Project initiated by the Long Now Foundation which is:

> "preserving information using extremely reliable storage (a micro-engraved nickel disk projected to last at least 2000 years) and scattering large numbers of replicas. Information is stored in analog form to ensure long-term readability. The project also publishes the material on-line to provide access" (Rosenthal, 2004:252).

2.3.1.6 File migration

Migration is a possible solution to ensure file access in the future in spite of changing hardware, software and file formats. In stead of depending on outdated systems, which are not supported anymore, file migration may seem to be an easy conversion process for the non-technical curator or Information Technology (IT) administrator. For example the Kodak Photo CD system was introduced in 1990:

> "as a consumer bridge between three very familiar - but formerly incompatible - systems; camera, computer, and television. Film images are transferred to a photo CD, allowing photographs to be viewed and manipulated on TV screens and computer monitors" (Peres, 2007:18).

Burns (2005:253) explains the various decisions to be made in terms of colour management when, for example the Kodak Photo CD system needs to be migrated due to file format, hardware or software obsolescence.

> "Kodak's Photo CD system, originally intended for consumer applications, has been used successfully by museums and libraries to store digital images from scanned film, prints and documents. With recent advances in digital image standards and their anticipated adoption by cultural institutions, questions arise as to how best to convert Photo CD image files. The permanence of digital collections for cultural and preservation institutions will depend upon the development of digital conversion strategies. These will include methods for digital image migration that not only retain current image integrity, but also allow for technology improvements".

2.3.1.7 Bit rot

Bit rot, alternatively called data rot, is considered to be a serious threat to digital collections. It could be defined as:

> " …a colloquial computing term used either to describe gradual decay of storage media or to describe the spontaneous degradation of digitally stored information over time" (Clarke, 2010:6).

Clarke (2011:7-10), Enterprise Storage Consultant at Oracle Corporation gives an overview of 4 types of data corruption, three of which is persistent and one transient.

Type one consist of a number of varieties for example:

- Bit(s) have flipped in a byte,
- Single Bit Error (SBE),
- Double Bit Error (DBE),
- Strong correlation with bad memory.

Type four which is persistent is still largely unexplained and not clearly defined.

Clarke (2011:28) concludes that:

> "bit rot is a fact of life and it may never go away and early detection is the first step towards a solution".

Whether we look at an image, a character, a number or listen to a sound generated by a computer, in the end, everything is just a bit stream (Peres, 2007:360).

By definition a bit stream is made up of a set of binary digits which is strung together in a specific sequence. However the complexity of a bit stream may cause an interpretation problem because:

> "a given bit stream can represent almost anything - from a sequence of integers to an array of dots in a pointillist-style image. Furthermore, interpreting a bit stream depends on understanding its implicit structure, which cannot explicitly be represented in the stream" (Rothenberg, 1995:43).

Bit streams are stored in different ways on each media type currently available and to retrieve it correctly from the physical media for example a Compact Disc (CD), hard drive or flash drive, and in order to represent the true original, it requires a hardware device, a controller and software.

A bit stream is represented in Figure 2.4 illustrating the possible interpretations (Rothenberg, 1995:47).

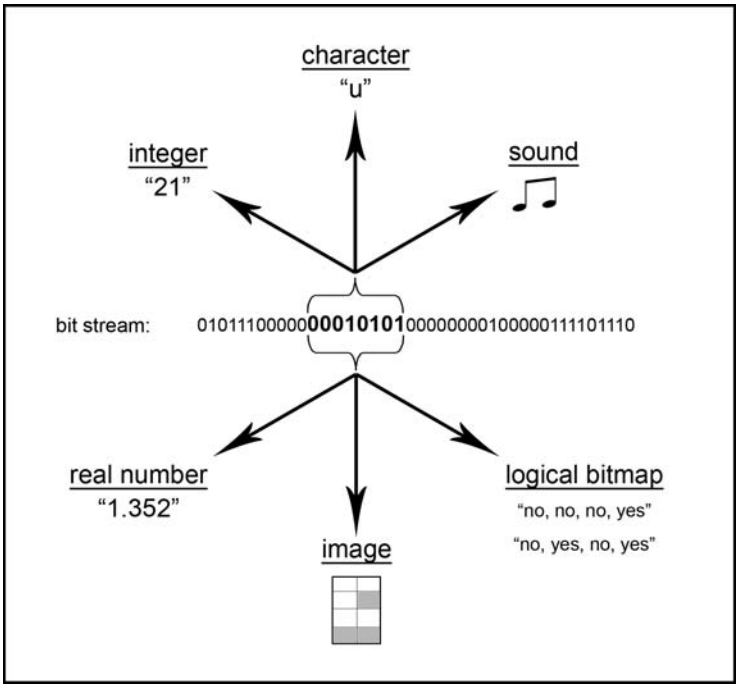


Figure 2.4 The bit steam can have more than one interpretation.

Due to the fact that the order of the bit stream determines the end result, it is clear that any interference or change in the bit stream may render a different and faulty end result. This may happen during any data copy stage especially when copying data from one media type to another due to the difference the way data is written on and retrieved from the storage media.

Another factor contributing to possible data rot is the form of compression used. Rothenberg (1995:47) explains the result of aggressive compression:

> "aggressive data compression may convert a bit stream into an approximation of itself, precluding a precise reconstruction of the original. Similarly, encryption makes it impossible to recover an original bit stream without the decryption key".

Bit Rot could also be the result of weak file format robustness explained by Heydegger (2009:315):

> "File robustness is the file formats capability for keeping its information as safe as possible in spite of data corruption".

Compression is suspected to be a factor affecting file robustness and increasing the danger of losing data during transmission over noisy channels which is a well-known phenomenon (Heydegger, 2009:318).

Heydegger's research was the first comprehensive research on the topic of image file robustness where the files were damaged and afterwards converted to an analysis format for final analysis which compared the pixel data from the undamaged and damaged files.

Heydegger concludes:

> "Our assumption concerning the negative relation of data compression and robustness could be verified. The result data reveal better performance of files with uncompressed data for almost all tested files. The study demonstrates that there are indeed factors, originating in file format design and functionality, which have an influence on the robustness of files" (Heydegger, 2009:323).

The possibility of data rot is rather significant when during the migration period of compressed files, there could be data loss which may render the file useless.

The impact of single bit error is neatly illustrated by the results of a project executed by Gattuso of the National Library of New Zealand (Gattuso, undated). He selected a test image (see Figure 2.5 below) in JPEG format and with dimensions 180 x 120 pixels (17514 bytes, which are equal to 140112 bits of data). He then wrote a script that looped over the image bitstream and sequentially inverted each bit in order and saved the new bitstream as a new image – giving a total of 140112 new images for further analysis. Each inversion procedure also included the repair of the previously

inverted bit. Thus each image represents a situation with only a single inverted bit amongst the total number of 140112 bits of image data. The wide range of image loss effects of the single bit changes is illustrated below by the three examples in Figures 2.6, 2.7 and 2.8. The categorisation of the damage types is as defined by Gattuso.

Figure 2.5 Master file Image consisting of 140112 bits of data. (Gattuso: JPG file 397_4.)

Figure 2.6 Damage type: Colour/Tone. The resulting image shows a colour shift or change. (Gattuso: JPG file 397_4.)

Figure 2.7 Damage type: Catastrophic. The changing of just 1 bit of data totally destroyed the image. (Gattuso: JPG file 230_4.)

Figure 2.8 Damage type: Image dimensions. The image has changed to a narrow band of colour. (Gattuso: JPG file 165_2.)

2.3.1.8 Outsourcing

Outsourcing is not intrinsically dangerous, but many valuable artefacts got lost over years or were damaged by outsourcing material for scanning or digitising. Rare books, maps and irreplaceable photographic material are especially vulnerable to misuse or theft.

As pointed out by Kavčič-Čolić (2012:97), outsourcing is not only a safety risk but includes quality delivered issues as well:

> "The quality of digital image mostly depends on the scanning technology, scanning software, and trained operational personnel. Before outsourcing scanning, it is recommended to get enough information on the experiences of the outsourcing company, their staff and technology. It is also very important to specify in detail all the requirements".

Kavčič-Čolić (2012:95) further addresses the issue of outsourcing also from an

active librarian's point of view and the importance of quality:

> "Many librarians entirely rely on commercial companies to which they outsource all the digitisation work. It may happen that these commercial companies do not share librarians' values and commitment to preserve digitised material. That is the reason why librarians have to take active role in digitisation projects and require the production of highest quality digitisation master files which will help to preserve the digital collections for the future".

As a practical example of the seriousness of quality for the librarian or curator of an institution versus the time consuming process of mass digitisation for the commercial company, Kavčič-Čolić (2012:95) describe the following scenario:

> "After we sent the request with our desired specifications to several commercial companies, some of them tried to convince us that for access we do not need TIFF or JPEG 2000 quality, but it is enough JPEG with loss compression, which is what they usually do for libraries, and their OCR which is 95% is sufficient for full-text searches. They refused to pack the metadata in the specified XML schema, because it was too time consuming. At the end, we decided to do all these required tasks by our own. This is an example showing why librarians need to take an active role in this field by taking charge and control of the whole digitisation work. And further, they need to require the best quality of the master files, since the investment in digitisation is very high. It is better to get less digital copies with the highest quality that can be used and reused in the future".

According to the handbook created for the Mellon Foundation by the University of Michigan, a good practice before outsourcing any digital projects is to evaluate vendor proposals using the following criteria for example:

- excellence of response,
- successful processing of the test material,
- ability to meet technical and managerial requirements,
- careful handling of fragile original material,
- qualifications and experience, evidenced by customer references, resumés of key personal, etc,
- financial stability and other various business issues. (University of Michigan Digital Library Services, 2001:13).

Most museums, libraries and archives in South Africa prefer not to allow outsourcing unless well controlled; often the artefacts are escorted by staff of the

institution to the scanning facility, monitoring the process and returning the items into safekeeping.

If outsourcing is an option for an institution, then they should set standards to meet their own demands after proper investigation.

2.3.1.9 Commercialisation of digital content.

Hahn (2006:21) warns about the dangers of large scale commercialisation:

> "When there is money to be made, libraries and archives should be vigilant and alert. Too much chumminess with commercial enterprises raises three basic problems or issues related to trust: quality, secrecy, and long-term stability. We need to spend our scarce resources for those digitization activities that not only will increase access, but will serve our long-term preservation goals as well".

Few commercial companies in South Africa operate on a mass digitisation scale. Africa-Media Online is a picture library, hosting some local images typically promoting South Africa with attractive landscapes. Apart from some historical images owned by Iziko Museums, not much alternative historical image files are available for browsing. The company's website does not address or promote the provision of long-term preservation and security of image files. Standards are not spelled out but only referred to as in line with recommended standards according to Unesco Working Group document.

2.3.2 Africa

During a visit to Timbuktu in 2001 by the then-President Thabo Mbeki, he was suitably impressed by the ancient manuscripts at the Ahmed Baba Institute that he pledged South Africa's support to preserve some of the most prized artefacts for the world to share. A project called the Mali-Project: Timbuktu Manuscripts was created with partners from the University of Cape Town and the National Library of South Africa.

Political instability in Mali in the early part of 2013 caused military conflict between the government and a rebel group. This conflict also affected valuable collections in the country and on the 29th of January 2013, The Cape Times newspaper staff writer wrote with the caption: "Rebels torch ancient texts preserved by South Africa".

> "The institute housed more than 20 000 manuscripts. Shamil Jeppie, the director of the University of Cape Town Timbuktu Manuscripts Project said the documents were invaluable for the history of the region. Half the documents had been digitised but that could never replace handling original copies. He said it made sense that the rebels would have destroyed the new building, out of revenge or spite" (The Cape Times, 2013: 1).

2.3.3 South Africa

To understand the scope of digitisation of photographic artefacts in South Africa and the possible threats to the collections, it should be possible to establish with reasonably accuracy the number of the original artefacts in collections. However, many surveys done proved that it is not the case. An unpublished survey done by Carstens (1994) with 39 respondents in South Africa, indicated there are about 1,120,463 photographic artefacts.

Meyer (2005:33) reported on a survey involving 39 museums in the Western Cape that:

> "Photographic artefacts made up the largest number of items in all museums, but actual numbers were reported vaguely".

Similar findings are reported by Page-Shipp (2011:13) in the South African Digitisation Audit done by the National Research Foundation. Although the report did not separate photographic material from any other historical artefacts in the collection institutions, the uncertainty of numbers is also reflected in the report:

> "There is a considerable variation in the, often only estimated, size of the collections which shows the numbers of collections in size categories, broken down according to status. It is no surprise that 'size unknown' occurs so often in the description of collections *Not yet planned*, and the peak in the total number of collections in the 100 to 5 000 categories reflects an intuitive sense of the size of document collections. The very high numbers of very large collections can be partly explained by the fact that, in such cases, mostly physical specimen descriptions are being digitised, and not three-dimensional (3D) imaging of the specimens themselves, although the latter does occur. Discussions with various role players suggest that the < 100 category is the most under-reported".

In some cases digitisation becomes a high priority due to the deterioration of the material. An example is the Clement donation. This photographic collection, owned by Mr Irvine Clement and donated to the District Six Museum in Cape Town, was found in a serious state of deterioration before it was moved to the museum premises. This collection was part of the van Kalker Studios in Woodstock, Cape Town. The collection was housed in an old church under extreme conditions and exposure to various uncontrolled elements including animal damage caused by birds that entered the room and caused droppings all over the boxes.

Figure 2.9 Bird droppings on photographic material storage boxes.

Figure 2.10 Silver mirroring (left) and negative curling and sticking (right)

The deterioration took on many forms due to the various factors causing the damage for example silver mirroring (Figure 2.10 left) and extreme curling and sticking (Figure 2.10 Right).

With local unrest from time to time in South Africa due to protests against failure of service delivery, at least two libraries were set alight with significant damage to the property and contents of the library. A well recorded event occurred on the 9th of February 2010 in the province of Mpumalanga at the town of Balfour in the Siyathemba settlement where the only library was set alight and a looting of the library started. (Tromp, 2010:6).

On the 10th of December 2010, a fire in the Wilcocks building of the University of Stellenbosch (Krige, 2010:1) damaged a part of the photographic collection of negatives beyond any possibility of repair or restoration. The damage was caused by the water that the fire brigade used in an effort to extinguish the fire on the uppermost floor of the building. Water flowed down the internal shafts of the building, collecting at the lowest level where the archive is situated. No disaster plan was in place by the time the incident took place with the effect that the room was sealed, locking in the water and dampness which caused the negatives to sustain permanent damage beyond any

chance of restoration. The negatives were to be re-scanned due to prior bad scan quality (Breed, 2012).

Figure 2.11 Permanent water damage and total loss of negative.

2.4 Digitising policies

2.4.1 Global

To ensure the safety, and access of original artefacts, the process of digitisation is seen as part of a possible solution. Therefore many countries formulated and adopted policies to facilitate the digitisation process. In an overview of digitisation policies in Turkey, Çakmak (2012:146) for example reports as follows:

> "Since their establishment, cultural memory institutions such as archives, documentation centers, libraries and museums have been conducting studies in order to obtain, organize, preserve and share information resources for public needs. States and institutions have developed and implemented policies for using information resources within the framework of existing infrastructure and technologies. Among these policies, digitization efforts developed and implemented by cultural memory institutions command our attention. Cultural memory institutions take part in digitization efforts for protecting cultural heritage of society and transmitting it to future generations, and they act according to these policies".

While a number of countries and institutions have digitising policies in place since

the 90's, many are still without any policy. Still others, such as the National Library of Finland, recently implemented policies published in 2011 (Finland, n.d.).

Policies are not stagnant documents and often need change to adapt and accommodate new approaches, latest technologies and procedures. An example of updating a policy is the Digital preservation and digitisation policy of the National Museum Australia. In this case the policy was approved in April 2009 and an update approved by May 2012. It is further stated that it will be reviewed again by January 2014 (National museum Australia, 2012:2).

Another example of changes in a policy is the case of the National Technical Library, Prague in the Czech Republic. The need for the change was due to a change of digitisation workflow in order to be comprehensive but also as simple as possible. (Řihák, 2012:57)

There are also individual institutions with their own policies such as the Institut national de l'audiovisuel (INA) which is the National Audiovisual Institute in France for the digitising and preservation of audio and video material (Rault, 2012).

Larger representational organisations like the United Nations offers a policy guideline document published by UNESCO, (Unesco Working Group, 2002). These policies often incorporate guidelines and best practices established by older and more experienced larger institutions for example the British Library (MacDonald, 2006) or the library of Congress.

In a final report published in The Hague to:

> “Investigate the current state of affairs in the area of quality assurance as far as this relates to the digitisation of cultural heritage in Europe” (The Centre of Expertise (HEC), 2007),

12 specific countries were investigated because they are considered to be at the

forefront of digitising cultural heritage. These countries are:

- Austria,
- Belgium,
- Denmark,
- Finland
- France,
- Germany,
- Italy,
- Norway,
- Portugal,
- Spain,
- Sweden,
- United Kingdom.

Although the document focus on quality assurance, digitisation policies very often include quality issues as well, containing as part of the policy or sub document the required quality parameters.

In the absence of a formal digitisation policy Söderbäck (2012:219) argues that it is really a poor idea to wait for a national digitisation strategy and recommend that the institution need not wait for others to take the initiative but should go ahead once enough knowledge and skills are present or accessible.

2.4.2 Africa

Not many formal policies are in place in Africa. With such valuable materials as for example in Timbuktu, it would be expected to see a digitising policy for the institution in Mali but the lack of a policy is probably the cause of only partial digitisation of very valuable artefacts. Van Wyk comments on the February 2013 unrest and damage to the Ahmed Baba Institute in Timbuktu:

"A formula must be found to digitise the documents" (Gibson, 2013:13).

In Kenya a land policy was approved in 2009 by the cabinet which includes the

digitisation of archival artefacts (Amollo, 2011:11).

In the context of Nigeria, Akintunde (2012:2) expresses the need for a structure:

> " ……..more of the institutions have been devising creative means of increasing their digital contents in the public domain, resulting in more Nigerian content on the Internet, and, particularly, more openness and sharability of institutional resources. However, quality of the content, organizational structure of the content, management, and other such issues may need to be addressed in a policy document in order to have a virile and sustainable open access platform".

Rosenberg, commissioned by the International Network for the Availability of Scientific Publications (INASP) to establish the current status of libraries in Africa, reported that:

> "Over the past fifteen years libraries worldwide have increased their holdings of electronic information and automated their operations, but within Africa digital development has been uneven" (Rosenberg, 2005:1).

Mnjama confirms Rosenberg's findings with his own observation about Africa:

> "Despite the fact many archival institutions are faced with major challenges of managing paper-based records, yet many archival institutions in the region aspire to transform their institutions and join the rest of the world in providing access through the use of modern ICTs such as the internet. Digitisation or migration of information from fragile archival materials electronic formats still remains a dream to many archival institutions in the region" (Mnjama, 2005:463).

Mnjama describes some of the material in danger:

> "Of all the archival materials available in the region, perhaps the most neglected archival resource are audio-visual collections which remain unprocessed and hence inaccessible to researchers" (Mnjama, 2005:66).

Contributing factors for slow digitisation and the lack of high quality digital content for repositories in Africa are identified by Ezeani, quoting Shibanda as being:

> “the real challenge for African digital information is to put in place an information management or professionalism that possesses the skill and competencies that can develop meaningful programs that supports and activate that use of information and communication technology" (Ezeani, 2011:3).

2.4.3 South Africa

2.4.3.1 An audit of South African digitisation initiatives

The lack of will and the perception of "non-importance" of a policy could be responsible for the absence of a National Digitisation Policy for South Africa. An overview of the attempt to put a national digitising policy for South Africa in place, starting with the South African Digitisation Initiatives audit in October, 2008 (Page-Shipp, 2011:8), may give perspective on the problem.

According to the publication of the findings of this audit by the National Research Foundation (NRF), a task team was appointed in March 2007 to:

> "participate in the process of legislative and policy formulation on digitisation of the heritage sector" (Page-Shipp, 2011:19).

After failure of the task team to meet, the matter was handed over to the Department of Arts and Culture (DAC) which set out to:

> "appoint a consultant to draft a 'policy on digitisation' that will support collection custodians in decision making regarding the permissibility of digitisation and web publication" (Page-Shipp, 2011:19).

The appointment of a consultant by DAC was done by means of a tender process but:

> "internal procedural irregularities led to the tender being cancelled and it has been reissued" (Page-Shipp, 2011:19).

A final draft copy of the "National Policy on the Digitisation of Heritage Resources" for public review, dated August 2010 was ready for discussion during a public workshop at the Gallagher Estate convention centre Midrand in February 2011, which the author attended. The various discussion groups during the workshop pointed out a number of uncertain issues for example copyright, foreign funding of digitising projects and the proposed creation of a National Digital Repository (NDR).

Concern was expressed about the NDR Repository's policy of enforcing the depositing of original master files:

> "digital masters must be lodged with a National Digital Repository. Any digital record existing outside of a National Digital Repository is not considered to be an authentic digital master" (South Africa, 2010:52).

Enforcing the transfer of master files to the NDR could have major implications for institutions in South Africa who have already digitised a major proportion of their collections for example the University of Stellenbosch, University of the Western Cape and the University of Pretoria. A large proportion of these digitised items are already available on-line for example on the World Digital Library (WDL) website. If the NDR becomes a reality, does this mean that all images or other documents in the WDL repository are not authentic due to the fact that the master is not in the NDR? Another question of concern is the retrospective amount of work that needs to be done just to be "authentic" according to the NDR definition. The retrospective work will be costly and needs staff at various institutions to re-do a proportion of collections already digitised. Do the institutions have the budget, staff and time to do the necessary rescanning and post processing and add the additional amount of metadata?

On the 26th of June 2012 a facilitator appointed by DAC, met the CEO and members of the preservation services including the author and other relevant staff of the National Library of South Africa in Pretoria, to discuss the National Policy on the Digitisation of Heritage Resources. The aim of the meeting was to establish the scope and cost implications of the policy and to present costing to the DAC Heritage Policy & Legislation Unit by the end of July 2012. During the meeting it became evident that there were still issues concerning copyright, the NDR and Information Technology for example, which were not clear. The facilitator was requested to have further discussion

with DAC in order to set a meeting between parties of DAC and the NLSA. Up to the present, 1 December 2013, no follow up meeting has been scheduled.

2.4.3.2 Audit findings

In a relative small country like South Africa with limited resources in terms of budget, knowledge, skilled staff, experience and equipment for digitisation, collaboration is essential between organisations to digitise effectively. However, the NRF audit recommended:

> "That, pending the formulation of a national policy on digitisation, professional organisations formulate their own best practice consensus for the guidance of members" (Page-Shipp, 2011:5).

The digitising process of any type of collection is a complex process. It should follow a well thought through process to decide on:

- what to digitise,
- the choice between long term preservation or just access to images or data,
- standards needed to conform to,
- workflows to maintain uniform standard,
- equipment needed to do proper scanning,
- metadata needed to identify and keep track of original and surrogates,
- storage space for master files as well as back up files,
- storage space for public access of images or data,
- staff needed to do digitising,
- choice between outsourcing versus in-house digitisation.

In order to enable institutions to fulfill their duty towards the National Heritage Resources Act, No. 25 of 1999, it may well be in the best interest of South African collection institutions if DAC can proceed with the completion and implementation of a National Digitising Policy to provide the guidelines and emphasise the importance of preservation by means of existing digitisation knowledge in the country.

However smaller institutions may not be able fulfil their duty due to financial constraints and limited funds. In these cases DAC or the provincial governments should

come to the rescue of the collections and not allow a situation similar to the present case of the District Six Museum in Cape Town, which is facing staff retrenchment and even a danger of total closure (Luhanga, 2012:8).

2.5 Current projects

2.5.1 Global

The process of digitisation provides the opportunity to access material in collections from anywhere in the world by means of the WWW if the collection is made accessible online. In order to achieve this outcome, various projects are underway in a number of countries. Sizes of the collections, budgets and staff related issues, are all factors that will determine the duration and cost of projects. A few projects are identified in the literature and listed below although there will be many more that are probably not publicly recorded and published until completed.

Tremblay (2008:114) reports that the Canadian National Defense Imagery Library was asked in 2005 to investigate digitisation options for their image collection consisting of photographic negatives. In 2008 they reported that the best choice to consider would be to digitise and resleeve the collection. The estimated cost would be 3.4 million USD and the time frame would be 5 years if the starting date is considered to be 2008.

Europeana 1914 - 1918, the current project run by Europana Libraries in Europe, plans to collect a substantial collection of digital content by 2014, which will represent the centenary of the outbreak of the First World War in 1914. Apart from collecting digital content from ten libraries in eight countries, the staff invites the general public to contribute personal memorabilia to the library. Stations have been set up where the

public can walk in, welcomed, and tell their stories as well as make available artefacts for scanning. Artefacts including propaganda notes, newspapers, trench journals, posters, personal letters, photographs, medals, uniforms and clothes are indexed and scanned on-site and handed back to their owners. The workflow procedure is explained in full detail to the contributing public on their public website at address: http://ec.europa.eu/information_society/apps/projects/factsheet/index.cfm?project_ref=270894.

The contributing libraries from the different countries found themselves on different sides of the historic conflict and the collection of artefacts in a single repository represents a unique collection in Europe and will be useful to a wide web audience including the public, family historians, museums, educational professionals, the media, archives, and historical societies. It is reported on their homepage that the consortium has made available 425,000 relevant items for the project and the collection will go far beyond any existing digital collection in terms of size and diversity.

Separate budgets for Europeana are in place for their different projects for example newspapers, cloud storage and Collaborative European Digital Archive Infrastructure (CENDARI) which provide and facilitate access to existing archives. According to the report the total budget in Euro is nearly 25 million which is 333 million in South African Rand value at the current exchange rate. Approximately 76% of the budget is supplied by the European Union (EU) according to the Europeana homepage on their website at www.theeuropeanlibrary.org/tel4/projects.

Projects in other parts of Europe include the National Library of Uzbekistan which reports the digitising of rare book collections and photographic prints (De Vries,

2009:24).

Google introduced massive mass digitisation projects. For example, in December 2004, Google announced the collaboration with five major research libraries to digitise more than fifteen million books from their collections and in exchange will provide the libraries with digital copies. However, in August 2005, Google announced a moratorium on their digitisation plans (Jeanneney, 2007:11).

A similar situation happened with Google's ambitious effort to digitise the world's newspapers. The intention was to make them available online but on 20 May 2011 Google announced that they stopped the newspaper scanning project. (Keller, 2011:1)

The exact reasons for stopping the digitising projects are not clear. Some publications indicated that copyright issues were part of the problem (Jeanneney, 2007:13). Hahn (2006:20) shed more light on possible reasons:

> "Google is being subjected to numerous lawsuits in the United States, France, Germany, and elsewhere because some publishers disagree on whether Google is infringing on copyright".

In this regard Hahn (2006:20) describe Google's attitude as:

> "extremely aggressive stance on copyrighted materials, insisting on an opt-out model that requires authors and publishers to contact Google and tell them they do not want their books included".

According to Hahn (2006:18) the crucial aspects of digitisation are high quality digitisation and long-term preservation of the digital content. Quality seems to be a direct problem as specifically mentioned by Jeanneney (2007:13):

> "In May 2005, Google placed on the Web the first works offered within the framework of its program. Their quality was often mediocre, no doubt because the job had been done too quickly".

Hahn (2006:22) cites Herkovic as saying:

> "Google partners have conceded quietly that the overall quality of the

scans has not been great. Andrew Herkovic of Stanford University Library was quoted in an article by Helm in *Business Week Online* saying “Google has never pretended to knuckle under to quality demands that [preservationists] hope for".

Hahn (2006:18) emphasise three issues with commercial companies:

"Quality, secrecy, and long-term stability are all issues that suggest it may be foolish to expect that commercial companies will share librarians’ values and commitment to digitised material preservation. We also should ask why Google is not adhering to preservation standards when scanning".

2.5.2 Africa

Ekoja from the University of Abuja in Nigeria reported in 2012 that the digitisation process of the National Archives and its holdings started in 2003 to enhance information preservation and service delivery:

"Every digital object irrespective of the content is created in a rendition system, which is made up of computer hardware, operating system, storage device, and application software" (Ekoja, 2012:6).

In a report by De Vries (2009:24) which forms part of a case study for low cost digitisation of member countries, Malawi reported the digitising of printed books, serials, divers documents and printed illustrations.

2.5.3 South Africa

According to the NRF audit it is reported that:

"Routine ongoing digitisation is taking place at the NLSA in Cape Town" (Page-Shipp, 2011:21).

However, the document is dated 31st August 2009 and the author's experience is that prior to 2009, all digitisation was done purely 'on demand' and with no standard of any sort applicable to any digital files with the effect that all digitised work done before this date was done with inferior photographic equipment and at a resolution of 72 DPI and no master files were created for preservation. This material cannot be considered

suitable for preservation, but instead need to be re-digitised to be of value to the institution. This observation gives rise to questions about the accuracy of the audit document in general. Without a physical on site audit, there can be no guarantee that all the information in the document is accurate enough to make any estimation of the general state of digitised collections.

Most collection institutions in South Africa are doing some form of digitisation although not always reported for public information. Some of the projects could be found on personal request.

Although no formal digitising policy is in place at the National Library of South Africa (NLSA) and no specific projects are formally identified, scanning on ad-hoc basis is taking place at present. Apart from ad hoc scanning at the Cape Town Campus, two newspaper titles are being scanned. Photographic negatives which consist of glass, cellulose acetate and polyester based are also being digitised for preservation purpose on an ongoing basis. These negatives and glassplates consisting of different formats and a variety of black and white as well as colour photographic material, is systematically scanned and re-sleeved in archival negative sleeves to slow down further deterioration. The scanning of rare books is done for preservation purposes and some of these digital records are also prepared for submission to the World Digital Library (Geustyn: 2014). The Pretoria campus of the NLSA scans selected titles of the black press newspapers.

The Archive of the University of Stellenbosch plans to digitise more negatives which were added to their existing collection since the survey as explained in chapter 3. Although not accurately counted, the additional material could be as much as 5000

negatives of various sizes and consist of black and white and colour photographic negatives.

The University of Pretoria continues to digitise various collections (Groenewald, 2013: e-mail).

2.6 Obstacles

Obstacles in general include funding issues, policies, work flow procedures, standards, storage space, and the cost of storage space. The literature contains many references to funding issues and usually report a shortage which most often is offset by donations and grants.

In cases where funding was successful, it is important to report progress on the project as the UNESCO (2002:43) guidelines point out:

> "Follow up progress reports should be submitted by participants at regular intervals, both to their managers and to the course organizers or funding body".
>
> If no reports are submitted, future funding applications may not be successful.

2.6.1 Global

In the United States of America and most of the European countries financial constraints are less of an issue than on the African continent, Therefore it is not uncommon that funding is sometimes provided to developing countries by Europe or the Americas for example by the Carnegie corporation.

The British Library supported the Fundamental Scientific Library of Armenia with 47, 000 Great Britain Pounds for a project that supposedly ended by 2010 for scanning 400 rare books and 1500 journal issues. This grant was forthcoming from the "Endangered Archives Programme" of the British Library (De Vries, 2009:7).

Funding is a major factor in most digital collections. It was reported on 30 May 2013 at www.infodocket.com that budget cuts from the EU will impact on the Europeana project. Projects are often optimistically envisioned without considering the real effect of budgets.

Funding for long-term preservation in terms of servers needed to accommodate data is crucial. Without foresight to maintain and upgrade regularly, a situation of possible data loss could occur. The more data added the greater the need for capacity becomes. Collections are growing due to more and more collections being digitised.

Palm (2006:3) explains the difference between digitally born files and digitised files in terms of storage cost. Born digital files are mostly small in size since they mainly consist of databases. On the other hand digitised records are mostly exclusively image files hence representing much more information and expensive to handle. The question was whether:

> "once materials were digitized, it was cheaper to maintain the digital files over time, or instead rely for long-term storage on images on microfilm produced from the digital files with the use of COM (Computer Output Microfilm)" (Palm, 2006:3).

Although the cost of hardware is still decreasing and is so cheap that it is barely worth discussing, Palm (2006:5) puts this in perspective when considering hardware for backup purposes:

> "While the price of computers in terms of capacity has dropped considerably, at the same time the amount of data that computers deal with and hence the capacity required for processing files has increased a lot. This is not necessarily a matter of dealing with more information –it often means just handling more options. This becomes obvious if one compares the cost of a single 2Tb hard disk drive – 450 euro,- - with the cost of a typical 2Tb back-up hardware system which may cost from 10 times as much – 4500 euros and upwards".

Furthermore, the cost of long-term preservation, is moving away from hardware

only and begins to affect the administration of it. Palm (2006:5) cites Jim Gray:

> "…But the real cost of storage is management. Folks on Wall Street tell me that they spend $300,000 per terabyte per year administering their storage. They have more than one data administrator per terabyte. Other shops report one admin per 10 TB, and Google and the Internet Archive seem to be operating at one per 100 TB. The cost of backup/restore, archive, reorganize, growth, and capacity management seems to dwarf the cost of the iron. This stands as a real challenge to the software folks. If it is business as usual, then a petabyte store needs 1,000 storage admins".

The cost of long-term storage is not stagnant and depends on the activity or usage thereof as explained by Palm (2006:9):

> "The costs of long-term storage are dependent on the rate of activity: the more the information stored is used, the higher the administrative costs. When use of the information goes up, there is also more need for external servers from which information is accessed".

Puglia (1999:1) discusses the components needed to be taken into account when planning a digitisation project such as on-going maintenance of images and metadata:

> "long-term maintenance of the digital images and associated metadata - is often not considered as part of project costs, but falls to institutions to absorb, so it is best to plan for the on-going costs from the beginning of the project".

Puglia (1999:1) cites Besser and Yamashita on the cost of developing and maintaining collections:

> "The authors are sceptical about the costs for developing and maintaining digital image collections decreasing over time, and conclude that digital access is not likely to be cost effective anytime soon".

Rosenthal (2004:249-250) also recognise the cost of preservation as a possible threat:

> "Unfortunately, the one thing everyone agrees on in the field of digital preservation is that there is not enough money to do the job. [The] Economic threats are perhaps the most serious. No institution has an

adequate budget for digital preservation, and most institutions have no budget at all".

2.6.2 Africa

According to Akintunde (2012:3) it was perhaps the modest progress in digitisation in Nigeria that:

> "caught the attention of the Carnegie Corporation of New York to include the library in its capacity building funding for the University of Jos in 2003. Thereafter, the library identified the retrospective conversion of its card catalogue as well as collection of theses and dissertations as priorities".

Although Malawi created more than ten digital collections of local publications which are not born digital and some are not available online, Salanje (2011:1) reports that the process of digitising is dogged by:

> "lack of proper digitisation equipment; inadequate expertise; getting copyright permission from creators of works; and delayed online accessibility".

2.6.3 South Africa

2.6.3.1 Funding.

Local.

Funding can be a major factor concerning a digitisation project. Liebetrau (2010:41) identifies 3 areas of funding:

- start up,
- ongoing for the programme,
- contingency funding to allow for changes in the scope, content and technology.

Each area of the funding includes funding for staff, information technology, equipment for digitisation and training.

Funding for a digitisation project can require a significant amount of money which the organisation cannot always meet. Projects are not small, and the demand is for

open access worldwide. The question also comes up: what monetary value does an image have when the primary use is, for example, only for information and research. The possible income from this item could be minimal and even if the complete collection is sold, the income may not even be near sufficient to sustain the project, or produce enough to cover all the costs involved from start to finish.

Ongoing funding is crucial to maintain and preserve a collection after its creation. In the case of the 10 year DISA project at the University of Kwazula-Natal from 1999 to 2009 (Liebetrau, 2013:e-mail), this may be the factor why the collection has largely become very slow and very often not accessible. The start-up funding was allocated and used and the project largely completed and made accessible for the public. But by July 2013 the collection was difficult to access, the cause is unknown but is probably due to a lack of system maintenance. It would be a waste of valuable resources in the past if 15TB of collection material just vanished (Pickover, 2013). The alternative would be to move the collection to the National Library of South Africa or to the University of the Witwatersrand for maintenance.

One-time external funding may cover only the start-up and contingency costs but:

> "typically, organisations need to identify and commit to ongoing funding for the programme" (Liebetrau 2010:41).

Local funding and grants are very limited. However there are institutions who applied for funding through the South African Lottery. The National Library of South Africa for example, was not successful with an application 5 years ago.

Foreign funding.

Although foreign funding in the past was well received, there is more scepticism nowadays about foreign funding. Early funding in South Africa by foreign countries had

the effect that a number of collections ended up in the hands of foreign funders who then claim to retain the copyright after completion of the project.

The Aluka portal which focuses on African collections, is a good example as explained by Page-Shipp (2011:18) in the National Audit Report of 2011:

> "As the project has proceeded, the production pressures arising from a need to 'feed the hungry website' have nevertheless created the impression that the partnership has become unbalanced in the Aluka direction, with too great a role being played by funding power. The recent transfer of Aluka into Journal Storage (JSTOR), another Mellon-funded initiative with similar access provisions, has increased the sceptics' nervousness."

Finances and budgets.

The South African government's annual budget cuts for almost all departments have had a negative impact on institutions dependent on public funding for digitisation projects.

Liebetrau (2010:2, 41) focuses on the South African budget constraints in relation to developed countries:

> "Developing countries like South Africa are following the digitisation trend set by developed countries. Many organisations need to go ahead with new digital projects despite financial constraints and diminishing institutional budgets. Due to annual budget adjustments and other financial shifts that an organisation may face, it may not be possible to provide evidence that funding will be sustained".

The annual report of the National Library of South Africa for 2012 (NLSA, 2012:45) explains its position in terms of budget:

> "The group is typically subject to budgetary limits in the form of appropriations or budget authorisations (or equivalent), which is given effect through authorising legislation, appropriation or similar".

2.6.3.2 Digitisation policy not finalised and in place

Page-Shipp (2011:20) stated that the issue that a national digitisation policy is

unlikely to be resolved in the immediate future and point to the need for guidance:

> "…there is a need for guidance that will reassure custodians of collections that are targeted for digitisation, especially where donor funding is involved, that they have taken adequate steps to protect the rights of the relevant parties and have not laid themselves, or the 'owners', open to exploitation".

2.6.3.3 Copyright.

Copyright remains a contentious issue for collection institutions and should be well described and adhered to. Care must be taken of copyright issues and properly applied and it may well be best to err on the cautious side.

Liebetrau (2010:8) gives an overview of the copyright implications on digital collections:

> "Copyright is a very important aspect of the digitisation process, as it encompasses the legal considerations that have to be made regarding the creation and maintenance of digitised collections. Directly or indirectly, copyright shapes the content of digital collections. In terms of the Copyright Act, works are released into the public domain when the copyright term expires".

The University of Stellenbosch photographic collection of the Watson and Lockley glass plate negatives is a case in point. Van Bart (2009:16) report in a local newspaper that this collection consisting of approximately 30 000 glass and film negatives were being digitised and are available for on-line purchase by the public. It was not until a public user complained about an image of a relative on display and available for purchase by any potential buyer, that the University realised the potential risk of images in the public domain without the required copyright clearance. Access to this website is now blocked for public access on the internet (Breed, 2013).

2.6.3.4 IT support cannot be underestimated

Digital collections are totally dependant on information technology (IT) support.

As IT is a support to the primary function of preservation, staff of the IT departments should work closely with digitisation curators and a two way understanding of issues surrounding preservation should be clear.

Page-Shipp (2011:25) emphasised the need for IT to be up to date:

> "Up-to-date IT infrastructure is essential if fast, convenient access and effective digitisation are to be achieved".

From a preservation strategy and staff point of view, teamwork is essential according to Page-Ship (2011:38):

> "Good relationships between IT support staff and the digitisation team are essential and it helps if the latter is well informed on IT issues".

2.6.3.5 Lack of collaboration

General lack of collaboration between institutions can be a major issue as it prevents a two way communication flow of information.

Liebetrau (2010:44) points out that:

> "each organisation must advance through stages of development to achieve a fully implemented programme, for example, acknowledge, act, consolidate, institutionalise and externalise; which means embracing inter-institutional collaboration and dependency.

Page-Shipp (2011:5) recommends a national digitisation and preservation support centre:

> "there are a number of developmental and support issues relating to the digitisation and preservation of heritage material that could well be dealt with on a common or coordinated basis in the South African heritage community. If these issues were to be dealt with 'centrally', it would be important to ensure an enlightened style that promotes support, rather than control, the effective use of distributed skills and expertise, and a high degree of transparency and good communication to promote progress and collaboration".

Collaboration could also be valuable when advice is needed before spending

huge budgets on equipment which may not fulfil the actual need in the institution. By collaboration it is possible to get first hand advice from institutions already equipped with similar equipment and who will be able to provide feedback on the success or failure of equipment based on their practical experience.

2.6.3.6 Advice from service providers / bureaus

Since 2010 many institutions in South Africa decided to invest in large format book scanners to digitise material such as, books, newspapers, periodicals, rare books and maps of varying sizes. The scanning of photographic prints with large format scanners are also included in the sales promotion of these scanners but the actual quality is not up to the expected standard for preservation purposes.

Vendor advice on the accessories required as part of the equipment suite may often be inadequate, necessitating that the institution does their own independent assessment. When decision makers at the time of purchase do not know exactly what material is earmarked for digitisation, costly wrong decisions can be made resulting in equipment that does not fulfil the need of the institution. Such decisions can lead to futile spending of valuable money. This situation can be prevented by requiring of the vendor to scan a sample of all typically material in the collection and a subsequent critical analysis of the results.

A typical example is the case of the Cape Town City Council. They purchased a special Kodak scanner for the digitising of photographic negatives. The unit manufactured by Kodak USA, was operated with an Apple Macintosh Operating system but after upgrading to a newer version of the operating system, new drivers could not be found or supplied. In the meantime this type of unit was discontinued by the

manufacturer Kodak which rendered the unit useless for further scanning (van Niekerk, 2010).

Vendors with little or no experience may advise clients who are requesting digital services that file types with inferior longevity characteristics are good enough for preservation.

2.6.3.7 Lack of photographic experience

Any digitising process which produces image files as the end product, is in essence photography. The same photographic principles in terms of photographic quality apply. Tone reproduction, colour, contrast, sharpness, exposure and proper use of light and the correct use of optics such as lenses are crucial considerations. Therefore staff involved in photography or at least with a sound knowledge of the above are recommended for this type of operation.

The need for sound knowledge about the digitising process is emphasised by Pretorius (2001:193):

> "Technical expertise is also required for both the planning and implementation phases. Skills acquisition is an especially problematic issue in instances where information/imaging technology experts are not primarily responsible for the project or readily available for the duration of the project. To ensure the effective capturing and enhancement of images a fairly high level of expertise is required of a range of technical aspects such as scanning resolution, pixel depth, dynamic range, gamma correction, colour models, colour balance and accuracy, file size, and communication protocol between digital scanners, cameras and the computer (TWAIN)".

This view is confirmed by Page-Shipp (2011:42) emphasising the need to be familiar with photographic methods which is essential to set up procedures for image capture.

2.6.3.8 Lack of training

Liebetrau (2010: 21) elaborates on the importance of the collection development of the institution and workflow of the digitisation process. Any successful digitisation of a collection is dependent on the quality and regular training of staff associated with the digitisation project:

> "The trust of the host organisation must never be in doubt and staff must be trained to retain and uphold it. Staff should also be trained in the use of different file formats and know where to store the information until it is ingested in a collection, repository database, or other method of digital archival storage. Staff should be encouraged to communicate across departmental boundaries to achieve greater exposure to available expertise. In-house training, attendance of conferences, registration on email list serves, the use of RSS-feeds and regular searches on the Internet for information regarding sustainable and preservable digital collections is recommended".

Page-Shipp (2011:4) explains the principle obstacle for training and development of capacity as well as skills as:

> "..the lack of informed and experienced practitioners of all types".

He further remarks that:

> "Pockets of expertise exist in various institutions, but most are sub-critical, with precious expertise bound up in only one, or at most two, individuals – often the ones whose enterprising spirit has established the digitisation programme. These people are critical to success in their current environments" (Page-Shipp, (2011:4).

The need for training arises in two categories according to Page-Ship (2011:4) firstly:

> "Existing staff in institutions who will be running digitisation projects in the short term to catch up with backlogs. They will require guidance and training to assist them in upgrading their skills. Training programmes aimed at these candidates are likely to attract large numbers of trainees in the first few years, but demand will tail off as the skills spread and the backlog of digitisation projects is worked off, and this should be taken into account in planning".

and secondly:

> "Digital librarians' who can take charge of the planning and management of projects and the development of repositories. The needs of existing incumbents of these roles can be met through workshops and networking".

With new technology, IT developments and improved digitising procedures, it is very important that training needs should be monitored and if the need for further training arises, attention should be given to it as soon as possible to stay current in the field of digitisation.

2.7 Standardisation and technical aspects

2.7.1 Background of standardisation.

The beginning years of digitisation were mainly focused on providing digital content while long term preservation, quality and standards were not yet properly in place. According to Kavčič-Čolić (2012:93) most collection institutions focused on production and neglected the quality needed for preservation. Kavčič-Čolić (2012:94) cited Hurts-Wahl who referred to the early years of digitisation as the "Wild West" days of digitisation mainly due to the fact that digital conversion quality differed between collection institutions.

The advantages of the application of standards are described by UNESCO (Unesco Working Group, 2002:52) in a guidelines document as follows:

> "Establishing digitisation procedures according to appropriate standards for managing electronic information facilitates access, use and long-term preservation. The role of standards has been critical to interoperability and to automating processes. Adherence to standards can facilitate preservation in managing the transfer of information between hardware and software platforms as new technologies evolve".

Applying standards in the digitising process ensure consistent quality files, but

Frey (1999:vi) comments that:

> "One of the most important and difficult questions to answer is what level of quality is really needed in digital image collections".

There is a constant tension between the issue of quality and storage space as one has an effect on the other. A high quality standard produces versatile digital files and could be utilised to its full potential in future with maximum detail retrieval as in the case with image files but at the same time these huge files require considerable storage space. Lower quality results in more manageable files but limit the utility of the files. Careful analysis of the actual usage of the files is needed to select an appropriate level of quality (Frey, 1999:vi).

The current literature usually addresses preservation and access alike. The implication is that preservation of digital images is crucial and cannot be thought of as only a digitising process without considering the effect of file longevity which guarantees access.

Kriegsman (2004:99) puts the digitising process in perspective by the following statement:

> "Digital archiving without preservation is just storage. Storing digital objects and images without taking other components into consideration will not help ensure that digital images will be accessible in the future".

Factors to consider before the start of a digitising process are identified by Kriegsman (2004:35-35):

- select what should be preserved,
- all media are ephemeral,
- plan for format obsolescence,
- quality expectations will change over time, most often quality will become more demanding,
- before creating or migrating an image, consider its potential future uses,
- high quality metadata is crucial,

- open vs. proprietary file formats,
- compression of files are degrading the quality.

The past few years the Library of Congress has worked towards achieving higher production levels while at the same time maintaining and even improving their image quality (Wheeler, 2008:171). However this was not done in isolation and underdeveloped countries can learn lessons from the benefits of collaboration between institutions especially when resources are scarce.

Wheeler (2008:171) comments as follows:

> "In an effort to continue improving image quality and productivity, the Library is working with almost a dozen government agencies that constitute the Federal Agencies Still Image Digitization Standards Working Group (FADGI). This working group is focused on developing standards, best practices, and tools to support imaging activities in the participating agencies. In connection with the work of this group, the Library is supporting the development of imaging targets designed to help achieve higher image quality and consistence".

It is worth considering collaboration between government agencies for developing standards, something that South Africa is lacking with the result that resources and knowledge are very often wasted. Collaboration efforts are also discussed by Söderbäck (2012:218):

> "In a small country such as Sweden, collaboration is crucial for long-term sustainability of digitization projects. The process of building cooperation is difficult, but will in the long run be equally or even more important than building individual archives".

Standardisation in the digital environment covers aspects such as:

- the working environment,
- calibration of hardware,
- general standards,
- the use of targets to benchmark equipment.

