Painting and Calligraphy Digitization Procedures Guideline

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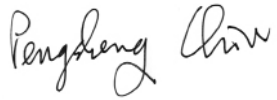
Taiwan Digital Archive Expansion Project

Preface

In January 2002, the National Science Council of the Executive Yuan of the Republic of China launched the National Digital Archives Program under the leadership of Dr. Ovid J.L. Tzeng, then vice-president of Academia Sinica. Over the past five years, the digital achievements attained by the project have been quite remarkable. The majority of these digital achievements may be viewed by the public (for non-commercial, lawful purposes) free of charge on the main portal site of the National Digital Archives Program (http://digitalarchives.tw). Since the beginning of 2008, the project leaders have embarked upon the second stage of development. The name of the project was changed to Taiwan e-Learning and Digital Archives Program (http://www.teldap.tw), and the executive director of this project is the current vice-president of Academia Sinica, Dr. Ts'ui-jung Liu. The Taiwan e-Learning and Digital Archives Program consists of eight core projects, one of which is the Taiwan Digital Archives Expansion Project (http://content.teldap.tw). Under the direction of Dean Fu-shih Lin, the College of Liberal Arts of the National Chung Hsing University, the Taiwan Digital Archives Expansion Project is closely collaborating with the experts and staff of the main TELDAP project and the other core projects. Our aim is to display Taiwan's cultural and natural diversity in digital form.

Since the completion of the first stage of the project, we have worked hard to record the digitization procedures of all of the organizations and institutions involved in digitizing their treasures. We have successively published over twenty digitization procedures guidelines related to the digitization of flora and fauna, archival documents, pictures, cultural relics, and other materials. The purpose of these digitization procedures guidelines is to forge specific guidelines for the digitization of different kinds of archival material, determine priorities in digitization work, establish meta-data, computer programs needed for digitization, and the long-term preservation of digital material. In order to strengthen international exchange in digital archival work, we have now translated three digitization procedures guidelines (on the digitization of ancient Chinese string-bound book, ceramics, painting and calligraphy) into English. By doing so, we hope to share our digitization experiences and spur cooperation in digitization work in future years.

We will continue to work together with the experts and staff of each digitization project to refine the digitization procedures guidelines for different types of digital archival material. We welcome any suggestions or comments on the digital archives by users in Taiwan or abroad.



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September 7, 2008

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One. Introduction

Ever since the National Digital Archives Program was launched in 2002, eight major holding institutes in Taiwan have been devoted to the digitization of rare and precious artifacts. New digitization methods have appeared along with new technologies, and after continuously trying different approaches to digitization, each holding institute has established a digitization procedure that best suits its current condition. In the past few years, general holding institutes have also joined the National Digital Archives Program via request-for-proposal (the Open Request-for-Proposal Project). However, not all institutes were entirely familiar with the digitization procedure, and due to insufficient budget and professional skills, digital archives produced by some institutes were found to be of lesser quality. The importance of gathering and arranging the cultural resources and digitization experiences of specialized holding institutes is without doubt, however, their quality and quantity is limited. If general holding institutes are intimidated by the digitization procedure, lack of management will cause the countless number of artifacts that are scattered in non-governmental circles to easily be lost with time. In the light of this, if experiences of institutes that are already in the National Digital Archives Program can be integrated and shared with other institutes that wish to engage in digitization via a systematic and standardized way, we could further promote the popularization of our fine culture.

This guideline was written for institutes that are relatively unfamiliar with the digitization procedure. It provides an operation procedure that is applicable to the digitization of most paintings and calligraphy, describing procedures and notices in a simple manner so that different institutes can rapidly learn and begin digitization work. Institutes can also establish digitization procedure to meet their requirements based on this guideline and their actual condition.

"Calligraphy" is the art of writing; the Chinese have a unique way of using ink and lines to express their sentiment on paper. "Painting" uses the elements dot, line, surface and color in a two dimensional space to express an image.

Current members of the Painting and Calligraphy Thematic Group (Please see appendix 2 for introductions to each unit), which is under the Content Development Division, include two typical large holding institutes – the National Palace Museum and the National Museum of History and two other institutes – Chinese Culture University Hwa Kang Museum[1] and China University of Technology Department of Visual Communication Design[2], which joined through the Open Request-for-Proposal Project. Collections of these four institutes that are undergoing digitization include Chinese paintings, calligraphy, prints, and western paintings (oil paintings, water color paintings). Although collections come in a variety of different styles, telling form the form of creation, they are all 2D visual art with relatively rich colors. Therefore, the digitization procedure planned by this guideline treats paintings and calligraphy as 2D art works with relatively rich colors.[3]

[1] The application by Chinese Culture University Hwa Kang Museum for the "Development of a digital archives system for modern precious artifacts" project was approved in 2004, and their second year application has already been approved.

[2] The application by Chung Kuo Institute of Technology Department of Visual Communication Design (Renamed China University of Technology on August 1st, 2005) for the "Lee Shih-Chiao Digital Museum Project" was approved in 2004; the project has already been concluded. In 2005, its application for the "Li Tse-Fan Sketches and Manuscript Digital Museum Project" was approved.

[3] Yung-Cheng Hsieh, 2004.11

Although different units have different digitization procedures due to different management methods, their digitization work procedures can basically be divided into three stages: preliminary operations, object digitization procedure, and metadata and database establishment. The digitization work of different units for each stage is as shown in Table 1; the content of this guideline is also based on these three stages, giving detailed descriptions of each stage.[4]

Table 1. Comparison of Digitization Work of Different Institutes

	Preliminary Operations	Object Digitization Process	Metadata and Database Establishment
National Palace Museum	1.Establish artifact digitization standards 2.Select objects	1.Image digitization (Digital Photography and film scanning) 2.Image color calibration 3.Storage and management	1. Analyze and edit metadata
National Museum of History	1.Establish prerequisite rules 2.Define work flows	1.Preparations (workroom arrangement, moving, borrowing and cleaning the artifacts 2.Photographing the artifacts 3.Image storage and management	1.Collect reference data 2.Develop and revise collection element analysis fields, cataloging rules, code list, system function requirements, and standards comparison 3.Produce a metadata specification 4.Develop a cataloging system 5.Artifact data cataloging 6.Revise the cataloging interface
Hwa Kang Museum	1.Artifact arrangement, object selection, list creation, and borrowing regulations 2.File naming, image format establishment	1.Digital photography 2.Color calibration 3.Digital printing 4.Image examination 5.Backup storage	1.Analyze and edit metadata 2.Data management system 3.Storehouse management system 4.Exhibition management system 5.Search and browse management system
Lee Shih-Chiao Fine Arts Museum	1.Prepare basic data of art works to be photographed	1.Set up the photography area 2.Borrow the painting and remove its frame 3.Position the painting and set up the camera 4.Set up and adjust lighting 5.Adjust lights and color temperature 6.Place the color chart 7.Photograph the painting 8.Store and backup the image file 9.Cut and adjust the image file 10.File conversions	1.Artifact data organization and analysis

[4] Please refer to the illustrated descriptions and digitization procedures survey on the Content Development Division's website for digitization procedure of each project http://content.ndap.org.tw/main/vision_brief.php?class_vision=12.

Two. Digitization Flowchart

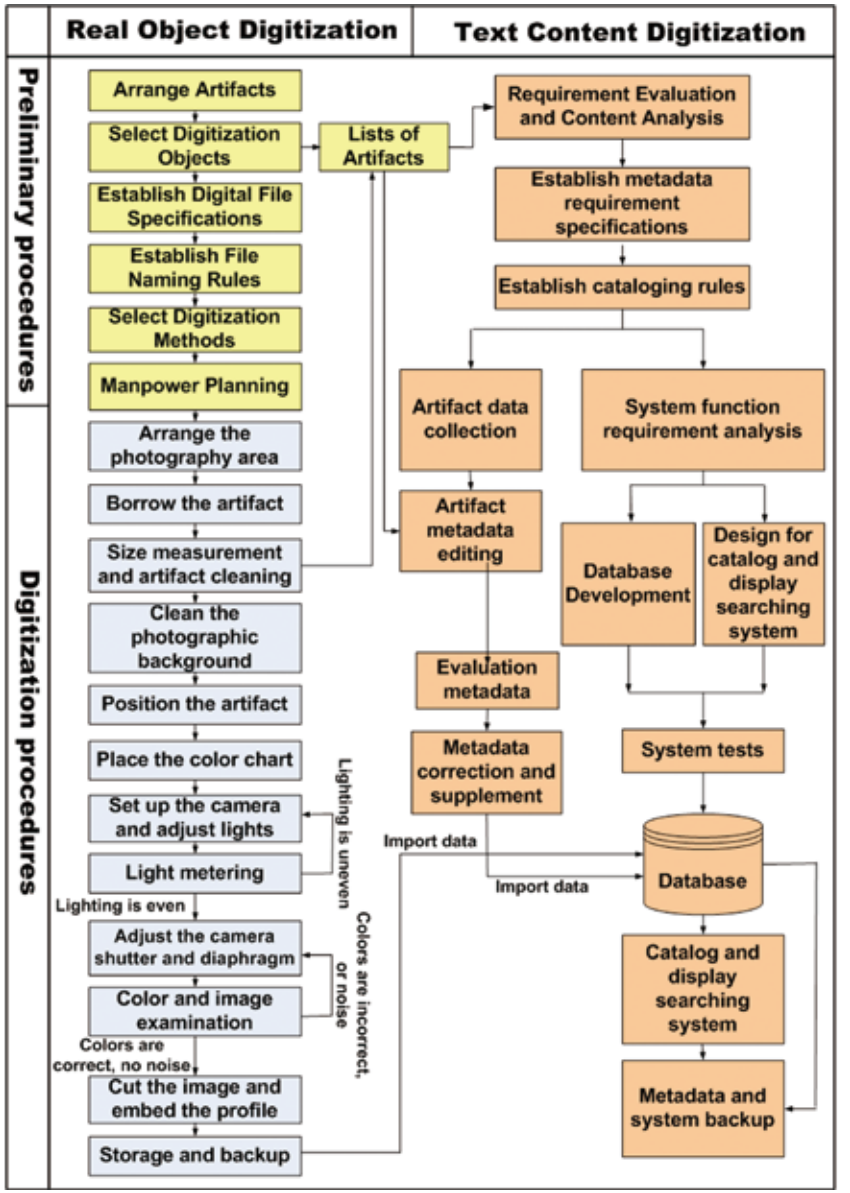


Figure 1. Painting and Calligraphy Digitization Flowchart

Three. Preliminary Procedures

Main tasks before the formal digitization of real objects include understanding the artifact's condition and planning the digitization procedure and method. These tasks can further be divided into artifact arrangement, digital file specification establishment, file naming, digitization method selection and personnel arrangements.

I. Artifact Arrangement

In order to plan the digitization of a collection that belongs to a typical large holding institute or an individual, the collection needs to be organized to find the types, quantities and preservation condition of artifacts.

(1) Making a List of Artifacts

This task allows the collection's size and the condition of artifacts to be understood. Due to different policies, different institutes generally have two ways for acquiring such a list.

(a) Retrieve the list from personnel that are responsible for managing artifacts to have an initial understanding of the artifacts.

(b) Make a list of artifacts in person and note special situations or differences with the original list.

No matter which method is used to acquire the list of artifacts, columns in the list will have some influence on digitization work planning and metadata design. Therefore, besides basic information of artifacts, such as its number, name and the artist, the artifact's preservation condition and whether or not was it repaired are all items that can also be noted; try to make the most complete record of artifacts when making the list to reduce the chance of needing to move the artifacts.

(2) Digitization Object Selection

When engaging in digitization with sufficient funds, it is natural to want to digitize the whole collection, but if there are difficulties, the priority of objects for digitization may be arranged based on the considerations below and noted on the list of artifacts:

(a) The artifact's class, such as national treasure, important artifact, and classification level.

(b) The artifact's preciousness, such as originality, rareness, value and irreplaceable characteristics.

(c) Difficulty of preservation, includes being fragile, can't be duplicated, or might disappear.

(d) Cost effectiveness after digitization.

(e) Application value in research, education and economics after digitization.

(f) Other.

During the process of making an inventory and selecting digitization objects, if paintings are found to need repair, it is best to find a mounting specialist, someone you are familiar with and is responsible, for advice or to repair the painting.