Over time, general working standards and recommended workflow procedures became

part of many institutions' official publications for digitising projects. (Geffert, 2008:29) argues:

> "It is obvious that at some point many years ago photographers became frustrated with the lack of consistency and eventually adopted standardised f-stops, shutter speeds, light meters, photographic targets, ISO film speeds, etc. Clearly without these foundations photography would not have become a universal medium. What we are experiencing today is a similar need for movement towards solid universal standards. We feel strongly that users worldwide will benefit from an increased emphasis on standardisation when it comes to digital imaging and print production. Unfortunately, creating change requires that people get directly involved in the discussions and testing required to influence the computer industry".

2.7.1.1 Working environment

Very often the working environment is neglected with the result that optimum conditions for digitising do not exist.

The physical environment for staff working with digitising equipment such as scanners must be comfortable. Sitting positions, the placement of computers, placing of scanners and the illumination in the room should not only be comfortable but also conducive for optimum performance of staff for long periods during the day.

The illumination and the colour of the working room especially the areas where colour correction and evaluating is done, should conform to recommended conditions. Very few published guidelines give attention to this aspect. However, the Federal Agencies Digitisation Initiative Still Image Working Group (FADGI) document gives guidance in this to this regard. The viewing conditions are set according to ISO 3664 and ISO 12646 which covers photography and colour proofing. When comparisons are made between originals and digitised items, the application of ISO 12646 should be followed (Williams, 2010:6).

The placement of computer screens should be such as to avoid any reflection or

direct light on the screens. The room colour should be a neutral gray with less than 60% reflectance to minimize flare perceptual biases. The room illumination should not exceed 32 lux when measured between the computer screen and the operator and have a colour temperature of approximately 5000 degrees Kelvin according to ISO 12646 (Williams, 2010:6).

An important aspect Frey (1999:32) addresses is the immediate environment where an operator sits:

> "Within the field of view of the operator, the area should be free from any posters, notices, pictures or any object which may affect the viewer's vision".

This could not only be distracting, but could also influence the operators colour interpretation.

2.7.1.2 Calibration of hardware.

Guidelines and policies very often reflect different emphasis on different aspects. For example some guidelines only refer to calibration of equipment such as the capturing devices and not the immediate computer environment such as computers screens and printing devices.

In the case of monitor calibration a major issue can develop when outsourcing scanning and the client does not see the same quality of a scan as the vendor because of calibration differences. It is recommended in such cases that the client and the vendor should use identical calibration systems to eliminate this problem (Frey, 1999:32).

Monitors are calibrated generally for a specific white point and gamma. Typical gamma for colour monitors range from 1.8 to 2.2 for personal computer systems. A

gamma of 1.8 is usually set for the Apple Mac. The white point is typically set at a colour temperature of 6500 degrees Kelvin (Frey, 1999:32). However more recent guidelines published by FADGI, preferred to calibrate monitors according to ISO 12646 standard which determine a colour monitor set to 5000 degree Kelvin and a screen luminance level of at least 85 candela per square metre (cd/m^2) but preferably more than 120 cd/m^2 (Williams, 2010:6).

There are various calibration methods and systems for monitor calibration on personal computers which includes software or hardware or both. More sophisticated systems are available which use devices like photometers and colorimeters (Frey, 1999:33).

Scanning devices are also subject to calibration processes. Scanners are set up to produce certain outcomes when scanning artefacts commonly referred to as aimpoints. In order to establish before and after settings, calibration charts of known properties are used to set the aimpoints.

The calculations for aimpoints are done with the aid of a Kodak grayscale Q-13 Color Separation Guide and Grayscale set. The protocol is summed up by Johnston (2002:210) as follows:

> "Ideal aimpoints for the channel values of the patches are calculated from the reflectances of the patches, using a function which is the inverse of a simple gamma display function. Scanner software controls are used to adjust the scanner's tonal capture response and the scan is repeated, until the RGB channel values as scanned match the calculated aimpoints. With the scanner (or camera) in this calibrated state, archival originals are scanned, and the resulting digital image files are archived as the digital masters without further tonal adjustment".

2.7.1.3 General standards

Apart from the ISO standards mentioned above, additional standards relating to

quality and procedures for scanning photographic material, should also be considered.

Photographic material occupies a large density range, generally more than non-photographic material as indicated by Williams (2005:slide 9) at the 2005 workshop in a Power Point presentation and presented here as Figure 2.12. Applying the appropriate standards during the scanning or image capture process, will ensure that optimum data capture, as well as recording of the full tonal range of the original, will take place.

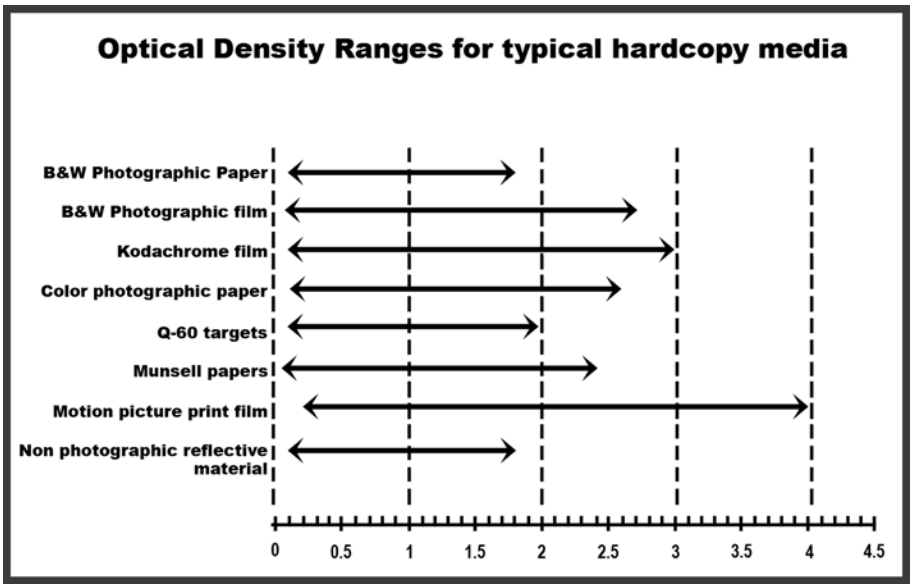


Figure 2.12 The Optical Density Ranges for typical hardcopy media. (Williams, 2005:slide 9).

The large body of the literature recommends criteria for capturing and post processing of image files. Colourspace, resolution, bit depth, allowable post processing of image files, and file formats for storing are usually recommended.

Most institutions are in agreement that each original artefact should be reproduced as a set of three separate digital images for the following uses:

- an uncompressed, non edited master image,
- a compressed image file for the purpose of web access,
- a thumbnail image for reference purposes.

The importance of the required level of quality of digital image files must not be underestimated. It is crucial for longevity and the full utilisation of the data in future. Guidelines and best practice documents of various collection institutions confirm the commitment of producing high quality image files. Apart from producing high quality surrogate copies from these master files, it is never clear what other possible uses the file will have. Johnston (2002:210) argues:

> "Because the investment of effort and expense required by the digital capture workflow (selection, description, preparation, scanning, etc.) was very considerable, an important planning consideration for each project was to maximize the usefulness of the resulting digital image files. In practice, this meant creating and maintaining a new archive of the digital image master files, and managing the digital image capture process so that the master files would be useful for other purposes not included in the immediate project goals.

General standards include recommended file formats for long term preservation which are non-propriety formats such as TIFF. Most guidelines suggest that files for archival use must not be compressed in any way due to the possibility of data loss during migration processes.

Frey (1999:36) in no uncertain terms recommends that data compression should be avoided for master archive files. She argues the main reason to be:

> "because in this case the future use of a digital image is not yet determined, one copy of every image should be left uncompressed. Current lossless compression schemes do not bring too much in terms of reduction of storage space. Also, it should be remembered that the loss of one crucial bit could mean the loss of all of the file information, even in the case of lossless compression".

A colour space of RGB is recommended for images in colour and sometimes black and white to retain the originality, but the advice to scan black and white in RGB for archival use by some institutions needs to be debated from a photographer's point of view and not only from an archivists point of view.

Principle recommendations for master files include:

- capturing the best quality within the constraints of the defined use,
- no use of interpolation is allowed,
- no sharpening of master images is allowed,
- all images to be captured at 100% size,
- images should be correctly orientated whenever possible to avoid deskewing later during post processing.

General standards for creating high quality digital master image files can be listed as suggested by the majority of important institutions:

- Colour space: Adobe 1998,
- Colour mode: RGB,
- Resolution: 600 - 4000 dpi (colour),
- Resolution: 360 - 4000 dpi (grayscale),
- Bit depth 8 (some cases 16 is suggested),
- File type TIFF 6 uncompressed,
- Margins 10mm margin should be visible beyond all sides of photographic prints.

A recommended procedure by FADGI for scanning black and white and colour negatives, is to scan the negatives as a positive which will result in a negative digital image. The reason behind this procedure is set out in the guidelines as follows:

> "Unlike scanning positives, reflection prints and transparencies/slides, there are no reference images to which to compare scans. Scanning negatives is very much like printing in the darkroom, it is up to the photographer/technician to adjust brightness and contrast to get a good image. Scanning negatives is a very subjective process that is very dependent on the skill of the photographer/technician. Also, most scanners are not as well calibrated for scanning negatives compared to scanning positives. Often to minimize loss of detail, it is necessary to scan negatives as positives (the image on screen is negative), to invert the images in Photoshop, and then to adjust the images" (Williams, 2010:61).

It must be emphasised that if any uncertainty exist about any procedure or standard before commencing a digitising project, the manager(s) will make the final decision about all the required parameters and communicate this to the digitising staff. Very often the manager will issue a written permission as explained by van Dormolen. (2012:25).

Although general standards are used as a firm base to ensure optimum quality, several tests can also be done by means of visual inspection of the image file on screen or in printed form after digitising the original, implying that a precise 'number only' approach is not the only and exclusive way to ensure optimum quality. For example noise present in a digital file may or may not be a case of concern. Williams (2011:216) explains why such issues may have differences of meaning to different people with the following phrase:

> "To turn a phrase, one person's signal can be another one's noise. Examples of this for reflective media are simple and few. An obvious one is choosing to digitize for paper structure (i.e. tooth) or simply the content provided by the original marking process. The latter is less demanding and almost in all cases more manageable and economical. Halftone structure is yet another. Are these flowers or weeds? Both can be considered of informational value, depending on who is asked, or an annoyance. The division lies in what can be considered of image value versus artifactual value".

2.7.1.4 The use of targets for benchmarking

There exist some uncertainties regarding the use of targets and Frey (1999:16) tries to explain that it is important to know that targets are about characterising scanning systems and it has nothing to do with the actual collection itself. It is also not equivalent to calibration of equipment although targets could lead the way to what and when to do calibration.

The use of benchmarking is explained by Frey (1999:34):

> "Benchmarking systems will help to compare different hardware, give more adequate information than that which is currently available from the manufacturers, and hopefully lead to a better understanding of the whole process".

Targets are a vital part of the image quality framework. In order to be able to make objective measurements of:

- tone scale reproduction:
  which is measured as the Opto-Electronic Conversion Function (OECF).
  Equivalent to the characteristic curve of a film, the OECF measures the success of the conversion of optical exposure or density of the original object in relation to the delivered pixel values of an image file. (Burns, 2010),
- detail and edge reproduction (Burns, 2010),
- Noise (Williams, 2010:24),
- colour reproduction (Williams, 2010:20).

For each of these parameters, different targets for different forms of images are needed (Frey, 1999:15).

Metamorfoze digitising guidelines of the National Library of the Netherlands suggested the use of various targets as part of their strategy to evaluate and calibrate digitising equipment (van Dormolen, 2012:31-33). Targets can be used day by day or from project to project to ensure consistency.

The UNESCO guidelines stated the following about equipment performance:

> "The equipment used and its performance has an important impact on the quality of the image. Equipment from different manufacturers can perform differently, even if it offers the same technical capability" (Unesco Working Group, 2002:19).

It is therefore strongly recommended to use targets for the evaluation of equipment.

2.7.1.5 ISO standards.

Standardisation in the field of scanning artefacts for museums, libraries and archives environment is relatively new. Although some basic standards were recommended as far back as 1974 (Dainty, 1974:1-2), it is only more recently that great steps have been taken to formalise standards and to make them part of the International Standards Organisation (ISO) documentation. These standards for example refer to:

- Tonal reproduction: (SFR) Measuring optoelectronic conversion functions (OECF), ISO 14524 dated 1999,
- Resolution: (Spatial resolution). Electronic scanners for photographic images Part 1, Reflective media, ISO 16067-1 dated 2003,
- Resolution: (Spatial resolution). Electronic scanners for photographic images Part 2, Film scanners, transmission media, ISO 16067-2 dated 2004,
- Noise measurement, Electronic still pictures imaging, ISO 15739 dated 2003,
- Dynamic Range, Electronic scanners for photographic images, ISO 21550 dated 2004,
- International Colour Consortium (ICC) Specification. ICC.1:1998 File format for colour profiles, version 4.1.
- Settings for monitors, light boxes and viewing booths. ISO 1264,
- Room setting and illumination: ISO 12646. (Williams, 2010:6),
- Viewing conditions: ISO 3664 and ISO 12646. (Williams, 2010:6).

2.7.2 Global

A number of institutions produced their own in house guidelines and best practice documents. These comprehensive guidelines contain very specific information applicable to that organisation including some references to ISO standards. They are

produced by institutions in the USA, British Isles, Europe and Australia. Less complex guidelines from other countries and institutions were studied and eventually it was found that the comprehensive documents should be used as preferred guides for standards and workflow.

Comprehensive documents consulted include:

- Digital imaging for photographic collections published by the Image Permanence Institute, USA (Frey, 1999:1-45),
- Federal Agencies Digitization Initiative Still Image Working Group USA (Williams, 2010:pp1-101),
- Metamorfoze Preservation Imaging Guidelines (van Dormolen, 2012:1-43),
- Guidelines for digitisation projects (Unesco Working Group, 2002:1-60),
- Technical standards for digital conversion of text and graphic materials. (Library of Congress, 2006),
- Europeana, best practice examples in library digitisation. (Sotošek, 2011:1-33),
- Just digitise it. (Public Record Office Victoria, 2011:1-25),
- Adopting ISO standards for Museum Imaging (Geffert, 2008:1-30),
- Digital Imaging Standards & Policies V.7 (Keefe, 2011:1-32),
- World Digital Library Image Standards. (World Digital Library, 2014).

It has been found that not much attention is given to the use of image capturing equipment for digitising projects such as scanners and digital cameras, and is rarely taken up in best practice or guidelines documents with the exception of the guidelines of the National Library of Australia which give detailed guidance and recommendations. For countries where little expertise is available and a general lack of sharing and networking is the reality, documents and recommendation like these are invaluable.

2.7.3 Africa

In African context no specific documents in terms of standards or best practices

could be found but instead reference is made to other existing standards and best practices published by established institutions outside Africa as in the case of Akintunde (2012:9) who refers to the digitising guidelines of the University of Southern Mississippi Libraries.

The absence of standards is specifically mentioned by Akintunde (2012:2). Although reference is made to output platforms, it may well be true for digitised images as well as it is often the case that African institutions are limited to very basic and domestic scanning equipment which is at the lower end of the digitising market. Akintunde describe the web content as:

> "Several Nigerian institutions that have been posting digital contents on the web do not appear to follow any standards and use diverse output platforms".

The absence of standards in Kenya is also reflected by Amollo (2011:22) during the Second International Conference on African Digital Libraries and Archives:

> "Libraries that wish to digitize should develop rules and standards specifically for the processes they intend to use. Standardization will ensure interoperability particularly if libraries intend to cooperate. KLA committee members should work closely with the Kenya Bureau of Standards to ensure that the standards are suitable for its members and that they are enforced by all the member libraries. This will help improve access and permanency of digital collections".

2.7.4 South Africa

In local context, Liebetrau (2010:32) explain best practices as:

> "Best practices are recommendations based on the use of optimal community-defined standards and international standards for selection of schemes, date formats, controlled vocabularies, cataloguing and archival description rules. Best practices provide documentation for decisions regarding formats and standards used. This enables efficient use of tools (technology) to convert, manage and harvest metadata and thereby maintain a standard of quality and promote collaboration".

Of special note in this statement is the collaboration issue. With the absence of a

National Digitising Policy collaboration is crucial to produce digital content of high and consistent quality.

There are at least two well documented local publications but with little reference to recommended standards for digitisation.

- UNESCO standards published in 2002,
- NRF guidelines published in 2010.

It is worth noting that the UNESCO guidelines were produced by an international group including a South African as a team member. This working group representing IFLA was commissioned to produce guidelines which should be applicable to institutions in countries of the developing world.

DISA used the UNESCO guidelines in the South African context but the guidelines do not contain any specific recommendation for the digitising of artefacts which will affect the quality of digital images. The document (UNESCO, 2002:18) explains only the terminology for example:

- resolution,
- bit Depth,
- image enhancement processes,
- compression,
- colour space and profiles.

The brief description of targets is included in the document, but the importance to use targets as part of benchmarking is not discussed. In terms of viewing and evaluating conditions for digital images and original artefacts, the document is very vague and no specific conditions are prescribed in contrast to the guidelines published by the Federal Agencies Digitization Initiative Still Image Working Group (Williams,

2010:6). UNECO viewing conditions are addressed by a very general remark and no mention of recommended colour of the room environment or colour temperature of lights and monitor is mentioned:

> "Image evaluation always needs a controlled environment. It is also important to adapt this environment to the requirements for viewing, which differs between the monitor and the source documents. Monitors are best viewed in low light, but not darkened rooms, and source documents in bright light. Surround effects like reflections can affect the evaluation and have consequently to be minimised for example by using a neutral background (grey) and neutral colours (grey, black, white) on the operator's clothes" (UNESCO, 2002:24-25).

The National Research Foundation guidelines publication is more specific with some technical detail and addresses issues such as file formats, resolution and compression (Liebetrau, 2010:22-26). Format and resolution is recommended as follows:

> "The scanned format for photographic imaging is TIFF 300-600 dpi colour or grayscale depending on the original. The derivative is normally displayed in JPEG but can also be embedded in other file formats such as PDF. For authentication, digital photographic editing is not recommended for master digital images".

No reference is made to calibration of any equipment or the use of targets for evaluating equipment.

2.8 Equipment

2.8.1 Global

Generally equipment is not discussed in standards or best practice documents, however the National Library of Australia lists the capture devices in use in the library. The message is clear that there is not a single piece of equipment that will enable an operator to digitise the diverse material in the collections at the different institutions.

Some of the equipment in use at the National Library of Australia (National

Library of Australia, n.d.) includes:

- digital cameras for example PhaseOne, Betterlight and Sinar P2 and eVolution,
- Canon digital single lens reflex,
- film scanners,
- flat bed scanners,
- large format scanner,
- overhead scanners,
- microfilm scanners.

Most of the documents used for the literature study concentrate on the use of various types of scanners for image capture, but only one institution make specific mention of the use and value of a medium format digital camera. Advantages of a professional digital medium format camera like the Sinar P3 are mostly underestimated. The use of a one shot digital camera for example to copy medium and large format photographic negatives such as glassplates is invaluable and some benefits are:

- maximum quality resolution can be obtained with proper macro lenses,
- there is no restriction on the size of the originals, the camera is flexible in comparison with a fixed size scanner,
- it can be used very successfully to digitise paintings,
- the imaging of 3D artefacts in the photographic studio or on location,
- adjustable front and rear end and provision to correct distortion by means of tilting of lens and back planes,
- higher productivity due to the one shot operation which is not limited to scan durations of a scanner as camera exposures are instantaneous.

2.8.2 Africa

No literature could be found which lists equipment in use in African countries.

2.8.3 South Africa

The DISA guidelines (using the UNESCO guidelines as basis) emphasises the dependence of quality images on high quality equipment:

> "The equipment used and its performance has an important impact on the quality of the image. Equipment from different manufacturers can perform differently, even if it offers the same technical capability" (UNESCO, 2002:19).

The National Library of South Africa is using a variety of equipment for the diverse items in their collections. Equipment included (Drijfhout, 2013):

- Large format A0 Zeutschel overhead scanners,
- Nikon Coolscan 9000ED for 35mm and medium format negative and positives,
- Epson V700 scanner exclusively used for large format negatives and positives /slides,
- Epson 10000XL A3 scanners,
- Canon EOS 450 digital camera for general use.

Some equipment in use at the University of Pretoria, Department of Library sevices, Digitisation Office includes (Groenewald, 2013):

- Large format A0 Suprascan 10000RGB overhead scanner,
- Bookeye2 Plus overhead scanner,
- Nikon Super Coolscan 9000 film scanner,
- Epson Expression 1640XL and 10000XL A3 scanners.

The University of Witwatersrand Digitisation Centre lists some of their equipment as follows (Pickover, 2013):

- Epson A3 scanners,
- Microfilm scanners,
- Bookeye A3 overhead scanners.

This list may not be complete.

In general good quality equipment used for digitising is expensive. In a money driven and competitive world, it is a fact that manufacturers and vendors will ride the boom of high demand for digitising equipment while the trend is on the increase. Unfortunately there could be a downside when an organisation is in a hurry to start digitising under pressure which may lead to bad decision-making in terms of equipment procurement. Proper research must be done beforehand to ensure that expectations will be fulfilled in terms of quality and quantity delivered by the equipment. Very often vendors may publicise the versatility of equipment where it may be clear to the expert that it is not the case.

2.9 Concluding overview

The literature study presents a number of papers and presentations addressing various issues of digitising from modest attempts to set standards during the early beginnings, until the recent inclusion of standards as part of ISO sets.

Recently a start has been made to integrate standards of various institutions into larger collective documents such as the integration of standards between FADGI in the United States and Metamorfoze of the Netherlands (Geffert, 2014:e-mail). This attempt will help to minimise differences of opinion about standards often not based on scientific testing and operating of equipment.

Furthermore, the literature provides a good overview of the use of targets to benchmark and calibrate digitising equipment which is important to maintain set standards for digitising collections.

The importance of co-responsibility of software developers to support long-term preservation and access to older data is underlined by Van der Hoeven (2004:5).

Valid recommendations are made by Page-Ship (2011:5) to encourage professionals to set up user groups in South Africa to advise and support digitising teams and managers. Such a user group initiative was established late in 2013 by staff of the National Library of South Africa and the Iziko Museums in Cape Town when the first meeting was held in Cape Town to introduce the various digitising teams of a number of collection institutions to each other. The user group will also aim to assist potential buyers of expensive digitising equipment with information before final decisions are made - a suggestion also made by Wheeler (2008:172).

The importance of technical photographic expertise needed by staff who is involved in the digitising process is discussed by Pretorius (2001:193). By appointing staff with a good basic knowledge of digitsing and to train staff that is lacking the skills to perform the necessary tasks can be a major factor in the success of the digitising team.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

The convenience of new technology to digitise and preserve historical images for future research and access, has a significant impact on collection institutions such as museums, libraries and archives. Very often there is pressure from the management of the organisation to start digitising without, or before, proper research and planning for the process has been done. In the case of the National Library of South Africa, Cape Town Campus, a large proportion of a map collection was digitised during the period 2005 - 2007 using inferior camera equipment. Although standards did already exist and were in fact published by UNESCO which Digital Innovation South Africa (DISA) used as basis by 2002, it seems that no consultation of the literature or the UNESCO standards was done (UNESCO, 2002:17-28), with the effect that all images were produced at 72 dots per inch (dpi) with an unknown colour profile and thus were not up to the standard for preservation purposes. Digitising in haste without proper planning and lack of best practices, results in a re-do and re-scanning of material, as well as in files without long-term preservation properties.

The issue is further complicated by the fact that the original photographic material may consist of a variety of formats and materials created by different earlier processes not familiar to present-day technicians and photographers. Some of the collections may include:

- photographic negatives which may be glass, cellulose nitrate, cellulose acetate or polyester based,
- photographic fibre or resin coated paper prints,
- positive images in the form of colour transparencies,
- lantern slides,

- Daguerreotypes,
- Calotypes,
- Tintypes,
- Cyanotypes,
- Various other lesser known types.

Initial research by means of informal discussion with curators of collection institutions in the Western Cape indicated that they were not using recommended best practices, procedures, and suitable equipment to produce image files suitable for long term preservation. The cause may be a lack of knowledge, a lack of resources, a lack of formal policies or just disregard of best practices.

The aim of the study was to establish the level of knowledge and technical skill of collection managers in the Western Cape that guided them in the decision making process when quality and longevity of image files used as surrogate copies of original photographic images are at stake.

Furthermore, the level of awareness of the importance of digital preservation was tested in three fulltime photography student groups, as well as amongst members of the PSSA.

The scanning of specific targets designed for scanners were used to measure actual performance of the selected scanners in comparison with the actual quality obtained with the selected quality setting in the dialog box of the scanner software.

The guiding questions to meet the above objectives were:

- To what extent have custodians of photographic collections used standardised scanning and workflow procedures to ensure optimum image quality?
- What was the level of knowledge when custodians decided on scanning procedures and workflows to establish reasonable file sizes versus quality compared to recommendations by research practitioners?

- What are the preferred characteristics of image data files to ensure optimal storage space and longevity of the files?
- What is the level of awareness of the complexity of digital preservation at fulltime student level at photographic teaching institutions in the Western Cape?
- To what extent are service providers / scanning bureaus informed of current practices in order to make recommendations and offer specialist scanning services to collection institutions?

3.2 Research design

Both quantitative and qualitative research methods were used in this study

3.2.1 Qualitative research.

In order to address the primary question, the recent literature was surveyed to form a background of the scope of digitising projects in South Africa as well as abroad. Attention was given to:

- application of policies,
- best practices, standards recommended and applied and considered to be suitable for archiving,
- the importance of testing equipment used in the digitisation process and workflow.

In order to be able to plan and execute a digitising project successfully, a minimum level of competence is needed from management who needs to plan and initiate the project. The literature was studied to provide a framework of what is internationally needed by managers to enable them to:

- implement policies,
- set, implement and control standards for a digitising project.

In order to be able to meet the required level of knowledge that managers need

to ensure that the digitising staff can perform efficiently, and to monitor performance of staff and the technical quality of the output, the literature study was used to establish the criteria needed to ensure sustainability of the project and the successful preservation and access of the digitised content for the future.

In situations where direct evidence was available to illustrate problematic issues, case studies were used and analysed.

3.2.2 Quantitative research.

3.2.2.1 Survey questionnaire.

Survey questionnaires were used to collect information about aspects of digitisation projects which were analysed to address further questions.

Additional questionnaires were used to establish the views of current student and amateur photographers, as well as service providers, on digital preservation.

These questionnaires were directed at:

- collection institutions,
- full time photography students,
- amateur photographers,
- service providers / scanning bureaus.

The questions in the different questionnaires were formulated in such a way as to elicit a response from the particular group based on their specific interest. It was expected to reflect the respondent's viewpoint, experience and expectations of digital preservation and the related issues. However, there may have been overlapping questions between the groups.

Questions for collection institutions were designed to gain insight into decisions taken by them about the application of policies, workflow, digitising standards needed for digital image preservation, and long term storage.

Full time photographic students were chosen to test their level of awareness, insight, expectation and provision for long term digital preservation as they need to advise their clients in the future. It was decided to use educational institutions that are:

- accredited educational institutions in the Western Cape,
- willing to take part in the survey,
- Final year students, as they are expected to have good insight into the future use and storage of image files.

The group of amateur photographers targeted in this study represents a cross-section of members of the Photographic Society of South Africa. The members are mixed with regard to their age, years of experience in photography and professions. As the organisation also focuses on national and international photographic exhibitions/salons, and furthermore confers Honours such as Associateship or Fellowship to qualifying applicants, it was expected that a higher level of awareness should be present in this group with regard to image preservation.

The service providers / scanning bureaus were identified according to their specialised services to government, semi-government and local government departments as well as to museums, libraries and archives and those who were using high end specialised equipment to provide high quality scanned image files. Therefore only two professional companies in Cape Town were identified to form part of the survey.

Service providers should be able to advise and give guidance with regard to preservation issues and are expected to have good insight and up to date knowledge about issues such as master files, file formats and characteristics such as compression, allowable post processing, and storage media and current trends in archiving of image files.

Some of the general photographic outlets such as minilabs did offer a scanning service to the general public but with limited and dedicated equipment depending on which company they represent (for example Kodak or Fuji). Scans for the public fall in a less critical category with the result that the services they offered were very basic and not of an archival standard as recommended by internationally published standards.

3.2.2.2 Collection institutions.

In order to establish the state of affairs of photographic collections in the Western Cape, a questionnaire was compiled and personal interviews were conducted on location with the identified institutions to complete the questionnaire. The questions in the survey were used to elucidate the following aspects:

- To what extent were custodians of photographic collections using standardised scanning and workflow procedures to ensure optimum image quality?
- What was the level of knowledge when custodians decided on scanning procedures and workflows to establish reasonable file sizes versus quality compared to recommendations by research practitioners?
- What were the preferred characteristics of image data files to ensure optimal storage space and longevity of the files?

The questionnaire also included questions to deal with the situation where institutions outsourced the scanning process to a third party, typically a service provider/scanning bureau.

The following are examples of questions which were included in the questionnaire:

- How many photographic negatives do you have in your collection?
- Do you have a current digitising policy in your organisation?
- Do you outsource your scanning of photographic prints and / or negatives?

- Do you have a standardised published digitisation workflow which you follow when scanning material?
- What resolution in dots per inch (dpi) do you use for actual scanning?
- What file format (for example, TIFF, JPG, PSD, PDF, DNG) do you use for your final digital file to archive?
- What is the life expectancy of your digital files in years?

The complete questionnaire is presented in APPENDIX A.

Institutions that were subjected to the questionnaire are listed below.

Table 3-1. Institutions with completed or uncompleted digitising projects.

Name of Institution	**Person to be interviewed**
Cape Town City Council, Cape Town	Mr Peter van Niekerk
Simonstown / Fish Hoek / South African Navy, Simonstown	Mr Eddie Wesselo
Stellenbosch University Archive, Stellenbosch	Dr Hans Heese
Iziko Museums, Cape Town	Ms L Hisham
Drakenstein Heemkring, Paarl	Ms M Lombard
De Wet Photomuseum, Hermanus	Ms Wilmans
Afrikaanse Taalmuseum, Paarl	Ms A van Zyl
National Library of South Africa, Cape Town	Ms M Geustyn

3.2.2.3 Full time photography students.

To test the level of awareness of the complexity of digital preservation at fulltime student level at photographic teaching institutions in the Western Cape, the following questions were part of the questionnaire:

- What does the concept "digital image file preservation" mean to you?
- Rate your opinion about the importance of preservation and access of digital image files for future generations.
- Did your lecturer discuss the importance of file formats with you at the time of commencing your photography course?
- What is the expected lifetime of the file format you are using at present to save your images?

- Which factors will determine the longevity of a file format?

It was expected that students in professional training programmes will take the issue of file longevity very seriously as this aspect can be compared to archived processed photographic material by earlier generations who practiced traditional film photography. A solid knowledge level of digital preservation is very important to fully understand the consequences of file longevity in the digital age.

The complete questionnaire is presented in APPENDIX B.

Institutions that were subjected to the questionnaire are listed below.

Table 3-2. Educational Institutions or organisations.

Name of Institution	**Number of students**
Cape Peninsula University of Technology, Bellville.	16 Final year photography students
Stellenbosch Academy of Design and Photography, Stellenbosch.	17 Final year photography students
Michaelis School of Fine Art, University of Cape Town, Cape Town.	9 Final year photography students

3.2.2.4 Photographic organisations.

A public survey to test the awareness and action to keep files safe for the future by members of the Photographic Society of South Africa who are mainly amateurs, was done by means of a voluntary web based questionnaire.

Questions, which were covered in the questionnaire, included:

- How many years have you been practicing digital photography?
- What does the concept "digital image file preservation" mean to you?
- Do you think that the file format you are using for storing images will always be accessible in the future?
- Have you made a study of the factors that will prevent you from accessing of files in the future?

- Which factors will determine the longevity of a file format? [Give two or three factors]

The complete questionnaire is presented in APPENDIX C.

Table 3-3. Photographic organisations.

Name of Institution	Number of participants
Photographic Society of South Africa, South Africa.	78 Voluntary members.

3.2.2.5 Service providers / bureaus.

Due to the lack of funding, proper equipment and staff, some institutions may decide to outsource the scanning of prints, negatives, maps, books and documents. In order to establish the awareness and the recommendations that a service provider supplies to the customer, the following issues were taken up with them :

- Have you been digitising photographic prints / negatives / positives / other?
- What is the typical size [number] of artefacts in such a collection?
- Does your client supply you with the digitising specifications for example what they require in terms of file resolution (dpi) and RGB or Grayscale?

3.2.2.6 Technical tests.

An initial literature study of best practices and implementation of standards at institutions outside Africa, confirmed the use of test targets to benchmark the quality needed for archival scans.

Preliminary research showed that no institution in the Western Cape have used any targets to test and verify quality of equipment and the resultant scans.

The general delivered quality of scanners vary from scanner to scanner although scanner specifications are often quoted to be similar for most. As an example; the 600

DPI image on scanner A may not be a 600 DPI image on scanner B.

Technical tests with scanning equipment.

Scanners that were tested were divided into 3 categories for reflective (prints) and transmission (negatives and positives) types:

- General reflective scanners,
- Large format reflective scanners,
- Transmission scanners.

The study included large format A0 (1190mm x 850mm) overhead scanners as these high end and expensive types of scanners are now well established in the digitising market and a number of government departments, universities, archives and museums have purchased units. They are mostly designed for scanning maps, documents, books and newspapers. However these scanners are also marketed as being good enough for the scanning of photographic prints and in some cases institutions are in fact using these scanners for this purpose as well. However, initial tests indicate an inferior quality of scans made of photographic prints. It was decided to include a Zeutschel OS 14000 and a Cruse scanner which differ in their basic construction. Although both scanners are using Charge-Coupled Device (CCD) sensors for image capture, the actual operation of the scanning heads differ, which causes specific differences in image capturing.

Published technical information of these scanners are usually not based on ISO standards with regard to the quality of the scans, for example the Zeutschel models. Since the start of this study, however, gradual improvements in large format scanners have been introduced and a recent brochure of the i2S Suprascan Quartz large format scanner manufactured in France specify the adoption of the Metamorfoze standards for

digitising. Specifications for this scanner contain references to targets for use for quality control. It was decided to include a QA-62 target analysis as part of the large format scanner category evaluation.

For the intended tests two types of targets were used to establish actual Spatial Frequency Response (SFR) and sampling in dots per inch (DPI) of the test target. Where applicable the data were presented in graphical format for scanner comparison. The two test targets that were used are:

- QA-62 target for reflective scanners for example photographic prints, documents books and maps.
- An Image Science Associates (ISA) Microfilm Preservation Target for transmission photographic material for example photographic negatives and positives.

The design of the targets conforms to ISO specifications.

The QA-62 test target.

A QA-62 test target was scanned at the following standard settings on each reflective scanner:

- 600 Dots Per Inch,
- Colour space RGB,
- Colour profile Adobe RGB 1998,
- Automatic colour correction and automatic exposure functions will be disabled,
- No sharpening function during or after time of scanning,
- No post processing of files before applying analysing software.

The QA-62 test target catalog part no QA-62-SFR-P-RM has the following characteristics:

- Product name:
  Slant Edge Scanner Target with Grayscale SFR & OECF #2,
- Substrate Size:
  75mm x 95mm,
- Substrate Type:
  White reflective photo-paper,

- Image Forming Material:
  Photographic Emulsion,
- Polarity:
  Positive,
- Image Placement Accuracy:
  Not Applicable,
- File Types allowed for analysis:
  TIFF and BMP,
- Description:
  Dark grey 25mm squared rotated 5 degrees (CW) on a grey field. Surrounding grayscale patches change in discrete steps from white to black. Twenty patches are provided, measuring 9 x 9mm each. The four corner-crosses measure 66.68mm centre to centre. The upper right grayscale patch is equal in density to the background of the rotated square (0.50 density). The lower left grayscale patch is equal in density to the centre rotated square (1.10 density).

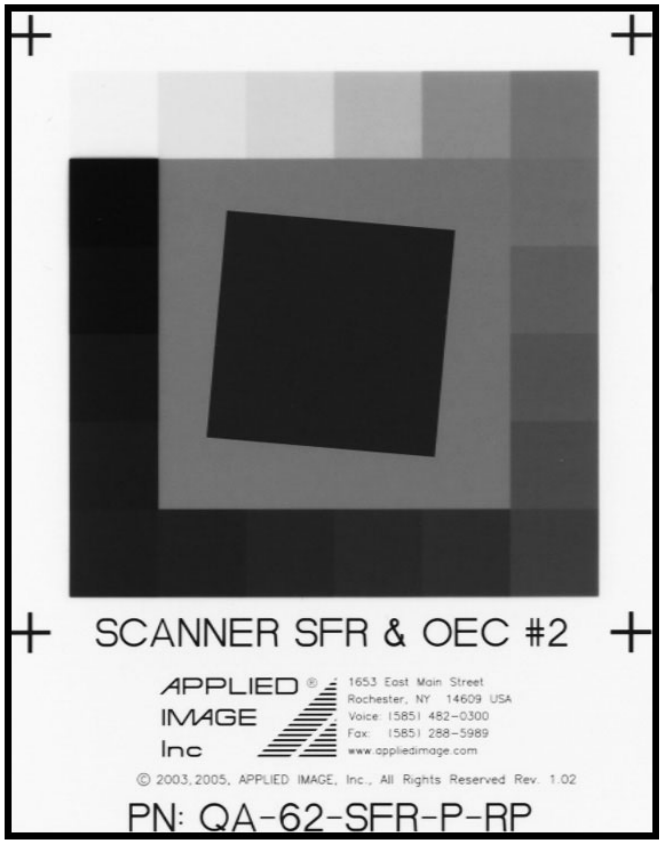


Figure 3.1 QA-62 target.

The target is designed to measure the following parameters:

- Grayscale patches – Intended to measure the Opto-Electronic Conversion Function (OECF) as described in ISO 14524. Two identical sets are provided to insure consistency. Optical transmission densities range from 0.10 to 1.40. The supplied software displays a graph of the OECF in terms of count value versus optical density (Burns, 2010:3). (Indicated as A in Figure 3.2).

- Slanted Edges – These edge elements provide the means to measure spatial frequency response (SFR) in both the horizontal and vertical direction as described in ISO 16067-2. SFR is a fundamental resolution metric. It also provides a measurement of the MTF. The spatial frequency associated with the 10% SFR response is often considered a threshold value for limiting spatial resolution (Burns, 2010:4). (Indicated as B in Figure 3.2).

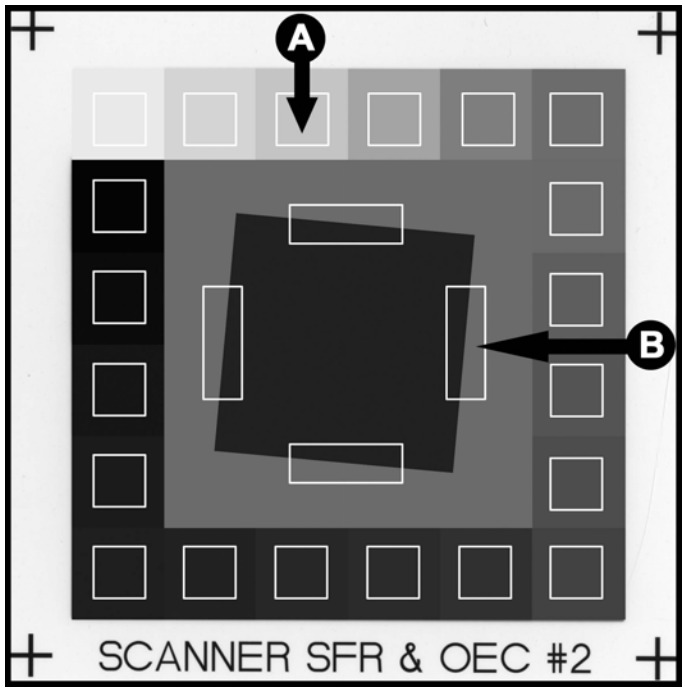


Figure 3.2 QA-62 target grayscale (A) and slanted edges (B).

Image Science Associates (ISA) Microfilm Preservation Test Target.

A Microfilm Preservation Test Target (Figure 3.3) was scanned at the following standard settings on each transmission scanner:

- 600 Dots Per Inch;
- Colour space RGB;
- Colour profile Adobe RGB 1998;
- Automatic colour correction or automatic exposure functions will be disabled;
- No sharpening at time of scanning;
- No post processing of files before applying analising software.

The ISA Microfilm Preservation Target has the following characteristics:

- Product name:
  ISA Microfilm Preservation Target,
- Substrate Size:
  35mm x 45mm,
- Image Forming Material:
  Photographic Emulsion,
- Polarity:
  Negative,
- Grayscale patches,
- Corner-to-corner diagonal line,
- Slanted Edges,
- Crosshair and circle fiducial marks (Indicated as 4 and 5 in Figure 3.4),
- File Types allowed for analysis:
  TIFF and BMP.
- Description:
  Consistent with preservation microfilm, it has a nominal background density of 1.00 and its features fill the entire 35 mm film width. Individual frames are 35 mm x 45 mm. Provides for the measurement of Spatial Frequency Response (SFR), resolution, macro/micro distortion, and grayscale behavior over a 0.10 to 1.20 optical density range when used with the supplied software.

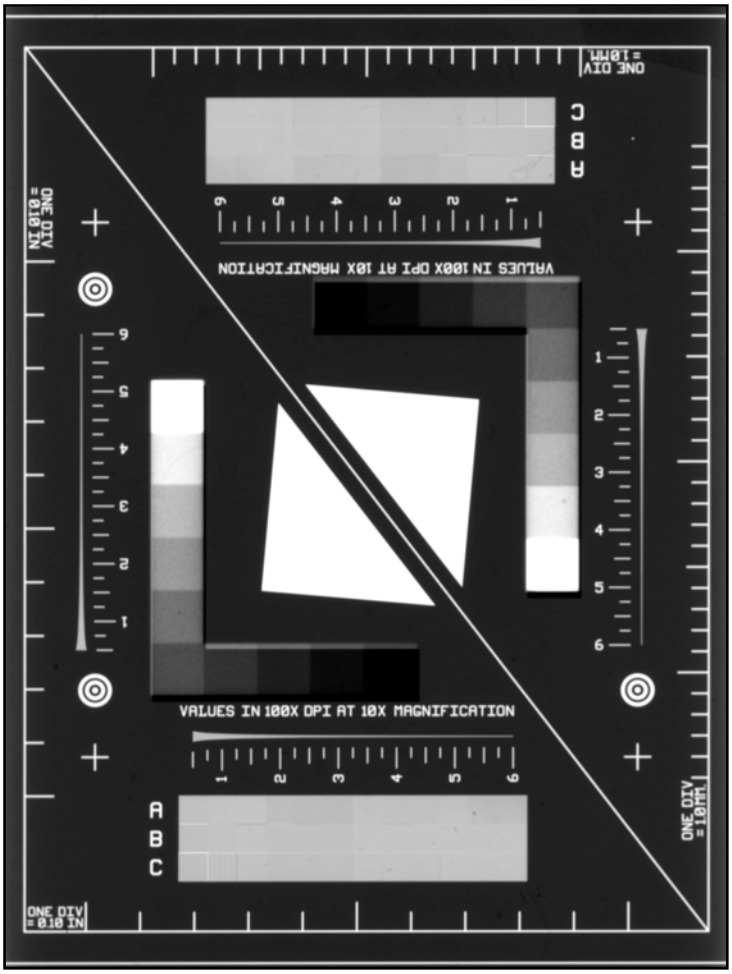


Figure 3.3 ISA Microfilm Preservation Target.

The target is designed to measure the following parameters:

- Grayscale patches – Intended to measure the Opto-Electronic Conversion Function (OECF) as described in ISO 14524. Two identical sets are provided to insure consistency. Optical transmission densities range from 0.10 to 1.40. The supplied software displays a graph of the OECF in terms of count value versus optical density (Burns, 2010:3). (Indicated as 1 in Figure 3.4).

- Slanted Edges – These edge elements provide the means to measure spatial frequency response (SFR) in both the horizontal and vertical direction as described in ISO 16067-2. SFR is a fundamental resolution metric. It also provides a measurement of the MTF. The spatial frequency associated with the 10% SFR response is often considered a threshold value for limiting spatial resolution (Burns, 2010:4). (Indicated as 2 in Figure 3.4).

- Corner-to-corner diagonal line – This is a common feature used in linear array scanner testing and is intended to measure sampling and scan motion fluctuations (Burns, 2010:4). (Indicated as 3 in Figure 3.4).

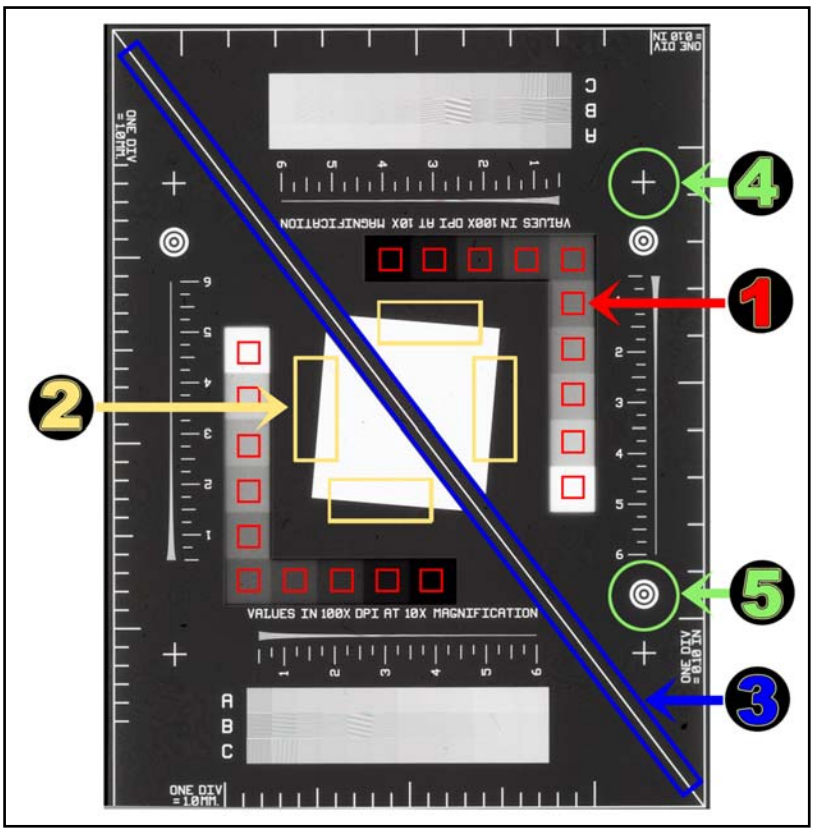


Figure 3.4 ISA Microfilm Preservation Target.

3.2.3 Analysing qualitative research

In order to benchmark projects in South Africa the literature study was used to establish how digitising projects were planned and executed at institutions outside South Africa. This information can be used to ensure that local projects are in line with best practices to ensure proper scanning procedures and workflow and maintaining a high standard of file integrity.

3.2.4 Analysing quantitative research

3.2.4.1 Survey questionnaires

The survey of collection institutions was analysed to establish if there was an awareness and application of best practice methods to ensure preferred workflow procedures and the application of best practices for file preservation.

Responses of photography students and members of PSSA by means of the questionnaire, were analysed to gain insight in the level of awareness of students and amateur photographers indicating the importance of proper file management to ensure access and longevity of files in the future.

The survey of the service providers / scanning bureaus was analysed to establish the best practices they use when supplying services, based on their research or experience, to the clients.

Displays of the analysed information are presented graphically and in tabular format. In the case of individual responses to questions the actual responses were quoted.

3.2.4.2 Technical tests

Software needed for analysing targets.

The following software was installed on a personal computer in order to analyse the scanned test targets:

- Matlab Component Runtime 2008b compiler needed for analysing reflection and transmission targets. The compiler is loaded in the computer memory to execute the mathematical calculations applied to the Region Of Interest (ROI) on the target by means of the appropriate software (Burns, 2008:1-9).

- SFR-edge-v6 for the analysis of the QA-62 target. The function of this software is to load the test image and execute the following functions.
    - Identify the gray patch areas on the test target image by means of the ROI and allow for adjustment of the ROI if necessary,
    - Identify the vertical and horizontal slanted edges on the test target image by means of the ROI and allow for adjustment of the ROI if necessary,
    - Provide ISO standardised imaging performance results (e.g. resolution, tone scale, white balance) in order to assess goodness of scan data.

Although earlier versions of the target analysis software are available, version 6 was used for the analysis on the recommendation of Don Williams (Williams, 2014:e-mail).

- Imcheck4v2 for the analysis of the ISA Microfilm Preservation Target.

  The function of this software is to load the test image and execute the following functions.
    - Identify the graypatch areas on the test target image by means of the ROI and allow for adjustment of the ROI if necessary;
    - Identify the vertical and horizontal slanted edges on the test target image by means of the ROI and allow for adjustment of the ROI if necessary;
    - Identify the Diagonal Line Region on the test target image by means of the ROI and allow for adjustment of the ROI if necessary.
    - Provide ISO standardized imaging performance results (e.g. resolution, tone scale, and scan speed uniformity) in order to assess goodness of scan data.

Analysing targets.

The scanner tests that were done reflected and compared the recommended tolerances published by Metamorfoze and NARA guidelines for scanner performances.

The following criteria were measured and compared:

A. Flatbed scanners (QA-62 target):

- Vertical and horizontal sampling efficiency, Red, Green, Blue and Luminance,
- Vertical and horizontal spatial frequency for SFR values in cycles per millimeter (cy/mm)
- Vertical and horizontal Red, Green, Blue mis-registration in pixel value.
- Opto-Electronic Conversion Function (OECF)

B. Filmscanners (ISA Microfilm Preservation Target):

- Opto-Electronic Conversion Function (OECF)
- Vertical and horizontal Resolution and Spatial Frequency Response,
- Micro (wobble) distortion.

3.2.4.3 Visual observations

Visual observations may be used to confirm certain types of deviations. For example Photoshop could be used to check micro distortion also known as wobble (Williams, 2013:e-mail). Colour misregistration could also be visually observed at 100% magnification as an extra quality check (Von Dormolen, 2013:e-mail).

3.3 Concluding overview

Existing literature were used to establish what standards are being used in similar institutions abroad and to establish by means of the questionnaire if the local institutions, used in the case studies, use similar standards to ensure long term preservation.

The aim of the questionnaires was to test the awareness level and pitfalls when not applying best practices before, during or after digitising projects.

The technical tests are proposed to verify equipment performance during the process of digitising.

The scanning of targets and comparison of image quality to the benchmark at the

beginning and end of every scanning session, is a generally recommended standard procedure (Burns, 2010:6).

CHAPTER 4
DATA AND FINDINGS

4.1 Introduction

Qualitative analysis to address the primary and further questions was done by the study of the most relevant and recent scientific publications in the field of digital preservation and archiving which include policies, standards for long-term preservation and benchmarking of scanner equipment. In a number of cases, the author entered into personal correspondence with the researcher or author of an article, which often resulted in a clearer understanding of the problem addressed or statement made. This was particularly the case with setting up measurement parameters and working procedures for actual performance testing and use of targets for scanner performance.

Quantitative research analysis was done by distributing questionnaires to address the primary and further questions. These questionnaires were aimed at not only institutions who are actively digitising photographic collections, but also fulltime photography students and amateur photographers who are members of the Photographic Society of South Africa, an organisation representing amateur photographers in South Africa.

It was planned that the questionnaires should establish the awareness level of digital preservation amongst the participants. Awareness includes recommended file types, file storage, longevity of files, and communication by lecturers to students to ensure file longevity for customers of professional photographers.

4.2 Qualitative research

To evaluate the primary question in terms of available literature, it is clear that the number of publications available globally containing detailed information about the

recommended standards are numerous and up to date with current trends to give clear guidelines. The past years saw an increase in the number of digitising standards which are ISO compliant to emphasise the importance of proper implementation of standards.

The literature study provided a number of digitising policies from various institutions such as museums, archives and libraries around the world. Although policies focus mainly on collection of artefacts, identification of artefacts for digitisation and access to this digital content, some policies do include basic technical criteria and standards for digitisation.

With well-researched and tested procedures and workflow, procedural and standards publications form the backbone of the digitising sections of these institutions. Even in South Africa with a general lack of published digitising policies for institutions such as the National Library of South Africa, the general workflow at the present time is partially in line with standards such as the Metamorfoze standards of the Koninklijke Bibliotheek in the Netherlands and FADGI in the USA.

From the literature it is found that the most recent and most comprehensive standards for digitisation is taken up in the Metamorfoze document of the Koninklijke Bibliotheek in the Netherlands and the standards document of the National Archives and Records Administration of the United States.

The case studies confirmed that enough information was available overseas and locally about proper digitising at the time when commencing the digitising projects. However, the custodians in the Western Cape showed a disregard of research into available literature to acquire the necessary knowledge of standards and procedures to guarantee high quality digital files to ensure longevity and access of digital image files in

the future. For example, DISA (by using the UNESCO guidelines) published recommended standards as early as 2002, yet the case studies proved the lack of awareness of these published standards in South Africa.

The level of knowledge of custodians at the collection institutions in the Western Cape was mostly very low. As an example in the case of the University of Stellenbosch archive, the file format chosen for digital preservation of 86200 photographic artefacts was JPG. In this case the curator did no research beforehand and the choice of format was left to a non-professional Information Technology staff member who emphasised the space saving characteristics of the file format rather than the longevity of the digital image files.

4.3 Quantitative research

4.3.1 Statistical analyses by means of questionnaires.

Three different questionnaires were compiled with some overlapping questions in all three.

4.3.1.1 Questionnaire 1

The first questionnaire was aimed at institutions that are digitising collections or that have finished with digitising and contains only a few responses of yes or no nature.

The same questionnaire was used for institutions that are scanning in-house as well as for those using outsourcing. The design of the questionnaire allows the relevant questions for each group to be addressed from question A1 or B1 to A13 or B14 whichever is applicable to the institution.

The responses of institutions were obtained by means of personal recorded interviews. The decision for personal interviews was taken after consultation with an

advisor of the Cape Peninsula University of Technology. The advantage of the personal interview was that it provided valuable additional information concerning digitisation and preservation at smaller institutions.

Column charts are used below illustrate the responses. The additional questions, which required individual responses, have been summarised when they are relavent to the questionnaire. Eight Institutions took part in the survey however certain questions only apply to specific institutions, therefore the number of respondents is shown below the graph as n=3, n=5 or n=8 being the number involved with the same question.

The institutions were are listed in Table 3.1 on page 117 above.

4.3.1.2 Questionnaire 2

The second questionnaire was aimed at full time photography students studying at three different institutions in the Western Cape.

Some questions contain a yes or no response while others required a written explanation. Column charts are used where applicable and personal responses are summarised.

The institutions surveyed are listed in Table 3.2 on page 118 above.

4.3.1.3 Questionnaire 3

The third questionnaire was aimed at members of the Photographic Society of South Africa. Members are usually independent amateur photographers taking part in monthly photographic club activities and national and international salon exhibitions. These members are at an advanced level of digital and traditional film photography.

A number of questions in the questionnaires could have a simple response for example a "yes" or "no" in which case the information presented will consist of column

charts containing the response of the respondents. Other questions needed a choice between two or three options and are indicated in a column chart.

In addition, responses from some questions may have led to a further question depending on the previous response. These types of response as well as questions containing personal verbal responses are quoted verbatim.

4.3.1.4 Responses from institutions survey.

Responses to the questions at the time of the personal interview are as follows:

Question 1: How many photographic prints do you have in your collection?

Total number of prints for all responses: 162,800.

Remark: None of the institutions could give exact numbers in their collections.

Drakenstein Heemkring indicated an "unknown" number.

Question 2: How many photographic negatives do you have in your collection?

Total number of negatives for all responses: 489,602.

Remark: Only the Drakenstein Heemkring could give an exact number of artefacts that were digitised others could only give an estimate.

Question 3: How many photographic slides do you have in your collection?

Total number of slides for all responses: 1,016,450.

Remark: Some institutions indicated they have a small collection of slides but could not give any estimate of numbers.

Question 4: Do you have a current digitising policy in your organisation?

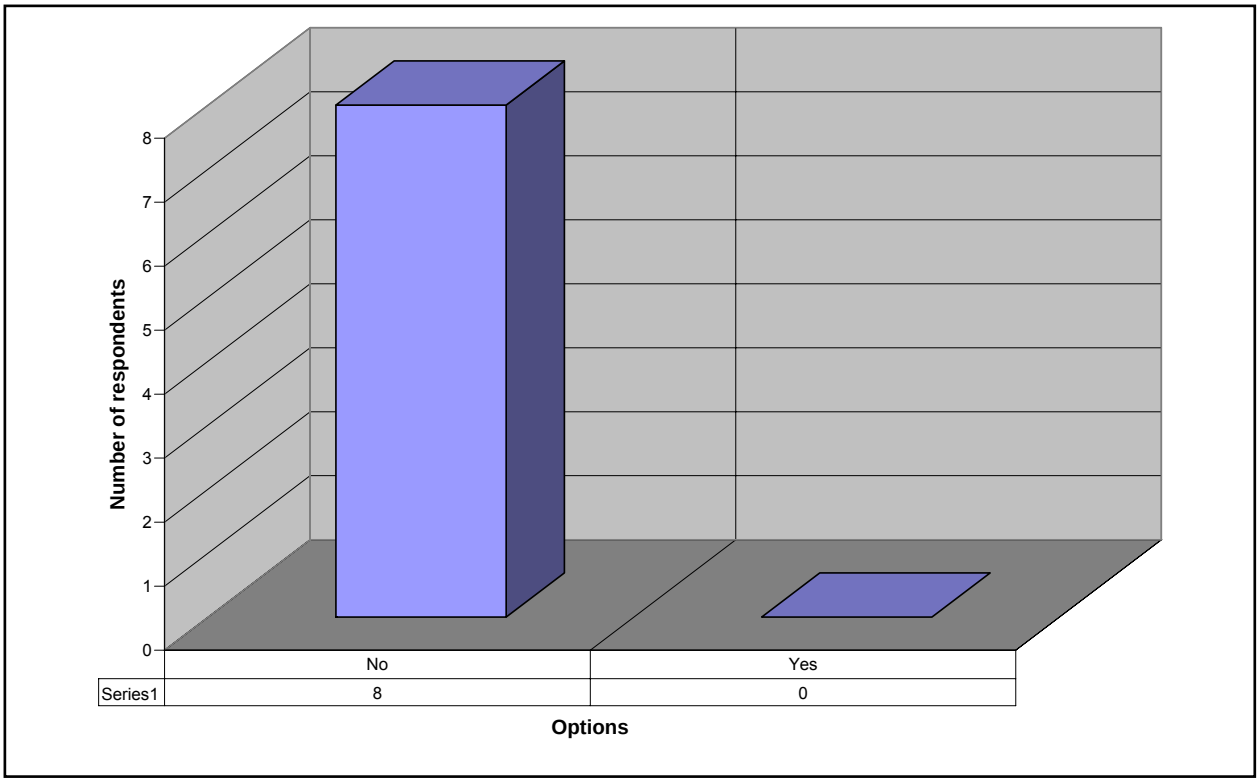


Figure 4.1 Current digitising policy.

Remark: None of the institutions has a digitising policy in place but the Afrikaanse Taalmuseum in Paarl indicated they are in the process of developing a policy.

Question 5: What is the purpose of digitising your collections: (1) Preservation (2) public access to material (3) both of the before mentioned?

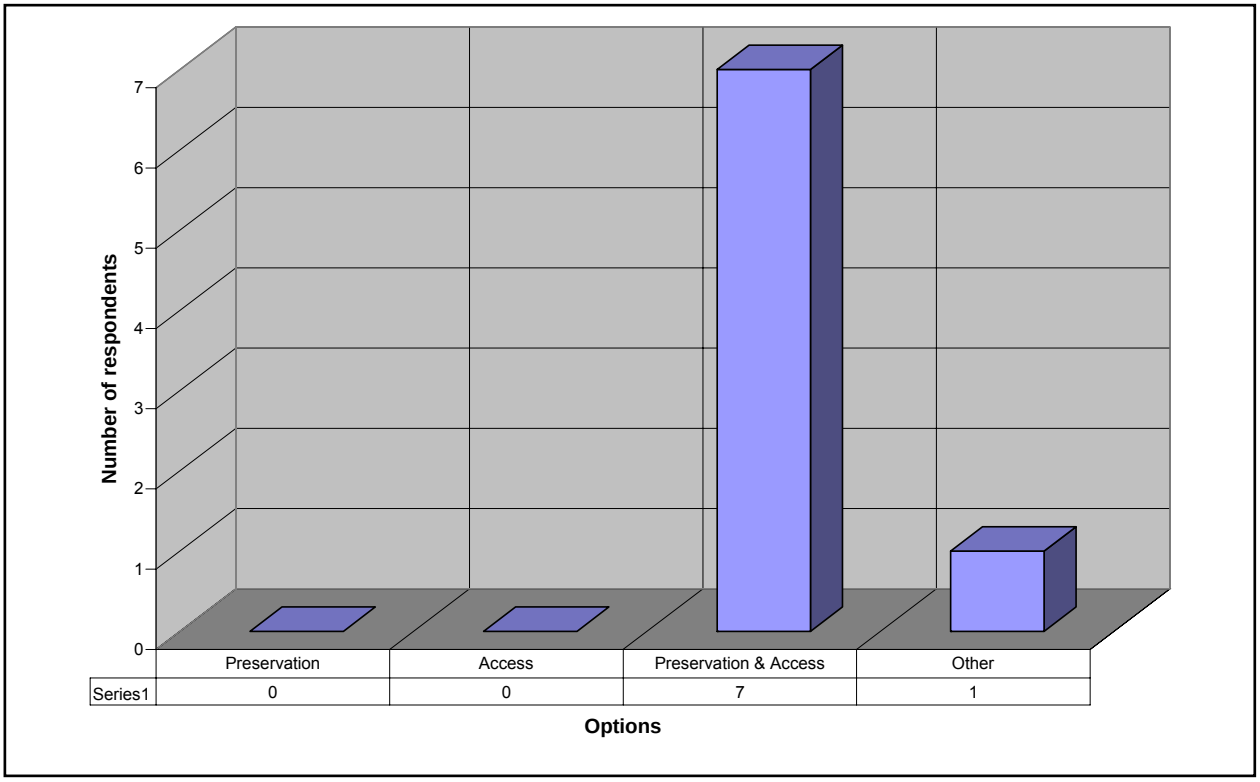


Figure 4.2 Purpose of digitising collections.

Remark: The main purpose for digitising the Cape Town City Council collection at the time of the interview was only for reference purposes to enable the identification of specific material for proper digitisation at a later stage due to the estimated large number of 1,300,000 negatives and slides in the collection.

Question 6 & 7: In what year did you start your scanning project and what year did you finish the project?

Stellenbosch University Archive started in 1999 and although the initial scanning is finished, more photographic material were added later which has not been scanned

by November 2013.

The Ou Hawe Museum at Hermanus started their scanning project of material in 2005 and finished in 2008.

Simonstown Naval Museum , Simonstown Museum and Fish Hoek museum started in 2006 but have not finished by November 2013.

Iziko Museums (Cape Town) of South Africa are doing ad hoc scanning.

National Library of South Africa (Cape Town Campus) started in 2009 with scanning on demand with inferior equipment. By November 2013 scanning is still mostly on demand but with an attempt to raise the quality to archival standards. Less than 4000 negatives and prints have been scanned to date.

Drakenstein Heemkring (Paarl) started in 1998 and finished in 2009.

Afrikaanse Taalmuseum was still investigating digitisation at the time of the interview in 2010.

Cape Town City Council started in 2007 to digitise photographic material but the process stopped in 2011 and is still unfinished. The purpose of digitisation is for identification of material only.

Question 8: Do you outsource your scanning of photographic prints and / or negatives?

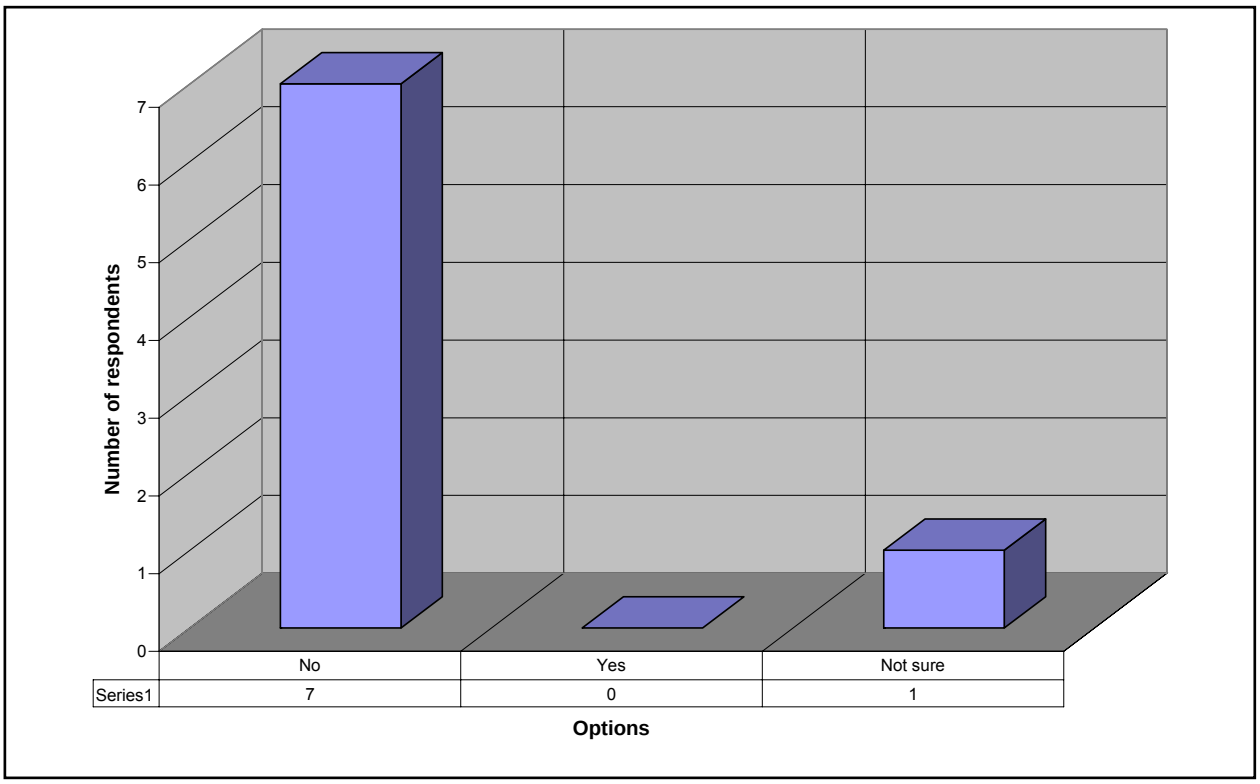


Figure 4.3 In-house scanning versus outsource scanning.

Remark: Three institutions responded indicating that generally, they do not outsource but under certain circumstances, they do request a commercial company to supply digital copies of selected items. This is mostly due to lack of proper equipment or insufficient funding available for a specific project. The Afrikaanse Taalmuseum indicated they are only in the planning stages and are not sure what they will do and will only make a final decision once they have investigated the issue.

Question A1 & B4: How many photographic prints have you digitised at this stage?

The responses from interviews always reported that the numbers were approximate.

Total numbers as reported by the persons interviewed is 3820. This number represents 2.3% of all collections in the surveys.

Question A2 & B5: How many photographic negatives have you digitised at this time?

The responses from interviews always reported that the numbers were approximate.

Total numbers as reported by the person interviewed is 139 672. This number represents 60% of all collections in the surveys.

Question A3 & B6: How many photographic slides have you digitised at this time?

The responses from interviews always reported that the numbers were approximate.

Total number as reported by the person interviewed is 1740.

This number represents 0.17% of all collections in the surveys.

Question A4: What type of scanner do you use for the material?

Scanners listed by the institutions are follows:

- Nikon Coolscan 9000 transmission,
- Canonscan transmission,
- Mikrotek with transparency adapter transmission,
- Epson V700 transmission / reflective,
- Epson 10000 XL reflective,
- Zeutschel OS 14000 Overhead large format scanner,
- Unknown type.

Question A5: Do you have a standardised published digitisation workflow that you follow when scanning material?

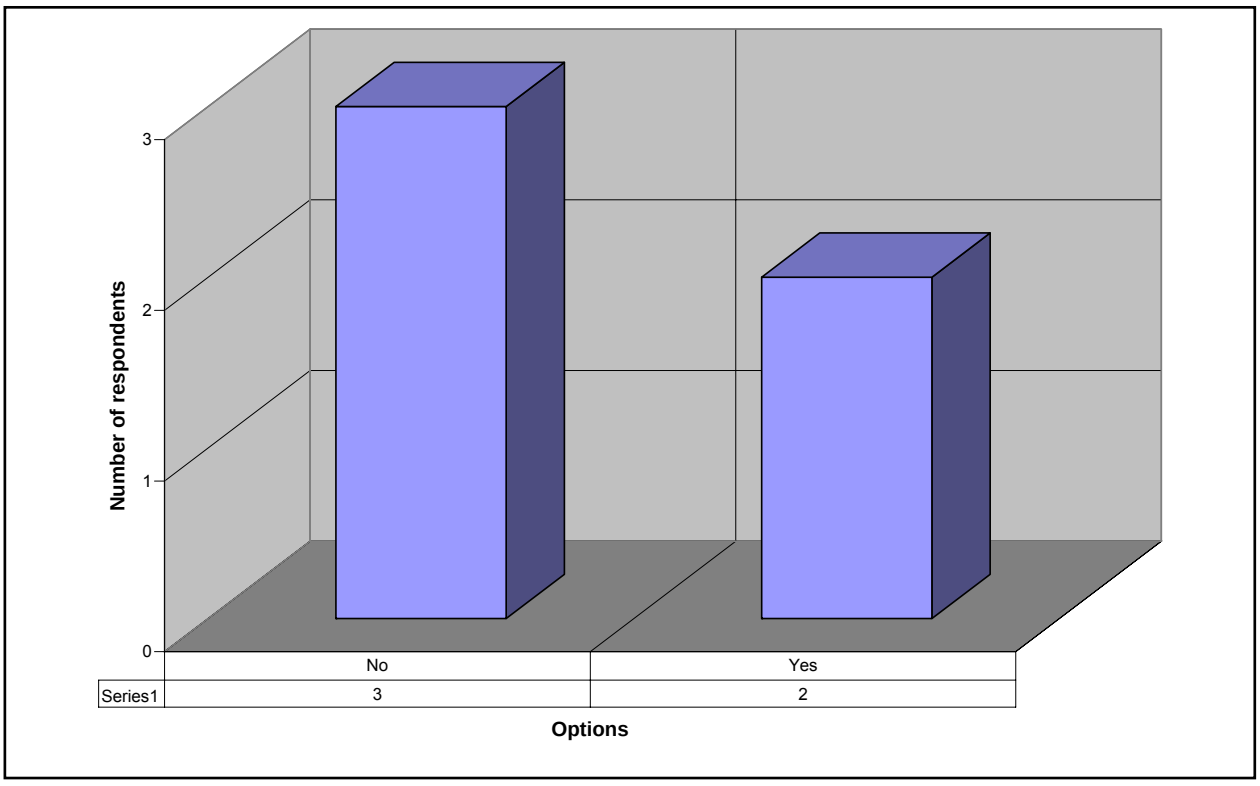


Figure 4.4 Published workflow.

Remark:

The question relates only to institutions that do their own in-house scanning.

Question A6: What resolution in Dots Per Inch (DPI) do you use for actual scanning?

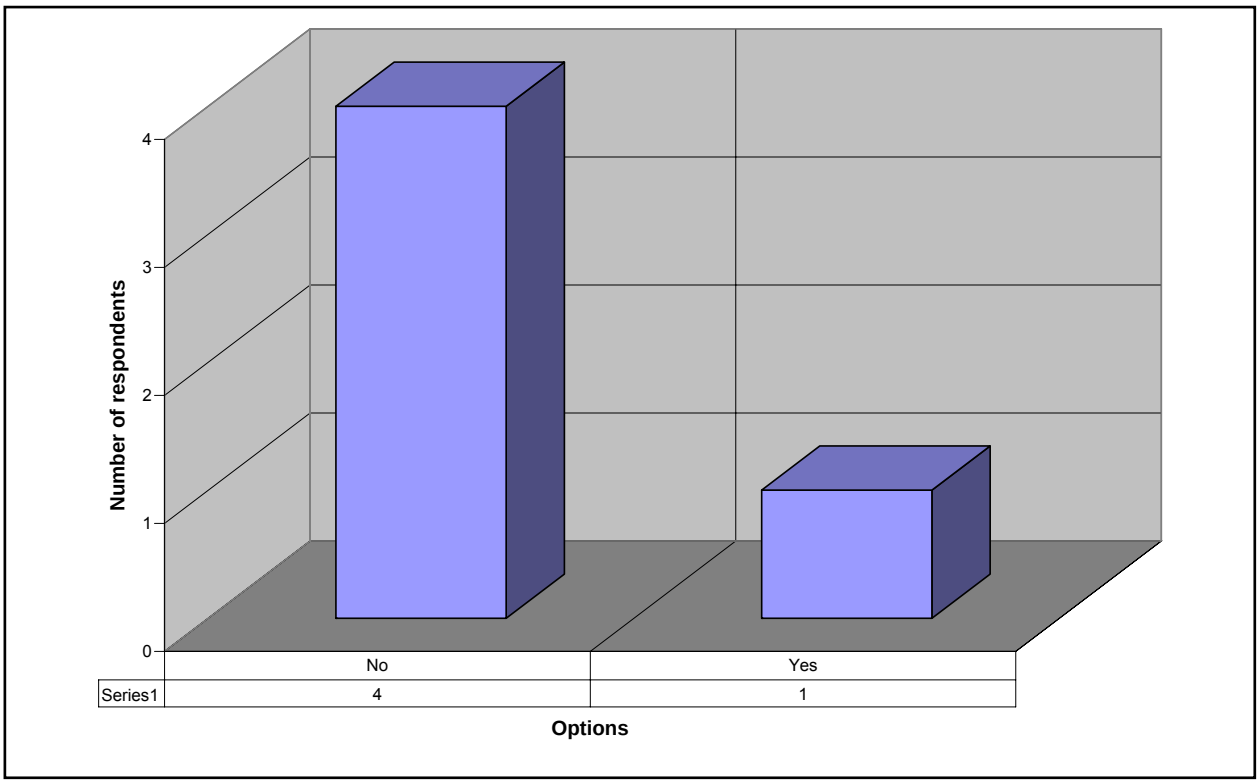


Figure 4.5 Resolution for scanning.

Remark: The National Library of South Africa indicated that other resolutions are also being used according to international recommended standards. For example; transparencies in black and white or colour and negatives in colour or black and white, are scanned at either 5000 DPI in the case of 35-millimetre format or at 1200 DPI for 6cm x 6cm, 6cm x 7cm and 6cm x 9cm format. This procedure is followed for cellulose acetate film as well as glass negatives. Glass plates, larger than mentioned sizes, are all scanned at 600 DPI.

Question A7 and B8: What resolution in Dots Per Inch (DPI) do you use for archiving the digital files?

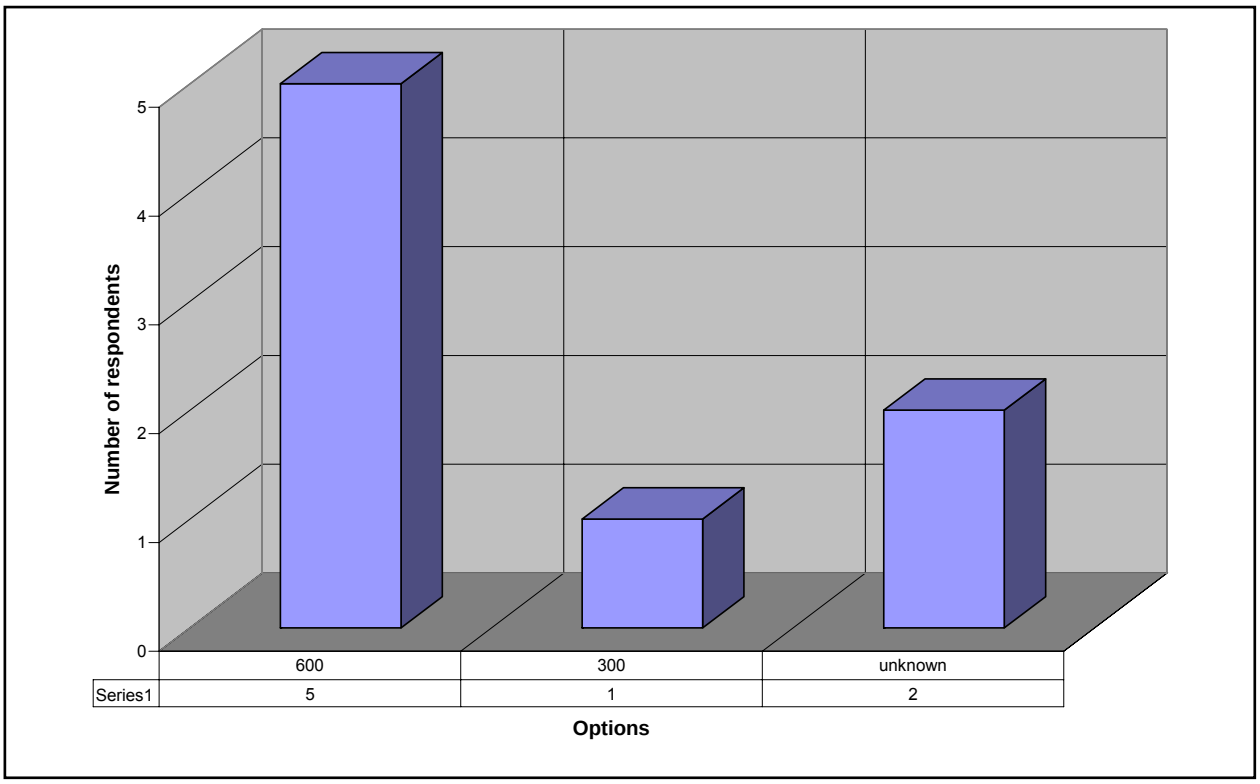


Figure 4.6 Resolution for archiving digital files.

Remark: Only the National Library of South Africa indicated that higher resolutions than 600 DPI are used for formats smaller than 6cm x 6cm for negatives and transparencies.

Question A8: Did you do research of file format characteristics of each file type, before making a decision as to which format to use for archiving to ensure file longevity?

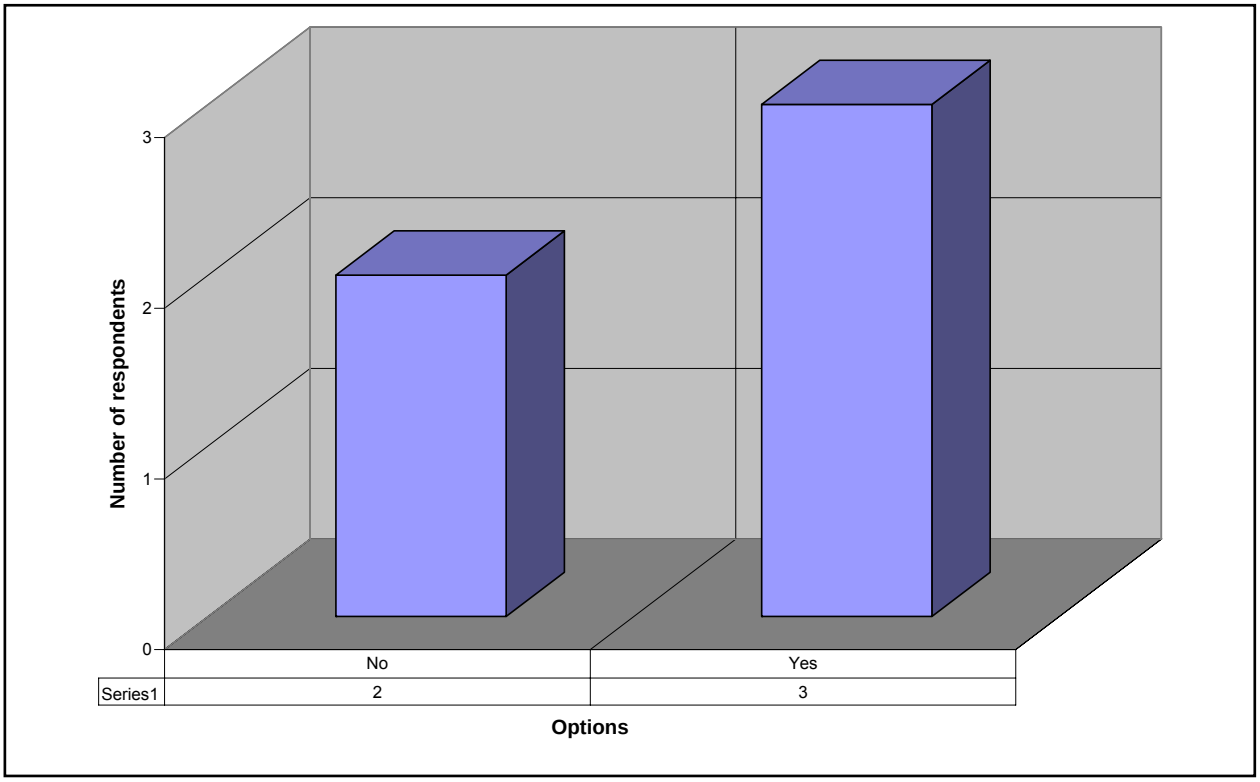


Figure 4.7 File formats for longevity.

Question A9 and B9: What file format (for example, TIFF, JPG, PSD, PDF, DNG etc.) do you use for your final digital file to archive?

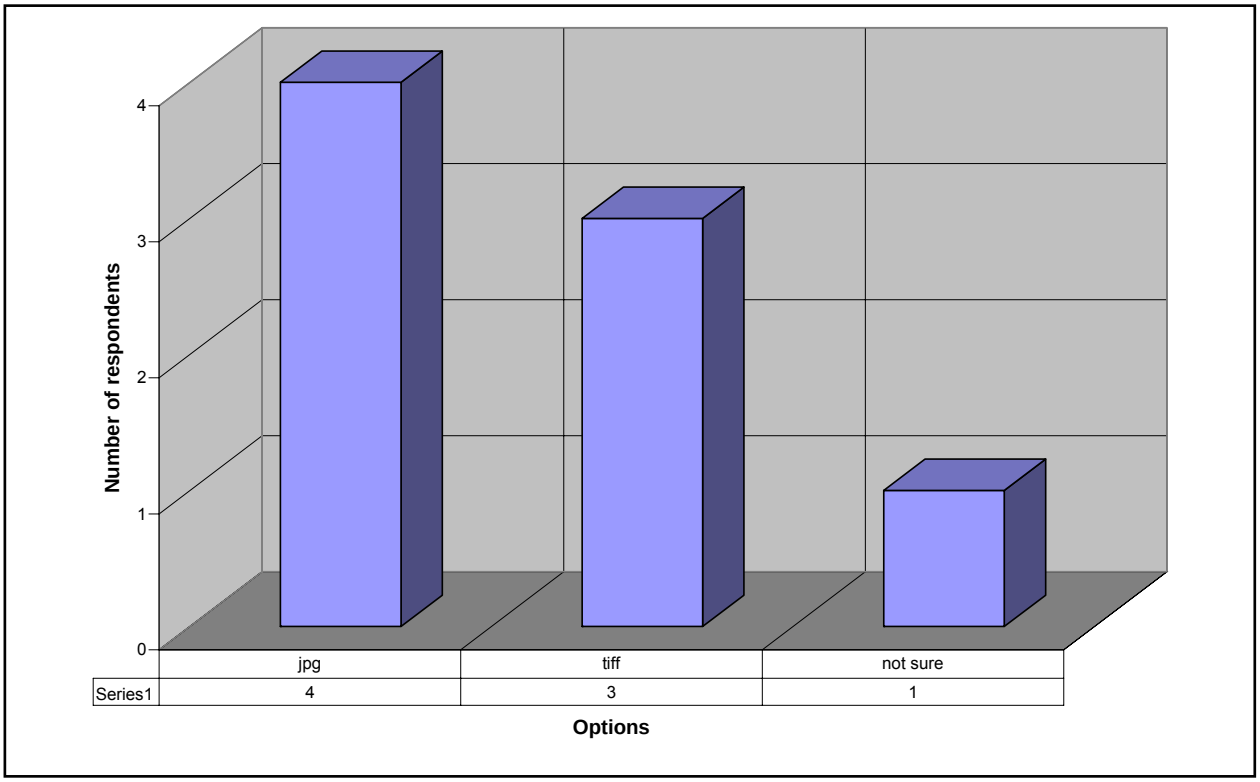


Figure 4.8 File format for archiving.

Remark: The "not sure" response is because digitisation is still in the planning stages.

Question A10 and B10: Do you use file compression during the process of file saving?

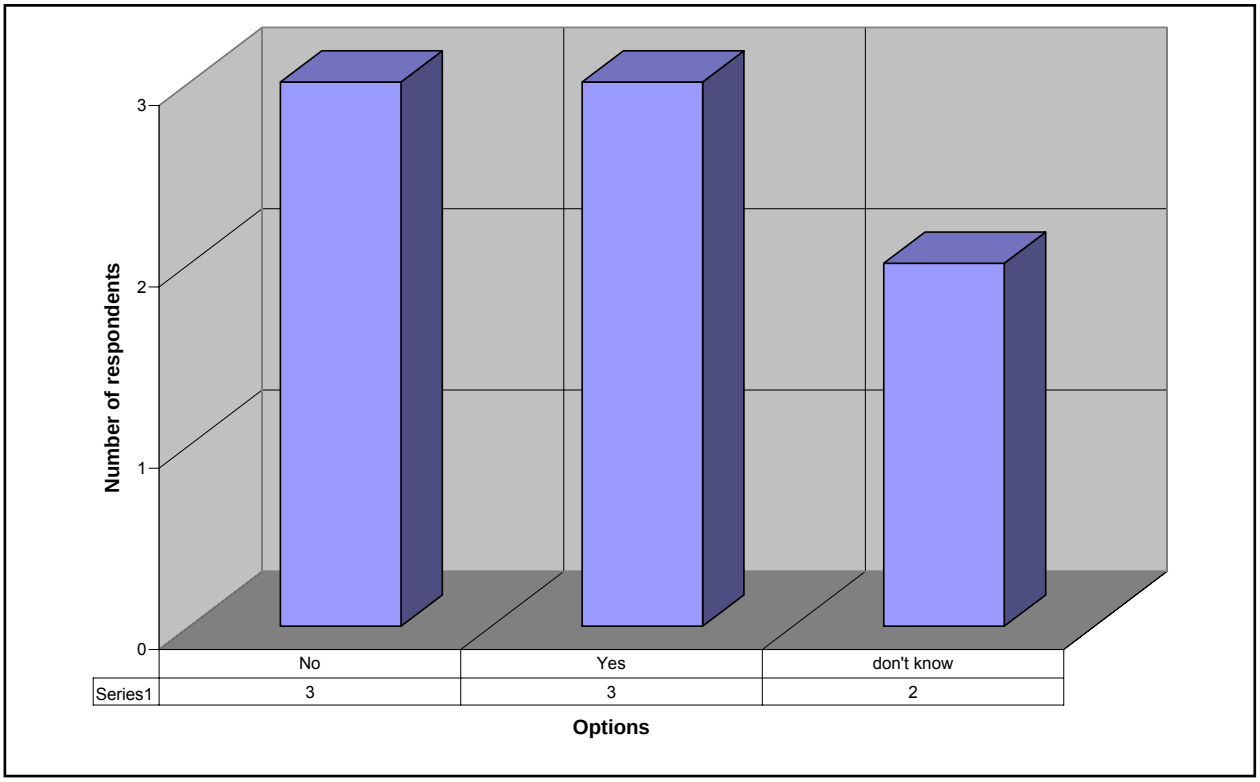


Figure 4.9 The use of file compression.

Remark: The "don't know" response is because digitisation is still in the planning stages.

Question A11: If Yes, why do you use compression techniques?

Remark: All respondents who responded yes indicated that compression is used to reduce storage space.

In the case where no compression is used, it was mentioned that compression is only used for emailing images for users.

Question A12 & B12: If you do use compression, on what information do you base your decision?

Remark: Only four institutions responded to this question. Their source of information regarding compression was:

- local photographers and the Digital Asset Management handbook by Tom Ang,
- consulting experts (experts not identified),
- research of international research publications as well as publications on best practices.

One response was that no information was available.

Question A13: Where did you get your advice from for decisions about file formats and compression techniques?

Remark: Only University Stellenbosch Archive and the National Library of South Africa responded that they have researched articles or consulted published books to enable them to make decisions concerning file compression.

Question B1: Do you feel the scanning service company or professional advisor has enough knowledge based on scientific proof, to give you the best possible advice on the archiving and preservation issues?

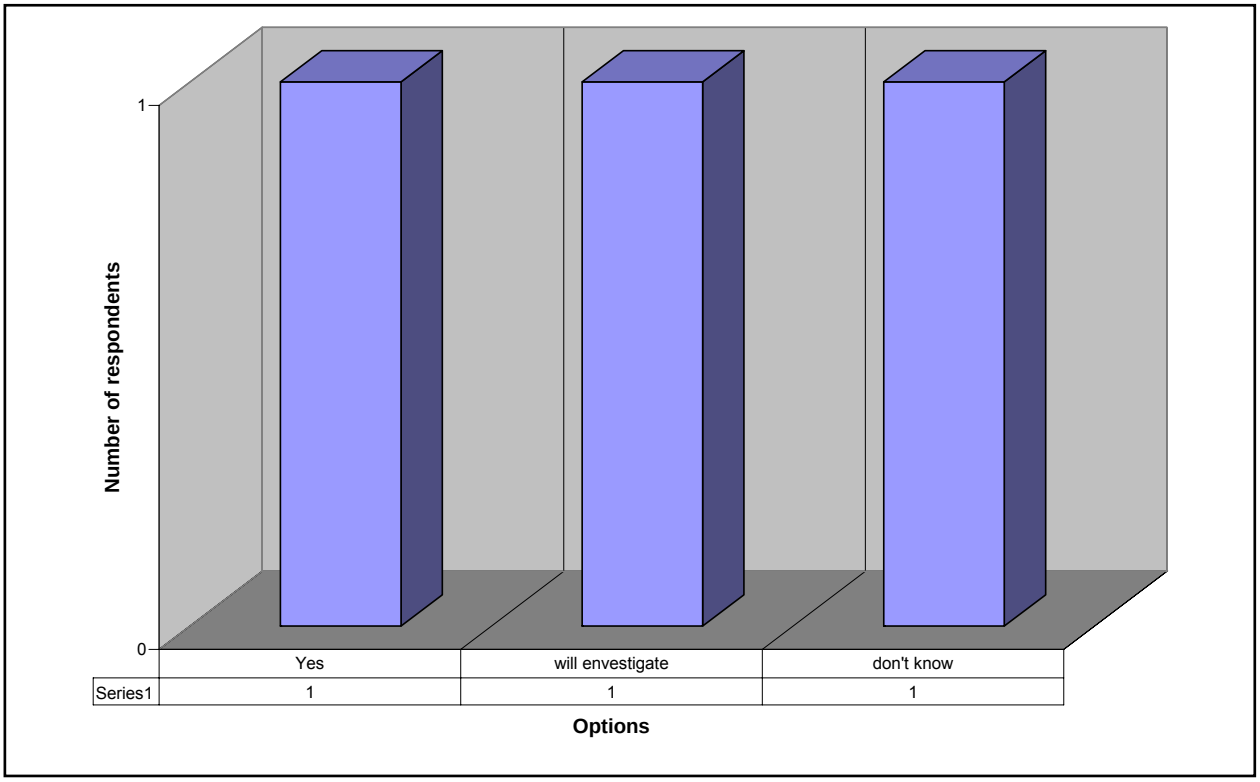


Figure 4.10 Service provider recommendations.

Remark: Only Ou Hawe Museum Hermanus responded positively.

Drakenstein Heemkring response was that they would have been more critical if they had more information about digital archiving requirements. Furthermore they indicated that neither the service provider (Stellenbosch Centre for Photographic Services) nor the curator of the collection had any prior knowledge about digital archiving requirements.

The "don't know" response is because digitisation is still in the planning stages.

Question B2: IF YES for question B1 state briefly why?

Remark: Only Ou Hawe Museum at Hermanus indicated that the service provider, although not professional had a personal interest in digital archiving they had trusted that the level of knowledge would have been sufficient to make informative decisions.

Question B3: IF NO for question B1 state briefly why.

Remark: Only Drakenstein Heemkring indicated that no advice was supplied to make informative decisions.

Question B4: How many photographic prints have you digitised at this stage?

REMARK: See Question A1 & B4.

Question B5: How many photographic negatives have you digitised at this time?

REMARK: See Question A2 & B5

Question B6: How many photographic slides have you digitised at this time?

REMARK: See Question A3 & B6

Question B7: Do you re-process or reformat the files coming from your scanning service company?

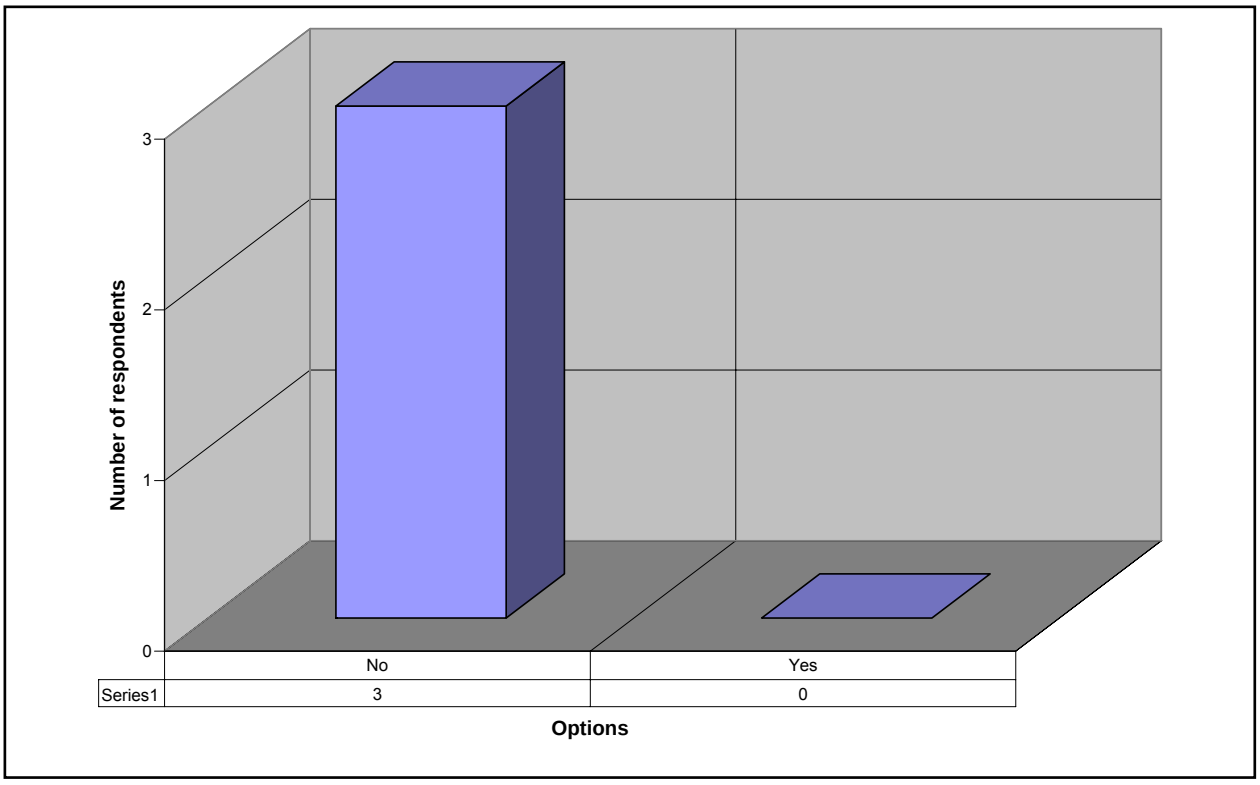


Figure 4.11 Reformatting of files for archiving.

Question B11: IF YES to B10, why compress?

No responses

Question B13: Are you satisfied with the quality and service of the scanning service company?

Remark: Drakenstein Heemkring responded both yes and no as they feel that they could have been better advised. Ou Hawe Museum Hermanus indicated they are satisfied.