II. Digitization Specification Establishment

When establishing digital file specifications, consideration needs to be given to the digital file's purpose and characteristics of the digital file specification.

(1) Confirm the Purposes of Digital Files

The first thing for planning digital file specifications is to understand the digital file's purpose. The purpose of digitization is to preserve artifacts using technology, which allows less damage to be done to the artifacts from regular usage, and allow them to be easily shared with the general public. Therefore, preservation and sharing are two very important purposes of digital files. In the sharing part, digital files are usually provided via the internet for users to browse, published, or made into duplicates of the original.

(2) File Specification Planning

File specifications include file format, color mode, color depth, resolution[5] and file size.

(a) File format: Image files have different formats due to different computer platforms and software (Table 2). RAW files are the original files produced from digital cameras, and are usually converted into more common formats, such as TIFF and JPEG.[6] The TIFF file format is an uncompressed lossless format and is the best selection for permanent preservation and conversion into other formats. For display on websites, most files are converted into JPEG or GIF formats. Although RAW files require specialized software to be opened, they contain images that haven't been modified after being taken and are of smaller size than TIFF files, which is why they have been gradually adopted by institutes as a means for permanent

[5] Digital images are based on dot matrixes; resolution (spatial resolution) refers to the number of dot values in a certain length. Resolution is represented in two forms, one uses the pixel, which is a basic element recorded when the image is imported, and is calculated using Pixel Per Inch (ppi); the other form uses dots, which is the physical element of an image, and is calculated using Dot Per Inch (dpi).

[6] Most RAW files can only be read by software that came with the digital camera. Therefore, if only RAW files are used for permanent preservation and the software for reading them cannot be installed in upgraded computers, then the RAW files will be useless. At present, Adobe Photoshop CS2 supports RAW files produced by some digital cameras (http://www.chinese-t.adobe.com/products/photoshop/cameraraw.html) and is without doubt a good tool to digital preservation. If software that supports RAW files produced by all digital cameras is developed in the future, then RAW files will become a good candidate for permanent preservation.

Table 2. Characteristics of different file formats[7]

File Format	RAW	TIFF	EPS	JPEG	GIF	BMP	PICT	PSD	PNG
Supporting RGB full color	▪	▪	▪	▪		▪	▪	▪	▪
Supporting 256 colors	▪	▪	▪		▪	▪	▪	▪	▪
Supporting CMYK	▪	▪	▪	▪				▪	
Images can be compressed			▪	▪	▪		▪		▪
Supporting layers								▪	
Supporting masks			◎		▪			▪	▪
Supporting online display				▪	▪			▪	▪
Suitable for general image storage		▪		▪				▪	▪
Suitable for permanent preservation		▪							
Suitable for printing		▪	▪						

▪ Indicates that the function is supported ◎ The new TIFF format supports masks

preservation.

(b) Color mode: The RGB color mode is capable of showing more colors (color gamut) than the CMYK color mode. Since photographed images are first examined on the monitor, it is best to use the RGB color mode. Change to other modes as needed for other purposes, such as output.

(c) Color depth: This is related to the color mode. When the color mode is RGB, the hues R, G and B each take up 8 bits (1 Byte). Therefore, the color depth adopted by color modes used in general computers is 24bits[8], also referred to as the 24 bit full color mode. Today, some digital products in the market have CCD that is capable of capturing 12 or more bit sampling for R, G and B, but such image files need be processed by higher level equipment.

(d) Resolution and size: The number of pixels in images photographed by digital cameras is fixed, but the output size is determined by the resolution chosen for output.

Table 3. Pixels and output size[9]

Image Resolution	Camera Pixels	Size of output using 200dpi (pixels/inch)	Size of output using 300ppi (pixels/inch)
640×480	300 thousand pixels	Inch: 3.2×2.4 cm: 8.13×6.1	Inch: 2.1×1.6 cm: 5.3×4.06
1024×768	800 thousand pixels	Inch: 5.1×3.8 cm: 12.95×9.65	Inch: 3.4×2.6 cm: 8.6×6.6
1280×960	1.2 mega pixels	Inch: 6.4×4.8 cm: 16.26×12.19	Inch: 4.3×3.2 cm: 10.92×8.13
1600×1200	1.9 mega pixels	Inch: 8.0×6.0 cm: 20.32×15.24	Inch: 5.3×4.0 cm: 13.46×10.16
2048×1536	3.2 mega pixels	Inch: 10.2×7.7 cm: 25.91×19.56	Inch 6.8×5.1 cm: 17.27×12.95
2592×1944	5 mega pixels	Inch: 13.0×9.7 cm: 33.02×24.64	Inch: 8.6×6.5 cm: 21.84×16.51
3264×2448	8 mega pixels	Inch: 16.3×12.2 cm 41.4×30.99	Inch: 10.9×8.2 cm: 27.69×20.83
4256×2848	12.1 mega pixels	Inch: 21.3×14.2 cm: 54.1×36.07	Inch: 14.2×9.5 cm: 36.07×24.13

[7] Source: Ming-Ching Hsu, 2001, page 51.

[8] DEach hue is 8 bits, so RGB full color is 8bits*3=24bits.

[9] The output size in the table is based on inches; the corresponding cm is for users in Taiwan to refer to.

Besides the principles above, the National Digital Archives Program and National Repository of Culture both have basic digital file specifications (Tables 4 and 5) for units to refer to when planning their own digital file specifications.

Table 4. File specifications of the National Digital Archives Program

	Permanent Preservation	Commercial Use	Online Browse
File Format	TIFF	JPEG	JPEG
Color mode	RGB (24bit/pixel or higher)	RGB (24bit/pixel)	RGB (24bit/pixel)
Resolution and Size	Original size 300dpi or higher	Original size 300dpi	72 dpi

Table 5. File specifications of the National Repository of Culture

	Permanent Preservation	Online Browse
File Format	TIFF	JPEG
Color Mode	RGB	RGB
Color Depth	Color 24bit/pixel or higher	Color 24bit/pixel
Resolution and Size	600dpi or higher	300dpi or image size 500×400 to 1000×700 pixels
Compression Quality	Uncompressed	75%

The previous section mentioned that "preservation" and "sharing" were two important purposes of digitization. Therefore, it is recommended to establish file specifications based on these two directions (Table 6). Considerations for each purpose are as follows:

(a) Permanent Preservation: All considerations, such as file format, color mode and resolution, should be in the best state, but whether or not digitization equipment supports the resolution should also be considered. The selection and planning of equipment will be introduced in following chapters.

(b) Online browse: The monitor's resolution is 72dpi. Therefore, the image's size only needs to be as large as the size that is displayed on the monitor; the unit used is pixels/inch, such as 640×480 and 1024×768.

Table 6. Recommended File Specifications

Purpose	Permanent Preservation	Permanent Preservation or Publishing	Online Browse
File Format	RAW	TIFF	JPEG
Color Mode	RGB (24bit/pixel)	RGB (24bit/pixel or higher)	RGB (24bit/pixel)
Resolution and Size	Original size 300dpi or higher	Original size 300dpi or higher	72dpi, should be based on the size displayed online

III. File Naming Rules

Each operating system has its own unique naming rules. Therefore, it is recommended to refer to the rules in Table 7 when naming files, and to avoid using characters or filenames that are not permitted by some operating systems to increase the file's compatibility. Furthermore, even though using Chinese filenames allow easy identification of files, they are liable to errors on the internet, which is why English letters and roman numerals are recommended for filenames.

Table 7. Naming rules of different operating systems[10]

	DOS and Windows 3.1	Windows 95/98/ Me/XP/NT/2000	Mac OS (Standard)	UNIX/Linux
Maximum length of filename	Filename is limited to 8 characters and the extension is 3 characters	Filename plus extension must not exceed 255 characters	1-31 characters	14-256 characters (depends on the UNIX/Linux version), includes filename extensions of any length
Blank space permitted	No	Yes	Yes	No
Digits permitted	Yes	Yes	Yes	Yes
Characters not permitted	* / [ ] ; " = \ : , | ?	* / < > " \ : | ?	:	*!@#$%^&()[]{}",?;<>
Filenames not permitted	Aux, Com1, Com2, Com3, Com4, Con, Lpt1, Lpt2, Lpt3, Prn, Nul	Aux, Com1, Com2, Com3, Com4, Con, Lpt1, Lpt2, Lpt3, Prn, Nul	All filenames are permitted	Depends on the UNIX/ Linux version
Case sensitive	No	No	No	Yes

[10] Source: Translations by Shih-Chieh Yen, Tzu-Wei Chin, 2004, 4-4 pages.

Units can combine collection management with file naming, such as adding the unit's code or the collection number. The National Repository of Culture has established a set of file naming principles and a file structure[11] that is applicable to all types of artifacts in the repository, including paintings. Therefore, it is suitable for referring to when planning filenames.

IV. Digitization Method Selection

Based on the actual situation of members of the Painting and Calligraphy Thematic Group, commonly used digitization methods are as follows:

(1) Scanning films from traditional cameras: Before participating in the National Digital Archives Program, the National Palace Museum and National Museum of History had already photographed artifacts using traditional cameras to publish albums. Therefore, in the digitization process, firms were contracted to scan these films using high level drum scanners.

(2) Direct capturing digital images: At present, all four members of the Painting and Calligraphy Thematic Group adopt this method for digitization; the equipment used is traditional camera (4×5 medium format professional camera) with a digital back.

Although traditional cameras do have their advantages in photography, they are more expensive and take more time than direct photographing of digital images after considering costs for film, preservation and outsourced scanning.

In the equipment of different units for directly photographing digital images, digital backs are further divided into scan and one shot backs.[12]

[11] Executive Yuan Council of Cultural Affairs National Repository of Culture digital file naming principles http://km.cca.gov.tw/download/_v20(20040608).pdf.

[12] One shot refers to the capture of an image from one opening and shutting of the camera shutter.

The advantage of digital scan backs is that they produce digital files with relatively higher quality, which benefits replica paintings or other printings[13], but they require more time for capturing an image and if they are moved even slightly or if other objects gets in the way before the scan back is done capturing an image, then the image needs to be retaken. One shot backs, on the other hand, don't have this problem, and coupled with the improved CCD technology of digital cameras or backs, the images captured by these backs can also be used for output. Therefore, one shot backs are recommended for digitization work.

V. Manpower Planning

Although different units have different systems and different manpower resources, manpower can generally be arranged according to the following two aspects.

(1) Existing personnel within the institute: Researchers or assistants from the original institute are familiar with system operations and artifacts and have a certain degree of academic accomplishment, which is why they provided great to preliminary operations and metadata planning in the digitization procedures.

(2) Contracted personnel

(a) Technicians: Mainly refers to specialists in digitization technology and information technology, such as professional photographers, database and web designers.

(b) Cataloging personnel: After the artifacts database is established, manpower will be required to key in data into the system. This can either be completed by existing personnel within the institute, or people with backgrounds in related fields can be hired to complete the task.

[13] The most powerful BetterLight scan back has 10,200×13,800 pixels, and is able to output a 51×69 inch (129.54×175.26 cm) image under the resolution of 200ppi and a 34×46 inch (86.36×116.84 cm) image under the resolution of 300ppi. (Translation by Fang-Shin Chiu, 2005, page 3-23)

Four. Object Digitization Procedure

After establishing operation standards for digitization work and planning manpower in the preliminary operations stage, holdings institutes may start the digitization of their collection. Below is a brief introduction and description of work principles during object digitization.

I. Photography Workroom Arrangements[14]

A suitable environment must be prepared before artifacts are formally photographed. The key to arranging a photography workroom is to eliminate any factors that might influence image quality and increase factors that will benefit the success of photography, below are a few principles that should be noticed:

(1) Neutral gray is the best color for walls in the photography workroom, especially when it's close the Kodak's 18% gray card, followed by white or black. The key to selecting wall color is to avoid affecting color management; lights used for photographing artifacts reflect off walls and influence image quality.

(2) The workroom should be far from any vibration sources, such as the street, trains, Mass Rapid Transit and elevators, to prevent the image from becoming blurred. Furthermore, the workroom should be close to where paintings are held, effectively reducing damage caused to paintings from moving them.

(3) In order to prevent the undesirable influence of stray light, which causes reduced image quality, it is best for the workroom to not have any windows, or have specially designed windows that don't let light in. If windows cannot be avoided, use thick opaque curtains or cardboard to block the light; this also helps when using the camera's view finder to observe the image.

(4) The minimum requirement on space in the photography workroom is that it should at least have room to place the camera's tripod, lights and a computer, and have room for personnel to move around. If the workroom has more space, not only will personnel be able to move in and out easier, paintings can avoid being damaged and large paintings will have no trouble being positioned. The criteria for choosing the photography workroom's length, width and height is as follows:

(a) Length: This is related to the size of the painting being photographed. Basically, the larger the painting the longer the room. In addition, also consider if a wide angle lens will be used, if so, then the length of the workroom doesn't need to be too long.

(b) Width: This is also related to the size of the painting being photographed. The larger the painting the wider the room. Furthermore, also give consideration to the lighting system being used, wider rooms benefit lighting arrangements.

(c) Height: Lighting and the camera needs to be adjusted for paintings of different size. When designing the workroom, the largest painting that will be photographed must be considered for an ideal location to be selected.

When photographing paintings, one side of the workroom can be used to place paintings. A board for attaching magnets can be installed on the wall and coated or covered with material that doesn't reflect light (such as black flannelette). In this way paintings that are on paper (such as Chinese paintings) can be fixed to the wall using magnets. If the painting being photographed (such as Western paintings) can't be fixed to the wall using magnets, or if there isn't enough room, then a picture stand or air pressure platform (magnetic panel) can be used to fix the painting.

[14] We are grateful to Mr. Chun-Hsiung Cheng and other members of the Chinese Culture University Center of Information and Communication for providing their valuable opinions and helping to revise the notices on planning photography workrooms in this section.

II. Borrowing Artifacts

Different institutes have somewhat different regulations on borrowing artifacts. Usually, a form needs to be filled out for borrowing artifacts so that the collection division's manager can have control over the whereabouts of artifacts. An example of an artifact borrowing list is as shown in Table 8.

Table 8. Example of an artifact borrowing list

"Digital Collection System of the National Museum of History" Artifact Borrowing List Date: Year: Month: Day:								
Registration Number	Name	Quantity	Unit	Change in Status (Borrowed)	Change in Status (Returned)	Date Borrowed	Date Returned	Notes
(Borrow) Responsible Staff: Exhibition Division Manager: Collection Division Manager:								
(Return) Responsible Staff: Exhibition Division Manager: Collection Division Manager:								

Personnel are required to remove any bracelets, watches, rings and necklaces and to wear clean gloves before touching the paintings to avoid damaging them. They have to be especially careful when moving paintings to and from the photography work area to avoid dropping the paintings and causing them to be folded or torn. Large paintings should be carried by two people both facing in the direction they are moving to prevent the painting from colliding with anything.

III. Size Measurement and Artifact Cleaning

Although size measurement can be carried out when making the list of artifacts, the artwork needs to be spread up for the task to be completed, which is an action that will be repeated during digital photography, therefore it is recommended to measure the artwork's size before digital photography to reduce the number of times the artwork is handled.

Small stains like dust are hard to avoid when storing paintings, so use a soft brush to gently remove stains on the painting when measuring its size.

IV. Preparations before Photographing Artifacts

(1) Cleaning the Photographic Background

Before placing the painting in the photography area, use a brush to clean any dust on the photographic background to avoid getting dust on the painting.

(2) Positioning the Artifact

Paintings with different mounting methods have different notices for positioning them:

(a) When hanging paintings mounted using an erect roller, hooks will usually be on the same line as the painting, so be careful that the hooks don't fall off and tear the painting.

(b) For paintings mounted using frames, try to remove the outer frames and glass (acrylic) to avoid reflections.

(c) Albums and scrolls of paintings or calligraphy must be carefully spread up on a flat and clean table (this should be noticed during size measurement) before being photographed.

(3) Placing the Color Chart

Place a gray scale card and a color correction card on both sides of the

painting before photographing it; the cards are for calibrating colors of the digital image.

(4) Color Calibration of the Monitor

In order for image colors to be accurately displayed on the monitor, color correction needs to be performed on the monitor before photographing artifacts. The monitor should be turned on thirty minutes before performing color correction, and it is best if the monitor has a shadow mask to avoid the influence of other light sources, which causes lower color correction accuracy. Introductions to three correction methods are as follows:

(a) Simple Monitor Correction: Use Microsoft Painting tool to draw color blocks, and then use the color blocks to adjust the monitor's color temperature, brightness and contract. The steps are as follows:[15]

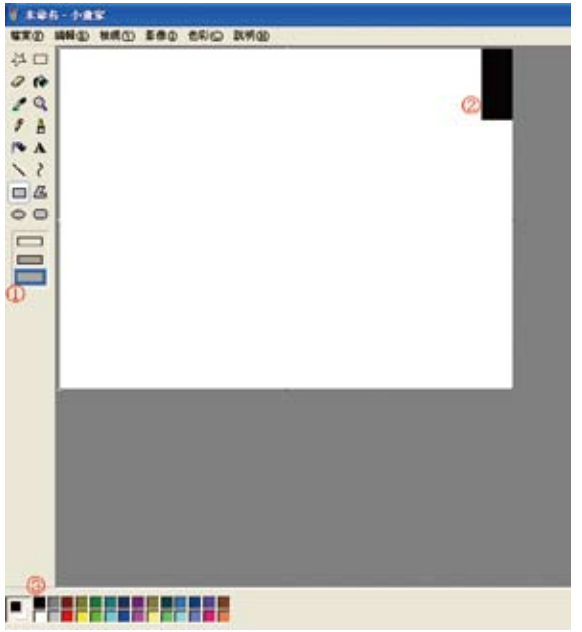


Figure 3.

(i) Producing a Color Check:

Step 1: Open Microsoft painting tool, select "fill with no line" under the "draw a block" item (Figure 3, ①) draw a block on the upper right corner (Figure 3,②) and use the original color black (Figure 3,③).

Step 2: Use the "transparent" under "select" (Figure 4,①), select the block that you just drew (Figure 4,②), and then copy the selected block to the drawing area (Figure 4,③).

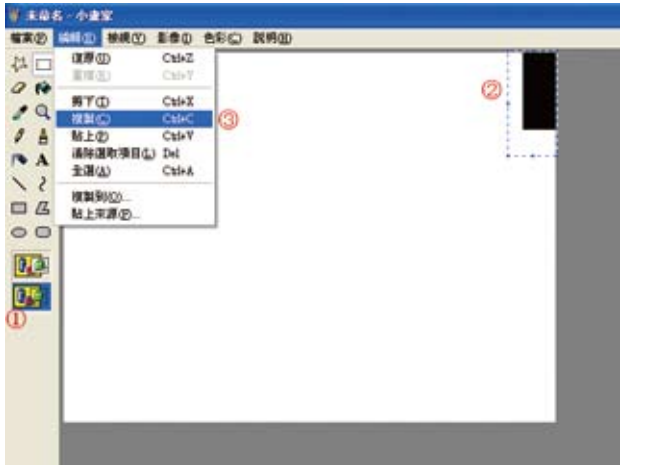


Figure 4.

[15] Source: Yokota Shinichi et al, 2004.

Step 3: Use the "Paste" command to paste the copied block in the drawing area (Figure 5,①), select "colors"/"edit colors" from the toolbar (Figure 5,②)/"Define custom color" (Figure 5,③), after filling "10, 10, 10" in the red, green and blue fields, press "add custom color" and then press "yes" (Figure 6). Choose the "paint bucket" in the drawing toolbar, click on the block that was just pasted (Figure 7,①), use the "transparent" function under "select", select the block and move it to the left of the first block (Figure 8,①).

Figure 5.

Figure 6.

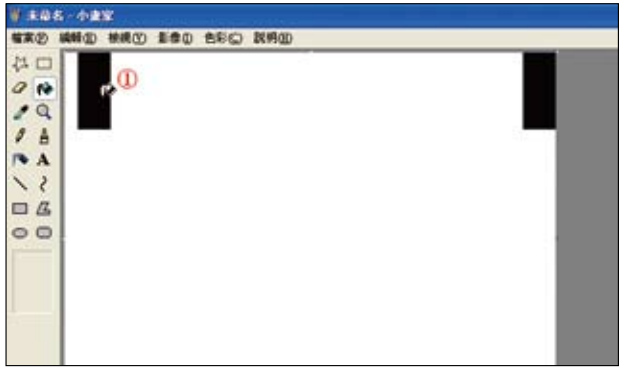


Figure 7.

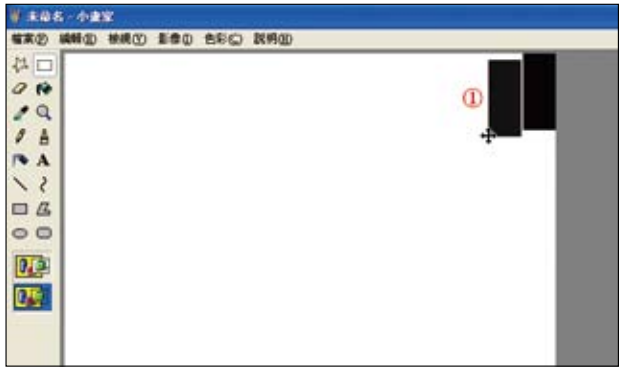


Figure 8.

Step 4: Repeat Step 3, increase the values for red, green and blue by 20 until they reach 250 (Figure 9).

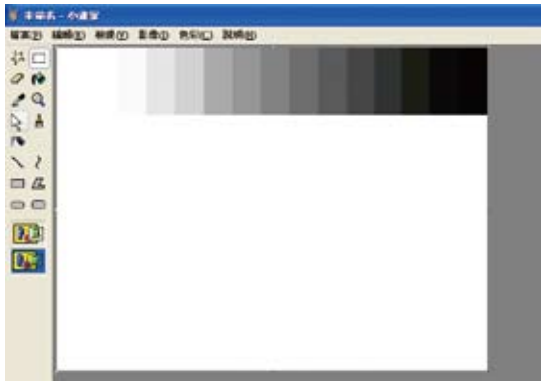


Figure 9.

Step 5: Next, draw a black rectangle that is about 1/4 the size of the drawing area, the values for red, green and blue should all be 0 (Figure 10).

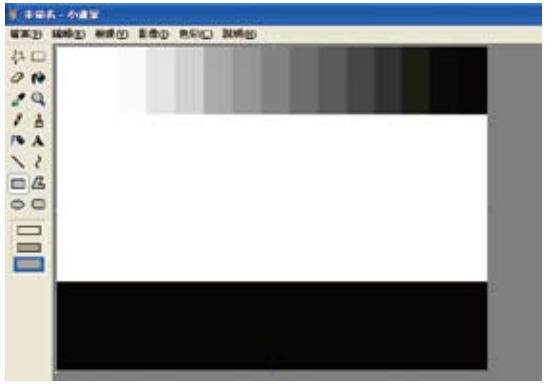


Figure 10.

Step 6: Draw a square on each side (doesn't have to be aligned with the edge of the drawing area) of the rectangle that is about 1/6 its area; the squares should have the values 5 and 10 for its colors (Figure 11).

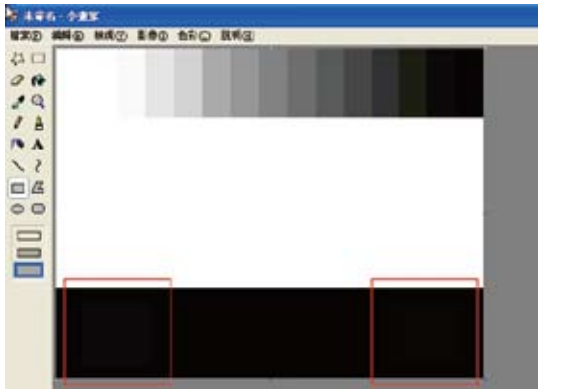


Figure 11.

Step 7: In the white part in the center of the drawing area, put three squares that have the colors "red=255, green=0, blue=0", "red=0, green=255, blue=0" and "red=0, green=0, blue=255" respectively (Figure 12).

Figure 12.

(ii) Monitor Adjustments (The monitor choice is ViewSonic VG510b):

Step 1: Use Paint to open the Color Check that you just made, adjust the monitor using its buttons (Figure 13 and 14).

Figure 13.