Question B14: If NO, why?

Remark: Drakenstein Heemkring response was "with hindsight we would have made alternative decisions".

Question 9: Do you archive files in RGB or Grayscale mode?

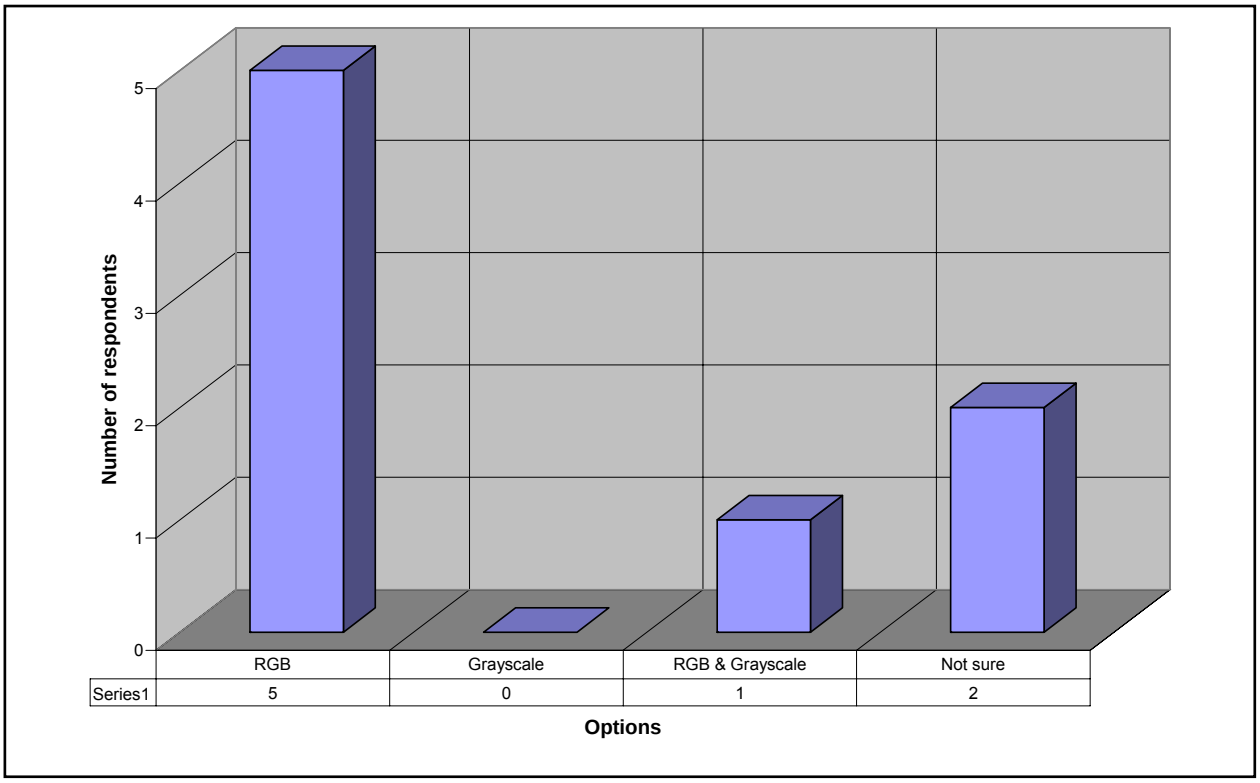


Figure 4.12 Selecting of a colour mode for archiving.

Question 10: Do you assign a colour profile during your scanning process?

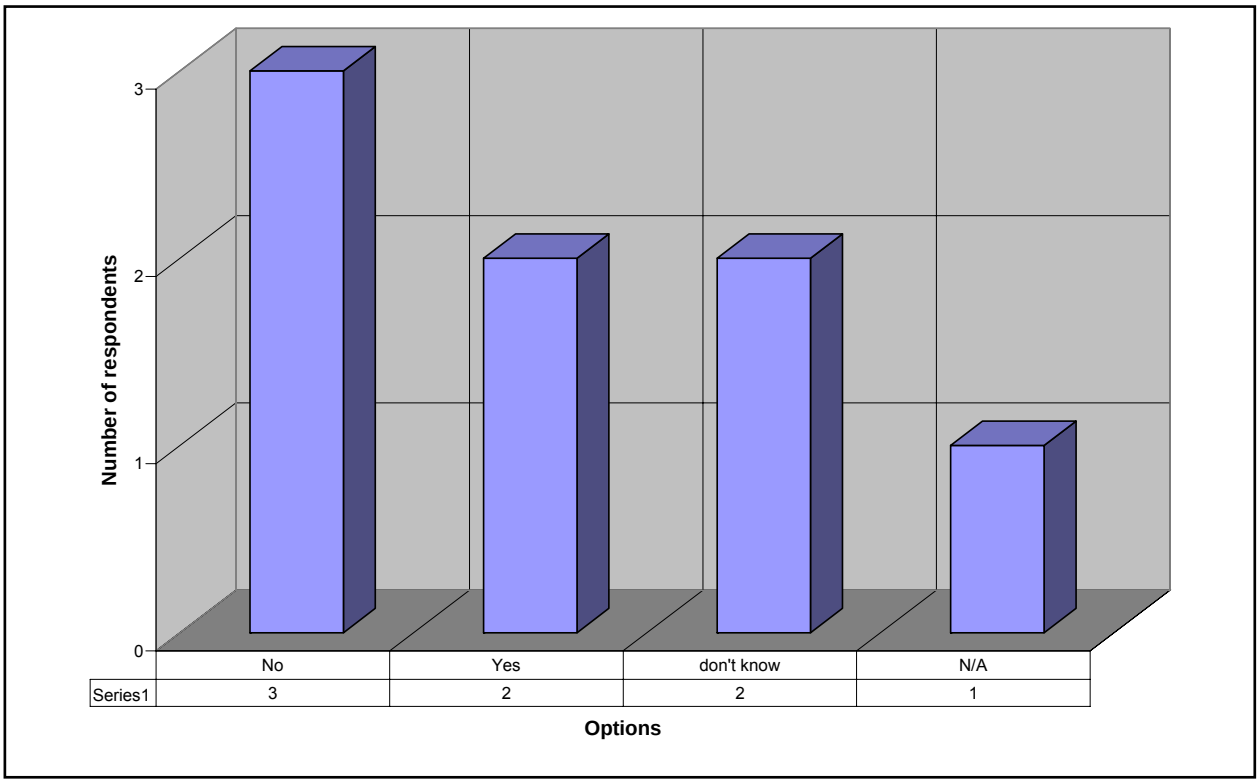


Figure 4.13 Assigning of a colour profile.

Remark: The "don't know" response is because digitisation is still in the planning stages.

Question 11: Do you assign a colour profile to your file before saving for archival purposes?

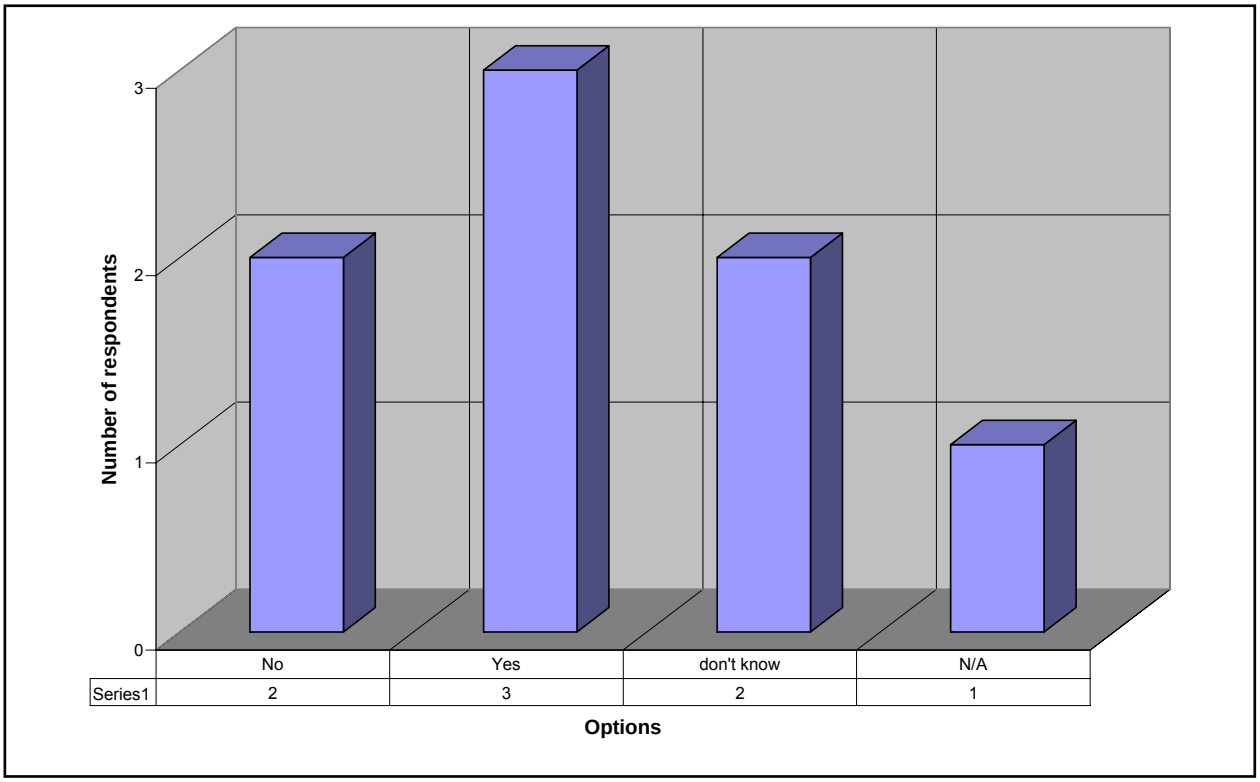


Figure 4.14 Assigning profiles for archiving.

Remark: The "don't know" response is because digitisation is still in the planning stages.

Question 12: Which image processing software do you use mostly?

Remark: The software mostly used is Photoshop, with some respondents reported using Photoshop in conjunction with other software.

Other software mentioned included: ACDSee, Picture Publisher and Photodraw.

Question 13: What is the life expectancy of your digital files in years?

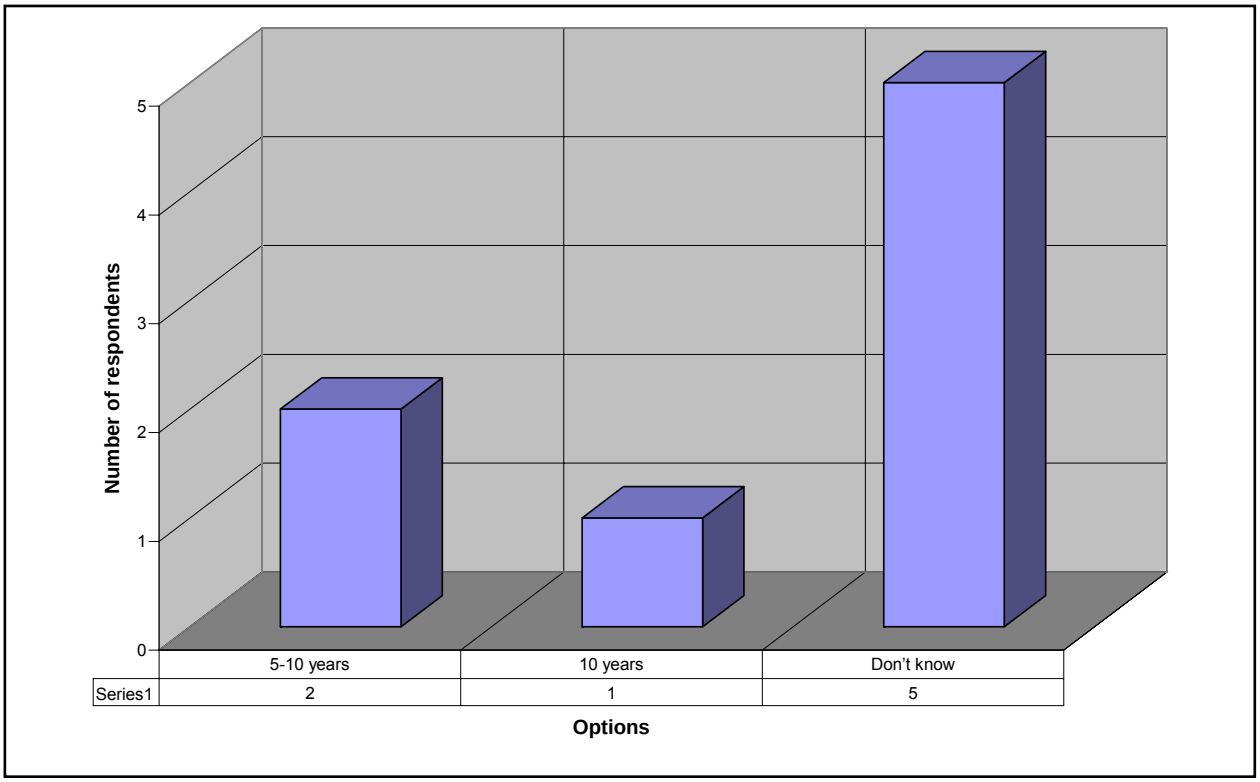


Figure 4.15 Digital file life expectancy.

Remark: The "don't know" response is because digitisation is still in the planning stages.

Question 14: Which medium do you use for storage for example: HDD, CD, DVD etc?

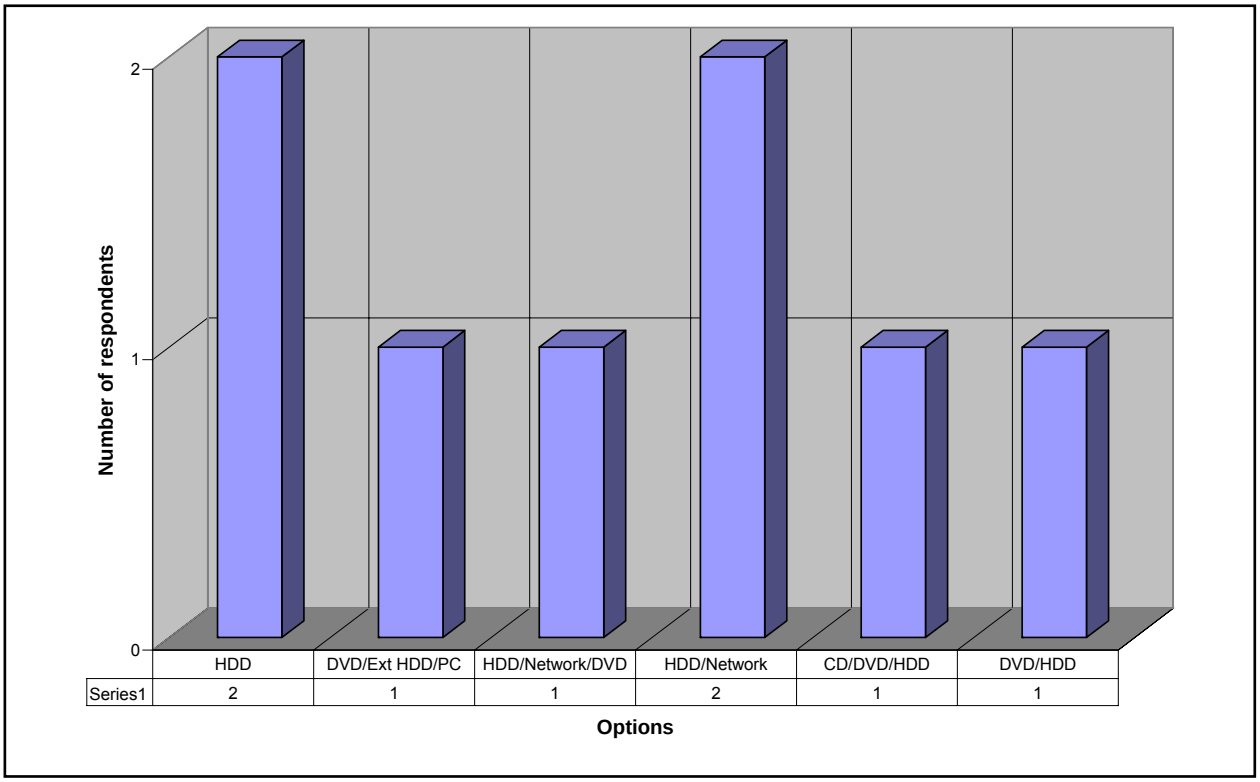


Figure 4.16 Types of storage medium in use.

Question 15: Do you destroy your originals once digitisation is complete?

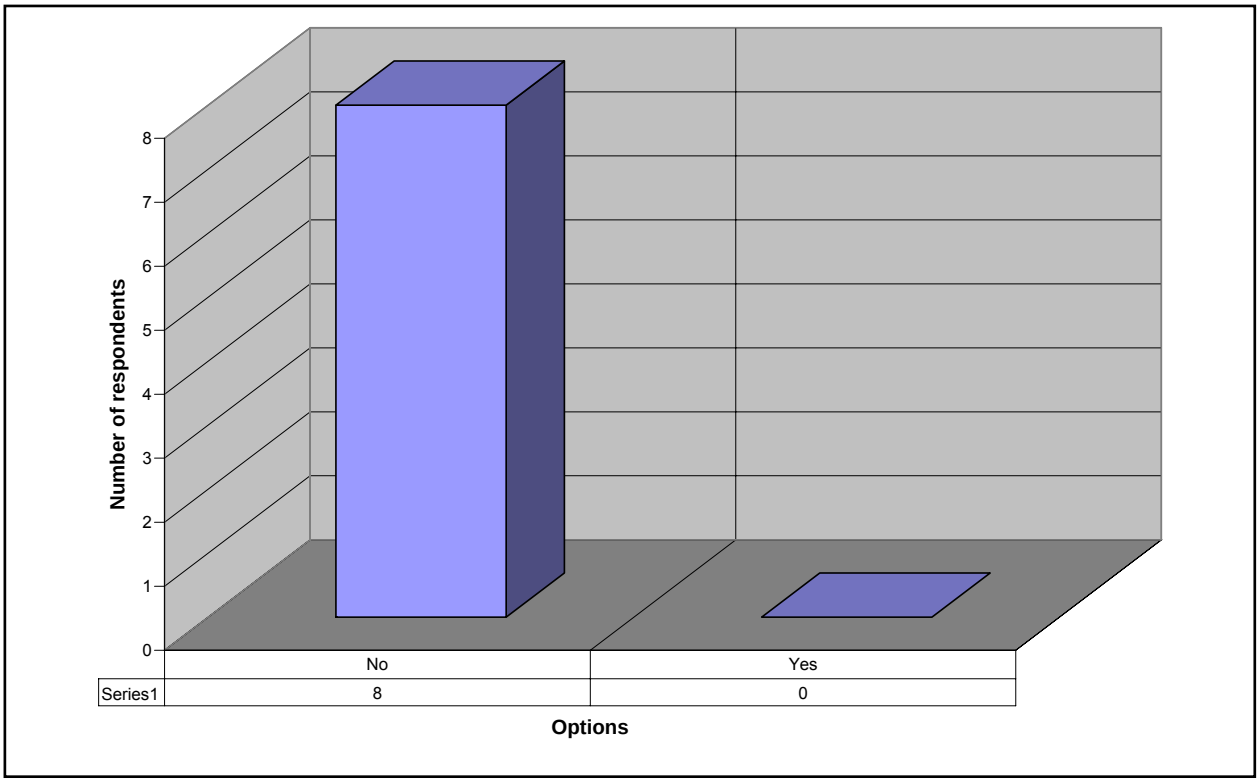


Figure 4.17 Destruction of original material.

Additional comments.

Very often during the interviews the questions evoked further information related directly or indirectly to the preservation issues. In many cases these comments were justified by, and in fact emphasised, the complexity surrounding digital preservation. Furthermore, in some cases these responses emphasised the effect of human behaviour on decision-making concerning preservation of digital data. Some of these issues are listed below.

- A general concern mentioned by more than one institution is the security and loss of valuable artefacts. Loss of material could be the result of allowing staff or people from the public to remove an artefact from the collection for private scanning. This concern is especially of importance when decisions for

outsourcing of scanning services must be made. (Reported by Cape Town City Council, Simonstown Museum and Drakenstein Heemkring).

- General lack of cooperation between staff members in the same organization to share knowledge. (Reported by Cape Town City Council).
- There is no common goal for preservation due to lack of knowledge of younger staff members. (Reported by Cape Town City Council).
- Budget constraints prevent the appointment of more staff and the funding of servers and proper backup systems. (Reported by National Library of South Africa and Simonstown Musem).
- The lack of a standard database for example different collections are on different databases. (Reported by University of Stellenboch Archive).
- Photographic glassplate negatives are handled without proper care for example the operator does not wear gloves to protect the glassplates from acid and grease from the hands. (Reported by University of Stellenboch Archive).
- In the case where more than one similar image is part of the collection, the choice of which to scan becomes an issue especially when the scan operator does not have any photographic background. Without a basic photographic background the scan operator may not be able to distinguish between an over or underexposed negative. A negative does not have any reference to allow the scan operator to decide how well the negative will be scanned. (Reported by University of Stellenboch Archive).
- The lack of sharing information and the resultant loss of files as staff do not know where files are stored on a server. By the time the responsible person resigns, retires or suffers a sudden demise, total loss of files could be inevitable and may not be retrievable. It is recommended that staff do not work in isolation. (Reported by University of Stellenboch Archive).
- Proper support from ICT (Information Technology) staff is absent. (Reported by University of Stellenboch Archive).
- Retrospective (hindsight) evaluation shows that better decisions could have been made. (Reported by University of Stellenboch Archive).

- The curator may not know most technical specifications for digital preservation. At least a basic understanding would be beneficial and would result in more trust in the operator (Reported by University of Stellenboch Archive).

- The lack of proper scanning equipment or digital cameras. (Reported by National Library of South Africa and Iziko Museums).

- There appears to be a lack of understanding by management teams in terms with regard to digitisation requirements - for example the number of staff required to do the job, training and management of staff and equipment needed for the digitisation process. (Reported by Iziko Museums and National Library of South Africa).

- There is a lack of a centralised facility for data storage for example a server. This could cause data files to be scattered on various personal computers of the staff in the digital section. (Reported by Iziko Museums and National Library of South Africa).

- The curator of the collection is not able to give any input regarding the digitisation and archiving of the digitised content as staff members in the different departments are working on their own. The lack of policies or standard work procedures and workflows are contributing factors to the fragmentation and the uncoordinated digitising of the collections. (Reported by Iziko Museums).

- Do not underestimate the value of high quality scanning. (Reported by Drakenstein Heemkring).

It is important to note that the abovementioned problem areas are not limited to these institutions only, but also appear in conversations with other institutions outside the Western Cape.

4.3.1.5 Responses from student's survey.

Responses to the questions acquired by means of the questionnaire are as follows:

Question 1: What does the concept "digital image file preservation" mean to you?

Explain briefly.

Selected individual responses listed below. The full response is reported in Appendix D.

- Archiving the digital files for future generations to observe and gain knowledge from us.
- It’s a way of saving or backing up your data, mostly images, in a digital format.
- It means having access to previous digital images for future use. (very ideal as a photographer).
- Preservation means keeping things exactly how they were many years before. Keeping the digital file in good condition so that it can be used again.
- It means that digital files such as jpg, RAW, TIFF images are to be kept in storage and backed up on various hard drives and computers so that they can be around for a very long time.

Question 2: Rate your opinion about the importance of preservation and access of digital image files for future generations? Mark your choice with an **X**

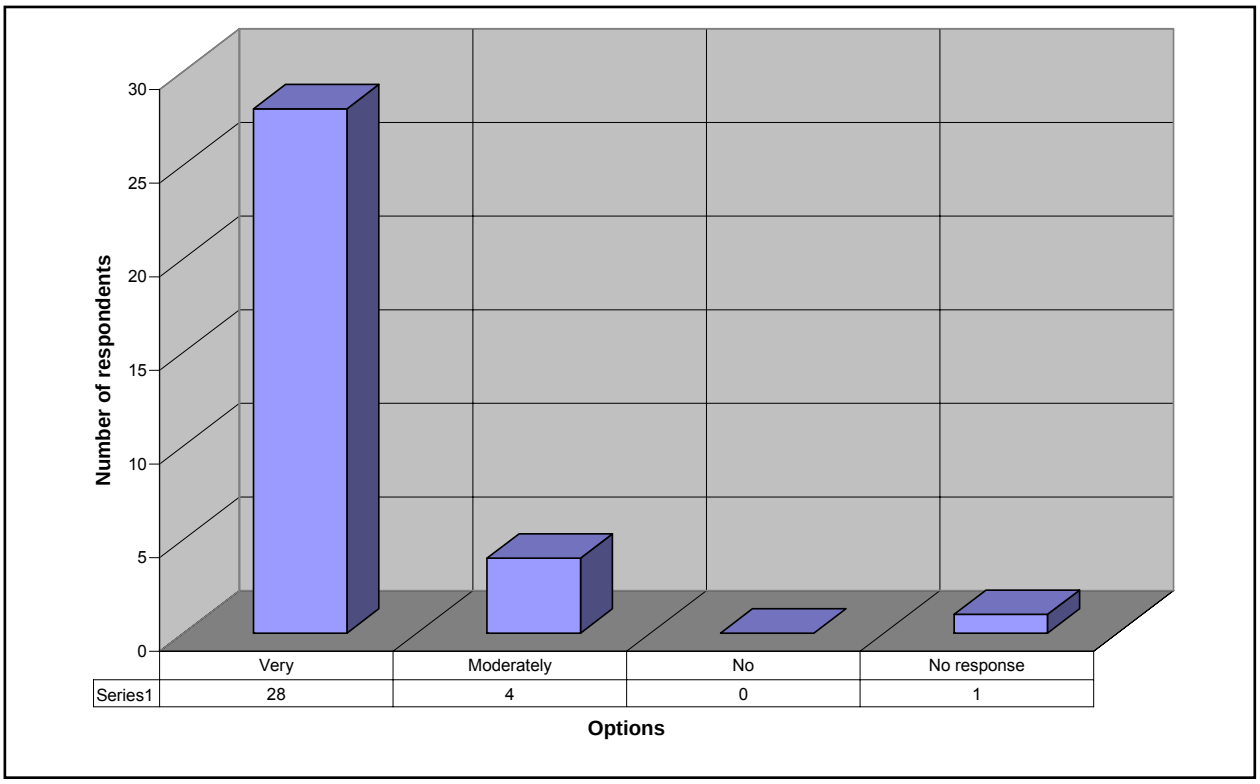


Figure 4.18 Importance of preservation.

Question 3: Is it important to have unlimited access to your image files for years to come? YES / NO.

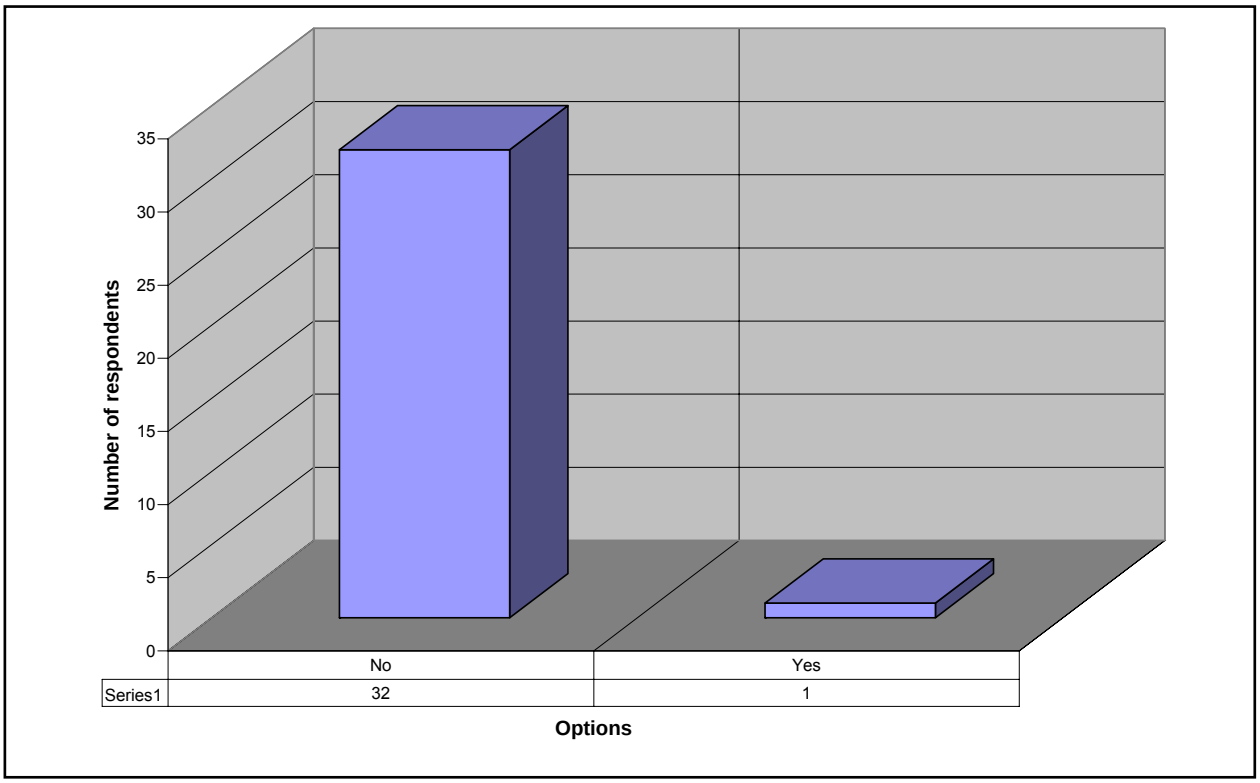


Figure 4.19 Access to files in the future.

Question 4: If your response is YES for the above question, can you briefly state the 2 most important reasons according to your judgment?

Selected individual responses listed below. The full response is reported in Appendix D.

- One can always have reference images of the past - It would be an ever growing portfolio.
- Well as a photographer, who creates new images on a day basis. These images that I use to get future clients. It would be great to have unlimited access to them in the future. It can be used as a timeline to see my growth.
- It is always good to see your improvement as a photographer and see your work

as a motivation. These images were the images that got you going from the beginning.

- So that you can go back to your files and either see how your work improved and so that you have proof it's your original work if anyone tries to copy it.
- Firstly, you are the creator of the images. Secondly, if you were to copyright your work you would have every right to full access, If you ever wanted show future family generations.

Question 5: Do you think that the file format you are using for storing images will always be accessible in the future? YES / NO.

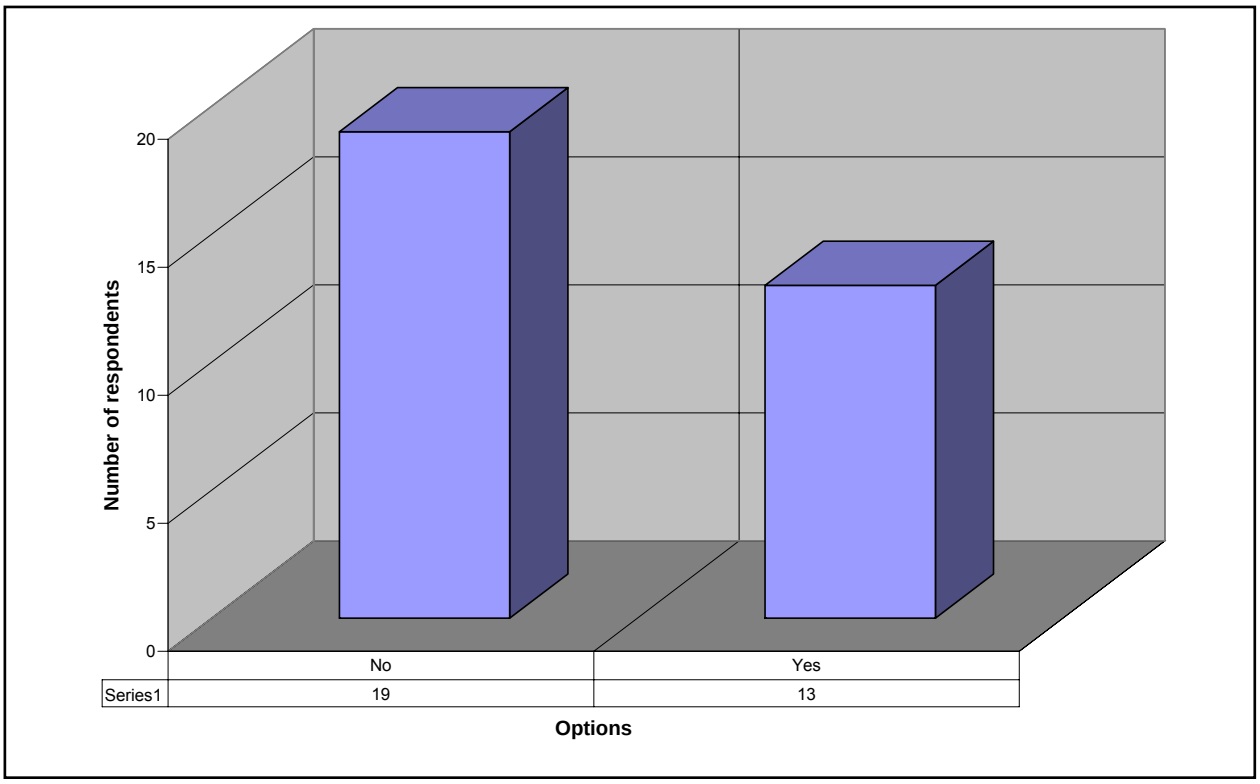


Figure 4.20 Future accessibility of files.

Question 6: If your response is NO to the above, what are your reason(s).

Selected individual responses listed below. The full response is reported in Appendix D.

- Well if you ask someone years ago if they thought VHS would still be around or even film for that matter. They might be in some shock, If they had said yes. We live in a developing world with new technology everyday. So I am sure it wont.
- Technology changes constantly.
- As technology keeps evolving and people would find better ways to store the images as.
- I do not know enough about file preservation.
- Because companies, elements etc. change and disappear all the time, you can't predict the future, so things could end without your control.

Question 7: Have you made a study of the factors that will prevent you from access your files in the future? YES / NO.

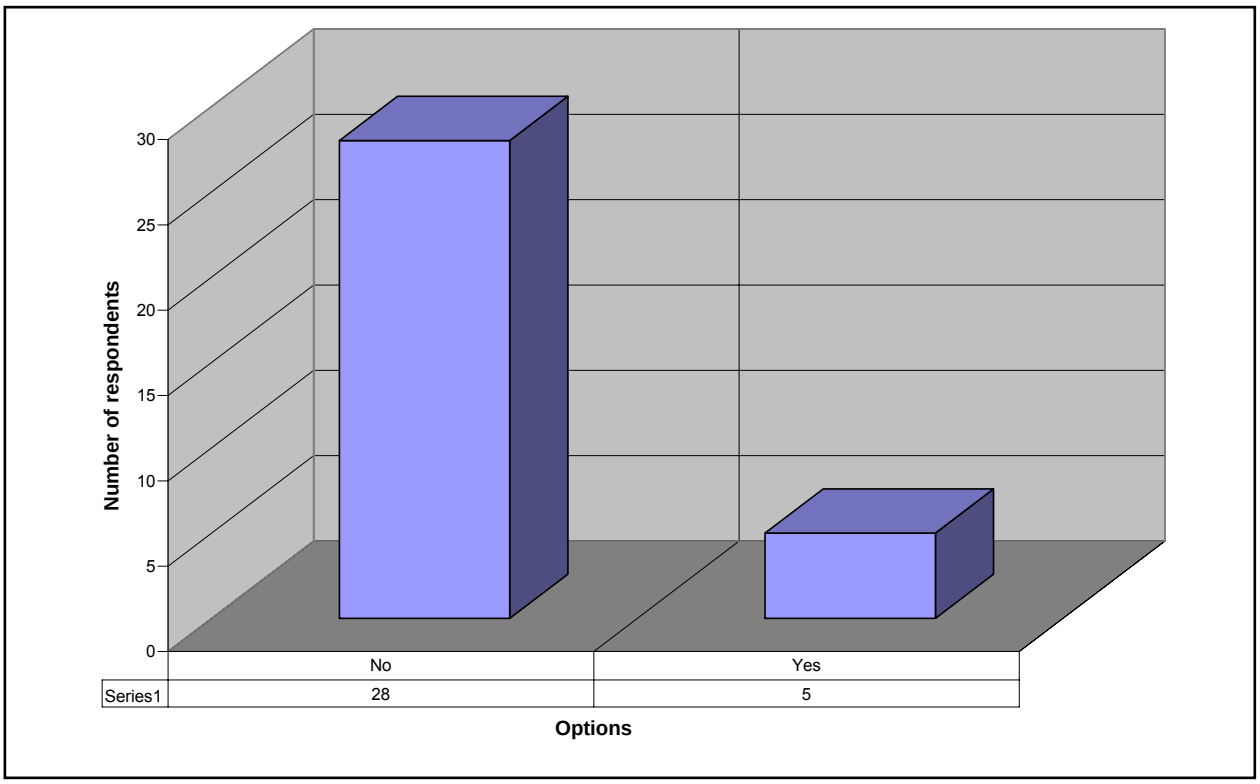


Figure 4.21 Factors preventing file access in future.

Question 8: If your response is YES to above question, give briefly at least two sources.

Individual responses listed below:

- Internet viruses, harddrive or computer crashing and files being deleted once a virus is detected.
- Firstly my lecturer and secondly the web. University of West England, 2012, choosing formats, www.uwc.ac.uk.

Question 9: Did your lecturer discuss the importance of file formats with you at the time of commencing your photography course? YES / NO.

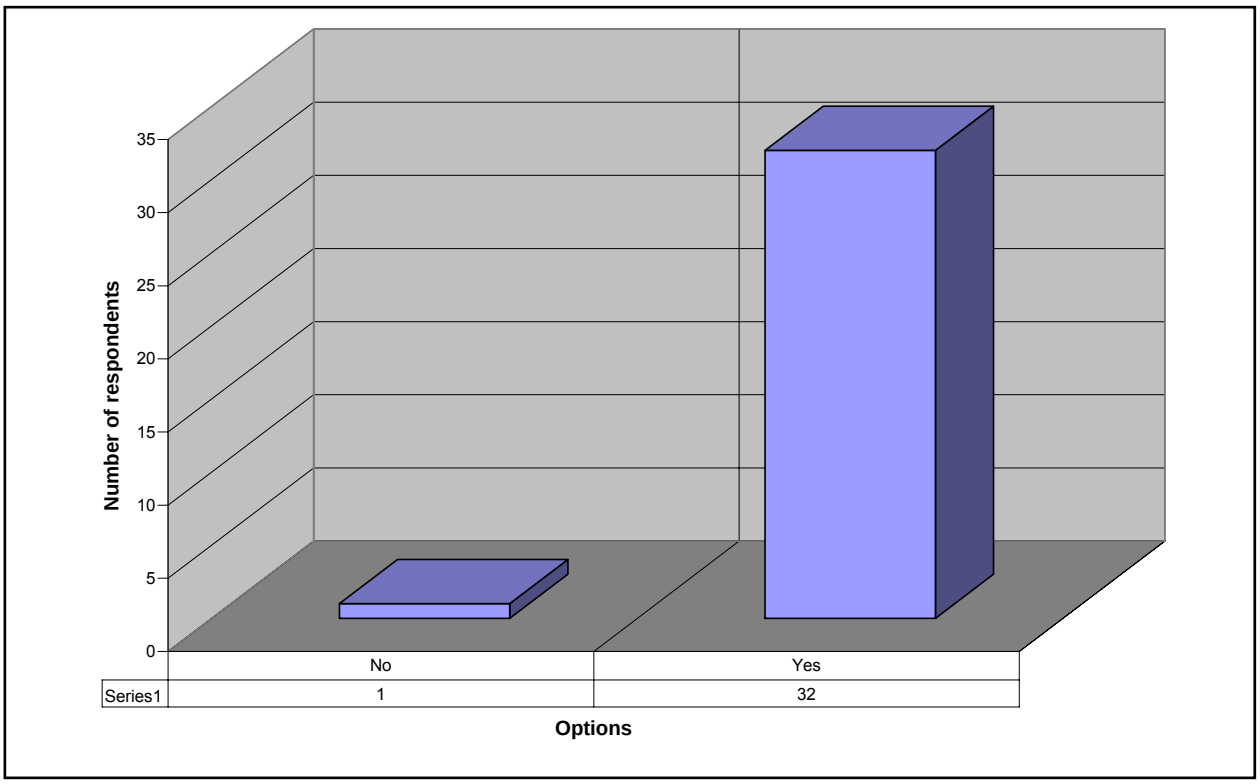


Figure 4.22 File formats discussion.

Question 10: What is the expected lifetime of the file format you are using presently to save your images? Months [how many] OR Years [how many]

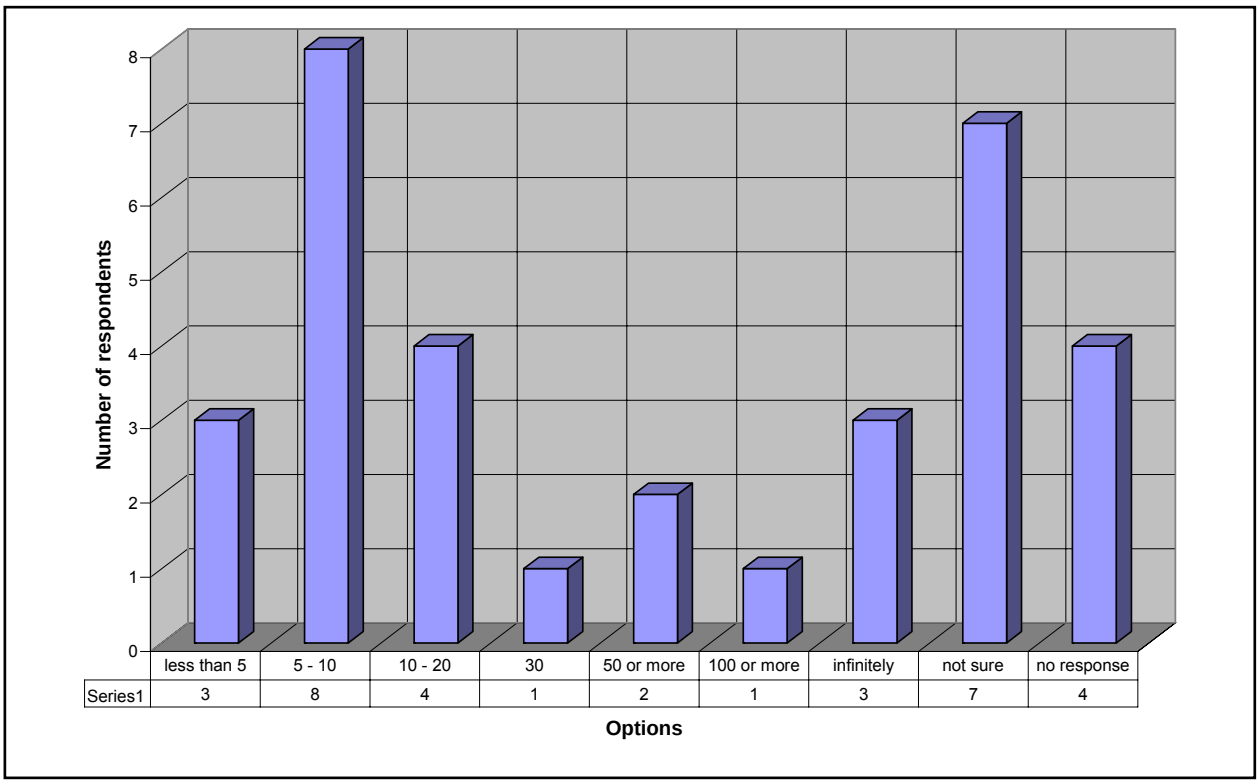


Figure 4.23 File format expected lifetime in years.

Question 11: Which factors will determine the longevity of a file format? [Give two or three factors].

Selected individual responses listed below. The full response is reported in Appendix D.

- Corresponding software to open the formats, - back-up of the different files.
- New programs that back-up information, Internet back-up files or programs, technology improvements.
- The advancement of technology and the lifespan of the person who owns the image.

- New technology, new programs.
- Do not know.

Question 12: Which file format do you use when exposing or capturing images in your camera? (a) raw (b) jpg (c) tiff (d) other If response is (d) "other" please indicate here.

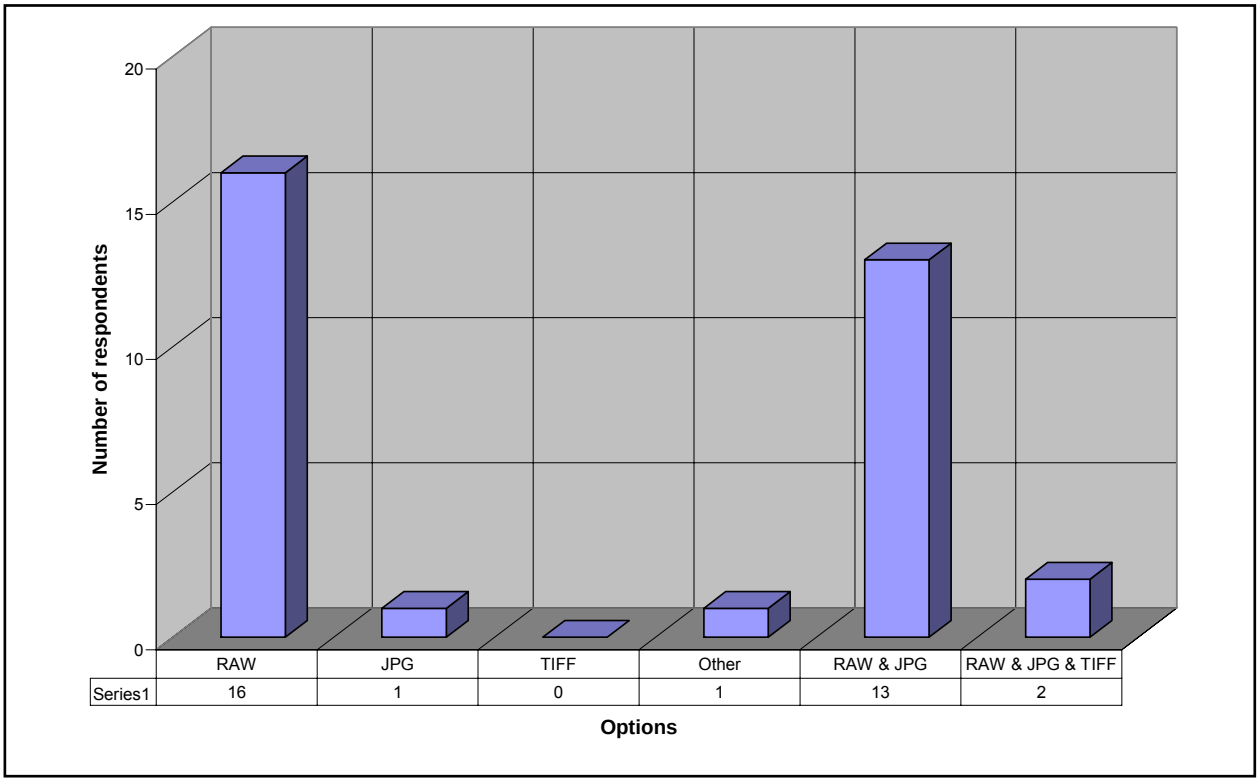


Figure 4.24 File format for image capture.

Question 13 & 13A (13A where applicable): Why do you save in this format indicated above? (If your response is based on your own research, please give a reference in your own words).

Selected individual responses listed below. The full response is reported in Appendix D.

- Use jpg for a quick reference viewing & RAW for a more critical viewing.

- It doesn't compress the image like the jpg does giving me to work with. Well its based on what my lecturers have taught me - and through experience whilst shooting - RAWS are just like its name "RAW" compared to jpg.
- It is a large file - better quality on my camera. RAW files are saved as larger, higher quality than others on my camera.
- Because we told to.
- RAW containing a lot of data - high quality for editing. JPEGs once image has been edited & is ready to print.

4.3.1.6 Responses from PSSA members survey.

Responses to the questions acquired by means of the questionnaire are as follows:

Question 1: How many years are you practicing digital photography?

78 Responses were received. Calculations were made to establish the following criteria:

- The average number of years the members are practicing digital photography which is 7.5 years.
- The minimum number years the members are practicing digital photography which is 1 year.
- The maximum number of years the members are practicing digital photography which is 18.

Question 2: What does the concept "digital image file preservation" mean to you? Explain briefly.

Selected individual responses listed below. The full response is reported in Appendix E.

- It means three quarters of club photographers do not have a clue what you are talking about, or why its important. Its professional's issue, not a hobbyist's one.
- To file and conserve digital images (including digitally captured images of documents, illustrations, photos etc.) allowing for logical access to these files hosted on computer networks, internet and main-frames for this purpose.
- Storing images for longer than casual use.
- The ability to store image files for unlimited periods of time and to be able to retrieve the files and use them at some future date using current easily available software and hardware.
- Ensuring that all saved files are archived and available in the future. Other issues like tagging, naming, metadata should also be considered.

Question 3: How important is the preservation of digital image files for future generations?

[Your opinion about the importance] Mark your choice with an **X.**

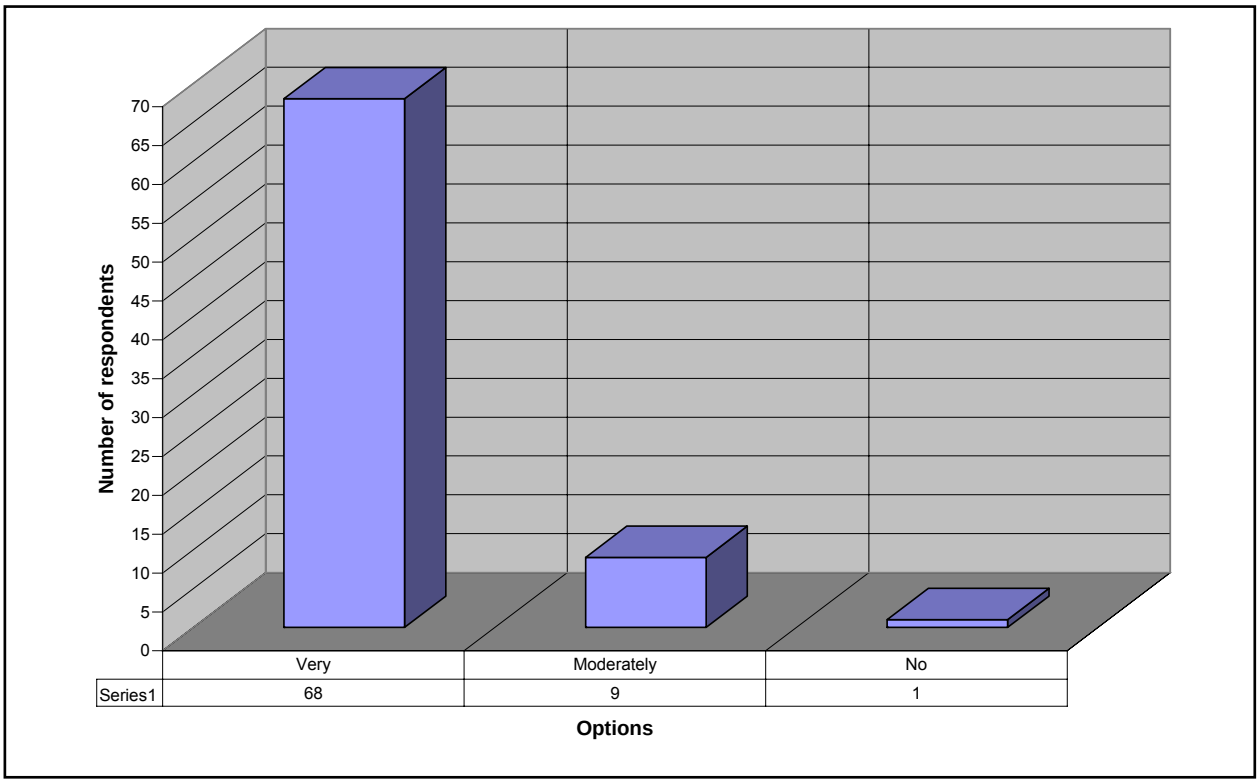


Figure 4.25 Importance of preservation.

Question 4: Is it important to have unlimited access to your image files for years to come? YES / NO.

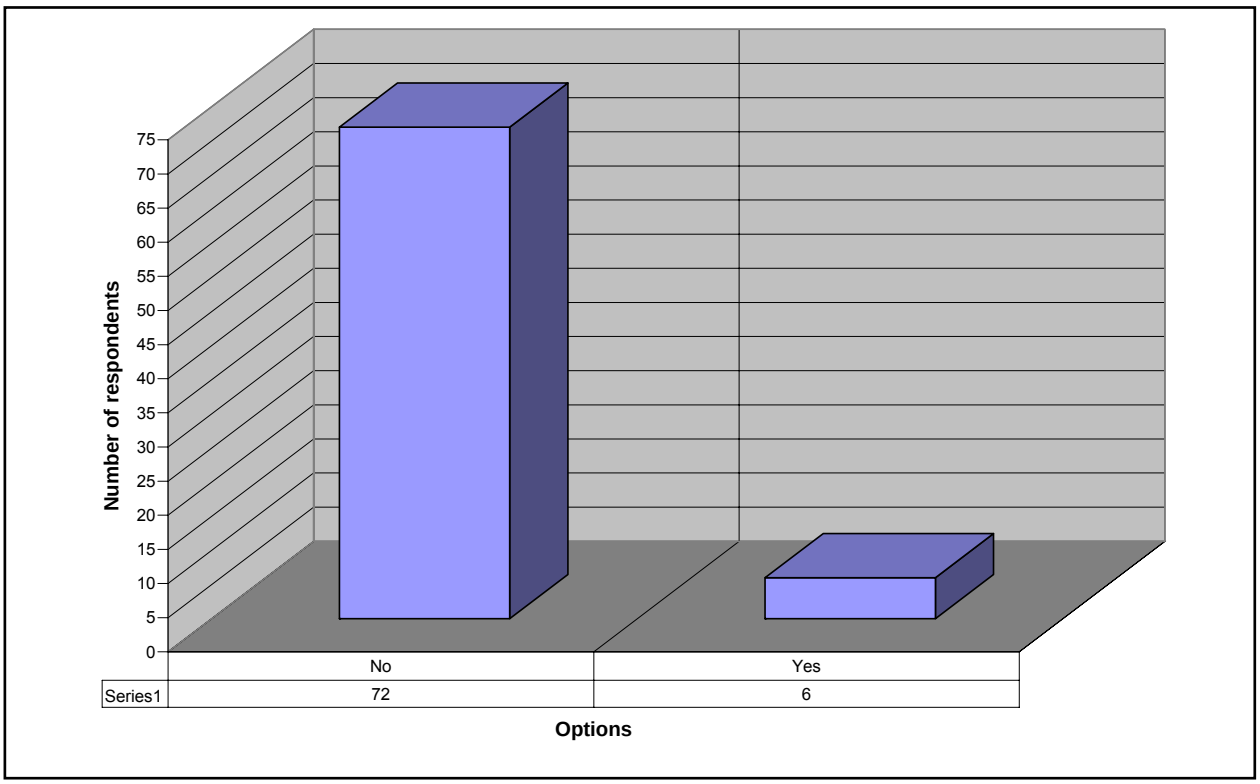


Figure 4.26 The importance of access.

Remark: This question was mostly incorrectly interpreted. The aim was to establish what effect file formats will have on access to files in the future and not the storage or restriction by oneself on the access of the file. For example if special software would be needed to access JPG or TIFF files in the future when systems of that time cannot be used to gain access to your own image files. The first response clearly indicated the misunderstanding.

A problem arose due to the fact that the questionnaire was unintentionally also sent out to individual members of PSSA by means of a circulated e-mail as opposed to the web based questionnaire only. The purpose of the questionnaire was not explained

in the e-mail, which could have resulted in superficial responses.

Question 5: If your response is YES for the above question, can you briefly state the 2 most important reasons according to your judgment?

Selected individual responses listed below. The full response is reported in Appendix E.

- If needed, one can refer back to images taken long ago and access to such an external system could help if there are any failure on ones side with backups being lost.
- They are important both as a collective visual historical record and as a personal history of where we come from.
- The deterioration of analog / organic documents including photos, Vinyl and magnetic sound is in need of digital conservation. Ultimately to conserve history.
- Availability to future generations. It is difficult to decide now what will be important and valuable to future generations.
- I am all for preserving history - important to do so. Future generations to benefit. Access to preserved archives provide info that could have been lost.
- As technology changes one may be able to process files more effectively. RAW processors improve all the time.

Question 6: Do you think that the file format you are using for storing images will always be accessible in the future? YES / NO

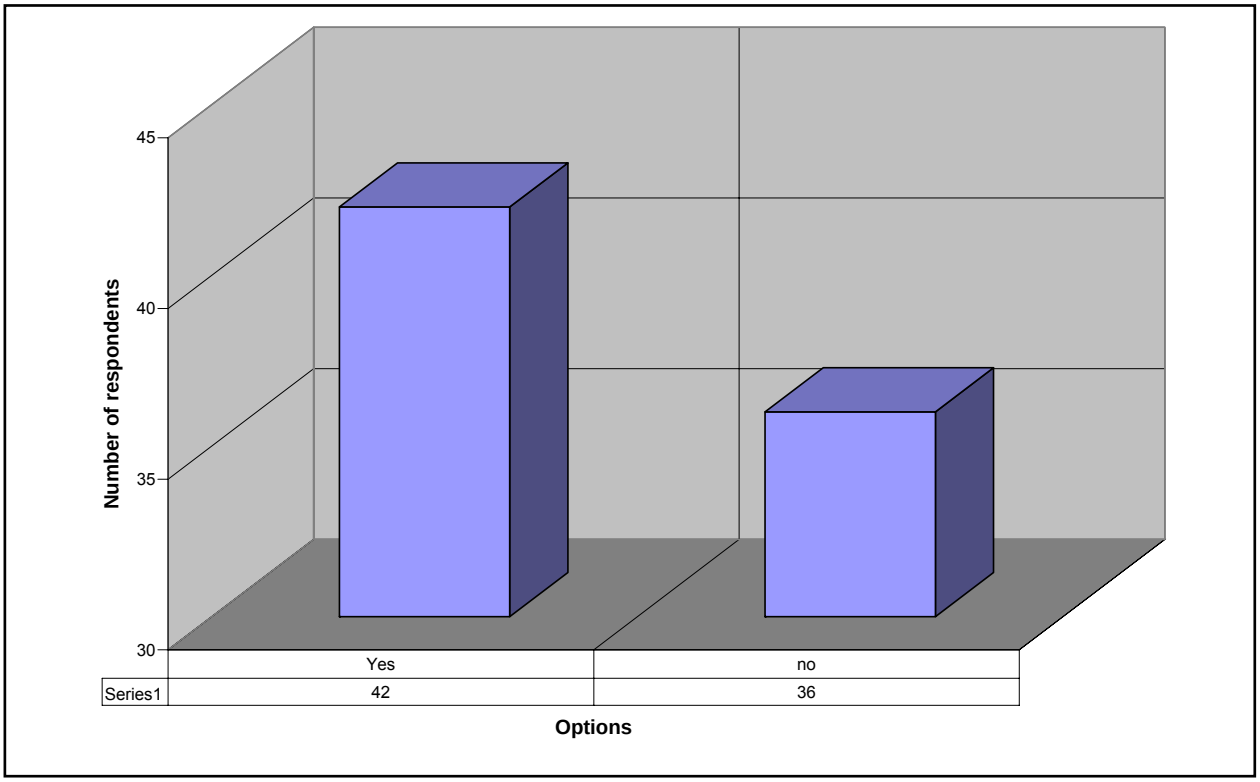


Figure 4.27 File format for future use.

Question 7: If your response is NO to the above, what are you reason(s)?

Selected individual responses listed below. The full response is reported in Appendix E.

- Technology is vastly improving and the size and format can change to better the images even if the size are reduced in another format.
- Not even spreadsheets and documents are readable forever. Software changes as hardware improves and ensuring backward compatibility becomes too much of a constraint.
- Preservation as I would like is apparently not possible, hopefully newer and more secure methods will be found even if software changes occur.
- People change things to sell new stuff and make money. It will be such a shame if this would be the reason for losing important history.
- If the camera company goes out of business, or the software companies stop offering support, one may not be able to open the files. One could always convert files to a open source platform - DNG, tiff ? But who knows what will be in 50-100 years.
- The present standards appear to be constant but the future could easily change this.

Question 8: Have you made a study of the factors that will prevent you from access of files in the future? YES / NO

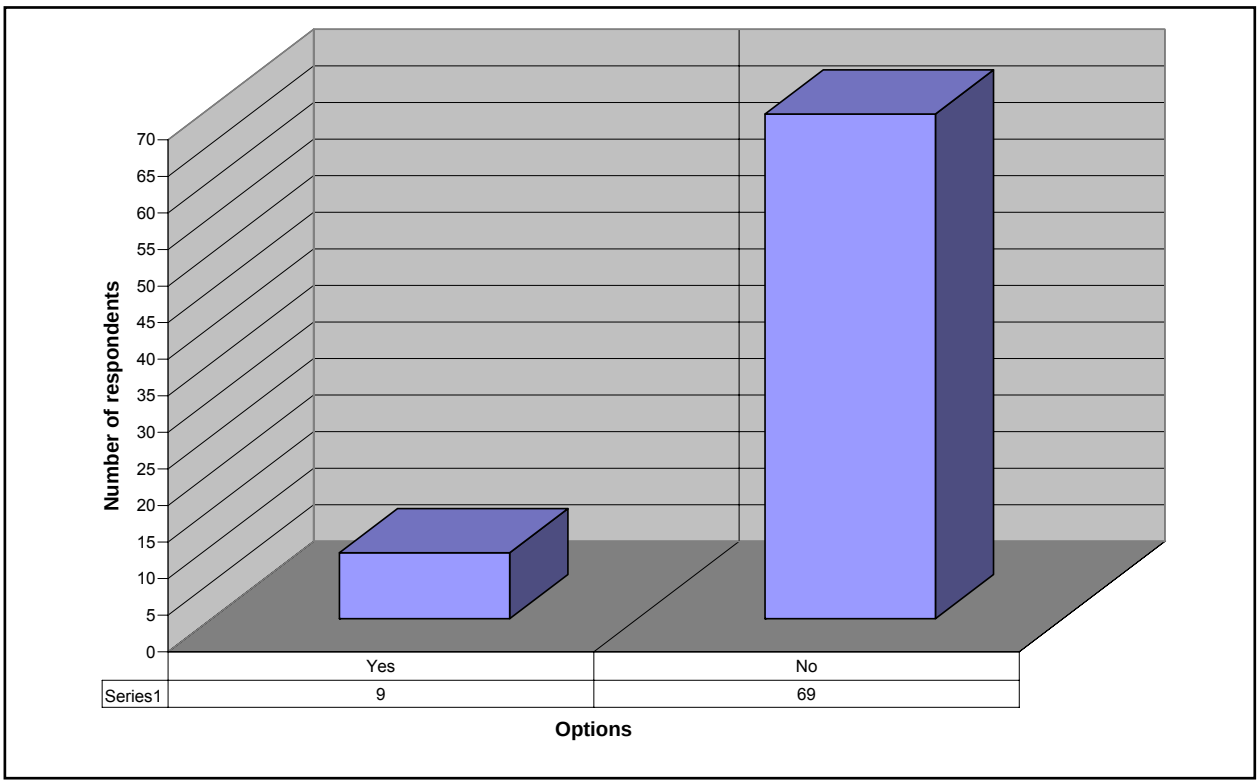


Figure 4.28 Study for access.

Question 9: If your response is YES to above question, give briefly at least two sources.

Selected individual responses listed below. The full response is reported in Appendix E.

- Wired magazine - Various internet sources, e.g., dpreview, pcmag.
- Popular Mechanics - discussions with clever IT people.
- Internet and subject matter experts in software design.
- Did not even know there was a possibility that I might not have access to files in the future!! Quite a scary thought.
- The internet was used.
- Variety of sources. Main points to consider is the digital readability of your source files. Proprietary formats can become an issue. Second point is possible deterioration of storage media.

Question 10: What is the expected lifetime of the file format you are presently using to save your images?

Months [how many]_____

OR

Years [how many]_____

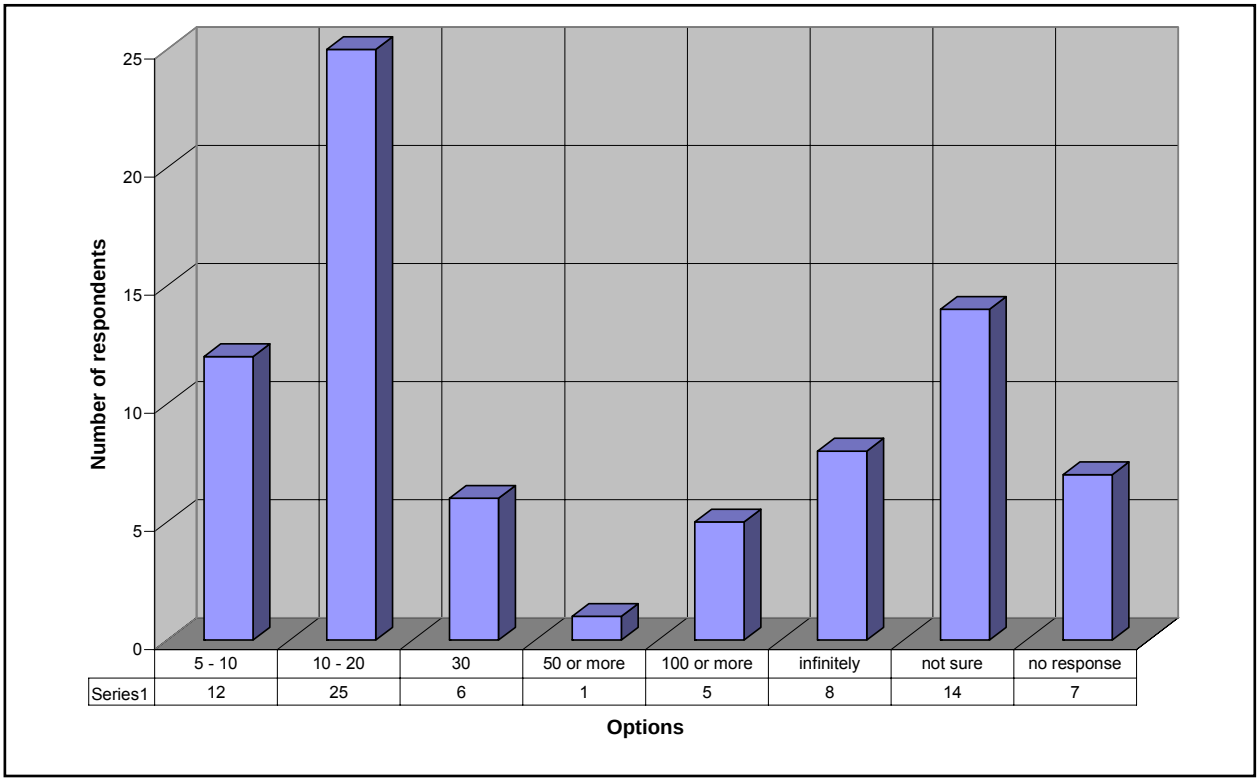


Figure 4.29 Expected lifetime of format in years.

Question 11: Which factors will determine the longevity of a file format? [Give two or three factors].

Selected individual responses listed below. The full response is reported in Appendix E.

- Simplicity, compatibility, cross-platform integration.
- Open source specifications, broad acceptance by software writers, broad acceptance by camera makers.
- Market demand and popularity (e.g. Cloud technology), availability of software and hardware.
- Common use, file size - for sharing, performance of format.
- I have no idea - haven't given this any thought - assumed it would always be available.
- Computer operating systems may not support older software, future programmes may not support old formats, current programmes may become obsolete and worth replacing.
- Data degradation and system changes.
- Proprietary format support. Efficiency of space utilization vs Quality of reproduction.

Question 12: Which file format do you use when exposing or capturing images in your camera?

(a) raw (b) jpg (c) tiff (d) other

If response is (d) "other" please indicate here:_____

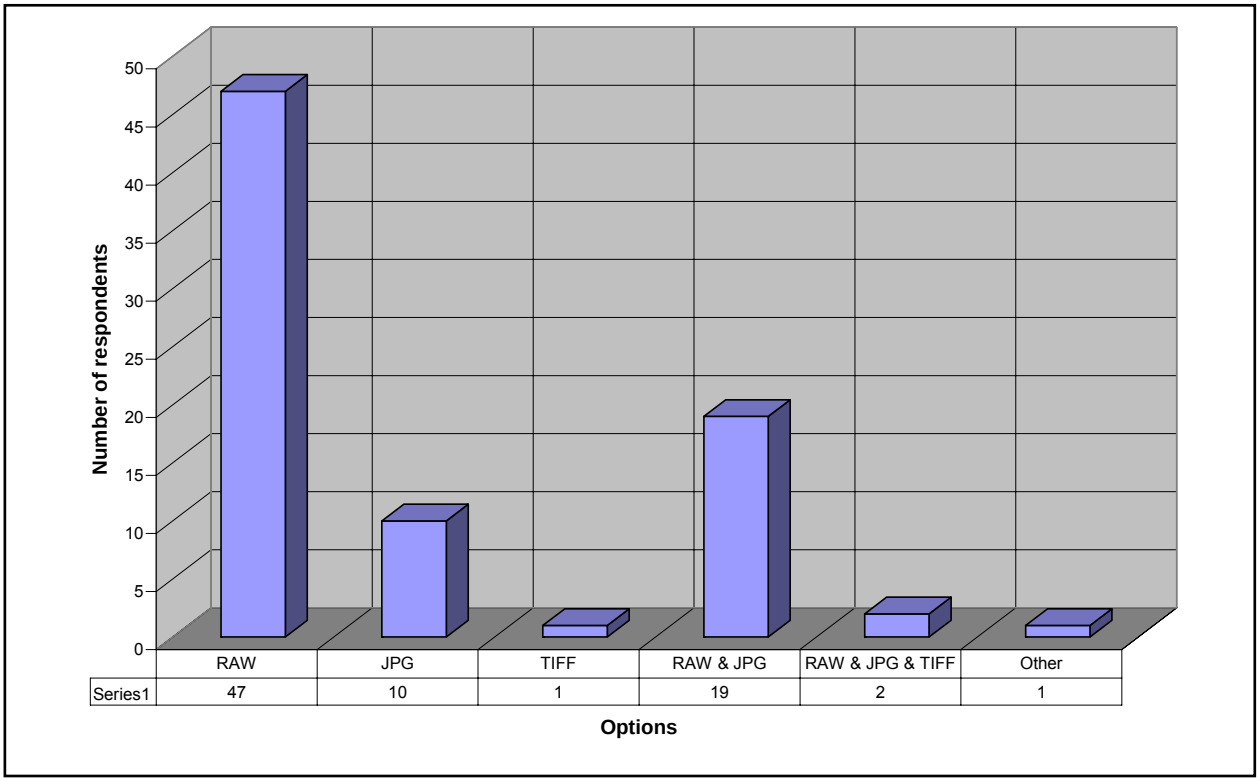


Figure 4.30 File format for image capture.

Question 13: Why do you save in this format indicated above?

(If your response is based on your own research, please give a reference in your own words.)

Selected individual responses listed below. The full response is reported in Appendix E.

- More options in post processing. Trained in the club to do that.
- Its all the options I am offered.
- CR2 is a proprietary format and I am concerned about Canon's track record of backward compatibility. They didn't write Windows 7 drivers for my 350D or Linux drivers for my canon printer. Not sure cr2 will always be readable. Dng is open source so more likely to be supported.
- Thats the way I was taught.
- It preserves the original image and image information to a large extent and uses less capacity than either Tiff or DNG. EXIF can be manipulated though I have no interest in doing so beyond adding relevant information - keywords, location etc.
- They are International formats & accessibility for clients and family, friends etc.
- I heard that jpg deteriorates in quality every time you open it. There is definitely better ability to get detail out of shadows in raw. The ability to handle noise in raw is superior. Not research own experience. in jpg I get virtually no joy in decreasing noise or grain but I can improve it a lot in raw processing.

Question 14: Any other comments.

Selected individual responses listed below. The full response is reported in Appendix E.

- Another issue is the durability of archiving hardware. External hard drives are hardly 100% reliable. I store files on the best quality hard drive I can buy and copy to a DVD once per year. I keep the hard drives in my safe and connect

them only when I am archiving.

- This is a very thought inspiring questionnaire! I am now aware of factors that I have not considered before, and would definitely like to know more.
- I am no longer young and hate changes that make it difficult for me to cope with.
- Thanks for the opportunity to take part in the survey. Will the results of the survey be made known?
- I have an idea you know something I most definitely don't!!
- Please send us a summary of the findings - I would like to know more about this as I am fairly ignorant of this.
- I don't think everyone realises that with new technology developing everyday that older images might become difficult to access in the future or very costly.
- Assuming that I understand the purpose of this survey, should any of the file formats we use today be phased out and superseded by new ones, I'm sure the imagery recorded in the old formats will be made importable into the new ones, as that is what is really important.
- Please share findings of this survey with us.

4.3.1.7 Responses from service providers / bureaus

It was envisaged that scanning service providers / bureaus would be included in the survey, but none could be found in Cape Town and surrounding suburbs at this time. In order to qualify as a service provider / bureau for the study, the provider needs to be contracted for a major digitising project for any institution in the Western Cape.

A number of photographic businesses in the area do offer digitisation of photographic material but they cannot be considered service providers / bureaus because of the low volume of digitisation and their service being rendered mostly for personal use and not for long-term preservation.

4.3.2 Analysis and results of scanned test targets.

The following graphs show the results of the various targets scanned.

4.3.2.1 QA-62 Target for reflective scanners.

The scanned targets were analysed and the results are graphically represented in the following order:

- Epson A4 V700,
- Epson Expression 1680 Pro A4 flatbed,
- Epson Expression 1640 XL A3 flatbed,
- Epson 10000XL A3 flatbed,
- Zeutschel OS 14000 large format A0 overhead,
- Cruse large format A0 overhead,
- i2S Suprascan Quartz large format A1 overhead.

All reflective targets were scanned in Red, Green and Blue (RGB) mode and with Adobe 1998 colour profile at 600 DPI. No corrections or any post processing was done except to change the default colour profile to Adobe 1998 after scanning the target with the Zeutschel OS14000 scanner (Figure 4.38).

It is important to emphasise the fact that there are two factors that determine effective resolution namely sampling rate and optical effects such as focus, F-number, optical glass and the scanner assembly. Although these factors can be configured independently, in the digital system they can limit each other. As an example, a high sample rate cannot compensate for a low quality optical system. Usually the weakest performing factor will determine the effective resolution (Burns, 2010:19).

To evaluate the performances of the different scanners, the tolerances set by Metamorfoze (Van Dormolen, 2012:16-38) and FADGI (Williams, 2010:16-33) were used as these standards are considered to be the most recent and advanced level of recommended standards and are included in some ISO standards. The required quality

for Metamorfoze is refered to as Metamorfoze, Metamorfoze Light and Metamorfoze Extra Light where Metamorfoze is the top required level. In the case of FADGI the levels are referred to as 1-star through 4-star where 4-star is the top required level. Presently there is an attempt to consolidate these two guideline documents. (Geffert, 2014:e-mail). However at this time there are small differences on some aspects of quality for example sampling efficiency for all levels required by Metamorfoze is 85% wheras FADGI required 80% for 1 and 2-star levels and 90% for 3-star and 95% for 4-star level.

For the purpose of analysis and where differences do occur for the quality levels, reference to both Metamorfoze and FADGI will be used for comparison.

The important aspects to consider analysing the graphs are:

- Sample efficiency (Figure:4.31) indicated as A:
  Sample efficiency expressed as a percentage. Horizontal and vertical RGB sample efficiency should be no less than 85%. This is an accepted standard for Metamorfoze at all three levels and FADGI level 3 standards. (Van Dormolen, 2012:16-38).

- Spatial frequency for SFR values (Figure:4.31) indicated as B:
  The SFR is an indication how an imaging system maintains the relative contrast of increasing content detail. The following is a direct extract from the Preservation Microfilm Scanner Target and Imaging Performance Software (Mscan) user guide:

  > "The input variable along the horizontal axis of the SFR curve is spatial frequency (Figure. 4.31 E) increasing to the right. The output response along the vertical axis is the change in contrast of those spatial frequencies after being imaged by a camera or scanner. Ideally then, one would like as little loss in spatial detail contrast (i.e. the % response value of the y-axis). This is reflected by the SFR curve remaining high with increasing spatial frequency (i.e. the x-axis)" (Burns, 2010:21).

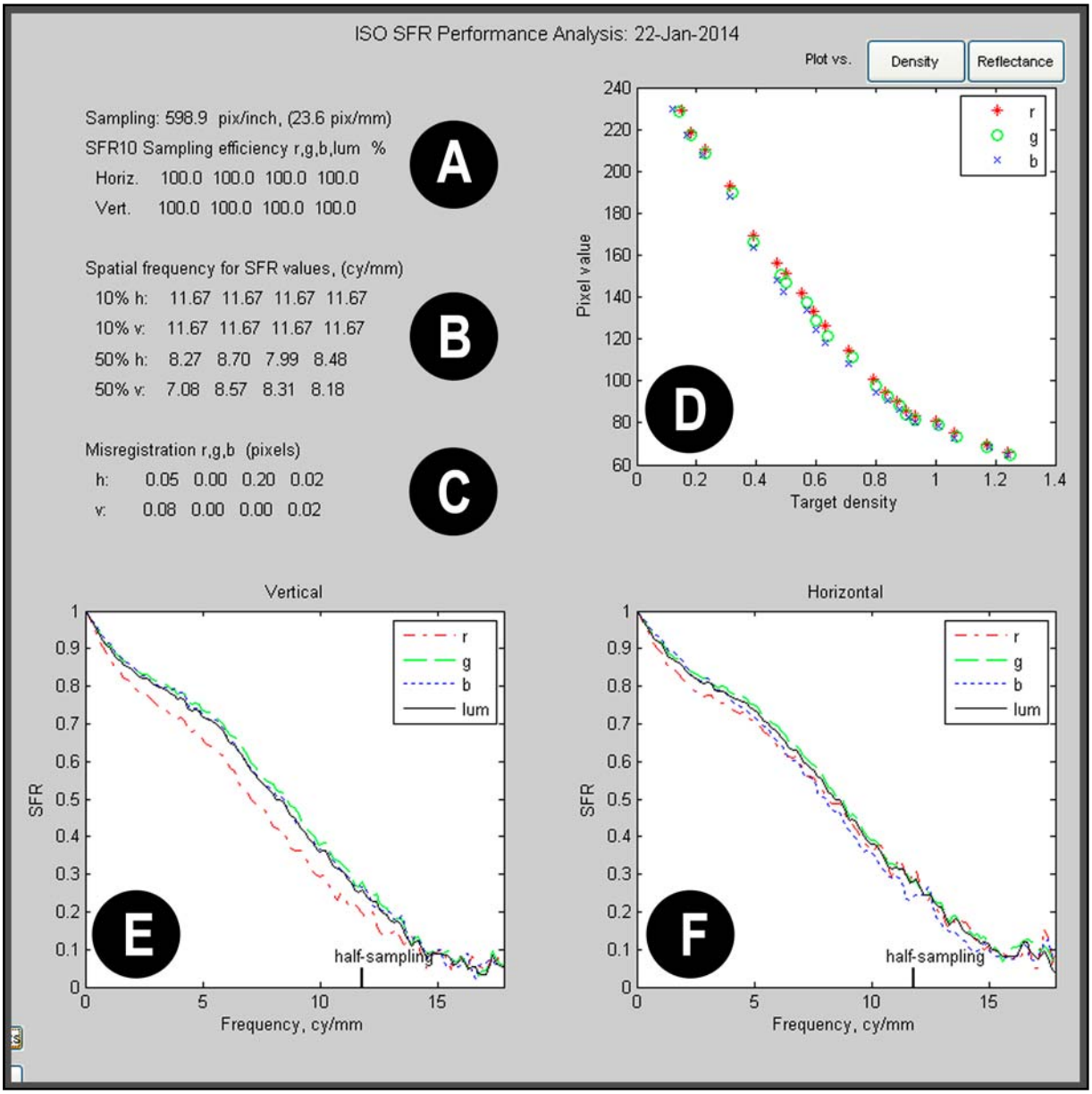


Figure 4.31 Legend to the readings on the graphs for the reflection target.

The alphabetical indicators refer to the explanations discussed at 4.3.2.1.

The SFR is used to determine the reported resolution value which is based on a 10% SFR value. Historical treatments of resolving power and the effective resolution over the past century has shown that the 10% value was consistent. The small vertical tick on the x-axis which is labelled "half-sampling", (Figure 4.31 E & F and Figure 4.32) is intended to provide a 100% sampling efficiency aim point for the 10% SFR response. It may happen that the SFR associated with the 10% response goes beyond this aim point. This is normal behaviour and there is no way to exploit the higher frequencies because of insufficient sampling. Values beyond this aim point are reported as being 100% efficient. A good quality scan which is well beyond the aim limits may then extend beyond the vertical mark and above the 10% SFR as indicated by the red circle in Figure 4.32 (Burns, 2010:22).

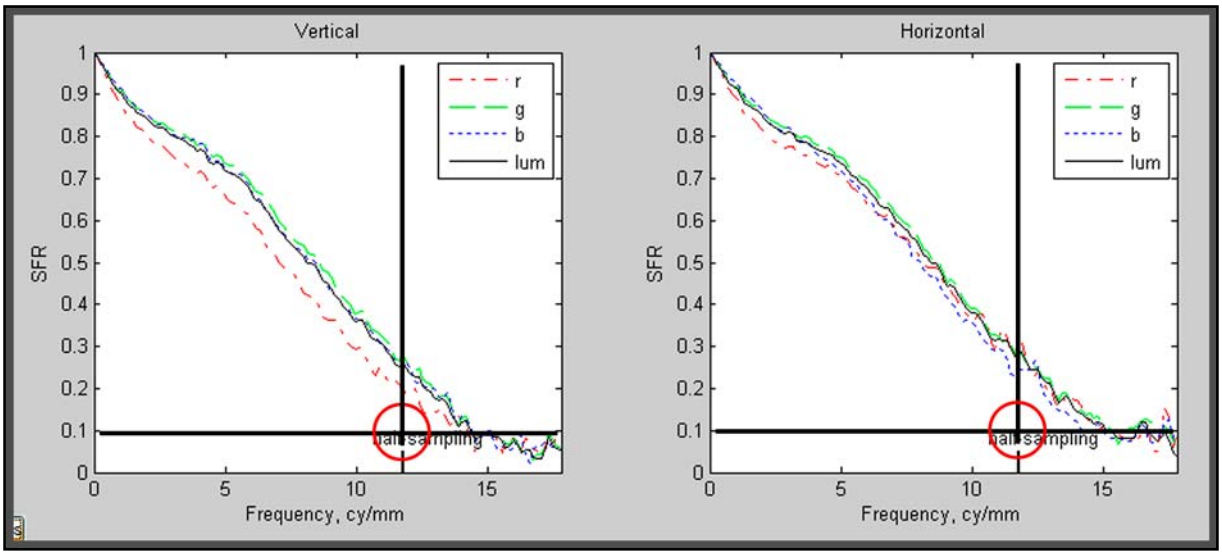


Figure 4.32 10 % SFR and half sampling indicators.

- Colour misregistration (Figure: 4.31) Indicated as C:
  Colour (RGB) misregistration expressed as number of pixels. For the most basic quality level, colour misregistration should not be more than 0.50 pixels for Metamorfoze Extra Light (Van Dormolen, 2012:16-38) or 0.80 pixels for FADI 1-star level. (Williams, 2010:16-33) Higher quality levels for Metamorfoze require not less than 0.35 pixels and FADGI would require not more than 0.33 pixels.
- OECF curve (Figure:4.31) indicated as D:

There is no single best OECF curve, but there are factors that would cause the curve to be erratic or change direction. The OECF can also be used to evaluate gamma (contrast) as well as lightness and will be a good indicator how the image will be displayed. FADGI guidelines make it clear that whatever tone response curve is selected, the important factor is consistency for a particular job. Consistency is a gradual curve without any sudden changes in direction (Williams, 2010:16).

A severe shift of the curve to the top or the bottom is an indication of over- or underexposure. In Figure 4.33 two curves are presented as an example. The curve on the left indicates an excessive overexposure due to the compression of the top left end of the curve which extends slightly beyond the 250 pixel value. On the right a curve with an extreme underexposure is illustrated. In this case the black values are at 1.2 pixel value up to a target density level of 1.1 before the upwards trend of the curve started but ends just above the 200 pixel value (Burns, 2010:14-16).

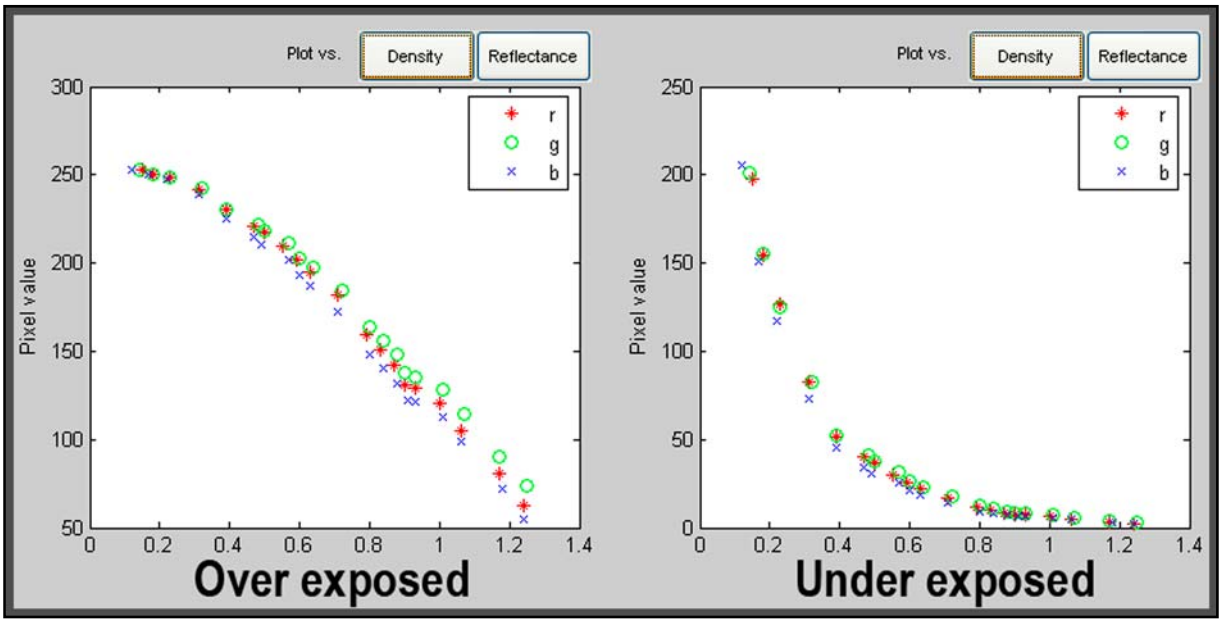


Figure 4.33 OECF curve displays under- and over exposure.

- Horizontal and vertical SFR differences:
  Differences between vertical and horizontal SFR (See Figure:4.31 indicated as E and F). SFR calculations to establish high, mid and low frequency resolution criteria, are based on the Luminance channel only. SFR may show a divergence between the horizontal and vertical SFR with increasing cy/mm due to scanner head motion especially with linear array scanners. As an example see Figure 4.47 indicated at B. (Burns, 2010:24).

- Effect of sharpening on the SFR behaviour.
  Aggressive sharpening will cause non-monotonic bumps which could exceed 1.0 SFR level (see Figure 4.45). Such sharpening will most probably cause haloes. (Preservation Microfilm Scanner Target and Imaging Performance Software (Mscan) user guide 2010:24). No sharpening is allowed for master files according to Metamorfoze, however minimal sharpening is allowed which does not exceed 1.05 SFR. The action of sharpening is subject to approval from the digitising project leader (Van Dormolen, 2012:26). In the case of FADGI standards 2 and 1-star level, sharpening is allowed up to a level of 1.2.

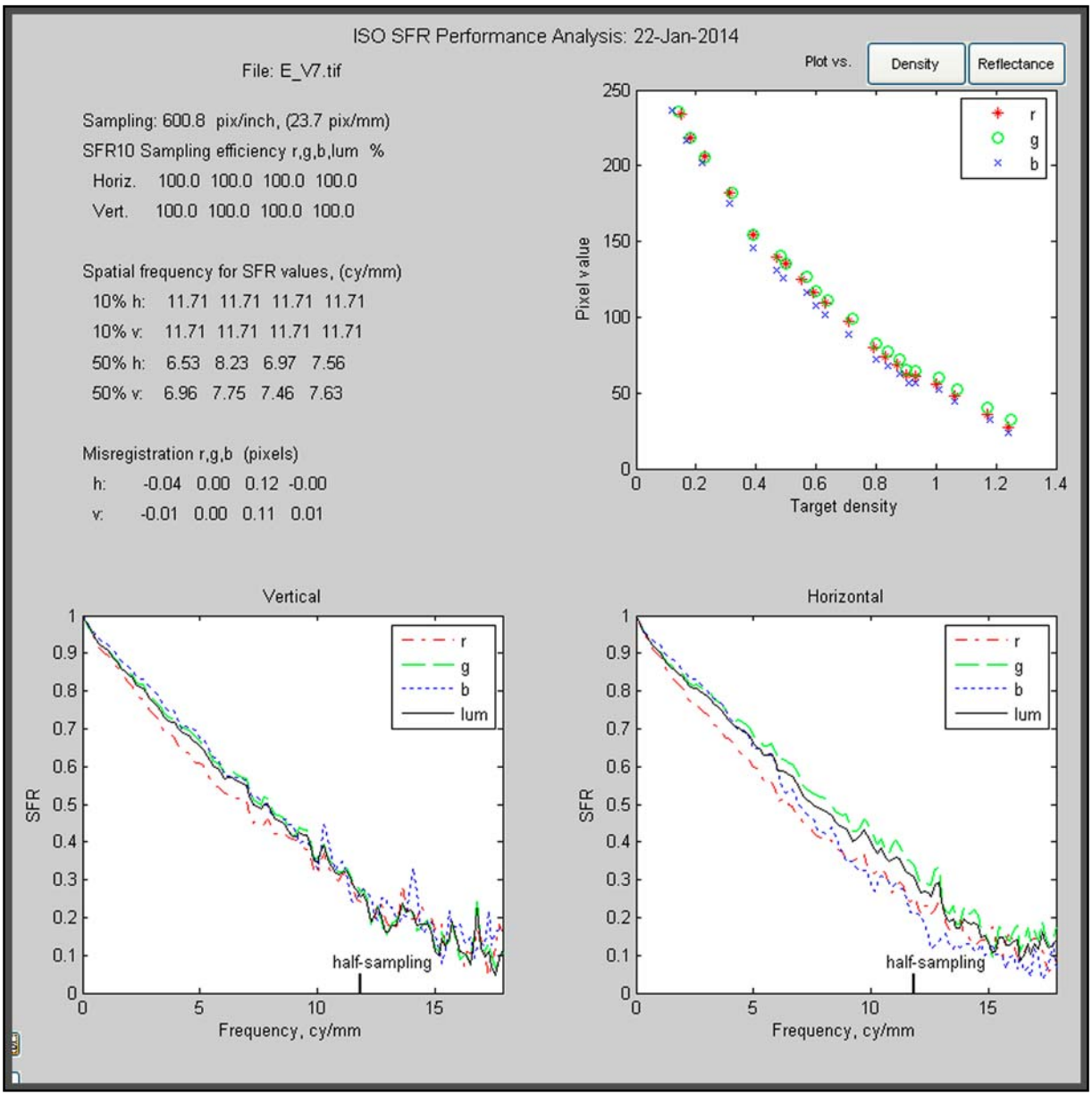


Figure 4.34 Scan results of QA-62 target: Epson V700 A4 scanner.

The scanner performed well in all areas and fulfilled the necessary criteria. Resolution is good well beyond the half-sampling and 10% SFR indicators.

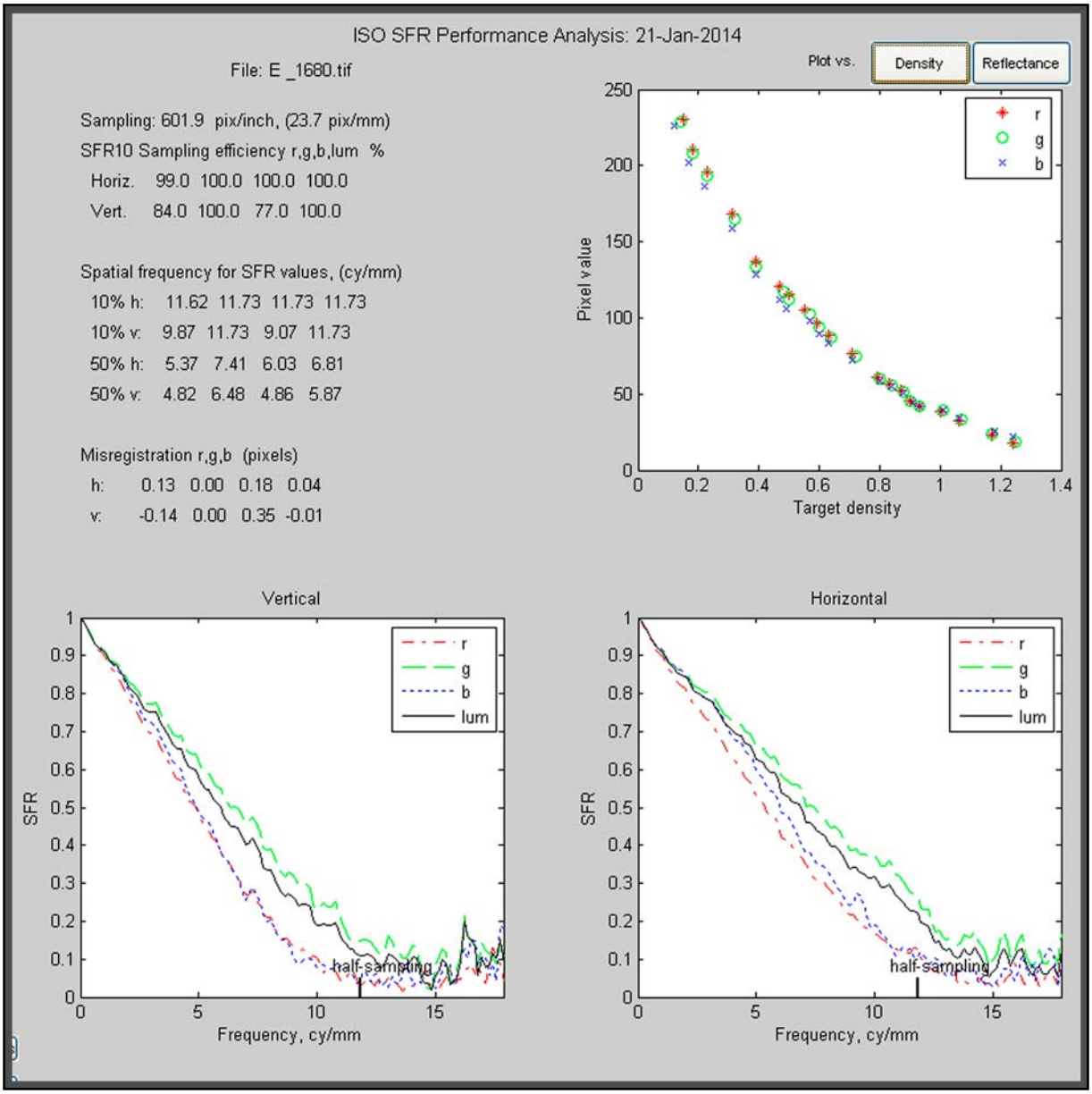


Figure 4.35 Results of QA-62 target: Epson 1680 A4 scan.

The scanner is an older type flatbed. Vertical sampling efficiency is still beyond the 80% and acceptable to FADGI 3-star level, but Metamorfoze standard requires 85% for all levels.

The OECF curve looks normal.