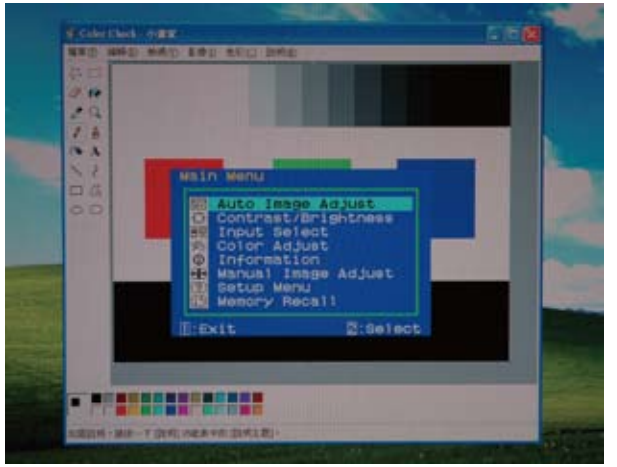


Figure 14.

Step 2: Adjust the monitor's color temperature. Generally speaking, 5500K to 6500K is a more suitable color temperature (Figure 15); the monitor will seem blue if the color temperature is too high (Figure 16) and it will seem yellow if the color temperature is too low (Figure 17).

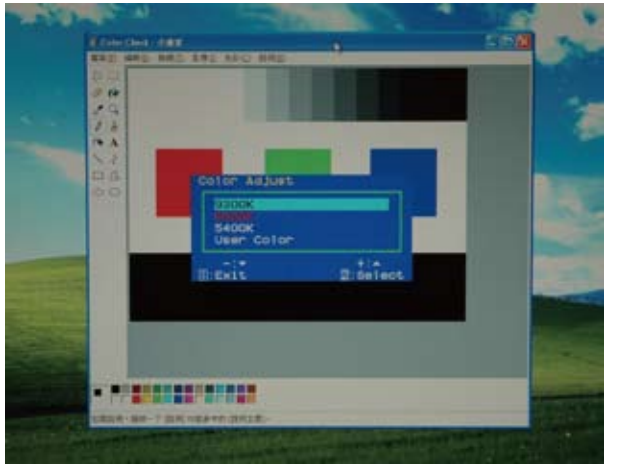


Figure 15.

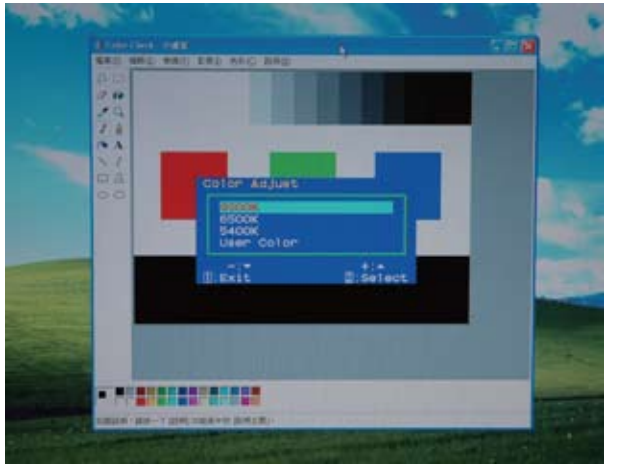


Figure 16.

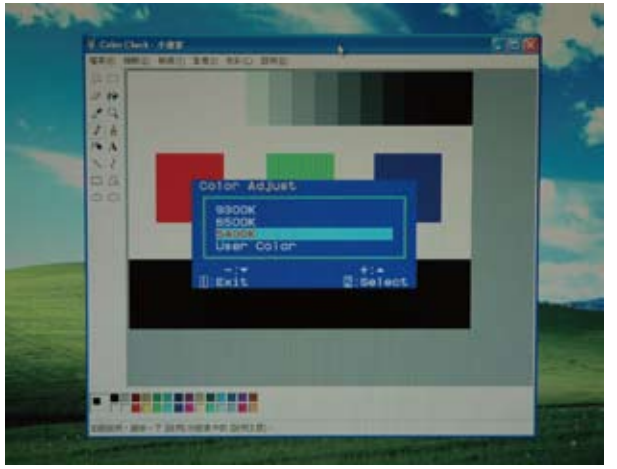


Figure 17.

Step 3: Adjust the contrast. Generally speaking, it is best to maximize the contrast to benefit brightness adjustments (Figure 18).

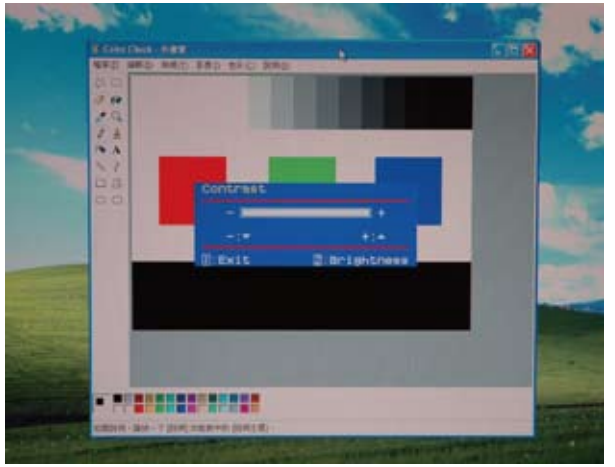


Figure 18.

Step 4: When adjusting the monitor's brightness, two parts of the Color Check needs to be verified, one is the white part of the color scale on the top should allow each different scale to be easy to recognize; the second part is that the two squares should fit in the black rectangle on the bottom, but should be identifiable by the naked eye (Figure 19).

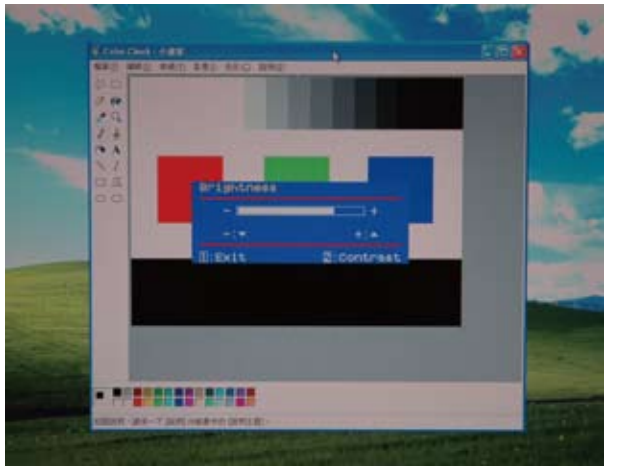


Figure 19.

(b) Software Correction: Use Adobe Gamma of Adobe Photoshop or ColorSync of Apple MAC for monitor correction.

(c) Hardware Correction: Institutes can purchase a monitor color corrector for hardware color correction. Turn of monitor color correction software, such as Adobe Gamma[16] before correction to ensure that the monitor color corrector and its software functions normally. Please refer to the color corrector's instruction manual for instructions on how to operate the hardware.

The simple correction and software correction methods all require

[16] Adobe Gamma overrides any other form of monitor color management, causing other color management equipment to be ineffective and influencing subsequent color management procedures.

examination by the naked eye, and are less accurate than hardware correction because adjustments by different people will have different results. However, under a limited budget, they are both options that can be considered.

(5) Camera Set Up and Settings

(a) Set up the camera on the platform, besides using the level to see if the camera is level, also notice if the camera is parallel with the artifact to ensure that the whole artifact is in the image.

(b) Add a lens hood to the lens to avoid photography lights from reflecting into the lens and producing light spots on the image.

(c) When setting up the camera, link it to the computer with an IEEE 1394 or USB line.

(d) After linking the camera to the computer, configure settings of the camera's software. Using Nikon D70 as an example, the camera comes with the software Nikon Capture Camera Control, which can be used to adjust exposure mode, sharpness, etc. and control the camera's photography actions (Figure 20). It is recommended to the read the manual carefully before photographing artifacts because different cameras use different software and hardware settings.

Figure 20. Nikon Capture Camera Control operation interface

(6) Adjusting the Position of Lights

(a) Turn on the lights at least 30 minutes before photographing artifacts so that its color temperature is equal to that of natural light.

(b) Place the lights to the left and right of the painting, forming a 45 degree angle.

(c) The lights should be at a distance from the painting that the lit area of the wall is 2~3 times the size of the painting, allowing the painting to be moderately and evenly lit without any shadows (Figure 21).

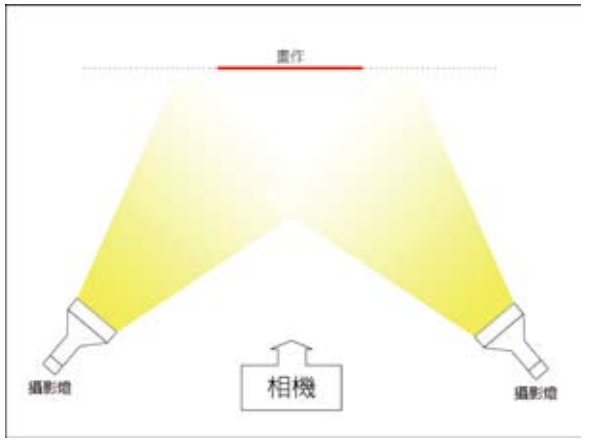


Figure 21. Light positioning for digital photography

(7) Light Metering

(a) In order for the light to be evenly distributed on the painting, first use a photometer to measure the exposure values of the painting's four corners, adjust the lights until they are even, then measure the center of the painting to adjust the camera's diaphragm[17] before formally photographing the painting.

(b) Personnel should not be too close to the painting to avoid affecting the exposure values that are measured.

[17] The photometer's sensor will have a white semi-sphere hood. When measuring the light, place the photometer in front of the object being photographed and face the hood towards the light to obtain a value.

V. Digital Photography, Color Correction and Post Processing

After preparations are complete, adjust the camera shutter and diaphragm to produce a suitable depth of field, allowing the painting to be clearly shown in the frame, and then use the control software to press the photograph button.

After the photographed image is transferred into the computer, immediately check if the image's exposure is correct, is there any noise in the image, do any light spots exist, and did color cast occur. If the image's colors are off or noise was produced in the image, readjust lights and equipment and re-photograph the object, or use the color chart that was photographed along with the object and in the toolbar of Adobe Photoshop, select "Image"/"Adjustments"/"Levels" "set the darkest point", "set gray point" and "set the brightest point" (Figure 22) and click on the black, gray and white blocks of the color card to remove color cast. If the image is correct, use editing software, such as PhotoShop, to cut off excessive parts of the image.

Figure 22. Using three color blocks to remove color cast

VI. Storage and Backup

After completing color correction and adjustments, embed Adobe RGB 1998, which has a wider color gamut and is commonly used, or the camera's default ICC Profile into the image file. Then name the file according to the established file naming rules and save the file into the hard drive. After digitization work is done for the day, it is recommended to backup all files of that day to a server or another computer. Files can also be regularly backed up to DVDs or other storage media every month.

In addition, the size of an image file can be estimated, which allows the required storage capacity to be calculated. For example, a 6 mega pixel digital single-lens reflex camera can capture images with a maximum of 3,008×2,000 pixels[18], the color depth is 3 Bytes when the color mode is RGB, so the picture will be 3,008×2,000×3 = 18,048,000 Bytes; 1KB = 1,024 Bytes, 1MB = 1,024 KB, so 18,048,000÷1,024÷1,024 = 17.21 MB, which means that a blank DVD with 4.7GB[19] of storage space can store roughly 270 images.[20]

[18] Using a resolution of 300ppi, the output's size will be 10.03×6.68 inches (25.48×16.98cm).

[19] 1GB = 1024MB.

[20] Formula for calculating file size (in MB): [(Width × Pixels of input equipment) × (Height × Pixels of input equipment) × number of bytes for color depth] ÷ 1,024 ÷ 1,024.

Five. Metadata and Database Establishment

To make things simple, you can think of metadata as the fields of data in a database; its establishment requires consideration of what kind of data you want to show users and what background data of artifacts you want to record. After databases and display management systems are established, metadata allows digitized text and images to be shared with global users via the Internet.

The "Metadata Lifecycle Model (MLM)"[21] was designed by the Metadata Architecture and Application Team to aid participation in the National Digital Archives Program. MLM describes procedures for planning metadata, and the following section describes principles of metadata and database establishment for paintings and calligraphy based on this model.