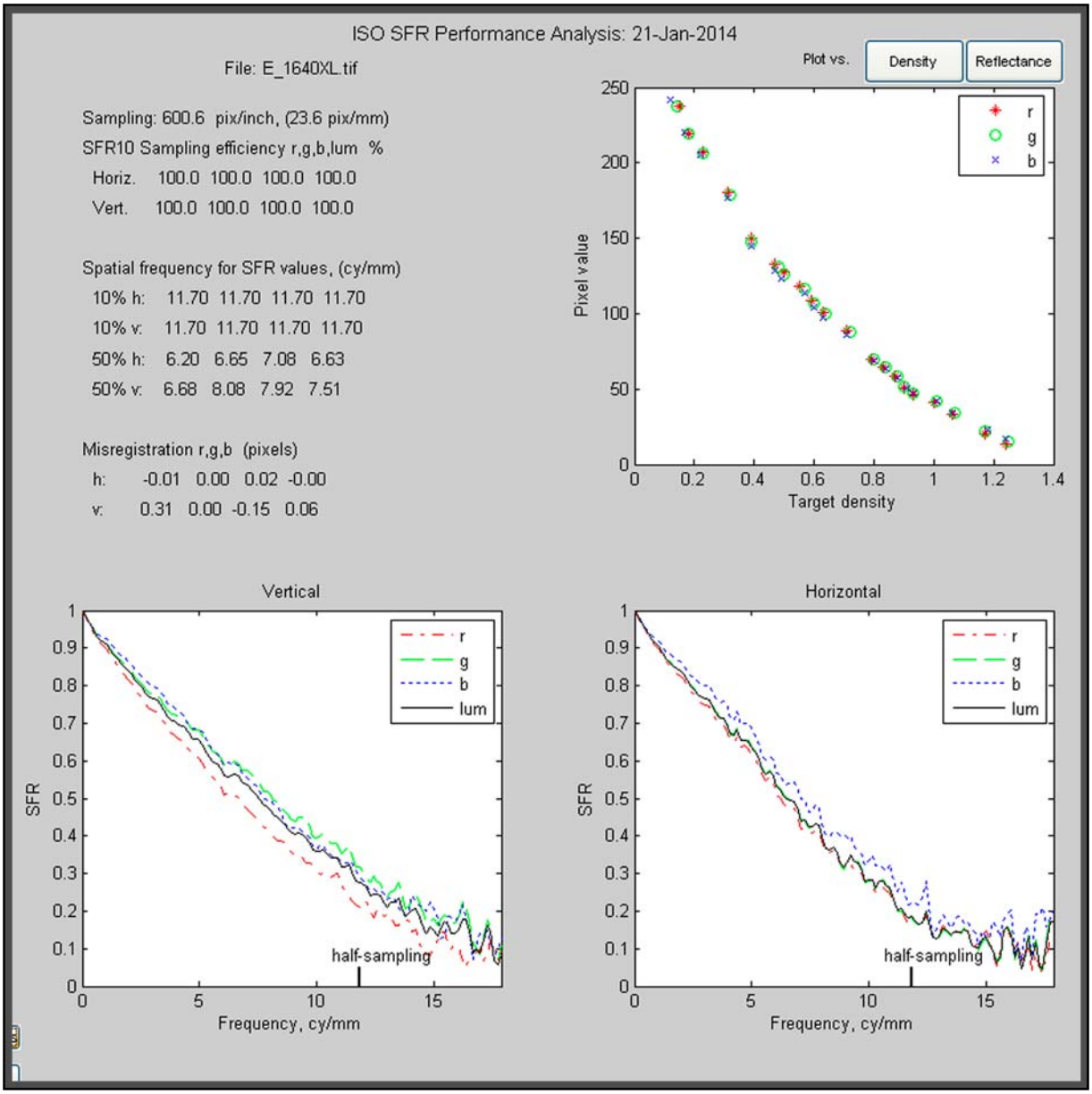


Figure 4.36 Scan results of QA-62 target: Epson 1640XL A3 scanner.

The scanner performed well in all areas and fulfilled the necessary criteria. Resolution is good well beyond the half-sampling and SFR indicators.

The OECF curve looks normal.

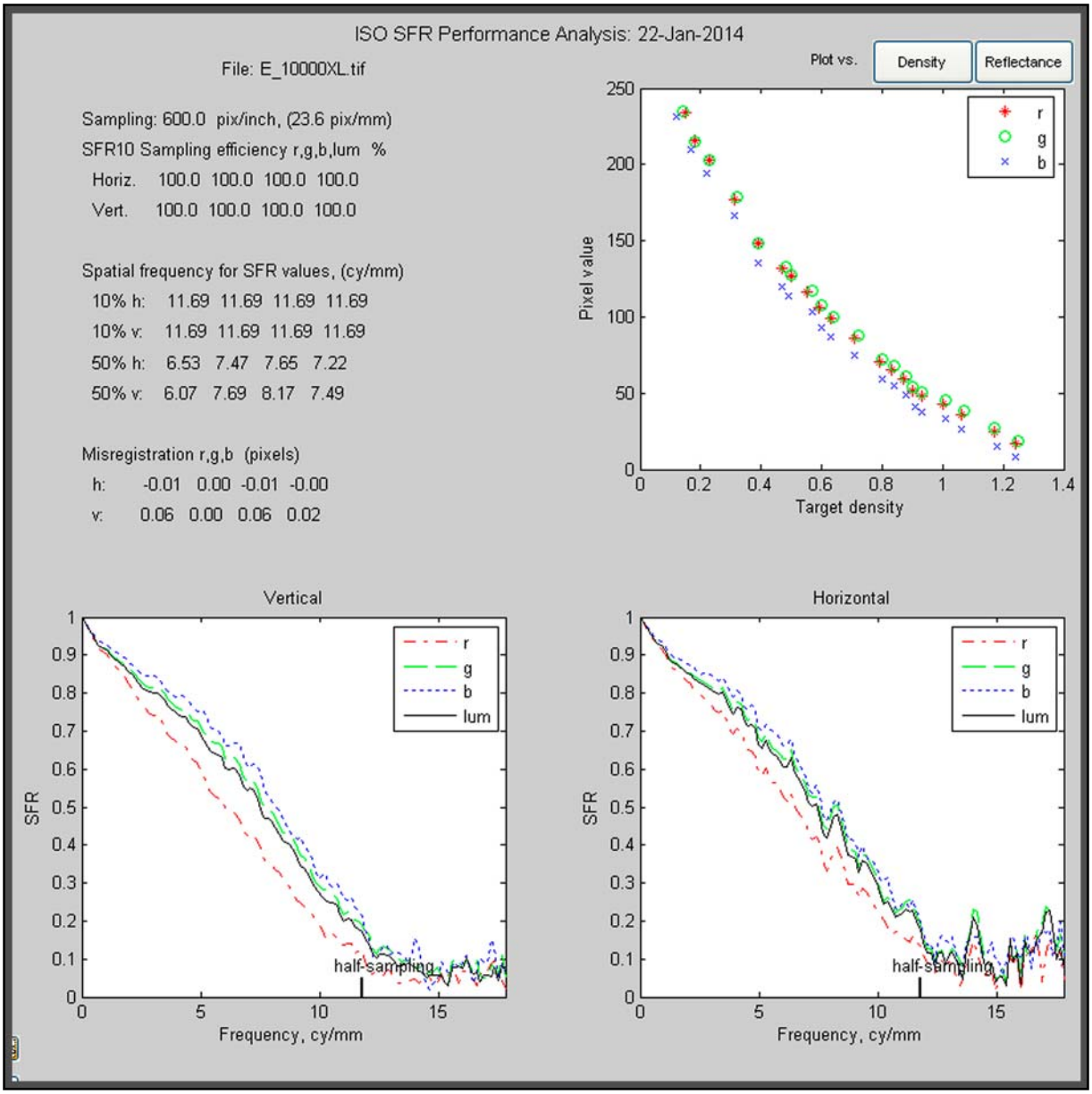


Figure 4.37 Scan results of QA-62 target: Epson 10000XL A3 scanner.

The scanner performed well in all areas and fulfilled the necessary criteria. Resolution is good well beyond the half-sampling and SFR indicators.

The OECF curve looks normal.

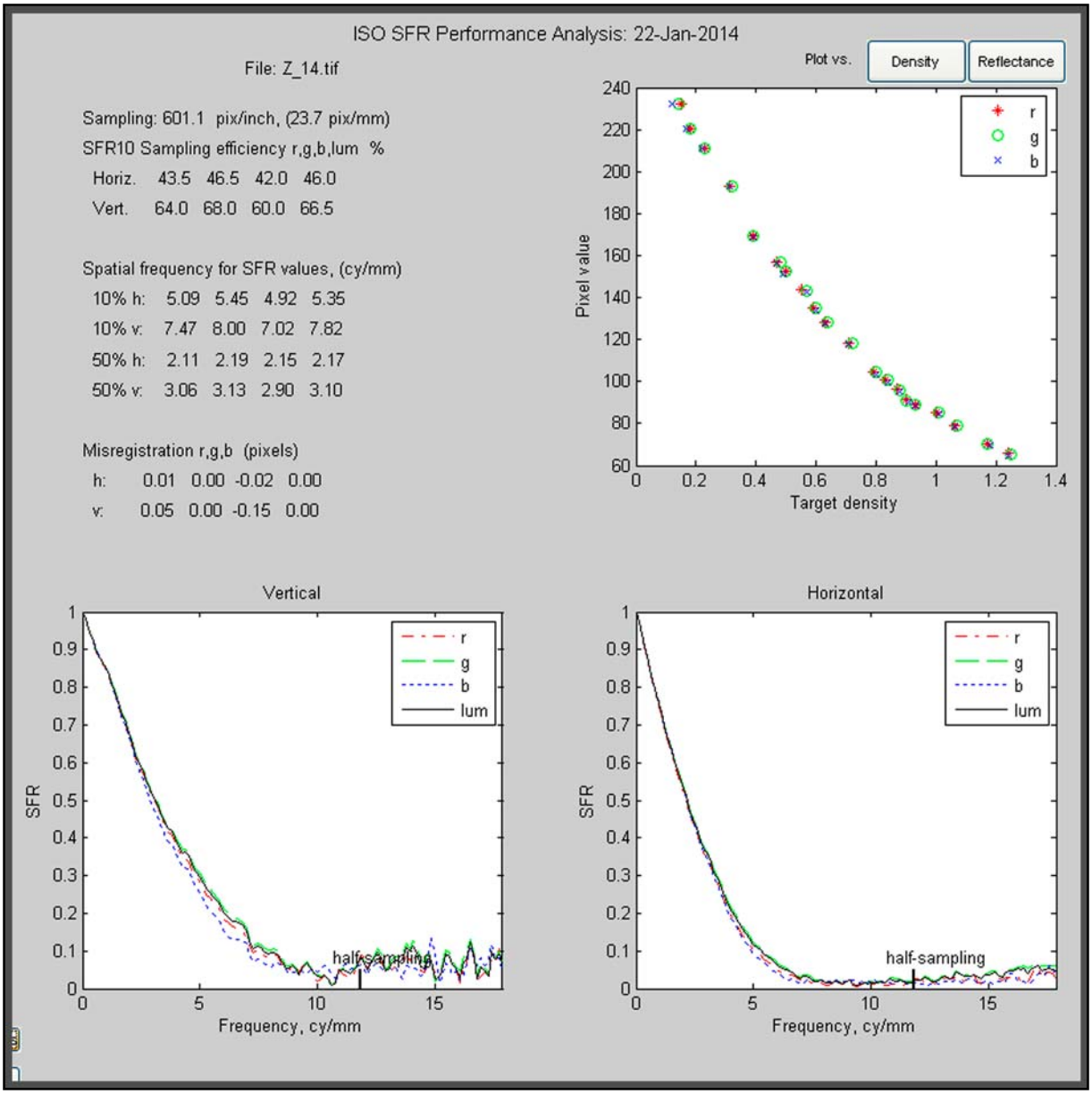


Figure 4.38 Scan results of QA-62 target: Zeutschel OS14000 A0 scanner.

This scanner did not behave well especially with the horizontal sampling efficiency. Red Green and Blue as well as the luminance were below 50%. Vertical sampling efficiency for Red, Green, Blue and luminance is mainly in the 60% range.

Resolution is very poor and is out of tolerance well before the half-sampling and 10% SFR indicators. For colour misregistration refer to Figure 4.43 and 4.44.

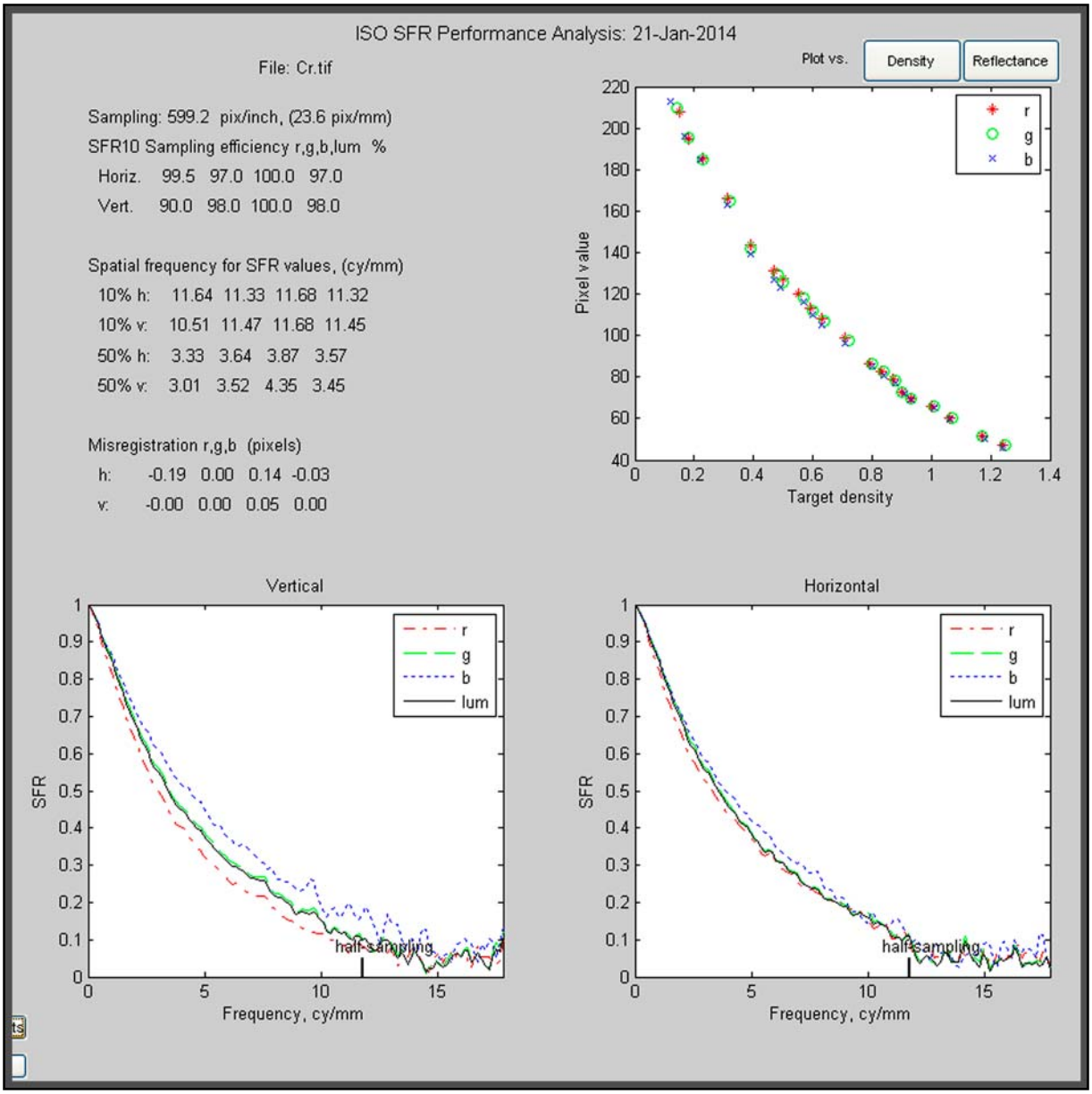


Figure 4.39 Scan results of QA-62 target: Cruse A0 large format scanner.

Sampling efficiency for this scanner is mostly slightly less than 100% for horizontal and vertical but still within tolerance.

Resolution is acceptable and just within tolerance before the half-sampling and 10% SFR indicators.

The OECF curve looks normal.

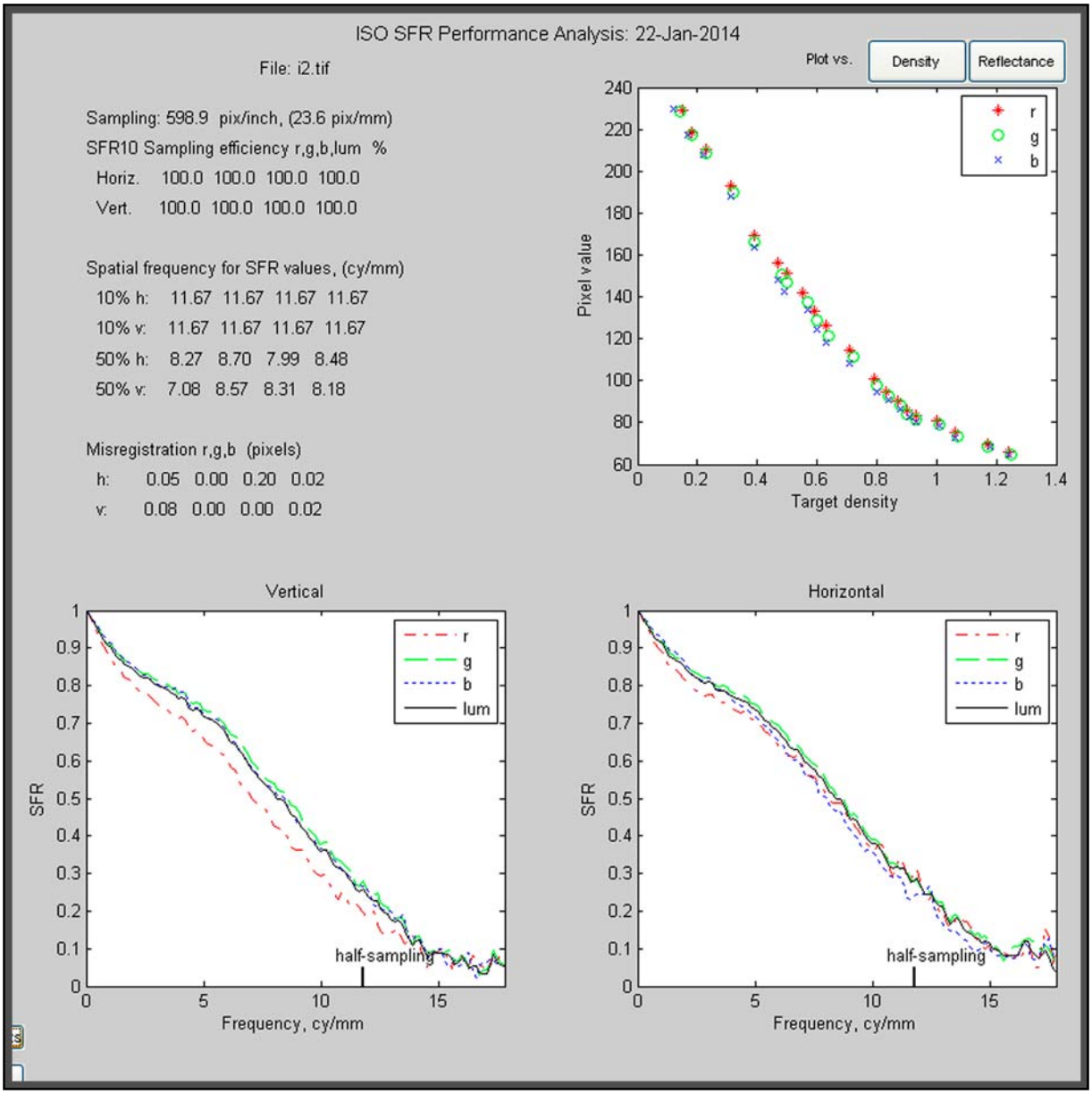
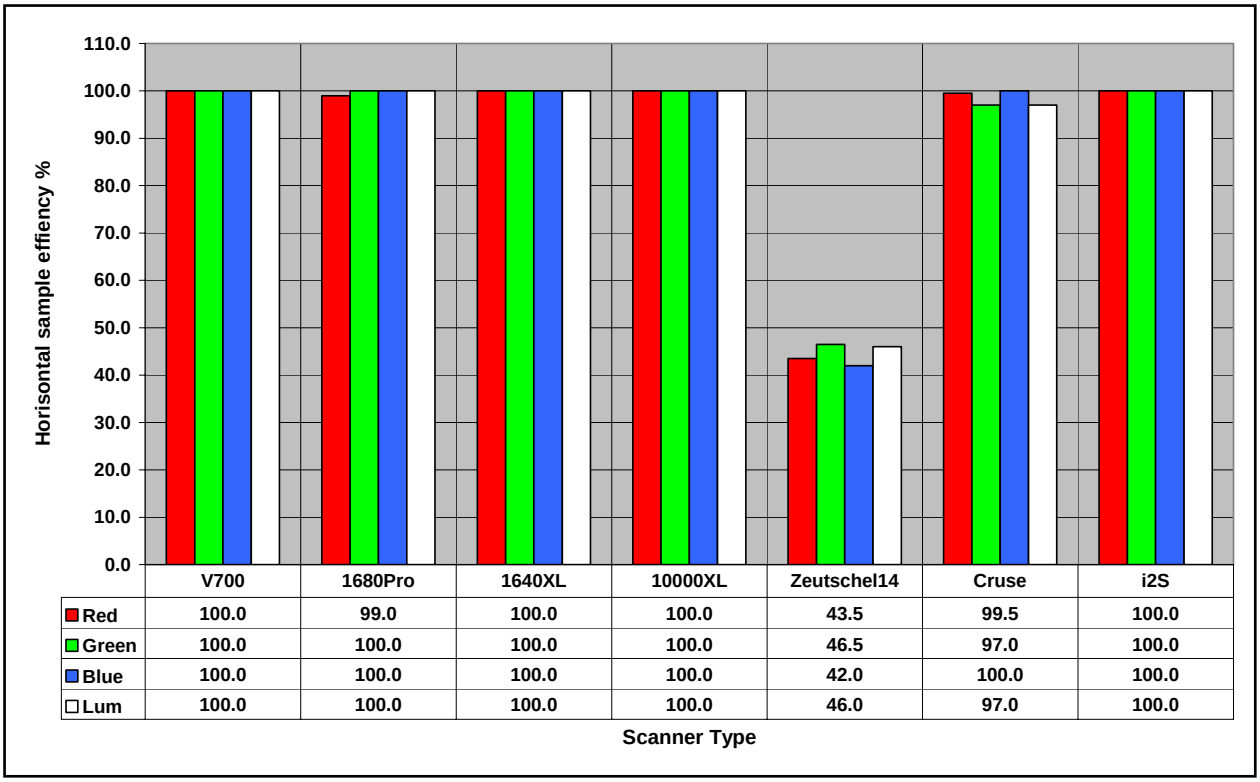


Figure 4.40 QA-62 target: i2S Quartz Suprascan Quartz A1 scanner.

This scanner performed very well in all aspects tested. Sampling efficiency both horizontal and vertical are 100% and SFR well above and beyond the half-sampling indicator.

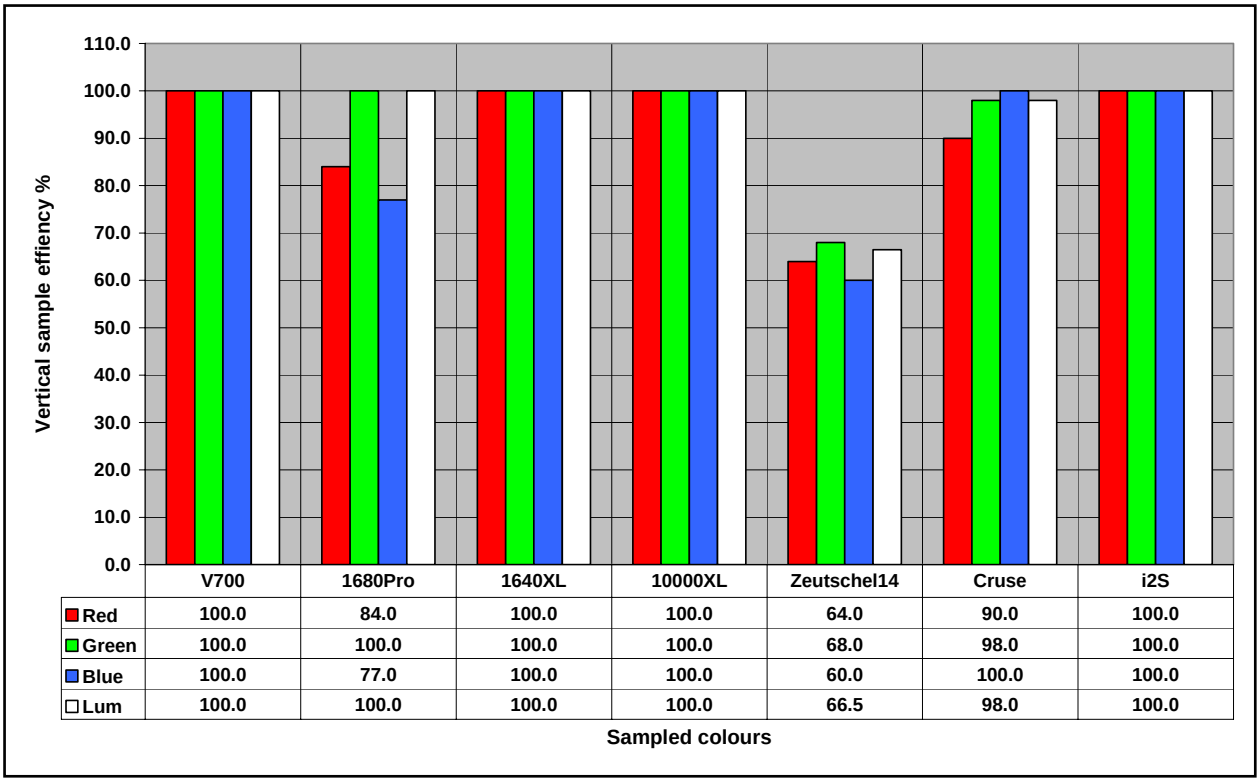
Sampling efficiency is excellent.



	V700	1680Pro	1640XL	10000XL	Zeutschel14	Cruse	i2S
Red	100.0	99.0	100.0	100.0	43.5	99.5	100.0
Green	100.0	100.0	100.0	100.0	46.5	97.0	100.0
Blue	100.0	100.0	100.0	100.0	42.0	100.0	100.0
Lum	100.0	100.0	100.0	100.0	46.0	97.0	100.0

Figure 4.41 Horizontal sampling efficiency comparison.

A direct comparison of horizontal sampling efficiency for all tested scanners indicates that the Zeutschel OS 14000 scanner performs below standard comparing to all others. Although some artefacts can be scanned with success with this scanner, it is not recommended for photographic prints. See example at Figure 4.57.

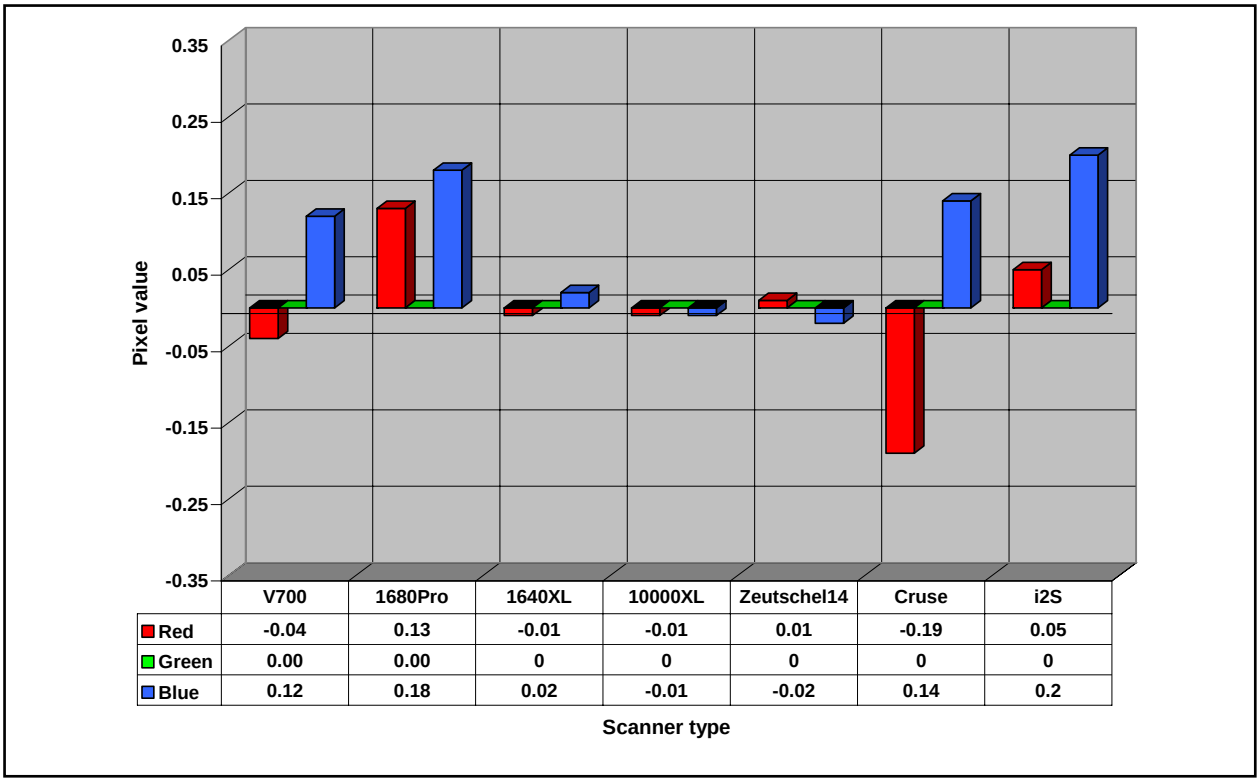


	V700	1680Pro	1640XL	10000XL	Zeutschel14	Cruse	i2S
Red	100.0	84.0	100.0	100.0	64.0	90.0	100.0
Green	100.0	100.0	100.0	100.0	68.0	98.0	100.0
Blue	100.0	77.0	100.0	100.0	60.0	100.0	100.0
Lum	100.0	100.0	100.0	100.0	66.5	98.0	100.0

Figure 4.42 Vertical sampling efficiency comparison.

A direct comparison of vertical sampling efficiency for all tested scanners indicates that the Zeutschel OS 14000 scanner is performing below standard. Although the vertical sampling rate is slightly better than horizontal, it is still out of tolerance. Although some artefacts can be scanned with success with this scanner, it is not recommended for photographic prints. See example at Figure 4.57.

The Epson 1680 Pro scanner performed lower in the Red and Blue region with the Blue just below the tolerance level of 80% according to FADGI 3-star level and below standard for Metamorfoze requiring 85% efficiency.

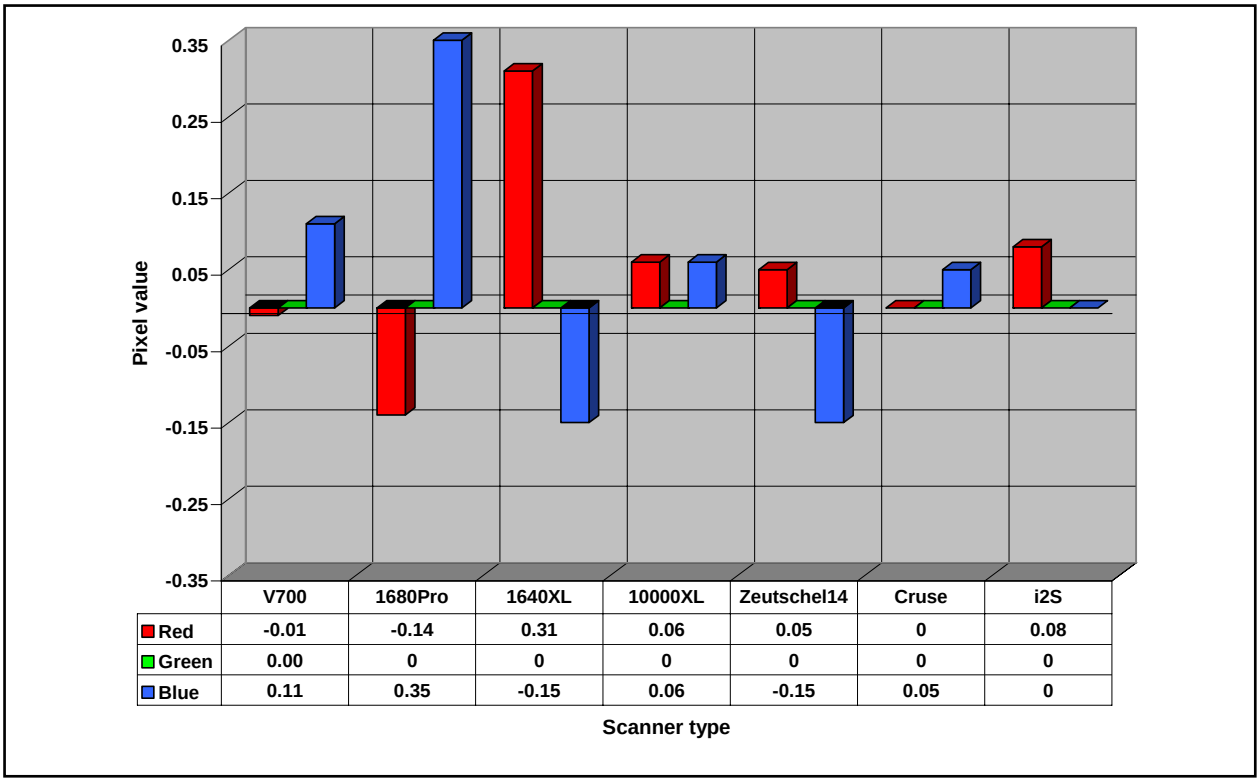


	V700	1680Pro	1640XL	10000XL	Zeutschel14	Cruse	i2S
Red	-0.04	0.13	-0.01	-0.01	0.01	-0.19	0.05
Green	0.00	0.00	0	0	0	0	0
Blue	0.12	0.18	0.02	-0.01	-0.02	0.14	0.2

Figure 4.43 Horizontal colour (RGB) misregistration.

Colour misregistration, also known as lateral colour error, is visible when colour channels are not spatially aligned or in register. It is commonly observed in the corners of the field of view where the lens design of the optics is under stress. It is visible as a colour fringe along edge transitions. The misalignment is measured on a scanned target on a slanted edge feature also used for SFR calculation (Williams: 2010:25).

The represented scanners Epson V700, Epson 1680PRO, Cruse and i2S all have a slight colour misalignment although still within tolerance of 0.30 pixels for Metamorfoze and FADGI levels of standard.



	V700	1680Pro	1640XL	10000XL	Zeutschel14	Cruse	i2S
Red	-0.01	-0.14	0.31	0.06	0.05	0	0.08
Green	0.00	0	0	0	0	0	0
Blue	0.11	0.35	-0.15	0.06	-0.15	0.05	0

Figure 4.44 Vertical colour (RGB) misregistration.

Colour misregistration between vertical and horizontal slants may differ due to the orientation of the target on the scan table or scan area.

Comparing Figure 4.43 with this reported graph, a clear difference in colour misregistration is visible when comparing the 1640XL scanner vertical registration with horizontal registration. Horizontal colour misregistration is very small while vertical misregistration is quite severe although still within tolerance of lower levels for FADGI 4 star level of 0.33 pixels and Metamorfoze Light and Extra Light of 0.50 pixels.

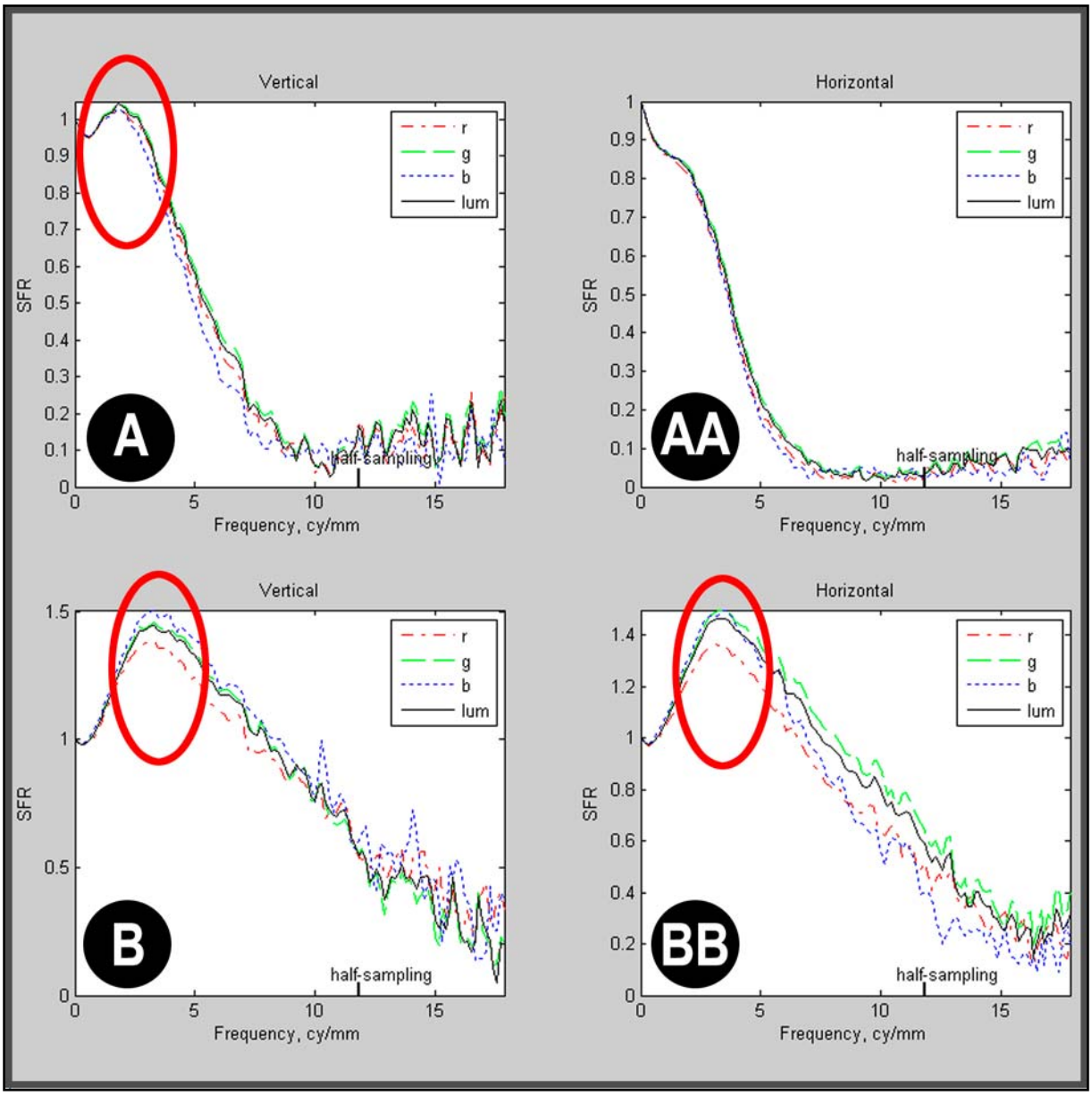


Figure 4.45 Effect of sharpening on the targets.

The resultant targets of the Zeutschel OS14000 (A and AA) and Epson V700 (B and BB) scanners when the target was subjected to sharpening. The targets were sharpened using Photoshop CS2 (version 9) and with the 'unsharp mask" filter set at Amount=100, Radius=2.5 pixels and Threshold=0.

In both cases the result of sharpening had the same effect but with different SFR

maximum values. The effect of the sharpening had a more destructive effect on the Epson V700 target (B) compared to the Zeutschel (A). However the Zeutschel vertical SFR (AA) behaved different from the horizontal SFR and was more destructive on the vertical SFR. The horizontal SFR (AA) behaved well and indicated only a small non-linear behaviour at 0.8 SFR for a few cy/mm.

As discussed, SFR values beyond 1.05 as in the case of the Epson V700, is not considered in tolerance and is not recommended (Van Dormolen, 2012:26).

4.3.2.2 ISA Microfilm preservation target for transmission scanners.

Graphs representing the results of transmission scanners:

- Epson V700,
- Nikon ED 9000,
- Flextight Precision III.

All transmission targets were scanned in grayscale mode at 600 DPI. No corrections or any post processing was done.

The important aspects to consider for transmission targets calculated from the graphs are:

- OECF curve (Figure:4.47) indicated as A:
  There is no single best OECF curve, but there are factors that would cause the curve to be erratic or change direction. The OECF can also be used to evaluate gamma (contrast) as well as lightness and will be a good indicator how the image will be displayed. FADGI guidelines make it clear that whatever tone response curve is selected, the important factor is consistency for a particular job. Consistency is a gradual curve without any sudden changes in direction (Williams, 2010:16).

  A severe shift of the curve to the top or the bottom is an indication of over- or underexposure. In Figure 4.46 two curves are presented as an example. On the left a curve indicates an excessive overexposure due to

the compression of the top right end of the curve which extends beyond the 250 pixel value. On the right a curve with an extreme underexposure is illustrated. In this case the black values are at 0 pixel value up to a density level of 0.4 before the upwards trend of the curve started but ends just above the 200 pixel value (Burns, 2010:14-16).

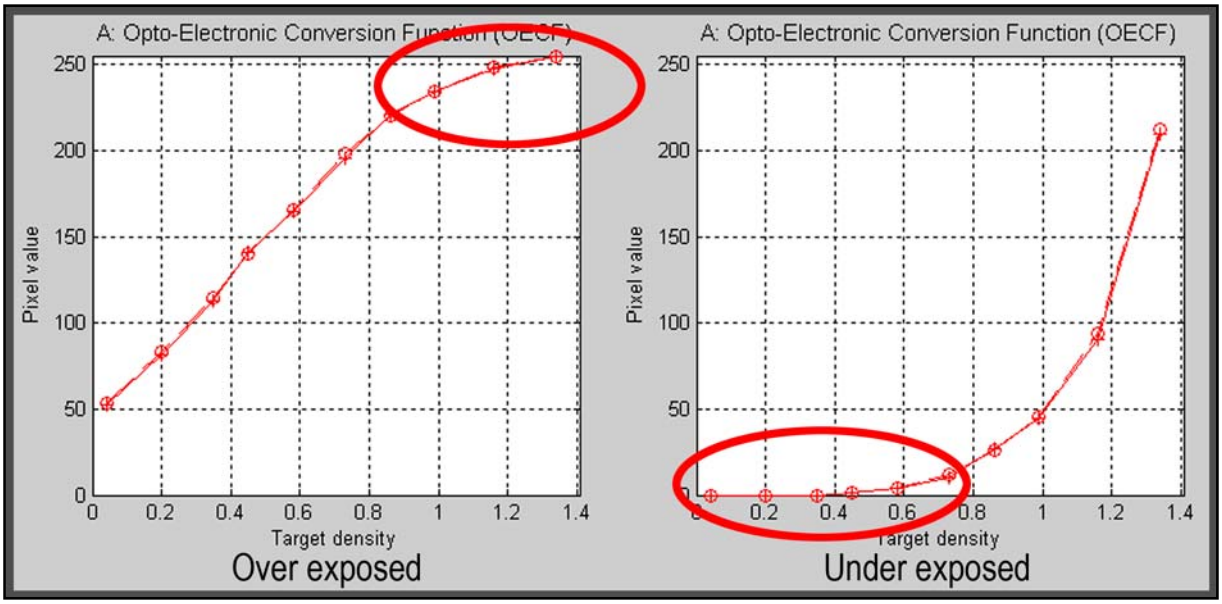


Figure 4.46 OECF curve displays under- and over exposure on microfilm target.

- Differences between horizontal and vertical SFR (See Figure:4.47 B): SFR may show a divergence between the horizontal and vertical SFR with increasing cy/mm due to scanner head motion especially with linear array scanners. (Burns, 2010:24).
- 10% spatial frequency response expressed in pixel value (See Figure:4.47 B). The same requirement for best resolution is applicable as in Figure:4.31.

- Sampling efficiency expressed as a percentage (See Figure:4.47 E): Horizontal and vertical sampling efficiency should be no less than 85%. This is an accepted standard for Metamorfoze at all three levels and FADGI level 3 standards. (Van Dormolen, 2012:16-38).

- Effect of sharpening on the SFR behaviour.
  Aggressive sharpening will cause non-monotonic bumps which could exceed 100% SFR level (see Figure 4.50). Such sharpening will most probably cause haloes. (Preservation Microfilm Scanner Target and Imaging Performance Software (Mscan) user guide 2010:24). No sharpening is allowed for master files according to Metamorfoze, however minimal sharpening is allowed which does not exceed 1.05 SFR. The action of sharpening is subject to approval from the digitising project leader (Van Dormolen, 2012:26). In the case of FADGI standards 2 and 1-star level, sharpening is allowed up to a level of 1.2.

- Wobble or micro distortion (Figure 4.47) indicated as C:
  Mechanical motion in linear array scanners will cause unsteady movements during the scanning process. These deviations are plotted on a graph as a function of distance and reported as a single root-mean square value. As this is the first broad attempt to do this analytically, Burns (2010:26) underline the fact that the resilience and sensitivity of this metric is still under scrutiny and the wobble test is intended as a test bed for future performance protocols.

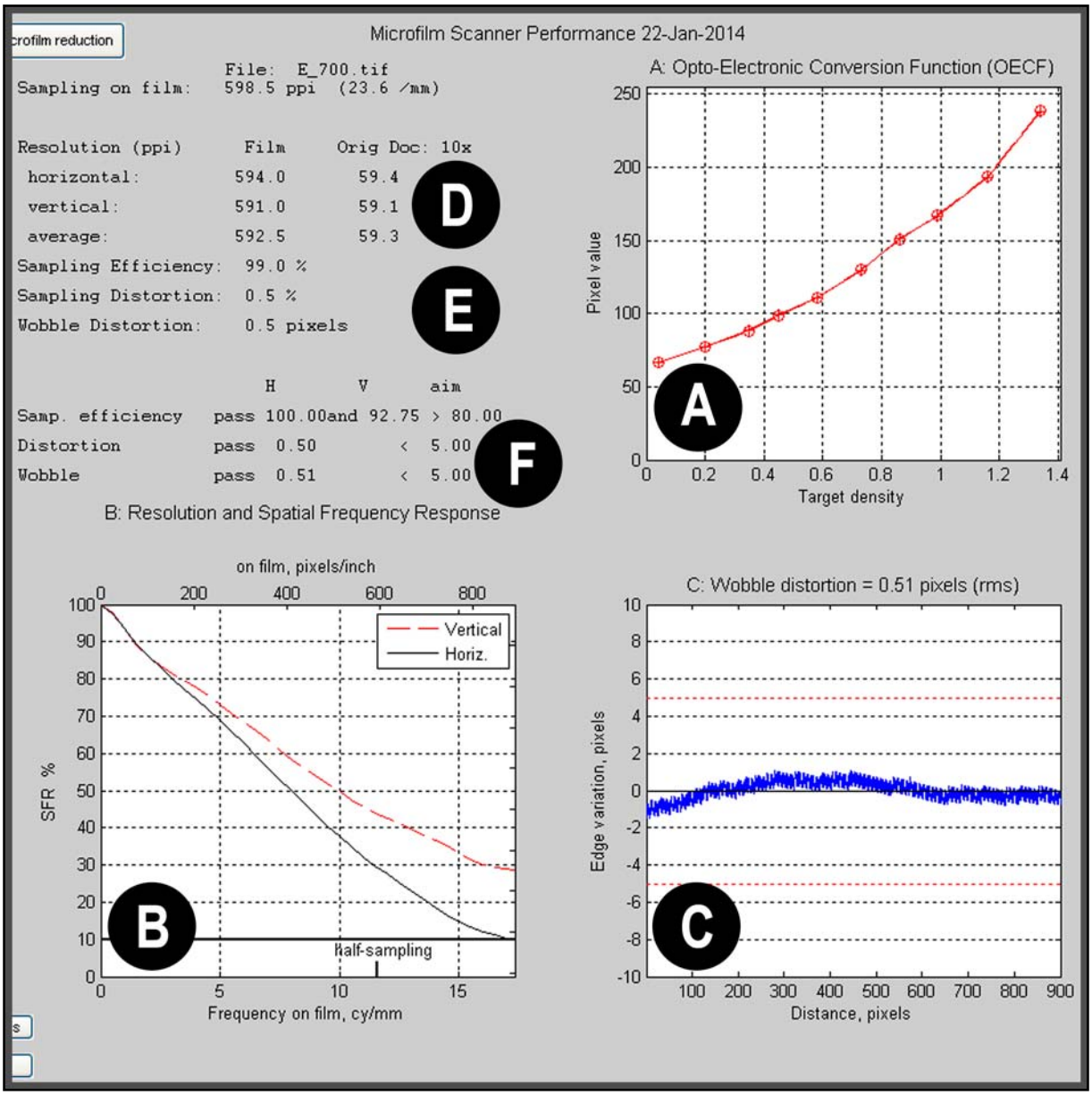


Figure 4.47 Legend for the readings on the graphs for the transmission target.

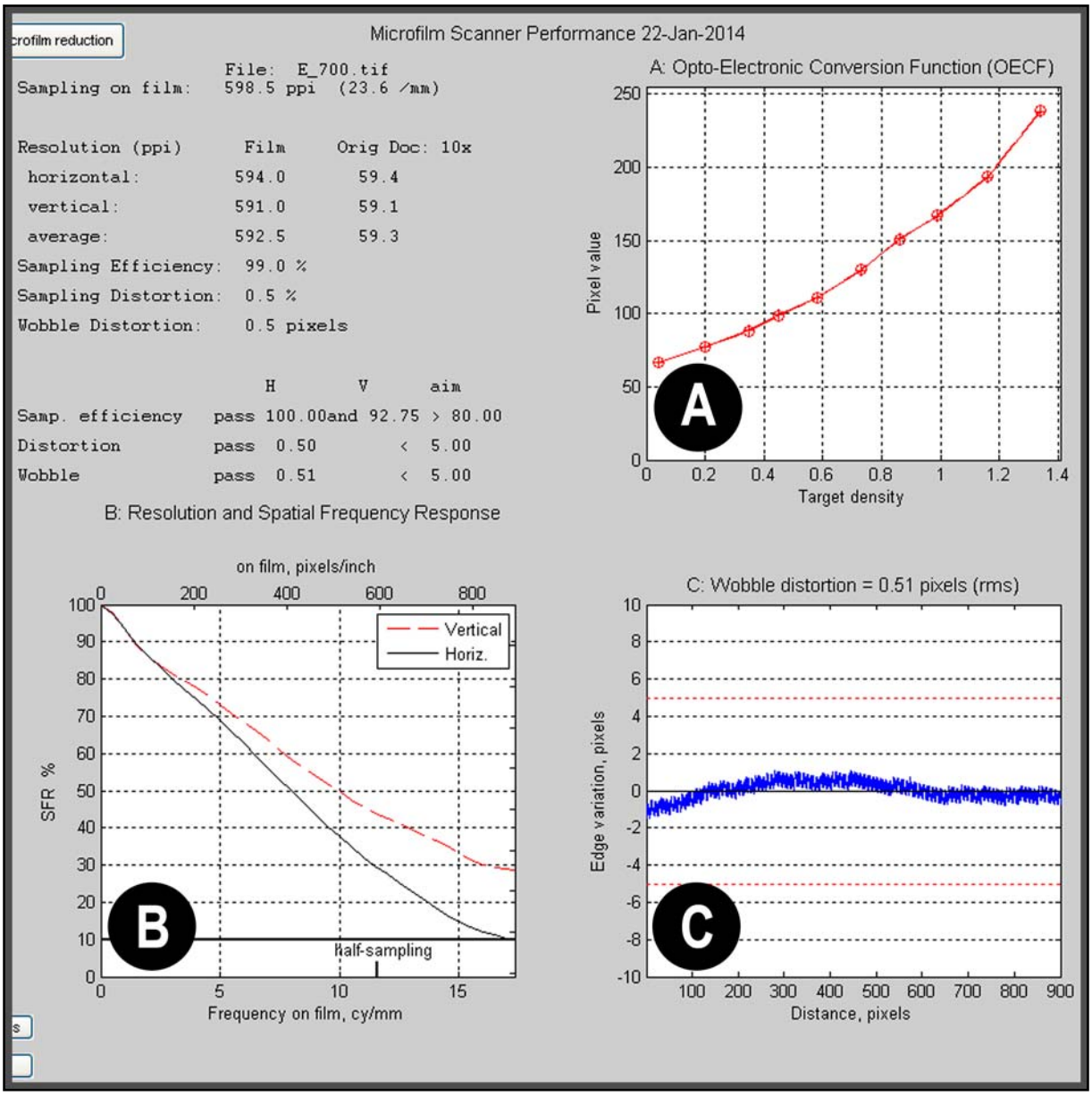


Figure 4.48 ISA Microfilm Preservation Target scanned with an Epson V700.

The image of the target produced by the Epson V700 transmission scanner shows normal OECF behaviour at A. SFR (B) is good and well above the 10% SFR indicator. Horizontal and vertical SFR is diverging towards higher frequencies due to the scanner head motion. The wobble as reported is well within tolerance.

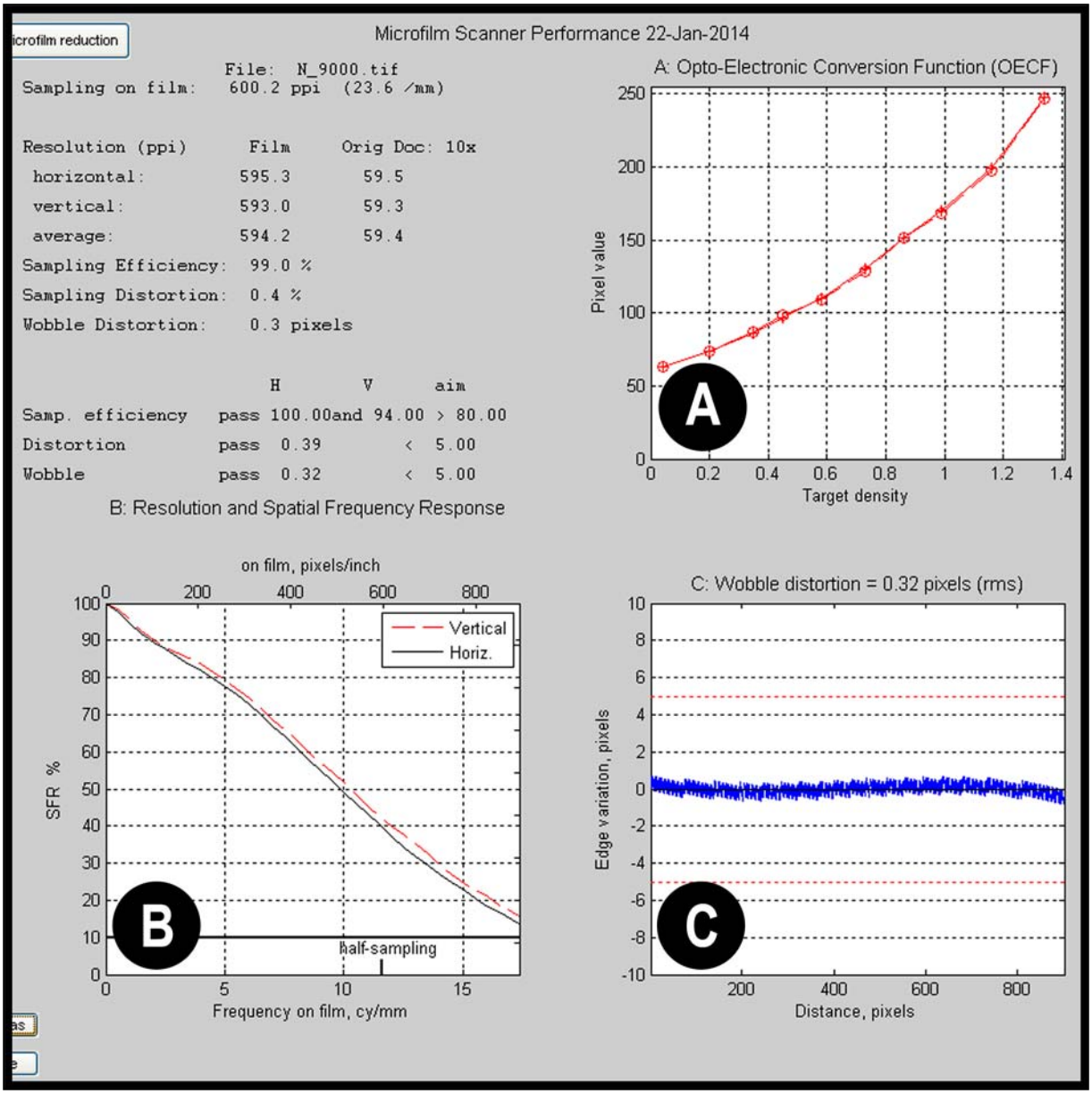


Figure 4.49 ISA Microfilm Preservation Target scanned with a Nikon ED 9000.

Results of the target scanned with a Nikon scanner. The scanner produced an even SFR with enough room above the 10% SFR and half-sampling indicator. The OECF is evenly spaced with pixel values close to 250. The micro distortion is very small and reported as 0.3 pixels.

The horizontal sampling efficiency is reported as 100% and vertical as 94%. With an aimpoint of 80% the reported numbers are well above 80%.

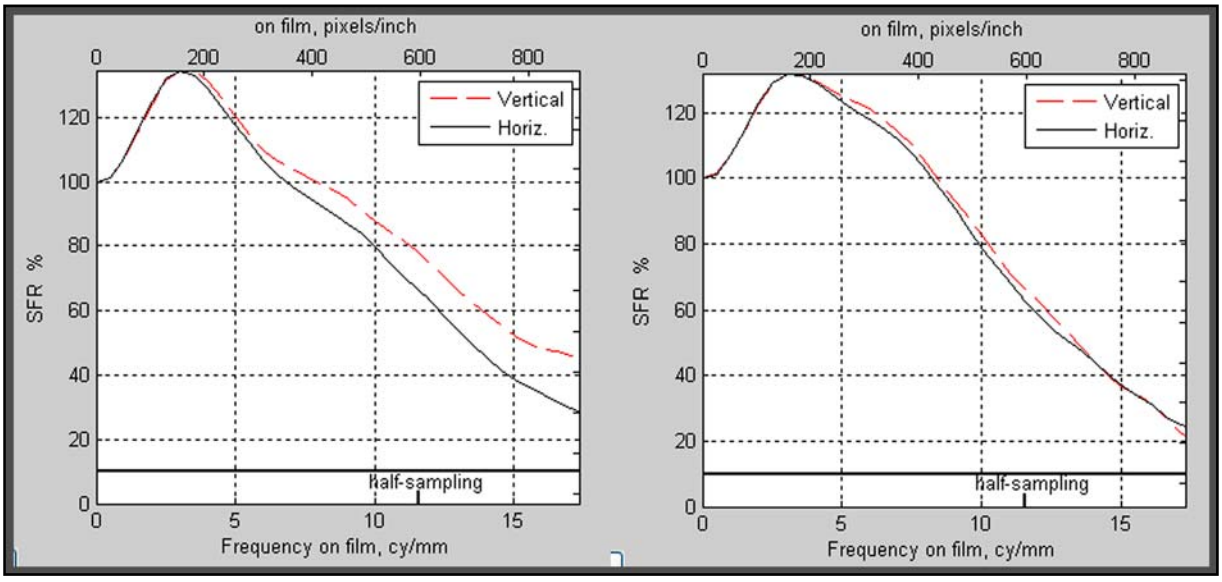


Figure 4.50 Sharpening effect on microfilm target.

Both targets, which were scanned with the Epson V700 and Nikon ED 9000 scanner, were sharpened in Photoshop. Sharpening took place using Photoshop CS2 (version 9) and with the 'unsharp mask" filter set at: Amount=100, Radius=2.5 pixels and Threshold=0.

The effect of sharpening on the targets produced similar effects for both scanners. The Epson target (left) showed an expected increase in SFR similar to the Nikon (right).

Although a Flextight Precision III scanner was also subjected to the target tests, the behaviour of the scanner at 600 dpi was not reliable. Repeated tests delivered the same results. The target analysis indicated a high level of sharpening behaviour at 600 dpi for the SFR analysis although all automatic functions were disabled in the scanner

software. However scanning the target at 3200 dpi resulted in a neutral SFR report with no sharpening behaviour. It was decided to exclude the scanner from the study because the reason for the apparent sharpening is unknown.

4.3.3 Visual observations.

Often visual inspection of a scan can confirm issues which are reported by the targets by using alternative ways to measure and assess the master image scans. However it must be clear that some parameters for example noise levels, cannot be tested without a target and proper analysing software.

Micro distortion (Williams, 2013:e-mail) and colour registration (Van Dormolen, 2013:e-mail) can be verified by using off-the-shelf imaging software for example Photoshop.

4.3.3.1 Micro (wobble) distortion.

In the case of film scanners and the use of the ISA Microfilm Preservation Target (Figure 3.3), the accuracy and consistency of the step-motor can be verified visually by using Photosop's measure tool. When a line is drawn from the left hand top corner to the right hand bottom on the diagonal line, it is possible to see if there is any deviation from the actual line on the test target as in Figure 4.51 where A is the diagonal line on the test target while B indicates the reference line in Photoshop. Figure 4.51 represents the Epson V700 scanner and Figure 4.52 represents the Nikon scanner. The resolution used for both targets was 600 dpi for comparison. The Epson clearly shows a greater deviation from the centreline. The difference is also reflected in Figure 4.48C (Epson) and Figure 4.49 C (Nikon).

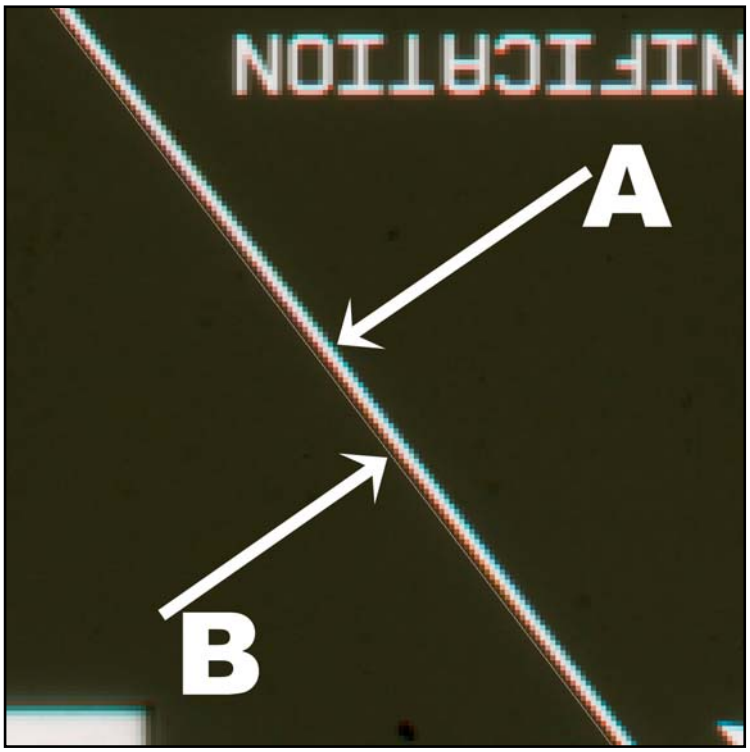


Figure 4.51 Micro-distortion (wobble) of Epson scan visible in Photoshop.

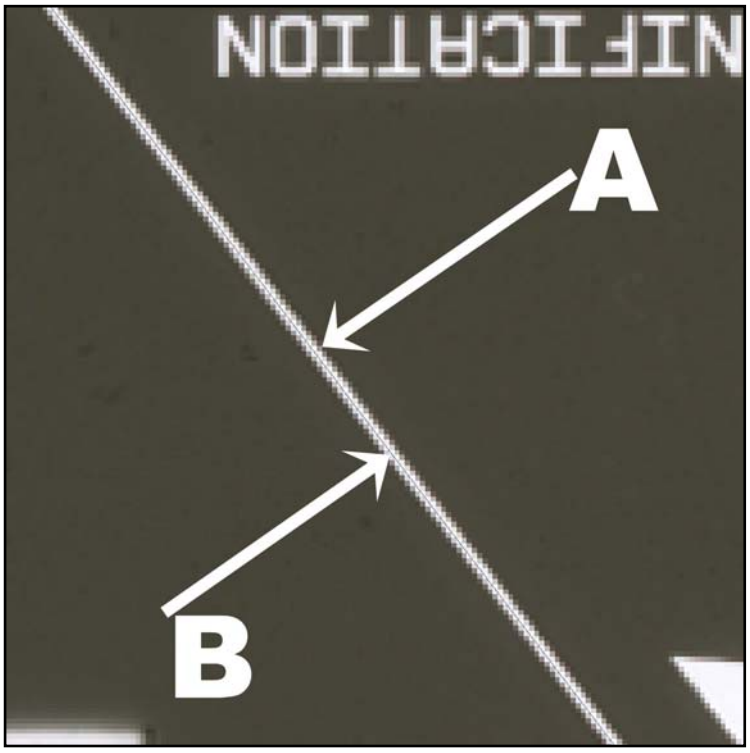


Figure 4.52 Micro-distortion (wobble) of Nikon scan visible in Photoshop.

4.3.3.2 Macro distortion.

Macro distortion is the difference in sampling rate between vertical and horizontal components of the scan (Williams, 2010:25). This could be verified by making a selection in Photoshop between the four fudicial (crosshair) marks indicated 4 in Figure 3.4. The selection should indicate the same number of pixels for the horizontal and vertical sides. By making the selection the number of pixels will be displayed in the Photoshop Info palette 600 pixels width x 604 pixels height (Figure 4.53 A). To calculate the percentage distortion the following formula can be used: [1-(w/h)] x 100 = % distortion. In this example Figure 4.53. [1-(600/604)] x 100 = 0.66%

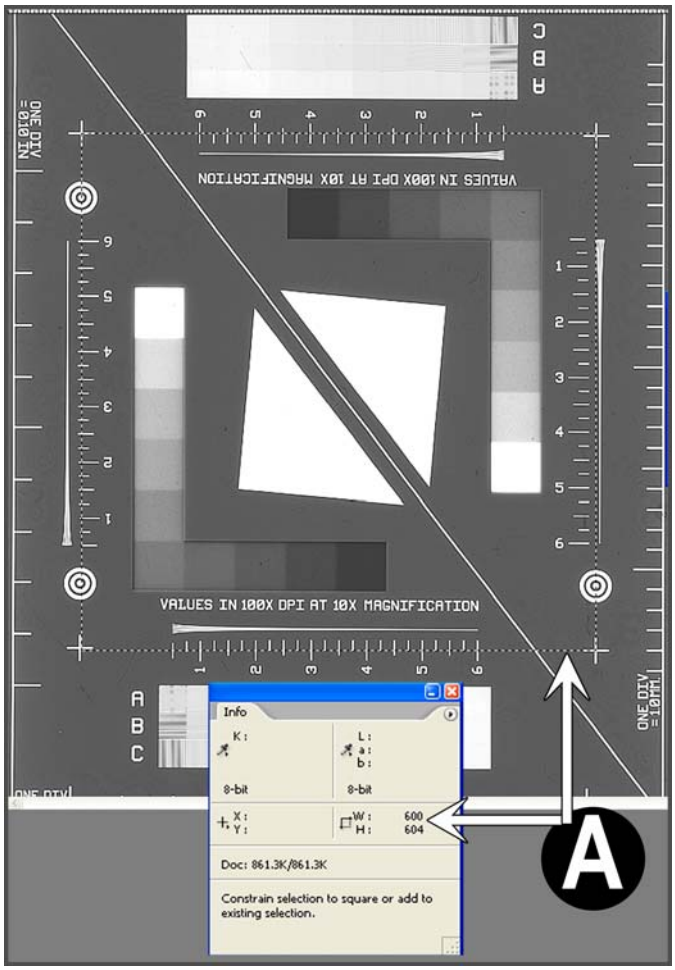


Figure 4.53 Manual measurement of macro distortion.

4.3.3.3 Colour misregistration.

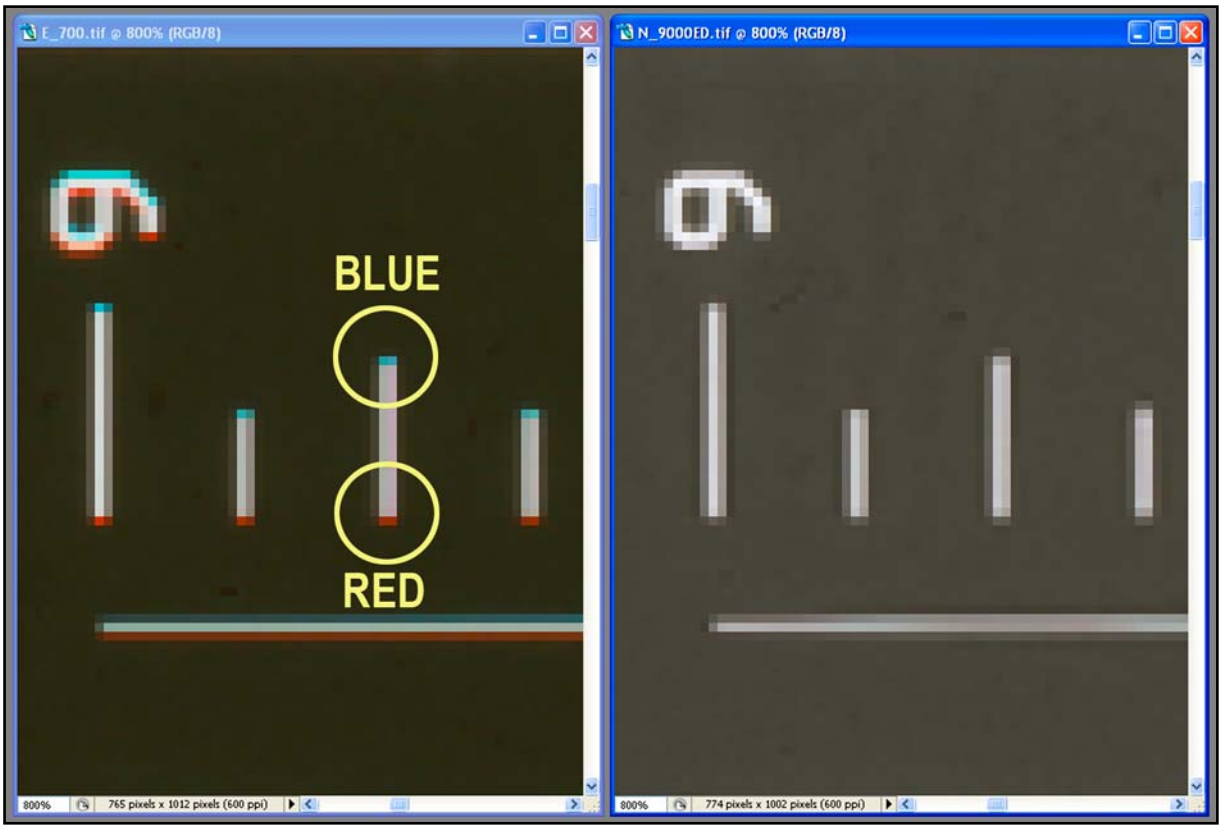


Figure 4.54 Visual colour misregistration. (Epson scanner left and Nikon scanner the right).

Colour misregistration could be visually observed by using any imaging software, in this case Photoshop CS2. Von Dormolen (2013:e-mail) suggested to use the eyes as an extra quality check by looking at any image at 100% magnification and to focus on small black lines. If there are any colour lines next to the black lines there is a significant colour misregistration. The areas close to the corners must be checked first.

In this example the Epson scan (left) and the Nikon scan (right) are compared and the Epson scanner showed misregistration vertically. A number of pixels with a blue colour at the top and with red at the bottom, are clearly visible whereas the Nikon does not show any colour misregistration visible with the naked eye.

4.3.3.4 Choice of material and equipment for scanning.

Often during the digitisation process of collections the staff may be confronted with more than one format of the same item. For example, there may be a choice of scanning the photographic print or the original negative. Before a final decision is taken a proper inspection of the material must be done. Not only should the quality of both items be considered, but the equipment available as well. In the case presented here as an example, a 102mm x 127mm size negative and a photographic print of 165mm x 210mm was submitted for digitisation. The area of the image to be compared for quality is indicated by the rectangle at A.

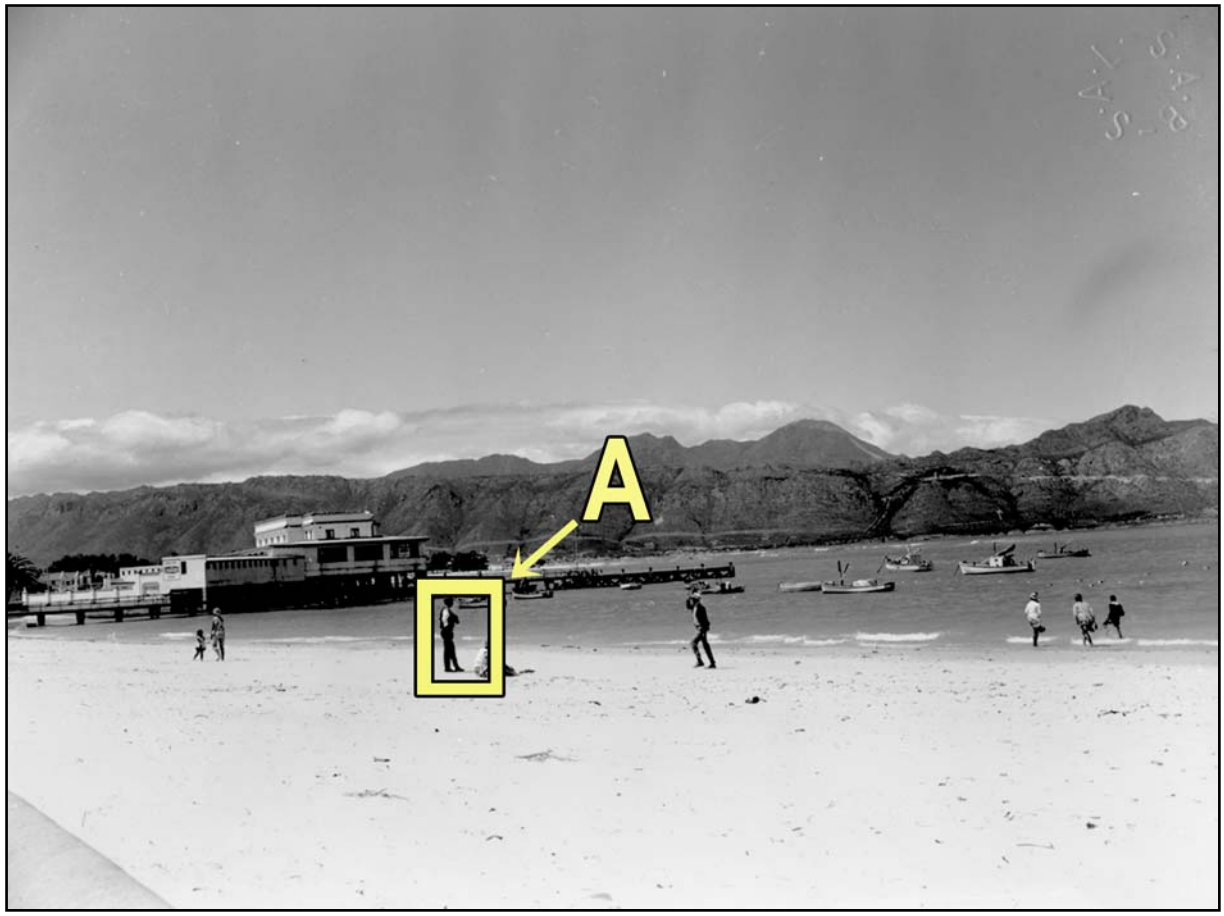


Figure 4.55 Outline of area to be tested for quality. (Photo courtesy NLSA).

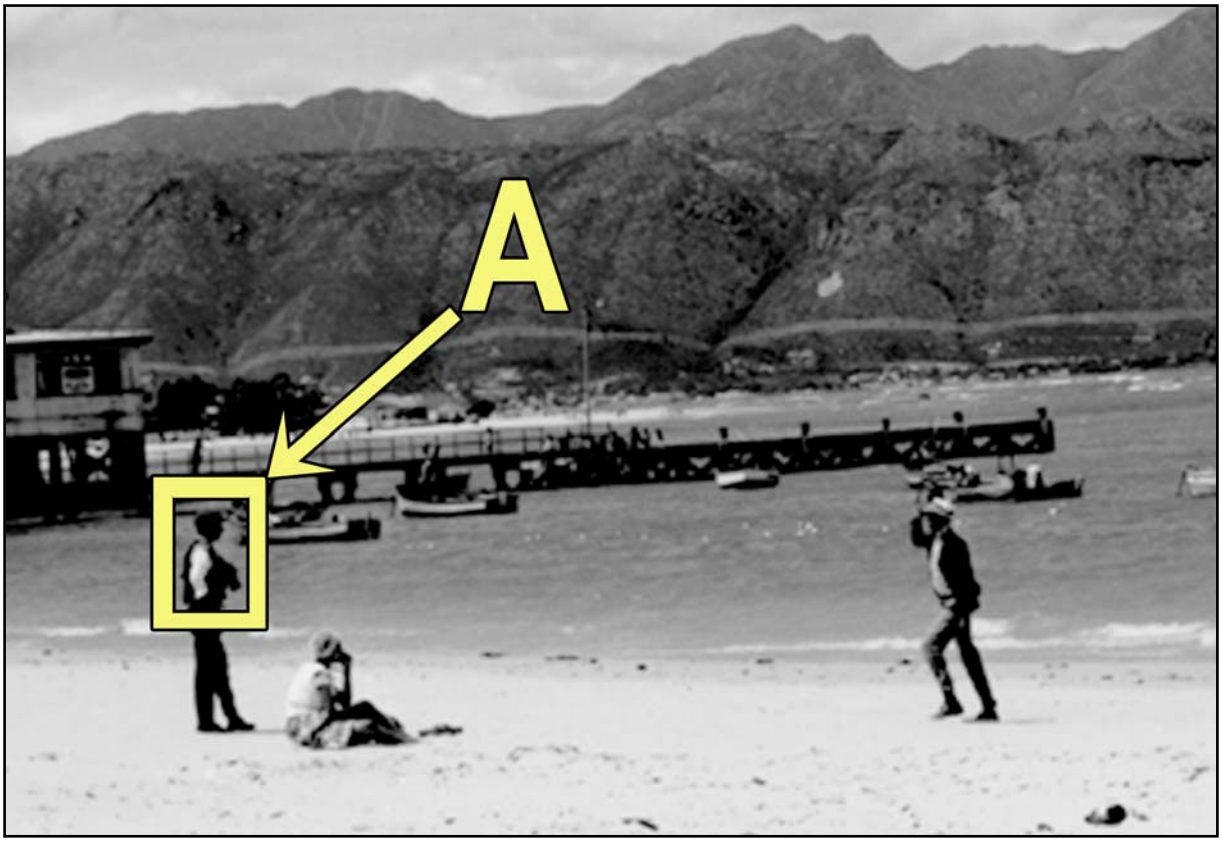


Figure 4.56 Enlarged section of area to be tested for quality. (Photo courtesy NLSA).

It was decided to scan both items to establish visually which one is the best candidate for the final scan choice, taken into account the available equipment. The photographic print was scanned on the Epson 10000XL scanner as well as the large format Zeutschel OS 14000 scanner. (See Figure. 4.37 and Figure 4.38 for SFR quality) The negative was scanned with the Epson V700 transmission scanner. The results of these scans are shown in Figure 4.57.

The test scan was created at 600 dpi in grayscale on all three scanners to be able to visually compare the image quality.

Figure 4.57 Comparison of three scans. (Photo courtesy NLSA).

Figure 4.57 represents the three scans which are scanned. From left to right the scan with: Zeutschel OS 14000 large format scanner, Epson 10000XL and the negative scan with a Epson scanner.

Visually there is a significant improvement in sharpness, tonal reproduction and background detail in the scan done with the Epson V700 compared to the flatbed scanners. The quality is in line with what can be expected when comparing the QA-62 reflection test chart and the ISA Microfilm Preservation Target of the scanners.

4.4 Concluding overview

4.4.1 Literature findings.

When addressing the primary question by means of the literature study, it was found that enough information for the successful digitisation of projects in South Africa is available to the collection managers to make well-informed decisions. However, they did not make use of all the available professional resources to guide them in the process of proper planning according to best practices. For example, the DISA project provided much needed information for institutions in South Africa although it could have been updated to remain current, yet these guidelines were not used by any of the institutions surveyed. It is not clear why institutions were unaware of existing guidelines, but the lack of networking, training and too much emphasis on non-professional guidance may have been contributing factors.

4.4.2 Institutions survey.

Although the policy issues were excluded from the study, it was often needed to consult the policy of an institution as these documents may include a section on the recommended standards although it was not a common practice to do so. None of the institutions surveyed have a digitising policy in place. Projects are done without proper planning which effect digitising standards, long-term preservation strategies, access to the digital material and copyright.

In the case of Stellenbosch University, the digitised material were made accessible by means of an online catalogue and an order service (van Bart:2009:16). The service was stopped after a copyright issue arose. A proper policy for the project may have prevented such a situation.

From the institutions questionnaire it is with one exception, difficult to establish an accurate number for the sizes of the photographic collections. This makes it difficult to calculate costs for digitising projects. The finding is in line with the report by the NRF compiled by Page-Shipp (2011:3):

> "There was also some duplication of collections where reports included all the aggregated collections on a particular topic (e.g. rock art), some of which had also been reported individually".

The lack of a digitising policy in the case of Iziko Museums of South Africa resulted in images being given away to people in London and to Africa Media Online who are selling images via the internet. They are also aware of vendors who are retaining image files on their computers. A policy would contain legal information about the transfer of files to the owner after the completion of a digitising project to prevent unauthorised use of images. A policy would also contain specific structure and procedures, which will prevent digital files from being scattered on different computers within the organisation, which is the case at present at the Iziko Museums of South Africa. The problem of lost material and security of collections associated with the lack of a policy was also emphasised by the Cape Town City Council and the Simonstown and Fish Hoek museums.

Although 87.5% (Figure 4.2) of respondents indicated that the digitising of collections is for access and preservation, none of the institutions have a proper IT structure with a dedicated archive server for the purpose of long-term preservation in place. For example, The National Library of South Africa which should be the foremost institution setting an example for South Africa, are using external hard disc drives for day-to-day digitising work while additional hard drive discs are transported to Pretoria head office for backup purposes.

Only two institutions did research into long-term digital preservation with regard to the file type issue. There was a general lack of knowledge in this area, probably due to the use of "non-professional" service providers or bureaus.

The view on file life expectancy from institutions is a very low five to ten years and 62.5% of the respondents indicated that they do not know. This may be a contributing factor why none of the institutions have proper archiving and backup servers.

4.4.3 Students survey.

It would be expected that students at professional training institutions would be better guided to understand the importance of digital preservation, but the questionnaires reflect a different situation. Students have the view that the Raw files (unprocessed digital image files containing only sensor data) are the best to use for long-term preservation. As each Raw type of file needs its own converter for a specific camera, it is unlikely that the progress in technology will keep the converter type active for more than 10 years. This view is supported by Barnett (Peres, 2007:402).

Students understand preservation (Question 1) only as the safekeeping or backup of files and do not consider the depending factors of preservation for example software and hardware support to enable a person to open and edit a file if needed. Notwithstanding the response on this question, 85% of respondents consider preservation as very important (Figure 4.18). However, it is also believed by 58% of the respondents that the file format they are currently using will not always be accessible in the future (Figure 4.20).

85% of respondents did not study the possible factors that would prevent file obsolescence and inaccessibility in the future (Figure .4.21). Expected lifetime of files is 5 to 10 years with 24% of respondents while 21% of respondents were "not sure" (Figure 4.23).

4.4.4 PSSA survey.

The response by respondents to Question 2 varied considerably. An informed view was reported as "that the media and file format remain readable for ever". Another response emphasised that:

> "three quarters of club photographers do not have a clue what you are talking about, or why its important. Its professional's issue, not a hobbyist's one".

This statement reinforces the vulnerability of digital images especially the only copies of personal family images on social media for example Facebook, Flickr and others. The importance of family images was emphasised in Chapter 1.

"All we took were the photographs" (Eismann, 2001:1).

Nevertheless 87% of respondents consider the preservation of digital files as very important (Figure 4.25).

Opposite views on the issue of file format and accessibility in future was reported by PSSA members and photography students. 54% of PSSA respondents indicate that file formats will always be accessible in future, whereas 58% photography students did not agree.

Responses from PSSA members (88%) and Students (85%) were very similar that they did not do a study of the factors that will prevent future access of files.

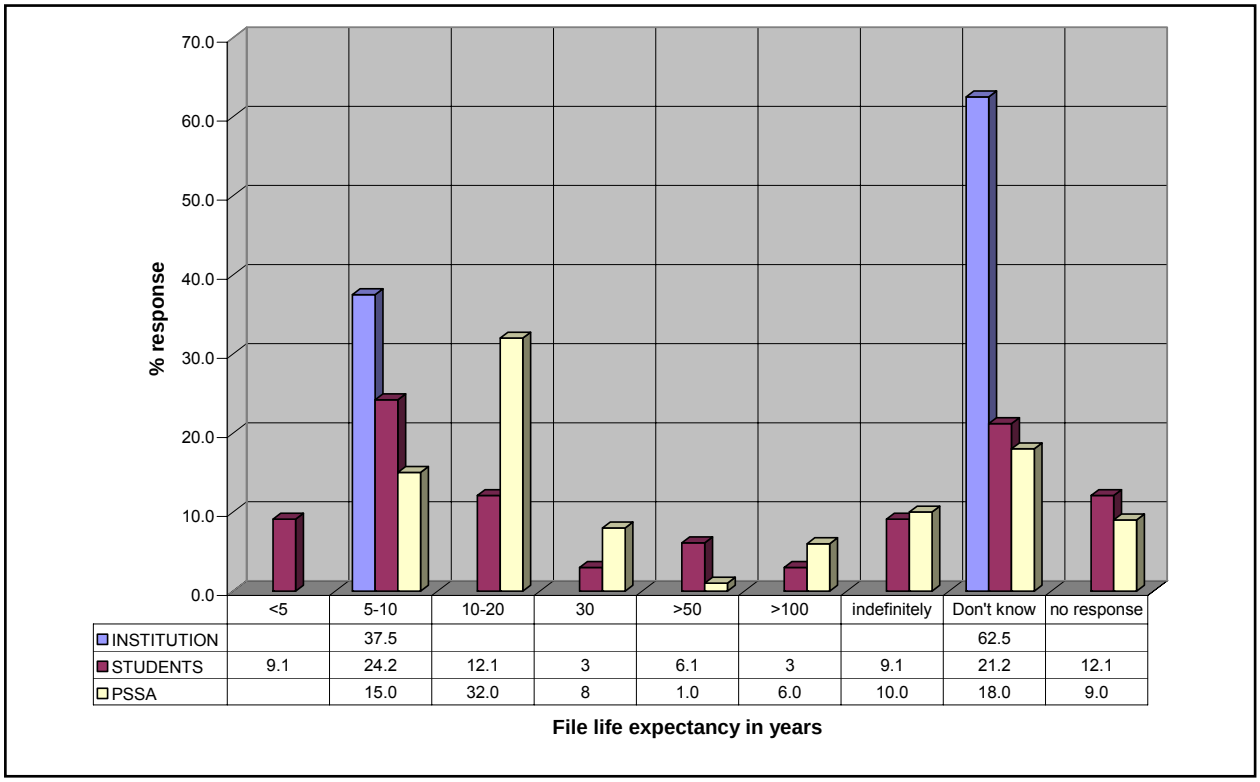
The response to Question 9 to establish whether any sources of information were

consulted to learn about the factors that will prevent future access to files, confirmed that no scientific papers nor any published work were consulted - only popular sources like monthly magazines and the internet. One significant response worth noting is the following:

> "Did not even know there was a possibility that I might not have access to files in the future!! Quite a scary thought".

This needs to be seen against a background of an average photographic experience of 7.5 years calculated from Question 1.

In order to conclude the survey questionnaires an important aspect to consider about digital files is the perception of life expectancy. In Figure 4.58 a comparison is graphically represented of the highest percentages of the various survey groups.



	<5	5-10	10-20	30	>50	>100	indefinitely	Don't know	no response
INSTITUTION		37.5						62.5	
STUDENTS	9.1	24.2	12.1	3	6.1	3	9.1	21.2	12.1
PSSA		15.0	32.0	8	1.0	6.0	10.0	18.0	9.0

Figure 4.58 Overview of digital file life expectancy by all participants.

Of special note is the high percentage of respondents who indicated a 'don't know' of which the highest percentage of 62.5% represents the collection institutions. This is a good indication of the lack of knowledge and research about the lifespan of a digital file at the institutions for whom life expectancy is crucial for long-term preservation as collections are relying on file longevity for future access and use.

4.4.5 Evaluating scanners.

The use of targets to calibrate and evaluate digitising equipment is an accurate method to assess their performance and should become a standard procedure for institutions to use. This will ensure that digitised material complies with accepted international standards. The result will be a collection of high quality digital material suitable for long-term preservation.

In the case of institutions with severe budget constraints and lack of staff, it may be argued that the use of targets may be too expensive or unnecessary to use while on the other hand it could be argued that with the knowledge and understanding of targets, better decisions can be made to ensure consistent high quality digital material. The success of a digitisation project is partially dependant on an understanding of key issues of the digitisation process by management. Don Williams (Williams, 2014:email) recommended convincing management to consider the cost of a high-end large format scanner in comparison with the cost of appropriate software to verify the results and to be sure that they get what they had paid for. It is rather a small percentage considering target set costs of R34 500, comparing to the R1 600 000 estimated cost of a high-end large format scanner which translates to about 2% of the total cost. Usually management has no problem investing a huge amount of money on equipment but they

are not often prepared to invest in the purchasing of appropriate software for quality management, control and calibration.

The fact that no institution in South Africa could be found that uses targets as part of their workflow; underlines the lack of proper working procedures and standards. By using targets to evaluate digital scanners as part of this study, they prove to be a reliable instrument to provide an accurate report on the performance of the equipment as well as the delivered quality level.

Targets are not restricted to scanners only. Institutions that are using other digital capturing devices like cameras should also use targets to test and evaluate their digital systems although this was not part of the present study.

CHAPTER 5
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The purpose of the study, as stated in chapter 1, was to determine the level of knowledge of collection managers in the Western Cape that completed digitisation projects or are in the process of digitising collections. An in depth knowledge of all aspects of the digitisation components is required to identify, prepare, digitise and backup the image files and to ensure a high quality file in a format which has excellent longevity characteristics.

Overviews of the available literature provide case studies, research and recommendations of quality and standards as well as international digitisation policies. These publications can be used to expand expertise in South Africa, avoiding mistakes made by the early leaders in the field. It is up to collection managers to investigate available literature and to collaborate with similar institutions to maximize the efficiency of their digitisation departments.

In the Western Cape a number of digital collections are not up to an acceptable standard as indicated by the survey feedback. There are instances where the managers did not know what the required standards and recommendations are, leaving the collection vulnerable. The technical aspects of digitisation should get high priority and attention to detail is important. Aspects of the digitising procedure include proper post processing of files if needed and a practical workflow and should include the use of targets for quality assurance purposes. The time needed by staff to re-scan files that are not up to standard can be reduced by scanning and analysing the targets on a regular basis. Staff should also be trained how to evaluate target scans and the importance of

following the prescribed procedures to maintain the quality of their work.

Students in general do not yet grasp the importance of file longevity for their professional career. Ideally, they should see themselves as professionals in the field to give guidance to future practitioners and be able to train and educate their customers. The professional photographer's involvement in preservation for the future may become very important. A general misunderstanding of differences between data longevity and media longevity was evident from the questionnaires.

The results of the survey of PSSA members also indicate a lack of understanding and comprehension of a potential problem of the preservation of digital image files. Ideally more articles of research in this field should be published to create a greater awareness of the problem. In discussions about preservation at public forums the perception very often is that the service provider of software and hardware will care about the preservation problem and the assumption often is that the software developer will make provision for the future to ensure access to files and long-term longevity of files.

The results of the scanner tests provide an overview of the actual produced output quality by means of measurable outputs by using targets. There seems to be a trend with recent scanner manufactures that they will in future qualify their scanner quality by referring to standards such as Metamorfoze and FADGI as indicated for example by Zeutschel scanners. Once this is done it will allow users to compare quality of scanners directly to make informed decisions before investing in high-end expensive scanners.

5.2 Conclusions

By keeping in mind the vast number of variables in the field of digitisation, there clearly is a huge responsibility on the shoulders of managers of digitising projects. A case in point is the recent allocation of a substantial amount of money by the Western Cape Government for digitisation projects over the next three years at the Western Cape Archives (Mohamed, 2014). A large-scale digitisation effort needs to be clearly outlined and all aspects of the project should be taken in account. The type of material in the collection, the standards needed to produce files with high file longevity characteristics, the appropriate equipment needed; quality control and the IT infrastructure to ensure the safekeeping of the data are all very important factors to consider.

The failure to adopt generally available standards and the lack of independent research in South Africa on preservation issues is causing fragmentation between institutions that are often not willing to communicate with each other. The outcome of this lack of communication could easily become a financial burden because mistakes can be made repeatedly. In the South African context, a Digitising Standards Working Group (DSWG), similar to FADGI, could be beneficial to advise potential buyers at various libraries, museums, archives, universities, government and semi-government organisations. The group can furthermore set up achievable standards that will guide the various institutions that are often working in isolation.

Another obstacle at present is the absence of a national digitisation policy, which seems unable to get to the final stages of implementation by DAC. The process has been dragging on since the publication of the National Audit in 2011 (Page-Shipp,

2011:5). Many institutions expect DAC and the National Library of South Africa to be instrumental in the implementation of the policy.

A clear message from several experts locally and abroad is the emphasis on collaboration, guidance and training. The well attended conferences, seminars and workshops in South Africa over the past four years is a clear indication of the need for information and guidance in the field of digitisation. Appropriate technical training for staff is essential for the success of projects and should be an integral part of the financial planning.

Quality acceptance of large format scanners as supplied by vendors to potential customers should be questioned unless they can provide evidence by means of proof of target analysis. This is already being implemented in the USA (Williams: 2014:e-mail) and should also be considered as part of the delivery and installation process in South Africa.

By testing a number of scanners using the specified targets, it was clear that not all scanners perform equally well. The use of targets should therefore form part of daily routine work and should be implemented at all institutions to guarantee the required quality by means of measurable outputs.

An important aspect of the digitising process neglected at seminars, conferences and workshops is the importance of IT support and infrastructure for the collections. The final outcome of a digitisation project ends on a server. Although servers are becoming less expensive, the demand for increased capacity is continuously growing. Literature suggests that the more the data are being used, the more expensive the servers become (Palm, 2006:5). Proper archive servers involve more than one server and a

simple single server system cannot meet the demand for long-term preservation. It is generally found that collection institutions are not alert enough of the dangers of inappropriate provision for servers. It may be appropriate to ask the question: if enough consideration is given to this issue.

Comparing traditional preservation recommendations for photographic material which include the use of archival wrapping material for storage of collections and a well-controlled climate environment, to modern day need of servers for the same type of storage in electronic format, is digital long-term preservation more affordable given the complexities of long-term preservation? If lack of finances in the past to maintain traditional air conditioners for climate control was problematic, will future financial provision be enough to ensure the maintenance of servers and file migration processes with associated complexities while budget cuts occur year after year?

The digitising process is in essence a photographic process. The only difference between traditional photography and digital is the recording medium which is now electronic whereas traditionally it was film. However the basic principles remain the same. The camera (which can also be a scanner), exposure, the use of light, the use of different types of lenses, issues with depth of field and aspects of copying artefacts, are all aspects in common with traditional photography.