I. Requirements Evaluation and Content Analysis

In order to be brought in-line with international practices, a suitable international metadata standard can be selected based on the type of object being digitized. From a scientific point of view, paintings and calligraphy are art works, and the "Categories for the Description of Works of Art (CDWA)" developed by the Art Information Task Force (AITF) of J. Paul Getty Trust is the relatively suitable international standard; CDWA is currently at its second version and defines 27 categories.[22] In fact, a relatively large proportion of domestic collections are Chinese paintings and calligraphy, keys to recording their mounting methods and appreciating their art is somewhat different from Western art works. Although bringing data in-line with international standards is still an objective, the attributes of an art work deserves to be clearly described. Therefore, it is recommended to use CDWA as a basis for developing more suitable metadata elements to describe features of an institute or individual's collection and record things that are worth specially noting.

In addition, the Dublin Core (DC) is also a metadata standard that can be used as reference. This standard was established to make the world's electronic resources more exchangeable and easy preservation. The Dublin Core only has 15 core elements[23] as an exchange format for various types of metadata, achieving openness and interoperability.

In the Painting and Calligraphy Thematic Group, collections of the National Museum of History and Hwa Kang Museum have both Chinese and Western paintings. In which Hwa Kang Museum combines features of both Chinese and Western paintings into the same metadata elements list. This guideline wasn't written for institutes holding any specific type of calligraphy or paintings. Therefore, holding institutes are recommended to use the metadata elements list developed by Hwa Kang Museum as reference for developing their own set of metadata elements.[24]

II. Metadata Requirements Specifications

After establishing usage standards and metadata elements, work with system developers on writing a metadata requirements specification. This specification should describe fields and function plans related to database

[21] Metadata Lifecycle Model (MLM) http://www.sinica.edu.tw/~metadata/design/lifecycle_new2.htm.

[22] Categories for the Description of Works of Art elements list http://www.sinica.edu.tw/~metadata/standard/CDWA/Element%20List.htm.

[23] Dublin Core elements list http://www.sinica.edu.tw/~metadata/standard/dublincore-chi.htm.

[24] "Chinese Culture University Hwa Kang Museum Development of a Digital Archives System for Modern Precious Artifacts" Metadata Function Requirements http://www.sinica.edu.tw/~metadata/project/filebox/hwakang/hwakang_spec_050126.pdf.

and system establishment. The key items of writing a requirement specification described below are based on a specification written by the Metadata Architecture and Application Team for aiding participation in the National Digital Archives Program; the 2001 metadata requirements specification of the National Palace Museum is used as an example for explanations.[25]

(1) List of Required Elements

This list is provided to system developers and programmers as reference when they are setting fields in the database and programming. The list includes element name, English name, data type, size, multi-value, attributes and provider.

Table 9. List of required elements

List of Required Columns	Description
Element Name	Chinese name of the metadata element.
English Name	English name of the metadata element.
Data Type	The type of data that is being input, such as Varchar, Text and Int.
Size	The number of bytes required for characters in the field.
Multi-value	The symbol ◎ is used to indicate whether or not the field contains more than one value. For example, when a work of calligraphy has both Kai Script and Running Script, both need to be represented in the script type field for the data to be correct.
Attributes	Attributes include: 1.Exclusive: Indicates that only one field in the database can have this value. 2.Increment: Whenever new data is added, the system will automatically increment the original value by one. 3.Restricted: The field can only be used by the administrator. 4.Pull-down Menu: Indicates that data for the field is selected from a pull-down menu. 5.Field Required: Indicates that the field must have a value. 6.Default: The system will set the field at a default value. Cataloging personnel can modify the value is necessary. 7.Fixed Value: The system will set a value that can't be modified by cataloging personnel. 8.Automatically Generated: The field's value will be automatically generated by the system and not filled in by cataloging personnel. 9.Link: Indicates that the data is in an external database.
Provider	Indicates that the data was produced by the system or filled in by cataloging personnel.

[25] Please refer to the Digital Archives Project of Chinese Painting and Calligraphy at the National Palace Museum Metadata Requirements Specification (version1.0) http://www.ndap.org.tw/2_techreport/techDoc/download/1.6.1.1.1.pdf.

Table 10. Example of a list of reguire columns (Excerpt)

Element Name		English Name		Date Typea	Size	Multi value	Attribute	Provider
編號		Id		Int	10	–	Exclusive, Incremental, Restricted, Automatically Generated	System
識別號碼	文物統一編號	Identify Number	Accession Number	Varchar	30	–	Link, Storehouse Management System, Restricted, Field Required, Exclusive	Cataloging Personnel
	原始編號		Entry Number	Varchar	30	–	Restricted	Cataloging Personnel
藏品類型		Type		Varchar	20	◎	Pull-down Menu, Field Required	Cataloging Personnel
編目層級		Catalog Level		Varchar	10	–	Pull-down Menu, Restricted, Field Required	Cataloging Personnel
品名	類別	Title	Title Type	Varchar	10	◎	Pull-down Menu, Field Required	Cataloging Personnel
	品名		Title Text	Varchar	80		Field Required	Cataloging Personnel
作者資料	姓名	Creator	Name	Varchar	20	◎	Link Name Authority File	
	其他識別資料		Identification	Text	600		–	

(2) Code Table

The attribute of this item indicates that its value is selected from a pull-down menu.

Table 11. Example of a code table (Excerpt)

Element Name		Code
Type		Calligraphy | Painting | Weaving | Embroider | Calligraphy Model | Rubbing | Ink Rubbing | Ink Rubbing (Picture Brick) | Other
Catalog Level		Single Piece | Collection Series | Larger Entity | Attachment
Title	Type	Main Title | English Translation | Original Name | Abbreviated

(3) Metadata Standard Comparison Table

Compare the metadata fields established according to requirements with international standards for the convenience of exporting data in the form of XML to foreign units. For Painting and Calligraphy, the two international standards CDWA and Dublin Core can be used for comparison (Table 12 and 13).

Table 12. CDWA Crosswalk (Excerpt)

Element Name		CDWA Elements
ID		This field isn't exported as XML data
Identify Number	Accession Number	CURRENT LOCATION−REPOSITORY NUMBERS
	Entry Number	CURRENT LOCATION−REMARKS
Type		OBJECT/WORK−TYPE
Catalog Level		OBJECT/WORK−CATALOG LEVEL
Title	Title Type	TITLES OR NAME−TYPE
	Title Text	TITLES OR NAME−TEXT
Creator	Name	CREATION−CREATOR
	Identification	CREATION−CREATOR IDENTITY
Quantity		OBJECT/WORK−QUANTITY
Dimensions	Extent	MEASUREMENTS−DIMENSIONS EXTENT
	Value	MEASUREMENTS−DIMENSIONS VALUE
	Unit	MEASUREMENTS−DIMENSIONS UNIT
Material	Extent	MATERIALS AND TECHNIQUES−EXTENT

Table 13. DC Crosswalk (Excerpt)

Element Name		Dublin core
ID		This field isn't exported as XML data
Identify Number	Accession Number	Identifier
	Entry Number	Identifier
Type		Type
Catalog Level		Type
Title	Title Type	Main title: Title
	Title Text	English translation, original name, abbreviated: Title-Alternative (Note7)
Creator	Name	Creator
	Identification	
Quantity		Format-Extent
Dimensions	Extent	Format-Extent
	Value	
	Unit	
Material	Extent	Description
	Material	

(4) Search Function Requirements

This part sets which field in the database is searched when key words are entered, and which fields are displayed in the search results (Table 14).

Table 14. Example of a search function requirements table (Excerpt)

Element Name		Key Word Search	Advanced Search Column	Displayed in Search Results
ID				
Identify Number	Accession Number		△	
	Entry Number			
Type			△	▪
Catalog Level				
Title	Title Type			▪
	Title Text	○	△	
Creator	Name	○	△	▪
	Identification			
Quantity				

Element Name		Key Word Search	Advanced Search Column	Displayed in Search Results
Dimensions	Extent			▪
	Value			
	Unit			
Material	Extent			▪
	Material			

(5) Function Requirements

Plan functions of the catalog and display system (Figure 23).

IX. System Function Requirements Description (NPM example)

1. Avoid repeated cataloging

Use the “Accession Number” to check whether or not files were already cataloged.

2. Checking the “Accession Number”

The system has a mechanism for checking and verification the “Accession Number”. There can only be two formats for “Accession Numbers”, the structure of each format is as follows:

Format 1:

Two Chinese characters+6 digits+1 letter+9 digits

E.g. 故宮001233N000000001

Format 2:

Three Chinese characters+4 digits+1 letter+9 digits

E.g. 故宮0567N000000000

3. Copy Function

To save manpower on cataloging, the theme project requires that the system have a record copy function. Cataloging personnel use the search function to find a specific record, press a button on the form to see cataloging data for that record, and only need to modify values for some of the fields. The same data can’t be cataloged if no modifications are made.

Figure 23. Example of System Function Requirements (Excerpt)

III. Cataloging Rules

Some institutes have one designated person to catalog artifact data to avoid inconsistency, which occurs when the task is done by multiple individuals with different thoughts. In order to have multiple people engaged in cataloging while maintaining consistence of cataloged contents, standards need to be established for what and how data is entered into a field; another way is to design the system so that only certain values can selected. Table 15 is an excerpt from the metadata function requirements of Hwa Kang Museum's "Development of a digital archives system for modern precious artifacts" project.

Table 15. Example of cataloging standards (Excerpt)

Element Name			Definition	Cataloging Standard
Identify Number	Accession Number		The artwork's serial number in the digital archives system	Revised from the original classification number Classification number / Classification quantity number 4 digits+4 digits E.g.: Artwork 3.02/65 is cataloged as 03020065 ◎Deposited artwork 1/1126a is cataloged as 01001126a (4 digits+4 digits+the English letter a)
	Entry Number	Serial Number	The artwork's original number when acquired	000681
		Volume Number	The artwork's original number when acquired	(Acquisition year/case number/ case object quantity number) Format 1: 2004/3081/3 Format 2: 1992/2338-1/2 Format 3: 1975/7953-86
		Classification Number	The artwork's original number when acquired	(Classification number / Classification quantity number) Format 1: 3.02/65 Format 2: 1/1126a

Element Name			Definition	Cataloging Standard
Type			The collection's type	Based on the categories of Hwa Kang Museum, selected from a two dimensional code table. First level: Chinese painting/ Calligraphy/ Western painting/ Other Second level: More detailed categories under the first level E.g.: Chinese painting – modern Chinese painting Western painting – water color painting

IV. System Design and Tests

Planning documents, such as the metadata specification and cataloging data, are used by system designers for developing the database, cataloging interface and display system. After development of systems are complete, related personnel run tests on the system to see if they meet requirements, are easy to operate, and whether or not the original plans need to be revised.

V. Artifact Data Cataloging

Besides acquiring data from the artifacts list, relevant literature and research achievements can also be used as reference for cataloging. Holdings institutes can temporarily use Microsoft Excel to record data in accordance with cataloging standards before the system is completed; the Excel files can be converted into XML and imported into the database later on.

IV. Data Storage and Backup

Data stored in the database need to be backed up regularly, preferably keeping remote backup, to avoid losing data due to human or natural defects.

Six. Equipment and Cost Analysis

I. Equipment Selection

In the chapter on preliminary operations, the one shot digital photography method was recommended for Painting and Calligraphy digitization, equipment selection principles related to this recommendation is as follows:

(1) Camera, Digital Back and Lens

Considering future applications of images, it is recommended to use digital single-lens reflex cameras or traditional medium/large format cameras with digital backs. Besides the benefit of being able to exchange lenses, better image quality can be obtained by adjusting the diaphragm, camera shutter and depth of field.

When choosing digital cameras or backs, there are two relatively important factors that have a great influence on image quality, one is the number of pixels and the other is CCD size. For example, for a 1.3 mega pixel and 5 mega pixel camera that both have the same CCD size of 1/2.7 inches, the 5 mega pixel camera will have a higher CCD density than the 1.3 mega pixel camera, and thus provide images with higher quality (Figure 24); for two 5 mega pixel cameras, if one has a CCD size of 1/1.8 inches with the same density as the other with a CCD size of 1/2.7 inches, the average area of a pixel will be larger than the camera with a CCD size of 1/2.7 inches (Figure 25), therefore receiving more color information (brightness and color) and providing better image quality.