The same principles apply to post processing or image editing of files. Actions such as image cropping, dodging and burning, colour correction and colour balance are similar actions compared to traditional colour printing in a darkroom. When selecting staff to fill vacancies for digitising departments, candidates with good photographic and computer experience may be highly beneficial to the organisation. Higher daily

productivity and ease of training for more complex digitising tasks will be some of the benefits when selecting these candidates.

5.3 Recommendations for future research

There are still a number of issues to investigate in the South African context. These issues may provide a basis for future research:

- The feasibility of the application of the Metamorfoze standards at institutions in South Africa.
- The actual quality of large format overhead scanners comparing to required standards set by Metamorfoze and FADGI.
- The use of a medium format digital camera to capture images such as 4"x5" and larger format glassplate negatives and paintings due to the high noise levels of the large format scanners experienced.
- The use of improved software to analyse target scans and to measure and evaluate more parameters including noise, colour accuracy, white balance error, illuminance Non-uniformity and colour encoding error.
- An objective study concerning the costs and non-monetary advantages of in-house digitisation.
- Testing quality of new technology, large format non-linear type scanners for example book2net Cobra scanners.

In closing

Although the field of digitisation in South Africa is not completely new, there still is a measure of uncertainty in areas of the digitisation process. The need for training is evident. Choices such as equipment, best practices, procedures for quality control and long-term preservation are areas that need proper attention for sustainable and successful long-term file storage for the future. This is echoed by Page-Ship (2011:4):

> "Where a large quantity of material has been assembled, from within or across institutions, consideration should be given to driving the production of digitised images as a factory-type operation, with attention to appropriate staff skills, production targeting and quality control".

The final outcome of any large scale digitisation project is the preservation of the image files for future access and use. The importance of financial responsibility to secure the files cannot be underestimated.

There seems to be no consensus or guarantee for digital file longevity in the literature, only recommendations of what should be done. The immediate past history of digital data is too short to predict accurate long-term properties of media and file formats being used for the safekeeping of data. Keeping the uncertainty in mind, Alvin Toffler (Toffler, 1970:390) cites Ralph Lapp, who reminds us of the train without driver:

> "We are aboard a train which is gathering speed, racing down a track on which there are an unknown number of switches leading to unknown destinations. No single scientist is in the engine cab and there may be demons at the switch. Most of society is in the caboose looking backwards".

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BIOGRAPHICAL SKETCH

Andries Theunis Carstens was born in Groot Drakenstein, Western Cape, in 1953. He attended Pierre Simond primary school in Simondium. During the primary school years, he was given a Voiglander folding camera. After exposing and developing a 120-format film, with very little success on correct exposure, and with his mother complaining that he was making too many adjustments on the camera, he gave it up and took the camera apart in pieces. High school education started in 1967 at Paarl Boys' High where his interest in photography was renewed when he was given a small Agfa Rapid 100 camera. In the same year his science teacher, Mr Jimmy de Jongh, started a photographic club at school, which he immediately joined.

After high school in 1971, he started as an apprentice at the former Nasionale Handels Drukkery in Cape Town which was responsible for printing weekly magazines such as Sarie, Landbouweekblad and Huisgenoot. Unfortunately he was not given the opportunity to be directly involved in photography and decided to resign to take up a technical assistant post at the former Department of Agricultural Technical Services on the research farm Bien Donne, close to Groot Drakenstein. Shortly before he left for military training in June 1972, he was transferred to a different section of the Department namely the Fruit and Fruit Technology Research Institute (FFTRI) at Stellenbosch to fill a vacancy as a darkroom assistant.

During his military training he was selected for the South African Air Force and underwent the 6 weeks photographic training course for darkroom assistants. On completion of his military training at the Flight Training School, Langebaanweg Air Force Base, he continued in his position at the Fruit and Fruit Technology Research Institute

with his main tasks being technical, scientific and research photography. By 1980, he had been promoted to Senior Photographer.

In 1980 he joined the photographic section of the Bureau for University and Continuing Education at the University of Stellenbosch as photographer in the Audiovisual section, later becoming head of the section - a post which he occupied until 1998.

In January 1998 the Bureau was restructured with the result that the photographic section was permanently closed. For a subsequent period of 11 years he specialised in aerial photography mainly used for survey purposes as he also holds a private pilot's license.

The move to digital photography raised many questions about data longevity and preservation and he started carrying out research in this field.

In 2008 he was appointed as head of the Reprographic and Digital Services Section at the National Library of South Africa, Cape Town campus. This appointment opened the doors to continue and finish the research which he began earlier, and which is relevant to his current work environment.

In his private time he likes to spend time on abstract and conceptual photography. He is a Fellow of the Photographic Society of South Africa, and has been an Associate of the Royal Photographic Society since 1980. Apart from photography he is still active as a private pilot with a little over 2,020 hours in command.

APPENDIX A

A.1. Questionnaire for institutions

QUESTIONNAIRE FOR INSTITUTIONS ON THE SCANNING OF PHOTOGRAPHIC NEGATIVES AND PRINTS AND PRESERVATION ISSUES OF DIGITAL IMAGE FILES.

Name of institution: _____

Town: _____

Contact person: _____

Position / title (eg. Head , assistant, technical officer): _____

Tel number:_____Fax number: _____

Physical address:_____

Postal address: _____

Date of interview: _____

Person interviewed: _____

NOTES

_____

_____

_____

_____

_____

_____

1 How many photographic **prints** do you have in your collection?

2 How many photographic **negatives** do you have in your collection?

3 How many photographic **slides** do you have in your collection?

4 Do you have a current digitising policy in your organisation?

5 What is the purpose of digitising your collections: (1) Preservation (2) public access to material (3) both of the beforementioned?

6 In what year did you start your scanning project?

7 In what year did you stop or finished your scanning project?

8 Do you outsource your scanning of photographic prints and / or negatives?

(A) IF NO:

A1 How many photographic **prints** have you digitised at this stage?

A2 How many photographic **negatives** have you digitised at this time?

A3 How many photographic **slides** have you digitised at this time?

A4 What type of scanner do you use for the material?

A5 Do you have a standardised published digitisation workflow which you follow when scanning material?

A6 What resolution in Dots Per Inch (DPI) do you use for **actual scanning**?

A7 What resolution in Dots Per Inch (DPI) do you use for **archiving the digital** files?

A8 Did you do research of file format characteristics of each file type, before making a decision as to which format to use for archiving to ensure file longevity?

A9 What file format (for example, TIFF, JPG, PSD, PDF, DNG etc.) do you use for your final digital file to archive?

A10 Do you use file compression during the process of file saving?

A11 If yes: Why do you use compression techniques?

A12 If you do use compression, on what information do you base your decision?

A13 Where did you get your advice from for decisions about file formats and compression techniques?

(B) IF YES:

B1 Do you feel the scanning service company or professional advisor has enough knowledge based on scientific proof, to give you the best possible advice on the archiving and preservation issues?

B2 IF YES for question B1 state briefly why?

B3 IF NO for question B1 state briefly why

B4 How many photographic **prints** have you digitised at this stage?

B5 How many photographic **negatives** have you digitised at this time?

B6 How many photographic **slides** have you digitised at this time?

B7 Do you re-process or reformat the files coming from your scanning service company?

B8 What resolution in Dots Per Inch do you use for archiving the digital files?

B9 What file format do you use for your final digital file to archive?

B10 Do you use file compression during the process of file saving?

B11 If yes: Why do you use compression techniques?

B12 If you do use compression, on what information do you base your decision?

B13 Are you satisfied with the quality and service of the scanning service company?

B14 IF NO: state briefly why?

9 Do you **archive** files in RGB or Grayscale mode?

10 Do you assign a colour profile during your scanning process?

11 Do you assign a colour profile to your file before saving for archival purposes?

12 Which image processing software do you use mostly?

13 What is the life expectency of your digital files in years?

14 Which medium do you use for storage for example: HDD, CD, DVD etc?

15 Do you destroy your originals once digitisation is complete?

APPENDIX B

B.1. Student questionnaire

STUDENT QUESTIONNAIRE 2013

INSTRUCTIONS BEFORE YOU START COMPLETING THE QUESTIONNAIRE

(The purpose of the questionnaire is to establish your perception about long term preservation of digital image files. There is no right or wrong answer, just what your opinion is about this issue and how important is digital data preservation for you.)

---

1 There are only 13 questions.

2 Please circle your choice in the case of a YES / NO response.

3 If any other response needed, please use the space provided.

4 Please be as honest as possible with your responses.

THANK YOU!

1 What does the concept "digital image file preservation" mean to you?
Explain briefly:

_____

_____

_____

2 Rate your opinion about the importance of preservation and access of digital image files for future generations?
Mark your choice with an **X**

Very	Moderately	Not
. . .	. . .	. . .

3 Is it important to have unlimited access to your image files for years to come?

YES / NO

4 If your response is YES for the above question, can you briefly state the 2 most important reasons according to your judgment?

_____

_____

_____

5 Do you think that the file format you are using for storing images will always be accessible in the future?

YES / NO

6 If your response is NO to the above, what are your reason(s)

_____

_____

_____

7 Have you made a study of the factors that will prevent you from access your files in the future?

YES / NO

8 If your response is YES to above question, give briefly at least two sources.

_____

_____

9 Did your lecturer discuss the importance of file formats with you at the time of commencing your photography course?

YES / NO

10 What is the expected lifetime of the file format you are using presently to save your images?

Months [how many]_____

OR

Years [how many]_____

11 Which factors will determine the longevity of a file format? [Give two or three factors]

_____

_____

_____

12 Which file format do you use when exposing or capturing images in your camera?

(a) raw (b) jpg (c) tiff (d) other

If response is (d) "other" please indicate here:_____

13 Why do you save in this format indicated above?

_____

(If your response is based on your own research, please give a reference in your own words.)

_____

_____

_____

Thank you for your co-operation.

APPENDIX C

C.1. PSSA questionnaire

PSSA QUESTIONNAIRE 2013

(The purpose of the questionnaire is to determine your perception of preservation of digital image files, the file types you use and the expected life time of your files to enable you to open (access), view and edit them in the future. There is no right or wrong answer we need your experience over time to be shared with us in this questionnaire)

INSTRUCTIONS BEFORE YOU START COMPLETING THE QUESTIONNAIRE

1 The questionnaire consists of 14 questions.

2 This is an interactive pdf file which will allow you to fill in the applicable boxes. Where a YES or NO is needed for input it will allow you one of two options.

3 If any other response is needed, please use the space provided.

4 Please be as honest as possible with your responses.

5 On completion, please press the SUBMIT button which will automatically send the questionnaire to me via e-mail.

THANK YOU! Antenie Carstens *(FPSSA, ARPS)*

---

1 How many years are you practicing **digital** photography?

_____

2 What does the concept "digital image file preservation" mean to you? Explain briefly:

_____

_____

_____

3 How important is the preservation of digital image files for future generations? [Your opinion about the importance] Mark your choice with an **X**

Very	Moderately	Not
. . .	. . .	. . .

4 Is it important to have unlimited access to your image files for years to come?

YES / NO

5 If your response is YES for the above question, can you briefly state the 2 most important reasons according to your judgment?

_____

_____

_____

6 Do you think that the file format you are using for storing images will always be accessible in the future?

YES / NO

7 If your response is NO to the above, what are you reason(s)?

_____

_____

_____

8 Have you made a study of the factors that will prevent you from access of files in the future?

YES / NO

9 If your response is YES to above question, give briefly at least two sources.

_____

_____

10 What is the expected lifetime of the file format you are presently using to save your images?

Months [how many]_____

OR

Years [how many]_____

11 Which factors will determine the longevity of a file format? [Give two or three factors]

_____

_____

_____

12 Which file format do you use when exposing or capturing images in your camera?

(a) raw (b) jpg (c) tiff (d) other

If response is (d) "other" please indicate here:_____

13 Why do you save in this format indicated above?

_____

(If your response is based on your own research, please give a reference in your own words.)

_____

_____

_____

14 Any other comments.

_____

_____

_____

APPENDIX D

D.1. Individual responses on questions from student survey.

D.1.1 Question 1 What does the concept "digital image file preservation" mean to you? Explain briefly.

1 Archiving the digital files for future generations to observe and gain knowledge from us.

2 It's a way of saving or backing up your data, mostly images, in a digital format.

3 It means having access to previous digital images for future use. (Very ideal as a photographer).

4 Preservation means keeping things exactly how they were many years before. Keeping the digital file in good condition so that it can be used again.

5 It means that digital files such as jpg, RAW, TIFF images are to be kept in storage and backed up on various hard drives and computers so that they can be around for a very long time.

6 To me it means keeping a digital file and keeping the file alive and running, and the access of digital files.

7 Saving image files for future use or safe keeping.

8 The protection and the safe keeping of photographs in a digital format like on a computer.

9 To me it simply means to preserve the image to the best it can, by preventing any damage to the image.

10 Which file format you would like to view or save your image as.

11 The best way to keep digital files in the best possible condition for the longest time.

12 Images that are kept on some form of technological device such as a harddrive external that's format is such that it can still be used and opened as programme technology advances.

13 To have a back up of your work.

14 Keeping a certain file or image over a long period of time.

15 It means the saving and preserving of files for future use.

16 It means safely archiving digital file formats for as long as possible. Optimizing accesibility of digital image files.

17 It means that all visual representations collected digitally can be stored or looked after for a long period of time.

18 I think it means a lot, people will be able to preserve important info about/from the past and the upcoming future.

19 The entire foundation of archival preservation has changed in the digital age. A lot more files can be stored more securely and for longer than in previous years.

20 The long term storage, backup and control of raw, dng, jpeg, etc files.

21 To preserve files and data for future use.

22 Backing up image files that could serve a purpose later.

23 Keeping digital images backed up in their original RAW state.

24 Saving an image digitally for posterity.

25 Ensuring that digital images are accessable in the future.

26 To make at least 2 copies of important digital image files organise and save them in different locations which are physically far apart eg. Computer + disk + flash.

27 I think it means keeping you digital images safe in a file.

28 Preserving files by making backups of them onto something like a CD - a hard copy.

29 It means storing images digitally and preserving them on data bases.

30 Keeping your digital image safe - like archiving keep it from wear and tear??.

31 Back up your stuff.

D.1.2 Question 4. If your response is YES for the above question, can you briefly state the 2 most important reasons according to your judgment?

1 One can always have reference images of the past - It would be an ever growing portfolio.

2 Well as a photographer, who creates new images on a day basis. These images that I use to get future clients. It would be great to have unlimited access to them in the future. It can be used as a timeline to see my growth.

3 It is always good to see your improvement as a photographer and see your work as a motivation. These images were the images that got you going from the beginning.

4 So that you can go back to your files and either see how your work improved and so that you have proof it's your original work if anyone tries to copy it.

5 Firstly, you are the creator of the images. Secondly, if you were to copyright your work you would have every right to full access, If you ever wanted show future family generations.

6 Everything in years to come will be in digital format technology is moving forward into the digital era.

7 Firstly, you might want to use it again for an assignment/project. Secondly to show people in the future what the past looked like.

8 It is important for future generations to know what the previous generations did; where they came from so that they know exactly who the(y) are.

9 It is important because when I am older I would (want) to look and show case the type of images I have produced.

10 Some images add value and you would want to hold on to them as memories and could be used for evidence or any source case.

11 As reference and a timeline of how the world changed and secondly it is essential to have digital images preserved.

12 The longer the file last the more valuable it could be and keep a good image for ever.

13 Image history see how your work has progressed and secondly to keep a record, maybe you need to use them again.

14 To have access to your work, for incase it gets lost. To make new prints, maybe of better quality. To do work on your images, a image is never finished.

15 Each photograph has a meaning so one should be able to hold on to all them. If you need to find an old photograph again.

16 Foor looking back at images for ideas or what technical view or aspect you used at that certain time.

17 Firstly keeping an updated and compreshensive library of your images and secondly easy accesability.

18 Its important because we should be able to access information we have seen

and collected.

19 For building image files portfolios and better judgement of past and future work.

20 Stock imaging - if you need to source an old file for a composite or such - nostalgic purposes.

21 It is important for historical use and history also personal files may have sentimental value.

22 Inspiration from old work - location database.

23 Recording / Archival purposes and if you need to re-print + need access.

24 Firstly for reference and secondly for reprinting.

25 Photos are unique, if they are lost, they cannot be replaced. Secondly one should be able to freely access photos for referencing and learning from the past.

26 I because they might be worth a lot. Also its good to have not just the print but a copy to print more.

27 To have a collection of work you have produced. (for future exhibitions or job applications).

28 One can build up a visual portfolio with digitally stored images and one can always go back to digitally preserved images and rework it or add to it.

29 Today world technology we don't have physical hardcopies of albums - we have digital ones - so when you wanna look back need ???? Able to 2. If we can't find images years from now - history will be los (to preserve).

30 If space is irrelevant, then it is just useful to have for [a] reflection for future photography [2] as visible progression and or interest in the past work.

31 [1] So you can look at them [2] So that you can always access them.

D.1.3 Question 6. If your response is NO to the above, what are your reason(s).

1 Well if you ask someone years ago if they thought VHS would still be around or even film for that matter. They might be in some shock, If they had said yes. We live in a developing world with new technology everyday. So I am sure it wont.

2 Because it will be upgraded technology wise it will be wiped due to lack of maintenance.

3 Technology changes constantly.

4 As technology keeps evolving and people would find better ways to store the images as.

5 I do not know enough about file preservation.

6 Technology will always change.

7 Technology is getting more advanced by the day, therefore formats and technology changes.

8 The digital world is rapidly changing and new advances may call for change.

9 Because companies, elements etc. change and dissappear all the time, you can't predict the future, so things could end without your control.

10 Technology is progressing everyday. The file format that is weaker will "fall away".

11 I am sure that if these file formats where to be discontinued a conversion would be simple.

12 Technology changes superfast.

13 It is possible that software of certain formats will become incompatible as

companies die out.

14 As technology is always changing and formats change.

15 I do not know , with the way technology is ever changing we will find it might not be.

16 If not, they will make a converter.

D.1.4 Question 8. If your response is YES to above question, give briefly at least two sources.

1 Internet virusses, harddrive or computer crashing and files being deleted once a virus is detected.

2 Firstly my lecturer and secondly The web. University of West England, 2012, choosing formats, www.uwc.ac.uk.

D.1.5 Question 11. Which factors will determine the longevity of a file format? [Give two or three factors].

1 Corresponding software to open the formats, - back-up of the different files.

2 The amount of quality it holds as an file format, - The amount of colours in the format.

3 Flash drives & hard drives, if similar file formats are available for a less size.

4 New programs that back-up information, Internet back-up files or programs, technology improvements.

5 Number of file format usage.

6 Firstly technology and secondly movement from stills to motion.

7 Saving the images in many ways.

8 Backups on archives, dvd, hard drives.

9 Firstly the upgrading of computers eg. Apple / Windows and secondly new formatted cameras.

10 The advancement of technology and the lifespan of the person who owns the image.

11 Programme advances, software advances and technological advances.

12 New technology, new programs.

13 The file type and the file size.

14 File accessibility and file size.

15 How well you treat the device that stores your file format.

16 Best file quality.

17 Conversion , programmes.

18 The format itself, Quality of hard drive / backup device.

19 In which programmes it can be opened - what company hosts the format eg. Psd.

20 Software integration - being able to convert to a newer format.

21 If the world doesn't end.

22 Do not know.

23 Technology changes / advances and accidental (or otherwise) deletion.

24 When editing, save as TIFF before compressing to a copied PPEG file and copy images to CD-R (so you cant write over).

25 I do not know.

26 I do not know.

27 Whether I need them again. Whether other people may need them and if I like

the image for whatever reason.

28 Technological advancement.

D.1.6 Question 13 & 13A (13A where applicable). Why do you save in this format indicated above? (If your response is based on your own research, please give a reference in your own words.)

1 Use jpg for a quick reference viewing & RAW for a more critical viewing.

2 It doesn't compress the image like the jpg does giving me to work with. Well its based on what my lecturers have taught me - and through experience whilst shooting - RAWS are just like its name "RAW" compared to jpg.

3 RAW gives the best quality & jpg the most common use.

4 Because RAW is better for editing files and jpg is better for saving good quality images on a smaller scale. RAW files allow me as a photographer to do more with it because it'sRAW no camera processing has occurred. I am able to do more with the file than a jpg.

5 Jpeg for easy viewing and RAW for full image quality.

6 When capturing in RAW, detail cannot be loss it's a format one can work with.

7 It is best to edit from RAW because you get all the details that was not edited by the camera.

8 RAW - big file ; editing purposes / Jpeg - small, internet.

9 It saves all the data of the image and no compressions are made.

10 A is better to work with when editing, B is just used to view in my camera.

11 It’s the full resolution of the captured image. Having the RAW image is the untouched image.

12 Bigger so best to work with.

13 Keeps its size easy to use and edit.

14 Best quality.

15 A better quality, bigger size.

16 More detail, no pixels.

17 Allows for maximum storage of information.

18 It stores more information than a JPEG.

19 RAW is the best.

20 jpg is widely used - jpg is compact.

21 For the best resolution, quality, and editing after shooting.

22 Best quality and most easy to work with.

23 Use in Photoshop preserves editing.

24 When you shoot in RAW, RAW has the most information - it stores the most info.

25 It's most easily read by programs.

26 It is a large file - better quality on my camera. RAW files are saved as larger, higher quality than others on my camera.

27 Because we told to.

28 RAW containing a lot of data - high quality for editing. JPEGs once image has been edited & is ready to print.

29 It is easy to edit in Bridge & Photoshop without compressing the file and the file is big so its better quality.

30 Its most common and takes up less space.

31 Easy to work with, no conversion. Good for test shots - RAW better for final.

32 Quality & file size. It depends what I am using the images for afterwards.

APPENDIX E

E.1. Individual responses on questions from PSSA members.

E.1.1 Question 2. What does the concept "digital image file preservation" mean to you? Explain briefly.

1 It means three quarters of club photographers do not have a clue what you are talking about, or why its important. Its professional's issue, not a hobbyist's one.

2 I prefer it to the old medium ie slides & prints. More images can be stored in less space for a longer period without deterioration. Backups can be made of more than one picture to store in a safe place. Better than negatives.

3 A way to save my images.

4 Archiving the original and/or the work file and/or final image conversion for later retrieval without loss in data or quality.

5 That the media and file format remain readable for ever.

6 That image format continues to be readable by future software. That the storage media continues to be readable by future hardware. That storage media does not fade or degrade over time.

7 How long they can be preserved.

8 Storing a digital image in a protected environment (redundant copies) and in a non-proprietary format that cannot be altered and which preserves the original image and image information.

9 To file and conserve digital images (including digitally captured images of documents, illustrations, photos etc.) allowing for logical access to these files hosted on computer networks, internet and main-frames for this purpose.

10 Storing images for longer than casual use.

11 The ability to store image files for unlimited periods of time and to be able to retrieve the files and use them at some future date using current easily available software and hardware.

12 Preserving the file without possibility of degradation.

13 To preserve your files.

14 Retaining the image in its original AND worked format.

15 The filing of digital images, stored on disc, to be preserved for future use.

16 Storing these files in an organised, catalogued way on at least three different storage mediums. Example, PC, DVD/CD and a virtual online storage like Dropbox or Cloud.

17 File storage without losing them, or ability to read them in the future.

18 Saving, or retaining the digital image with the ability to access the file at a later stage with the quality of content remaining intact or not losing quality.

19 For Web access there need not be total file preservation. You should have your files backed up on your own system for editing purposes. The web master should decide how long the photos are on the web.

20 I cannot answer your question. I preserve most and appreciate the facility.

21 It is to save the images that you have photographed in a digital format for future viewing and editing on different storage devices e.g. computer hard drives, portable hard drives, CD's, DVD's, etc. It must be saved in such a format that you will be able to access it in future.

22 Keeping all images in format for future retrieval - the same way as photo albums.

23 I suppose it means the same as filing negatives in the previous years of doing

printed photography. I still refer back to my old negatives and most definately to some of the earlier pics I took digitally. Would like to preserve them for future use.

24 Backups of all my images.

25 Data storage.

26 Storage of digital images.

27 A safe method of saving and backing up images.

28 Keeping your photo in its original format on your computer.

29 Ensuring that all saved files are archived and available in the future. Other issues like tagging, naming, metadata should also be considered.

30 Saving of digital photo's. I make back-up in case my laptop get stolen on my external hard drive.

31` The storing and protection of digital file in order to preserve the integrity of the original file.

32 Safely storing electronic copies of image files.

33 It means for me the way that I "store" all my images.

34 Being able to save and access digital files on an external hard disk, computer, flash disk or any other new future invention, for at least 100 years. Also to be able to print or transfer these images without losing quality to any future invention.

35 Storing images etc for an extended period of time.

36 Keeping your digital files secure for extended periods of time.

37 To savely save files for future use including a proper backup system as well as

preservation of RAW images to revisit old shots as and when new technology becomes available.

E.1.2 Question 5. If your response is YES for the above question, can you briefly state the 2 most important reasons according to your judgment?

1 Why would I want limited access? Its MY files, i want them when I want them, where I want them? I do not want to limit myself on the access of my own files.

2 If needed, one can refer back to images taken long ago and access to such an external system could help if there are any failure on ones side with backups being lost.

3 For fast and easy access to my images.

4 Ease of access and immediate retrieval.

5 Its like a book if it's not on the shelf in view it will be forgotten.

6 I take pictures of events and people that are important to me and my family. It's my hobby. I collect images, I don't consume images.

7 History of family, relive my passion.

8 They are important both as a collective visual historical record and as a personal history of where we come from.

9 The deterioration of analog / organic documents including photos, Vinyl and magnetic sound is in need of digital conservation. Ultimately to conserve history.

10 To retrieve images for own historical records, memories etc, to see development of artistic capabilities.

11 Availability to future generations. It is difficult to decide now what will be

important and valuable to future generations.

12 Certain images are irreplaceable personal pride.

13 Unlimited access for ME only. This does not mean unlimited access for all.

14 History of image for personal archives. To work on "old" images made in the past for present use.

15 The ability to retrieve and view content and the ability to edit the content.

16 I am all for preserving history - important to do so. Future generations to benefit. Access to preserved archives provide info that could have been lost.

17 Editing and future use e.g. salons, family, etc.

18 The same way that photo albums are available at any time.

19 I am sure future generations would have some use for pics taken by me especially my own family (when I'm not here anymore). Who knows maybe I become famous!!

20 I would like to see images I have captured, as a reminder of happy times and beautiful places, someone else might find them useful.

21 Images are to be remembered, shared and enjoyed at any moment in time.

22 Babies and kids grow up, people die, images of them should last "forever".

23 To pass on information and to reuse when necessary.

24 Especially important for family photos and occasions for future generations, important if you have a specially good image to preserve and also for historical reasons.

25 Recall memories; see how far you have progressed.

26 This is no different to your photo albums in the old days...they are your

memories, these can be a reference to historic events, the preservation and access of which is invaluable.

27 To have access to images for aide memoire purposes, to have access to raw images for possible future reprocessing.

28 To be able to re-use images, even the RAW format with better, newer tools, because it is personal records.

29 Reliving places I've been to, people I knew, i.e. for sentimental reasons, and also preserving it for future generations. Also for editing, re-working, re-using photographs for future club and salon competitions.

30 For viewing at leisure, for future reference.

31 To preserve history, to be able to use old files.

32 My images represent captured memories as well as important personal creations.

33 Memories, art.

34 As technology changes one may be able to process files more effectively. RAW processors improve all the time.

35 These are records of life personal or professional for an artist.

36 Firstly I do Commercial Photography and might need some images of past assignments, secondly, I might want to retrieve old family photos for various reasons.

37 To use in my day to day family life. A record of the past and should be available on demand.

38 For later use in e.g. AV's.

39 Ongoing management of files re continued preservation or deletion at end of useful life. Access as and when needed.

40 Images represents memories, that cannot be replaced or recaptured, so preserving memories for future generations is of great importance. Accidents happen and clients can loose their photo's, to be able to replace the images lost will be priceless.

41 For educational purposes, preservation of history.

42 Photos represent memories of what you saw and experienced. It will help to support failing memories.

43 Photos are most probably the best form of preserving history as photos contain more detail than mere text. If you file your photos and you do not have unlimited access what is the use you cannot enjoy them when you want.

44 Memories, reference to the past for comparison.

45 Family photos for children as the grow older and all further future generations and for ourselves as we grow older and sit around in age and go back into our lives.

46 For family to refer to as well as images which might have historical or educational value.

47 If it is not easily accessible, why do you have to keep them in the first place.

48 Digital files replace photographic negatives and form an irretrievable record of history. Hence they become an important reference source for future generations. If access to them were limited, it would mean that access to the history of the past would be constrained.

49 The next generations have an interest in keeping "family history" pictures. Data/images can get lost for various reasons.

50 For future reference, for children.

51 Replaces the traditional family album and therefore needs to be available indefinitely. Various valuable records are stored on image files.

52 I often go back to my old images and need to have immediate access. It is also important to allow family members to have access to these images.

53 Way to build the history for the future generation, keeping memories.

54 Some photo's can not be re-captured, the history of ones photo's not replaceable.

55 I would want to use them at times even if years old for use in a project, nostalgia.

56 Keep memories, keep beautiful photos.

57 Reminder of past events; submission to camera club.

58 Personal Preference to have acess 24/7.

59 My photography is very important to me, not only personally but also for sharing and sometimes selling.

60 Easy to electronically transmit. Not affected by the natural elements.

61 Because I like to look at them and use them for different things.

62 You need to go back to your old images, if it is just to have a look at how your kids changed over time or a nice vacation the family had.

63 When submitting photos and the judges request the original photo you need to be able to submit it. If someone else maybe uses your photo then you have the

proof of the original photo.

64 For historical reasons - both for Family history, and for general humanity history.

65 Re-use old files for salon entries. Photos from tours abroad must not get lost.

66 For record keeping ie what have I entered and how was it processed. Newer techniques are evolving which can then be used to improve my images.

67 I like to make AV's and want all my files available.

E.1.3 Question 7. If your response is NO to the above, what are you reason(s)?

1 Technology are vastly improving and the size and format can change to better the images even if the size are reduced in another format.

2 Technology is evolving all the time. Old video formats are no longer available so could digital. Photoshop's RAW converter does not support older model cameras anymore.

3 Not even spreadsheets and documents are readable forever. Software changes as hardware improves and ensuring backward compatibility becomes too much of a constraint.

4 New technology on the horizon.

5 Technology develops so rapidly and market forces predominate. If market demand for a file type declines and another becomes dominant a file type could be dropped. However some file types may be more long lasting than others (jpeg tiff dng for example).

6 Preservation as I would like is apparently not possible, hopefully newer and more secure methods will be found even if software changes occur.

7 With the constant "marching forward" of technology, discs might be replaced.

Floppy - Stiffy - CD - ? Hardly any more floppy or stiffy drives available.

8 Technology development. We will have to update our old image files into new formats as new technology advances.

9 Depends on the changes in computer technology.

10 People change things to sell new stuff and make money. It will be such a shame if this would be the reason for losing important history.

11 File formats mature and evolve.

12 I had my first computer 29 years ago... no hard drive... only "floppy" drive... whats after hard drives?

13 Because the technology changes too quickly.

14 Changes occur very fast in the computer world and old stuff becomes completely outdated.

15 The way the technology is changing and these newer and more efficient ways of capturing images, as well as the networks and PC's rapid development, there is a strong chance that this format will change, and accessibility along with it.

16 The RAW files are proprietary and may have to be converted to a DNG format at some stage. The TIFF files should be accessible in future.

17 Technology is consistently changing. Stiffy and Floppy disks are no longer available.

18 Whilst I think that technology will change so that current file types and digital storage formats will become outdated and eventually redundant, I do think that conversion mechanisms will be created to transform existing files into the newer formats (in the same way that video can be converted to digital recording).

19 Storage methods without saying will always improve, that is not the problem. Software is also forever changing and old programs that we use to use do not work with some of the latest operating systems.

20 If the camera company goes out of business, or the software companies stop offering support, one may not be able to open the files. One could always convert files to a open source platform - DNG, tiff ? But who knows what will be in 50-100 years.

21 Because the technology changes all the time and programs also; company are not always making the effort to be back-compatible.

22 There will most probably be better file formats developed in future.

23 Technology changes too fast.

24 Technology advances and changes at amazing speed.

25 The pace at which technology develops and changes has sinister implications for accessibility to stored material. For example, valuable images were stored on the Sony Betamax recorders of the 1980's. Today one cannot get a Betamax recorder to access the material.

26 Obsolescence.

27 Technology is developing so rapidly that current systems and file formats may become obsolete.

28 Camera RAW formats change with time and no doubt jpeg format will be superseded.

29 Technology changes. Can you still access Floppys or stiffies. Can you still without huge evert access VHS or Bets videos?

30 Tech progress.

31 Technology changes and the fle format today will not be the future.

32 Digital media is not very trustworthy and can fail.

33 I'm not sure, things change.

34 As technology advances, so will the type of image file. Files will need to be converted to what ever the new technology brings.

35 A good example of this is what has happened in music (record->tape->CD->Audio file (and there are a myriad of those)).

36 Programmers always seem to find a way to do things "better". An example is the obsolete DOS-system which served me very well.

37 The present standards appear to be constant but the future could easily change this.

E.1.4 Question 9. If your response is YES to above question, give briefly at least two sources.

1 Future-proofing of file formats being one. no one can access floppy disks or Betmax tapes anymore, formatting has become obsolete. There is no guarantee that the most advanced file formats today will be relevant tomorrow. However, one has to trust that something like a RAW, DNG or TIF file will be "future proofed", either as a standard "in perpetuity" or as a format that can easily be "up-sampled" to whatever future formats will bring. Secondly, data loss. Cloud storage in my opinion is risky as a primary storage. One DoS attack on cloud storage and all access of files *poff gone*.

2 Adobe DNG and .jpg are here to stay until digital photography is superseded by

another technology. And Adobe Inc stays in business, and not put their head in the sand like Kodak, and think film is forever !

3 Wired magazine - Various internet sources, e.g., dpreview, pcmag

4 Popular Mechanics - discussions with clever IT people.

5 Internet and subject matter experts in software design.

6 Did not even know there was a possibility that I might not have access to files in the future!! Quite a scary thought.

7 Passed experience.

8 The internet was used.

9 My earliest storage was based on CD's, but that was later discarded in favour of HDD. When USB HDD's become obsolete, it will probably be necessary to move the files to another medium.

10 No, but I am storing everything in a digital negative format (DNG).

11 Internet and own experience.

12 Having the correct conversion software

13 Having the correct hardware to view the new file types Screens & Printers.

14 I can only HOPE the JPEG-format will last for some time to come.

15 Variety of sources. Main points to consider is the digital readability of your source files. Proprietary formats can become an issue. Second point is possible deterioration of storage media.

E.1.5 Question 11. Which factors will determine the longevity of a file format? [Give two or three factors].

1 Simplicity, compatibility, cross-platform integration.

2 The use of it on software, availability of software.

3 Hard drives can last forever if looked after.

4 Popularity of use, cheaper alternative.

5 Stability of the storage medium and availability of suitable display software.

6 Open source specifications, broad acceptance by software writers, broad acceptance by camera makers.

7 How to access them, the quality they are stored on.

8 The format will remain unchanged as long as it continues to satisfy the technical requirements of the camera / display appliance. New programs will most likely be backward compatible with current image file formats.

9 This will probably be a piggy back of technologies which is already active for this purpose - magnetic to lasar - to solid state - to whatever is next.

10 Changes in software used to read the data.

11 Market demand and popularity (e.g. Cloud technology), availability of software and hardware.

12 Availibility of software and lifespan of hardware.

13 The quality of the storage device or format.

14 General use thereof.

15 If it easily accessible and affordable. New technology to always include, and not replace, e.g. discs. The quality of the discs to be used.

16 Common use, file size - for sharing, performance of format.

17 The software available to read present formats. Present computer technology that update, advance and change.

18 Life span of the hard drive, changing software.

19 Computer technology, camera technologies (these change more often).

20 I do not know.

21 Technology advancement, type of format used and type of software used.

22 Change in software/hardware.

23 I have no idea - haven't given this any thought - assumed it would always be available.

24 Advances in software technology, new types of file format will render current types obsolete.

25 Dont know.

26 Quality of the image... pixels etc.... In the old days each program had its own format.

27 Storage quality.

28 Changes and updates in computer language and more modern developments occurring constantly.

29 Open format, general usage.

30 I don't know. I am new at this. Only bought my camera in December 2012.

31 New developments, space saving on servers, need for energy conservation.

32 Computer operating systems may not support older software, future programmes may not support old formats, current programmes may become obsolete and worth replacing.

33 New Technology (Software and Hardware).

34 The availability of electricity. Being able to access it with current hardware.

35 Changing technology (e.g. 'stiffies' can no longer be used with modern PCs), advancing technology.

36 Solid state as opposed to disk drives, software.

37 Number of people using the format, ease of use.

38 I do not know.

39 The software supplier(s) of the viewers/editors make provision to access the "old" formats. Future hardware will be able to read current CD/DVD formats.

40 File Size, amount of data available in the given file size, software that makes use of that file format.

41 Flexability. Support. Company staying in business.

42 Advancement in technology and demand for older technology combined with the cost factor.

43 Don't know.

44 Continued appropriateness of the particular technology, the need to access even outdated formats for practical reasons.

45 The integrity of the storage device, outside factors like temperature or humidity?

46 Its being in use, the software and hardware in use at any time. Whether or not a better or more useful file format is developed.

47 File format i.e. RAW, etc. where you store it.

48 The usage, the ability to remain high quality, hardware speed or the file format's inclination to inhibit the system performance.

49 Technology changes, deterioration - eg. .jpg files, life of HDD.

50 Do not know.

51 Whether the software will be available and be able to read the file format.

52 Quality of the storage device.

53 Since I can remember jpeg has been available and doubt if it will ever disappear.

54 The rate of technological innovation. The number of people demanding access to current formats in future. The economic seduction enticing manufacturers to render existing technology obsolete because of greater rewards promised by new inventions.

55 Data degradation and system changes.

56 Rapid advance of new technology.

57 Old hard and software still being available and operational.

58 How much of it is in current use, how robust the current format is for long term use.

59 Number of users, better technology.

60 Technology (HW and SW), backup.

61 Not sure.

62 My own interest to convert my images to the latest technology. ie. Jpeg to whatever the industry is dictating.

63 If there is no progress and the format stays the same, if progress enable's one to convert to new format.

64 Popularity of a camera and its format and popularity of a primary software e.g. Adobe.

65 Popular format that is widely used, ease of use and editing options.

66 Industry Trends, manufacturing direction.

67 Care and demand.

68 Quality and accessibility.

69 Safe storage. Protected from harmful electromagnetic fields and the like.

70 I use an external hard drive, how does one know?

71 Your computer hard drive, your delete button.

72 Popularity, i.e. what is the most "endemic" and "embedded" out there.

73 File size and performance of operating system. Also the type of media, be it a hard drive, tape drive or Compact Disk.

74 New technology, market trends, camera and computer manufacture trends.

75 Proprietary format support. Efficiency of space utilization vs Quality of reproduction.

E.1.6 Question 13. Why do you save in this format indicated above?

(If your response is based on your own research, please give a reference in your own words.)

1 There is no reason at all to shoot JPG, unless you are a working sports photographer or photograph gramma's birthday. Any image worths keeping,is worth keeping in the best possible format. RAW gives you almost infinitely more options than JPG ever could. higher colour gamut, wider dynamic range, etc,etc. JPG is for people who either a) need to deliver a picture to a product quickly, such as sports and press photographers where quality of image does not matter or for b) hobbyists who do not really care about the technical quality of their images. If RAW is good enough for the best photographers in the world,

its good enough for me.

2 Depending on what I am taking pictures of. Jpeg for commercial ie. Weddings, Birthdays etc RAW for Commercial orders and private use, size of files for editing can become a problem if the harddrives are not large enough.

3 Both available om camera.

4 More options in post processing. Trained in the club to do that.

5 Its all the options I am offered.

6 CR2 is a proprietary format and I am concerned about Canon's track record of backward compatibility. They didn't write Windows 7 drivers for my 350D or linux drivers for my canon printer. Not sure cr2 will always be readable. Dng is open source so more likely to be supported.

7 Thats the way I was taught.

8 It preserves the original image and image information to a large extent and uses less capacity than either Tiff or DNG. EXIF can be manipulated though I have no interest in doing so beyond adding relevant information - keywords, location etc.

9 Optimum quality. This questionnaire (space) is hardly sufficient for such elaboration.

10 On PC, CD and external drive.

11 I don't. I save as a dng and an uncompressed jpeg. I have faith in Adobe Photoshop' commitment to the dng format. For archiving and to be on the safe side I save a copy as an uncompressed jpeg. No great research, It just seems to me that these offer dependable long term prospects. Tiff is also dependable

but the files are much larger.

12 Lossless file for possible reworking as I improve my post processing. Following recommendations of others.

13 Yes.

14 Those are the ones that I choose as departure point for editing. Personal preference.

15 To keep as much data as possible available.

16 Best value between file size and quality.

17 To capture as much detail to work with as possible in raw. And always having the original file for processing later.

18 Greater versatility in post production. It is a loss less file.

19 Maximum data for editing.

20 Best quality and user friendly.

21 With raw more detail can be retrieved when doing editing and jpg for sharing and limited to space. Internet and fellow photographers.

22 Raw in case I want to edit picture in future and jpeg for edited versions.

23 I work mostly in photoshop and will hopefully one day be able to work with the "raw" format as well. (Still getting the hang of it).

24 Better information from the file.

25 Better options for later.

26 They are International formats & accessibility for clients and family, friends etc.

27 For best quality. This format has been recommended by all experts.

28 Easiest and quickest.

29 It is an Open format.

30 It's the format my computer can read and I can still edit in RAW on PS.

31 Raw gives me a lot more options during editing and converting. This was based on much of the readings of photo magazines and internet teachings, photoshop tutorials etc.

32 Because it is equivalent to a hard negative. I use the camera's raw format. I do not (yet) use DNG because in my experience the DNG standard has changed too many times. Files that I converted to DNG some years ago cannot be read by some later programmes.

33 Because I believe it is a better format than the brand specific format and will always be supported by Adobe.

34 More info on the file.

35 I shoot in raw and save in jpg and tiff.

36 Most detail available for processing.

37 Preserve the most data. Read some books and thou shalt learn.

38 Convenience, relatively small file size when compared to RAW or tiff.

39 Best format for editing + some categories at photo competitions require that you have the RAW format available if the judges do require these.

40 This format captures the most information.

41 Gives me most flexibility in post processing, and allows me to throw away data I don't want rather than the camera compressing my file.

42 Supposed to be one of the best.

43 Because it gives me as photographer the most control on the image processing

afterwards. Memory space is not that expensive any more.

44 Easiest and most practical.

45 To preserve all the original data captured by the camera and Question 2. Contact with digital knowledgeable people. (IT Experts).

46 RAW for VIP images. Jpg for everyday pics, tiff for printing purposes.

47 I find it easier to publish the images on the net, and use the images.

48 It is best for storing the maximum information captured by the sensor. I have widely read up on the differences between raw and jpeg formats, and experimented with both formats on computer to study the differences between the resulting quality and pixilation when doing radical editing.

49 I believe that it is the best way known to me to save photos at the moment. Who knows what the future holds? This is what we are being told by expert photographers at the club meetings.

50 I heard that jpg deteriorates in quality every time you open it. There is definitely better ability to get detail out of shadows in raw. The ability to handle noise in raw is superior. Not research own experience. in jpg I get virtually no joy in decreasing noise or grain but I can improve it a lot in raw processing.

51 File contains the most data and does not deteriorate too fast. Jpg files do not survive.

52 I work in Photoshop and as understand that format is constant (unlike Jpg) that seems safe enough for the moment. I am not that well informed.

53 I was told that it is the best format to use.

54 It's what I shoot in.

55 jpeg quality is not always as accurate, although i rarely edit my images, the odd occasions will be better to edit in raw or tiff.

56 Because the amount of information captured and stored is significantly more extensive than in other formats and allows for greater latitudes in the processing functions of the images. I used to shoot in Jpeg and RAW but realised that I was wasting 16% of capacity because all the information I wanted was in the RAW image.

57 I am a casual photographer and see no need to do more.

58 To preserve the full data in the original raw file and in PSD to preserve the changes I have made in Photoshop, should I wish to do further work on the image at a later stage. DVD as a further backup.

59 Standard procedure.

60 Ability to modify in future.

61 Retains maximum detail.

62 Give better editing functions.

63 To maintain the original image as an original back up and source.

64 Jpeg to save disk space and have quick access to view. Raw for quality of images.

65 It is what I started with.

66 Pure data capture which can be manipulated.

67 More data in image. More data to use when editing photos.

68 That is the only format my camera allows. Camera club recommends raw format though, which is supposed to store a lot more image information, but I do

not have any experience with raw (yet). I have not done my own research on the subject.

69 Keeping original unedited version in CR2 format and the edited copy in TIFF format.

70 I assume that the deterioration of the files is minimal. Just general reading.

71 Most information for processing.

72 Jpg mostly used as it is the default system.

73 That's what I know.

74 It is easiest to use.

75 Then I have more opportunities in what why I want to compile my images and for better printing quality as well as better format.

76 Can be used, viewed, and altered in a wide variety of hardware & software, and output devices (e.g.printers). My own experience.

77 I chose it "on-camera" because it saves space (compressed). RAW files are too large. I only have the 2 choices on my camera.

78 Raw gives me all the information to work with and tiff keeps this info plus my editing available. Jpeg to transfer. From training courses attended.

79 The least possible loss of captured data vs stored data.

E.1.7 Question 14. Any other comments.

1 I'm interested as to WHY this line of questions in a survey - I think theres a lot of other things that could have been asked on a club-level survey. I think this entire thing is probably above the knowledge-level of half of club members, whom I monthly have to explain the difference between RAW and JPG to.

2	We have already completed one questionnaire this is the 2nd, please can we see the results, if you can take the trouble to devise and send them out surely to those that reply you could show the results/conclusions. Thank you.
3	I save images on external hard drive because optical media fade over time.
4	Another issue is the durability of archiving hardware. External hard drives are hardly 100% reliable. I store files on the best quality hard drive I can buy and copy to a DVD once per year. I keep the hard drives in my safe and connect them only when I am archiving.
5	The file size should keep up with the times the old 1027x768 is not being used in a lot of over sea's salons.
6	The reason for this survey is unclear. Why, for who, by who, statistical functionality, availability to all?
7	Possible communication about future changes.
8	This is a very thought inspiring questionnaire! I am now aware of factors that I have not considered before, and would definitely like to know more.
9	On the computer I save the files as DNG and then into JPG for screening.
10	I am no longer young and hate changes that make it difficult for me to cope with.
11	Thanks for the opportunity to take part in the survey. Will the results of the survey be made known?
12	I have an idea you know something I most definitely don't!!
13	Digital has made Photography so easy... but for many a loss in quality...
14	Sorry, I am really new at this. Don't think I was of any help. Have a lovely day.

15 As cameras become more sophisticated and image capturing devices such as sensors currently, go through the development, it is logical that someone will will develop some format more efficient. 2002 the sony mavica captured JPEG only onto a disc of a few pixels, now we have Nikon's D800 at 36.6 megapixels and 71 mb per photo in RAW...that is only 10 years! Change is inevitable!

16 This was kinda stupid survey and the purpose of the survey should be stated upfront.

17 Please send us a summary of the findings - I would like to know more about this as I am fairly ignorant of this.

18 Most people dont consider the effect of file format and accessibility in the long term. Most point and shooters do not even have a back up of their images unless they have been uploaded to a social media site.

19 I don't think everyone realises that with new technology developing everyday that older images might become difficult to access in the future or very costly.

20 The best thing that could have happened to Photography.

21 Assuming that I understand the purpose of this survey, should any of the file formats we use today be phased out and superseded by new ones, I'm sure the imagery recorded in the old formats will be made importable into the new ones, as that is what is really important.

22 I back up my main C drive on an internal E drive as well as an external F drive and occasionally special images are saved on DVD.

23 Please share findings of this survey with us.

24 I would be interested in your final thesis, and where you see the future of digital

image preservation.

25 People are under the impression that data stored on CDs will last for ever. A CD deteriorates very rapidly. Expect a life of 2 years (Cheap) to 7 years (expensive). Even removable hard drives seem to lose data.

26 I am beginning to think one should store your RAW files as DNG ... less chance of issues with proprietary support.