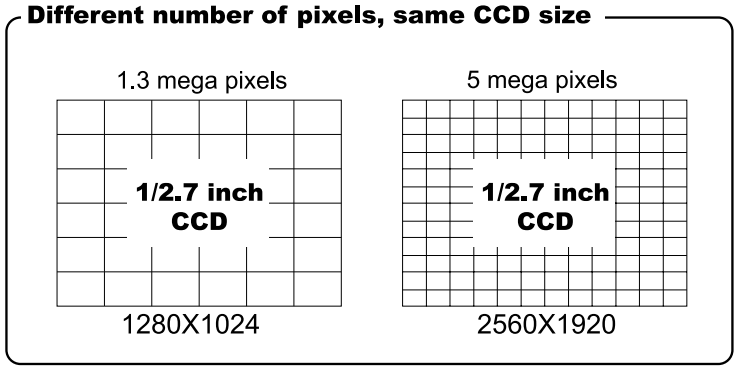


Figure 24. Different number of pixels, same CCD size

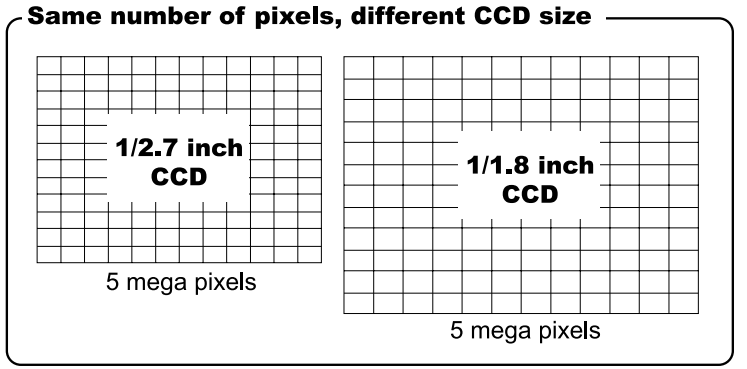


Figure 25. Same number of pixels, different CCD size

Well known camera brands, such as Nikon, Canon, Hasselblad and CONTAX, etc., which are recommended because accessories are easier to purchase and repair is more convenient. PHASE ONE is currently the most common digital back used with these traditional camera brands. With sufficient funds, the fully integrated medium format digital camera launched by Hasselblad this year has 22 mega pixels and is a good option. In addition, a stable tripod and platform that can make detailed adjustments also need to be purchased for setting up the camera.

Lens selection also affects image quality. The light sensing device used by digital single-lens reflex cameras is either CCD or CMOS, both of which are smaller than the film of traditional cameras, causing the focal distance to be multiplied (generally by 1.5 or 1.6) after the lens is installed. Since the objects are fixed and photographed within the photography workroom, zoom lenses are recommended to avoid the need to move the camera.

Furthermore, a macro lens can be installed on the camera for photographing artist signatures, which is a detailed part of painting and calligraphy.

(2) Lights

The paper or canvas used for calligraphy or paintings are made from paper, silk or hemp, and become fragile when shone on by sunlight or artificial light; the different dyestuff used in painting and calligraphy also cause different degrees of deterioration or color fading. Therefore, in order to achieve the purpose of artifact preservation, not only should lights for regular artifact display be controlled, putting artifacts under light for too long should also be avoided. Standard color florescent tubes are recommended for lighting because they are continuous light sources, yet produce less heat than light bulbs with tungsten filaments, minimizing the damage done to artifacts.

(3) Computer

(a) Hardware: Currently, popular computers are divided into two kinds, the PC is for general word processing and the MAC is for processing graphics and publishing, computer selection can be based on the following principles:

(i) Host:

a. PC: Selection keys are CPU speed, motherboard functions and memory. Different equipment results in different computer performance.

b. MAC: Macintosh computers have fixed hardware for different

models and provide significantly higher performance in processing ability and usage convenience. Its system is relatively stable because it doesn't have mixed brands of software that could conflict with each other.

(ii) Random Access Memory (RAM): For different applications to run smoothly, the more RAM a computer has the better, but don't install more RAM than the maximum amount the operating system can utilize. Generally speaking, graphics or image editing software requires at least 512MB or 1GB of RAM.[26]

(iii) Graphics card: Computer systems for image processing should select high performance graphics cards to rapidly process large amounts of RAW files while providing fine and delicate colors. For graphics cards currently in the market, more expensive graphics cards have higher performance, ones with relatively better graphics functions are all above NT$3,000. Cheaper graphics cards or built-in graphics chips are sufficient for general word processing.

(iv) Monitor: Computer monitors in the market are either Cathode Ray Tube (CRT) or Liquid Crystal Display (LCD). The displayed image quality is determined by monitor size, pixel/dot pitch, angle of view, resolution and color depth. If better color management is required, consider using professional monitors, such as EZIO or BARCO. Furthermore, light in the work area might reflect off the monitor and into the user's eyes, causing glare and preventing the accurate determination of colors; installing a monitor will improve the situation.

(v) Hard drive: This is for storing image files and, of course, the bigger the better. Still, file storage should be carefully planned and the size of an image file should be estimated. For better performance, store the operating system and applications on a different hard drive from image files. Furthermore, mobile hard drives can be purchased as an alternative for remote backup.

(vi) DVD recorder: DVD recorders are now very economical and a blank DVD can store 4.7GB of data or even 8.5GB for DVDs writable on both sides, making it a good option for remote backup.

(vii) Interface card: Some digital cameras and mobile storage equipment use FireWire (IEEE 1394) to transfer data, which is preferable option because it is faster and more stable than USB. Select motherboards that have the IEEE1394 function or purchase an additional 1394 interface card.

(b) Software: When selecting software, besides considering its functionality, also notice its minimum system requirements, such as CPU speed, memory, disk space, resolution, CD-ROM drive, operating system and other input/output devices (Figure 26).

Figure 26. Adobe PhotoShop CS2 system requirements[27]

[26] At present, motherboards used in PCs all have dual-channel memory modes. Installing memory into both channels boosts memory performance.

[27] http://www.chinese-t.adobe.com/products/photoshop/systemreqs.html.

Below is an introduction to some commonly used software:

(i) Operating System (OS):

a. PC: Windows XP/2000/NT, Linux

b. Macintosh: The latest operating system version is Mac OS X 10.4 Tiger.

(ii) Image processing software: This is the second most important software besides the operating system. At present, Adobe Photoshop has the largest market share among image editing software and can be used in both operating systems of Macintosh and Windows of PC; the color management software Adobe Gamma in Photoshop allows basic monitor color correction in Windows.

(iii) Webpage design software: Macromedia Dreamweaver, Flash, etc.

(iv) Database software: MySQL

(v) Website server software: Apache

(vi) Other Applications:

a. PC: Microsoft Office (Word, Excel, PowerPoint, Access, etc.), antivirus.

b. Macintosh: Microsoft Office for Mac.

(4) Other Equipment

(a) Gray scale card and color correction card: To check colors of the image file.

(b) Light meter: To ensure that light is evenly distributed and color cast won't occur.

(c) Level: To check if the camera or artifact is level.

The most important thing before buying any equipment is to listen and compare user experiences; also, read test reports in magazines or on the internet to understand a product's condition in the market. For example, if a new model is in the market or the product is no longer produced. Institutes can also invite the manufacturers to introduce and test their product to avoid buying unsuitable equipment.

II. Cost Analysis

Numerous cost estimation variations can result from just the choice of different cameras. Therefore, this guideline only conducts cost analysis for two situations: A basic digital image system (6 mega pixel camera, output size of roughly 10.03×6.68 inches using 300dpi) that achieves basic quality, and an advanced digital image system (10 mega pixel or above camera, output size of roughly 14.2×9.5 inches using 300dpi), which is used by institutes with many years of experience in digitization, such as the National Palace Museum and National Museum of History (Tables 16 and 17). Possible difficulties in manpower, resources and time from preliminary operations, object digitization to database establishment are briefly described. Software/hardware specifications and prices in the cost analysis are based on the supply contract of Central Trust and prices listed on websites (Please see Appendix 3 for detailed specifications and brands of some equipment).

Digital photography can be outsourced and the cost is calculated by case; this way institutes don't need to purchase photography equipment, such as cameras and lights. Using the Lee Shih-Chiao Museum as an example[28], the photography fee for 200 artworks was NT$127,000, about NT$635 per piece, which is relatively cheap and proves the method to be suitable for small quantities of artifacts. However, institutes still need to understand equipment functions to communicate with the photographer and acquire images that meet digitization requirements.

[28] Chung Kuo Institute of Technology Lee Shih-Chiao Fine Arts Museum Project [Western Painting] Procedures Survey http://content.ndap.org.tw/main/doc_detail.php?doc_id=486&class_vision=12.

Table 16. Basic Digital Image System

Procedure	Work Content	Operators (Professional Ability)		Hardware	Software	Standard Basis (Technical Standard, Cost Specification, Quality Requirements, etc.)	Time Consumption	Conclusion (Difficulties, Faults, Features)	Material, Maintenance Fees	Notes
		Number of People	Salary	Name, Quantity, Price	Name, Quantity, Price		Work Hours/ Days			
1	Preliminary Operations: 1.Making a list of artifacts 2.Digitization object selection 3.Digital file specification establishment 4.Establish file naming rules 5.Digitization method selection 6.Manpower Planning	1.Collection manager (To provide or help make the list of artifacts) 2.Researchers 3.Assistant*2 (Has related academic background and at least 1 should be familiar with static photography)	1.Collection manager and researchers may have additional bonuses. 2.Using the NSC's salary for assistants as an example, bachelors: NT30,400 masters: NT34,000	1.PC-Pentium 4.2G or higher (includes monitor) for general word processing and use as a server. Operation system is windows 2000 or higher NT35,000	1.Microsoft Office Chinese standard version 2003 (**Word / Outlook / Excel / PowerPoint**) NT 13,350	1.Make a list of artifacts and plan digitization work in accordance with policies of the holding institute. 2.Select digitization objects based on its class, preciousness, preservation difficulty, and cost effectiveness in research, education and economics. 3.Plan digital file specifications based on the purpose of images. Permanent preservation TIFF, RGB, 300-600dpi. Online browse: JPEG, RGB, 72dpi. 4.Refer to the naming rules of different operating systems. (Such as the National Repository of Culture's file naming rules)	2-3 weeks	1.Work time depends on the quantity and content of artifacts 2.Produce a list of artifacts to refer to when cataloging metadata.		

Procedure	Work Content	Operators (Professional Ability)		Hardware	Software	Standard Basis (Technical Standard, Cost Specification, Quality Requirements, etc.)	Time Consumption	Conclusion (Difficulties, Faults, Features)	Material, Maintenance Fees	Notes
		Number of People	Salary	Name, Quantity, Price	Name, Quantity, Price		Work Hours/ Days			
2	Object Digitization 1.Photography workroom arrangements 2.Borrowing artifacts 3.Size measurement 4.Cleaning the photographic background 5.Positioning the artifact 6.Placing the color chart 7.Set up the camera 8.Adjust lights 9.Light metering 10.Photography 11.Color correction and image cutting 12.Storage and backup	1.Collection manager (To provide or help make the list of artifacts) 2.Researchers 3.Assistant*2 (Has related academic background and at least 1 should be familiar with static photography)	Manpower arrangements here are the same as for preliminary operations.	1.Black flannelette (For hanging over the photographic background) 2.Magnetic photography platform 3.Magnets 4.Cotton gloves (Replace whenever dirty) 5.Brush (For cleaning the photographic background) 6.Tape measure (For size measurement) 7.PC (Same as the one used for preliminary operations) 8.PC-Pentium 4 2.8G or higher (monitor not included, built-in DVD writer) NT 35,000 9.200G 3.5" mobile hard drive NT5,000 10.17" LCD monitor NT10,000 11.Digital Single-lens Reflex Monitor (6 mega pixels or above, includes 18-70mm lens) NT37,900 12.Metal tripod NT4,400 13.Three-faceted platform NT2,000 14.Camera lens hood NT200 15.Color Checker (includes gray scale card and color correction card) 1 set NT1,200 16.Florescent tube (1000W quartz light, frequency 30000 -55000Hz, 2 tubes) 2 lights, NT30,000 17.Light stand * 2 NT5,800 18.Handheld electronic light meter (Supports incident light, light reflection and continuous light measurement) NT6,830	1.Software for word processing is the same as for preliminary operations. 2.Adobe PhotoShop CS 2 Chinese version NT29,300	1.Borrow artifacts according to the rules of each holding institute. 2.Remove all accessories and put on clean gloves before touching artworks. 3.Place color correction cards on both left and right sides of artworks. 4.Use the light meter to see if values of the four corners of an artwork are consistent to achieve even light distribution. 5.After achieving even light distribution, measure the center of the artwork for adjusting the camera shutter and diaphragm. 6.After transferring the photographed image to the computer, use the color checker in the image to check the image; also, check if there is noise in the image. 7.After checking the image, embed the ICC profile and save the file.	1.The photography workroom can be arranged before photography if it is in a fixed location. 2.Workroom arrangement on the day of photography requires 30-60 minutes. 3.Size measurement takes about 20 minutes. 4.Artifact positioning 20 minutes 5.One artwork takes 30-50 minutes from arrangement to photography. 6.Backup images produced every day to other hard drives. 7.Backup files to a DVD every week or month.		1.One blank DVD (4.7G) is NT15-20	

Procedure	Work Content	Operators (Professional Ability)		Hardware	Software	Standard Basis (Technical Standard, Cost Specification, Quality Requirements, etc.)	Time Consumption	Conclusion (Difficulties, Faults, Features)	Material, Maintenance Fees	Notes
		Number of People	Salary	Name, Quantity, Price	Name, Quantity, Price		Work Hours/ Days			
3	Object Digitization 1.Metadata planning 2.Database and system establishment 3.Data cataloging	1.Researchers 2.Assistant 1-2 people (Has related academic background) 3.Work-study student (Has related academic background and system developer)	1.Manpower arrangements here are the same as for preliminary operations. 2.Using the NSC's salary for work study students, the daily wage for a bachelors or higher is NT800	1.PC (Same as the computer used for preliminary operations)	1.General word processing software is the same for preliminary operations. 2.My SQL	1.Designed based on the metadata specification produced during metadata planning.	1.Metadata planning 2-3 weeks 2.Webpage, system design 1.5 months 3.Data cataloging 1 month (depends on the number of artifacts)	1.Produce the metadata specification (includes system planning, cataloging standards, etc.)		

Table 17. Advanced Digital Image System

Procedure	Work Content	Operators (Professional Ability)		Hardware	Software	Standard Basis (Technical Standard, Cost Specification, Quality Requirements, etc.)	Time Consumption	Conclusion (Difficulties, Faults, Features)	Material, Maintenance Fees	Notes
		Number of People	Salary	Name, Quantity, Price	Name, Quantity, Price		Work Hours/ Days			
1	Preliminary Operations: 1.Making a list of artifacts 2.Digitization object selection 3.Digital file specification establishment 4.Establish file naming rules 5.Digitization method selection 6.Manpower Planning	1.Collection manager (To provide or help make the list of artifacts) 2.Researchers 3.Assistant*2 (Has related academic background) 4.Photographer (Familiar with static photography)	1.Collection manager and researchers may have additional bonuses. 2.Using the NSC's salary for assistants as an example, bachelors: NT30,400 masters: NT34,000	1.PC-Pentium 4.2G or higher (includes monitor) for general word processing and use as a server. Operation system is windows 2000 or higher NT35,000	2.Microsoft Office Chinese standard version 2003 (**Word / Outlook / Excel / PowerPoint**) NT 13,350	1.Make a list of artifacts and plan digitization work in accordance with policies of the holding institute. 2.Select digitization objects based on its class, preciousness, preservation difficulty, and cost effectiveness in research, education and economics. 3.Plan digital file specifications based on the purpose of images. Permanent preservation TIFF, RGB, 300-600dpi. Online browse: JPEG, RGB, 72dpi. 4.Refer to the naming rules of different operating systems. (Such as the National Repository of Culture's file naming rules)	2-3 weeks	1.Work time depends on the quantity and content of artifacts 2.Produce a list of artifacts to refer to when cataloging metadata.		

Procedure	Work Content	Operators (Professional Ability)		Hardware	Software	Standard Basis (Technical Standard, Cost Specification, Quality Requirements, etc.)	Time Consumption	Conclusion (Difficulties, Faults, Features)	Material, Maintenance Fees	Notes
		Number of People	Salary	Name, Quantity, Price	Name, Quantity, Price		Work Hours/ Days			
2	bject Digitization 1.Photography workroom arrangements 2.Borrowing artifacts 3.Size measurement 4.Cleaning the photographic background 5.Positioning the artifact 6.Placing the color chart 7.Set up the camera 8.Adjust lights 9.Light metering 10.Photography 11.Color correction and image cutting 12.Storage and backup	1.Collection manager (To provide or help make the list of artifacts) 2.Researchers 3.Assistant*2 (Has related academic background) 4.Photographer (Familiar with static photography	Manpower arrangements here are the same as for preliminary operations.	1.Black flannelette (For hanging over the photographic background) 2.Magnetic photography platform 3.Magnets 4.Cotton gloves (Replace whenever dirty) 5.Brush (For cleaning the photographic background) 6.Tape measure (For size measurement) 7.PC (Same as the one used for preliminary operations) 8.Apple Mac G5 or higher (monitor not included, built-in DVD writer) NT74,900 9.200G 3.5" mobile hard drive NT5,000 10.Apple 20" LCD monitor NT27,900 11.Hasselblad Medium Format Camera (22 mega pixels) NT850,000 12.Metal tripod NT4,400 13.Three-faceted platform NT2,000 14.Camera lens hood NT200 15.Color Checker (includes gray scale card and color correction card) 1 set NT1,200 16.Florescent tube (2000W quartz light, frequency 30000 -55000Hz, 2 tubes) 2 lights, NT52,500 17.Light stand * 2 NT5,800 18.Handheld electronic light meter (Supports incident light, light reflection and continuous light measurement) NT6,830	1.Software for word processing is the same as for preliminary operations. 2.Adobe PhotoShop CS 2 Chinese version NT29,300	1.Borrow artifacts according to the rules of each holding institute. 2.Remove all accessories and put on clean gloves before touching artworks. 3.Place color correction cards on both left and right sides of artworks. 4.Use the light meter to see if values of the four corners of an artwork are consistent to achieve even light distribution. 5.After achieving even light distribution, measure the center of the artwork for adjusting the camera shutter and diaphragm. 6.After transferring the photographed image to the computer, use the color checker in the image to check the image; also, check if there is noise in the image. 7.After checking the image, embed the ICC profile and save the file.	1.The photography workroom can be arranged before photography if it is in a fixed location. 2.Workroom arrangement on the day of photography requires 30-60 minutes. 3.Size measurement takes about 20 minutes. 4.Artifact positioning 20 minutes 5.One artwork takes 30-50 minutes from arrangement to photography. 6.Backup images produced every day to other hard drives. 7.Backup files to a DVD every week or month.		1.One blank \ DVD (4.7G) is NT 15-20 Images taken by a Hasselblad H1D medium format digital single-lens reflex camera can reach 132MB, meaning that one DVD can store roughly 35 images.	

Procedure	Work Content	Operators (Professional Ability)		Hardware	Software	Standard Basis (Technical Standard, Cost Specification, Quality Requirements, etc.)	Time Consumption	Conclusion (Difficulties, Faults, Features)	Material, Maintenance Fees	Notes
		Number of People	Salary	Name, Quantity, Price	Name, Quantity, Price		Work Hours/ Days			
3	Object Digitization 1.Metadata planning 2.Database and system establishment 3.Data cataloging	1.Researchers 2.Assistant*2 (Has related academic background) 3.Webpage, system designers (outsourced production)	1.Manpower arrangements here are the same as for preliminary operations. 2.The price for webpage design is based on pages, NT$2,000 ~3,000 per page	1.PC (Same as the computer used for preliminary operations) 2.PC-Pentium 4 2G or higher (includes monitor) for use as a server NT35,000	1.General word processing software is the same for preliminary operations. 2.My SQL 3.Linux	1.Designed based on the metadata specification produced during metadata planning.	1.Metadata planning, 1 month 2.Webpage, system design 1.5 months 3.Data cataloging 1 month (depends on the number of artifacts)	1.Produce the metadata specification (includes system planning, cataloging standards, etc.)		Source of webpage design price http://www.laypu.com/service/service04.htm

Seven. Benefits and Prospects

This guideline on the digitization of paintings and calligraphy has combined the experiences and approaches of many institutes in the National Digital Archives Project and supported it with related theories. Its purpose is to help institutes that wish to engage with digitization work to rapidly become familiar with the whole procedure and begin planning.

This guideline is a first version and has many contents that require improvement, such as how digitization work should be carried out under different management methods, Painting and Calligraphy types and budgets; the continuous development of new technologies also makes it hard to define details in the procedure. This is why only the most fundamental principles for each procedure were described, so that readers of this guideline will have more flexibility to make suitable plans according their own requirements. This guideline also hopes to make the following contributions:

(1) Allow holding institutes and individuals that wish to participate in artifact digitization to easily understand digitization procedures guideline.

(2) Expect this guideline that can be standard operations procedures. Then, the digitization procedures can help institutes save time on training new recruits and ensure that all tasks are handed over when personnel are replaced.

(3) Implement SOP in the digitization procedure to accelerate work progress and control digital content quality.

(4) Formulate digitization procedure standards by establishing SOP, and widely provide them to participants of the National Digital Archives Program and holding institutes about to establish digital archives.

Although this guideline hasn't yet completeness, we intend to adjust its contents along with environment changes and make it more appropriate for future situations.

Eight. Conclusions

When the National Digital Archives Program just began, every institute in the program invested tremendous amounts of manpower and efforts in the digitization of precious artifacts; they all had a vision that collections wouldn't be limited to museums, not to mention locked away in repositories. Technology has allowed these artifacts to be presented to the public, and even to the world via the internet, allowing more people to understand the extensive and profound Chinese culture, while accelerating the applications of digital content in industries and education.

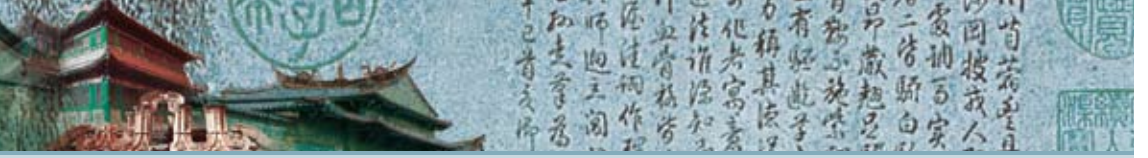
For this purpose, this guideline hopes to combine tacit knowledge and explicit knowledge[29] and provide a basis for institutes that wish to engage in digitization work to refer to when writing their proposals or selecting equipment. We often hear the saying "changes supersede plans"; the development of technology is truly astonishing. Even so, we still hope that this guideline will be able to provide the reader with keys and experiences of digitization work, allowing digitization work to not just belong to large holding institutes, but can be easily learned and operated.

Digital contents cannot be completed by one single person or institute. It requires selfless sharing, provision of experience accumulated over the years, and full devotion. Only in this way will the best quality be obtained and rich cultural assets be more effectively displayed and applied.

Here the author would like to thank project directors and related personnel of the National Palace Museum, National Museum of History, Chinese Culture University and Chung Kuo Institute of Technology for setting aside time in their busy schedules to assist the survey of this guideline, allowing this guideline to have more detailed information on the operation situation and experiences of each unit and causing the digitization reference standard to be more complete. The author would also like to thank Professor Ming-Ching Hsu of the Department of Information Communications, Chinese Culture University for providing his valuable opinions on the reference standards in this guideline.

The author would also like to thank project director Mr. Fu-Shih Lin and joint director Mr. Peng-Sheng Chiu for their encouragement and guidance and colleagues for their assistance during the production of this guideline.

[29] Tacit knowledge is personal knowledge that can only be perceived, including technology and cognition; explicit knowledge is knowledge that can be conveyed verbally. (Wen-Hsien Chen, 2002, page 288)



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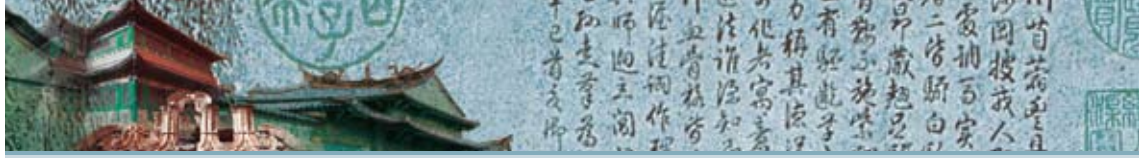


【Appendix 2】 Projects of the Painting and Calligraphy Thematic Group Over the Years

Thematic Group Convener:	Director Yao-Ting Wang of the National Palace Museum Department of Painting and Calligraphy
Thematic Group Contact Person:	Mr. Tung-Chih Hsieh of the National Palace Museum Department of Painting and Calligraphy

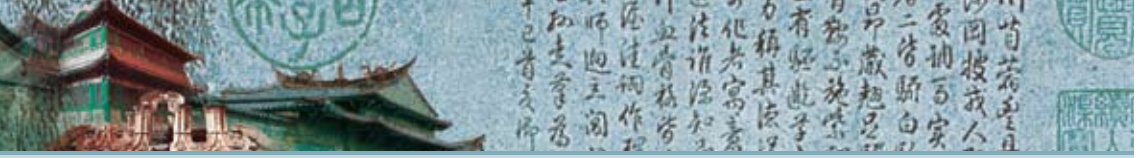
Unit	National Palace Museum
Project Name	National Palace Museum Cultural Artifacts Digital Archives System Development – Painting and Calligraphy Digital Archives Subproject
Project Website	http://www.npm.gov.tw/dl/03/index03.htm
Project Implementation Period	2002~
Director	Miss Fang-Ju Liu, Section chief of the National Palace Museum Department of Painting and Calligraphy
Contact Person	Mr. Tung-Chih Hsieh of the National Palace Museum Department of Painting and Calligraphy E-mail: hitosi3@npm.gov.tw
Introduction	The National Palace Museum's collection of paintings and calligraphy by famous masters are roughly from the 10th century (early Northern Song) to the 18th century (Chien Lung emperor of the Ching Dynasty). In recent years, the National Palace Museum has also been collecting the works of modern artists, and the number of calligraphy, rubbings, paintings and embroideries kept by its Department of Painting and Calligraphy is now over 10,000. Contents of the project include establishing a painting and calligraphy collection management system, exhibition management system, and unifying databases of name authority, Painting and Calligraphy terms, and seals. For digital images, besides photographing artifacts and outsourcing the digital scanning of film, in 2004, the National Palace Museum began planning a painting and calligraphy digital image capture system to accelerate digitization, reduce cost, and achieve the goal of digitizing its whole collection.

Unit	National Museum of History
Project Name	Digital Collection System of the National Museum of History
Project Website	http://nmh-ndap.nmh.gov.tw:8080/index.htm
Project Implementation Period	2002~2006
Director	Mr. Yung-Chuan Huang, Deputy Director of the National Museum of History
Contact Person	Miss Shu-Chuan Su of the National Museum of History E-mail:nv2ah6@nmh.gov.tw
Introduction	This project divides paintings and calligraphy into the following 5 categories for digitization: prints, Chinese paintings, calligraphy, Western paintings and photography, and has carried out digitization according to the schedule in its proposal. Its tasks include: (1) Developing metadata and related systems for the digitization of its painting and calligraphy collection. (2) Planning the digitization of its collection and establishing an image file storage and management system and standard work procedures. (3) Cooperating and sharing resources with other members of the Painting and Calligraphy Thematic Group. By carrying out the above mentioned tasks, the project gradually establishes a collection digitization system and digitization work mechanisms and environment for the museum, achieving effective production, management of knowledge and full utilization of various digitization resources; the digital files are provided for value-added applications, such as research, education, and promotion of culture.

Unit	Chinese Culture University
Project Name	Development of a digital archives system for modern precious artifacts
Project Website	http://140.137.11.178/hkm/System/public/index.jsp
Project Implementation Period	2004~ 2006
Director	Administrative Project: Mr. Shun-Tzu Tsai, Director of Information Center, Chinese Culture University Subproject: Miss Ming-Hsiang Chen, Director of the Chinese Culture University Hwa Kang Museum
Contact Person	Administrative Project: Mr. Chun-Hsiung Cheng of Chinese Culture University Information Center E-mail: jasoncheng@staff.pccu.edu.tw Subproject: Miss Shu-Yuen Chen of the Chinese Culture University Hwa Kang Museum E-mail:yuan@staff.pccu.edu.tw Miss Yen-Hua Sung of the Chinese Culture University Hwa Kang Museum E-mail:syh2@staff.pccu.edu.tw
Introduction	From Hwa Kang Museum's collection of Chinese paintings, water color paintings and oil paintings by modern and contemporary artists, 450 artworks of birds and flowers, figures and animals, themes that possess historical heritage and cultural connotation, were selected for high quality digitization. After completing digitization, artifact metadata was established based on the latest international standards. The establishment of a digital archives database allowed the school's collection of artifacts to become organized and provided consistent management; this benefits future exhibitions, thematic object selection and artifact preservation and allows the provision of services including artifact appreciation, education, research, management and publishing. The digital archives Painting and Calligraphy management system developed by Academia Sinica Institute of Information Science was introduced in the first year of this project. With the foundation of two systems including the multimedia center's system, the project continued to develop the system to enhance archive management functions. The digital museum's website design was reinforced to provide good Painting and Calligraphy appreciation services and to meet requirements of the Union Catalogs of Digital Archives System, providing XML exchange format data to satisfy integrated search services. Furthermore, the project was also engaged in the research of value-added applications (includes e-learning) to elevate the value of digital archives.

Unit	Chung Kuo Institute of Technology Department of Visual Communication Design
Project Name	Lee Shih-Chiao Fine Arts Museum Project
Project Website	http://dnastudio.ckitc.edu.tw/li-digital/
Project Implementation Period	2004
Director	Mr. Fu-Kuang Chien Dean of the Department of Technology Department of Visual Communication Design, Chung Kuo Institute of Technology
Contact Person	Miss Hsiao-Peng Chien of Chung Kuo Institute of Technology Department of Visual Communication Design
Introduction	Mr. Shih-Chiao Lee was one of the leaders of Taiwan's early art movement, his conscientious and careful attitude towards art creation, rich thoughts and critical personality have all contributed to his unique and skillful painting style. He educated quite a few second and third generation excellent artists of Taiwan, and is an invaluable asset to Taiwan's art circle. The over four hundred oil paintings, water color paintings and sketches that Mr. Shih-Chiao Lee left after he passed way are collected in the Lee Shih-Chiao Museum. These artworks are an important cultural heritage in Taiwan's history of art and need to be carefully preserved for future generations to appreciate and study. The purpose of this project is to digitize paintings and manuscripts collected in the Lee Shih-Chiao Museum and establish a Lee Shih-Chiao Digital Museum. The completion of this project is expected to benefit the popularization of art education and elevation of social culture.

Unit	Chung Kuo Institute of Technology Department of Visual Communication Design
Project Name	Li Tse-Fan Sketches and Manuscript Digital Museum Project
Project Website	
Project Implementation Period	2005
Director	Mr. Fu-Kuang Chien Dean of the Department of Technology Department of Visual Communication Design, Chung Kuo Institute of Technology
Contact Person	Miss Yin-Hsia Fan of Chung Kuo Institute of Technology Department of Visual Communication Design E-mail: yin.hsia@msa.hinet.net
Introduction	Li Tse-Fan is an important artist to Taiwan's art development during the Japanese Occupation, and is also an art educator that devoted his life to the education of countless talents. His paintings, books and related data are now collected in the Li Tse-Fan Museum. These precious data are important cultural assets to Taiwan's history of art development and should be passed down to future generations; especially the sketches, each picture records a step in the master's spiritual course, possessing even more value for appreciation and study. The purpose of this project is to digitize the sketches and manuscripts collected in the Li Tse-Fan Museum and establish a Li Tse-Fan Sketches and Manuscript Digital Museum.



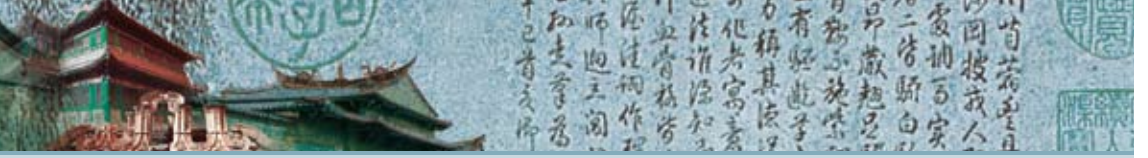
【Appendix 3】 Detailed Specifications of Equipments in the Cost Analysis Table

Note: The specifications and prices below are only for reference.

Equipment Name	Specification	Price	Source
Nikon CoolPix D70s Digital Camera	· Effective Pixels: 6.1 mega pixels · Image Sensor: RGB CCD, 23.7 x 15.6mm, 6.24 mega pixels · Storage Media: CompactFlash™ (CF) Card (I/II Type) and Microdrive™ Please refer to the website for more detailed specifications.	NT37,900	Yahoo Shopping Center http://buy.yahoo.com.tw/gdsale/gdsale.asp?gdid=53340
MATIN Rubber Standard Lens Hood	Suitable for 55mm lens	NT180	Keystone http://www.kphoto.com.tw/front/bin/ptdetail.phtml?Part=AM-6234&Category=59622
Kodak Q-13 Color Checker	The attached gray scale card and color correction card both have a ruler on it, 8.5 inches long.	NT1,200	Keystone http://www.kphoto.com.tw/front/bin/ptdetail.phtml?Part=ATFKQ13&Category=59358
MANFROTTO 055D Tripod	Assembled Height: 61 cm Shortest Height: 56 cm Longest Height: 181 cm Tripod Leg Diameter: 30,25,20 Weight: 2.2 Kg Maximum Capacity: 6 Kg	NT4,400	Keystone http://www.kphoto.com.tw/front/bin/ptdetail.phtml?Part=ACC045351&Category=59339
Three-faceted Platform	The three facets can be controlled independently, comes with safety plates that can be rapidly removed, and can hold medium and large cameras. Weight: 1.05KG Capacity: 6KG Height: 14CM	NT2,000	Keystone http://www.kphoto.com.tw/front/bin/ptdetail.phtml?Part=AFE0276&Category=59343
SLS FL-110A Fluorescent Lamp	High power light emission equal to a 1000W quartz lamp Type: FL-110 Tube: 55W×2 Operating Voltage: 110V Color Temperature: Standard color temperature 5500+-300K Frequency: 30000-55000Hz Light Adjustment: Full light - 1/10 light/comes with power adjustment knob Dimensions: 59×22×8cm Weight: 6Kg Accessories: Four reflection plates, power adjustment knob	NT15,000	Keystone http://www.kphoto.com.tw/front/bin/ptdetail.phtml?Part=ATK073&Category=59386
SLS FL-110A Fluorescent Lamp	High power light emission equal to a 2000W quartz lamp Tube: 55W×4 Operating Voltage: 110V Color Temperature: Standard color temperature 5500+-300K Frequency: 30000-55000Hz Light Adjustment: Full light - 1/10 light/comes with power adjustment knob Dimensions: 59×43×11cm Weight: 13Kg Accessories: Four reflection plates, power adjustment knob	NT26,250	Keystone http://www.kphoto.com.tw/front/bin/ptdetail.phtml?Part=ATK0720&Category=59386
SLS-LS96HAB Medium Air Pressured Light Stand	Positive pole black coating aluminum tube, surface treated to prevent reflection, and air pressured anti shock center pillar extends the lifespan of lights. Contracted Height: 111 cm Height: 125.5-286 cm Net Weight: 1.85KG Capacity: 7 KG	NT2,900	Keystone http://www.kphoto.com.tw/front/bin/ptdetail.phtml?Part=ATK0037

Equipment Name	Specification	Price	Source
POLARIS Electronic Light Meter	· Incident light, light reflection measurement · Continuous light measurement · Wired, wireless flashlight measurement · Multiple flashlight calculation · Power saving design · Uses one AA battery · Displays remaining power · Personalized EV micro adjustment · Range EV1-19.9 · Accuracy 0.1EV · Weight 93 grams	NT6,830	Keystone http://www.kphoto.com.tw/front/bin/ptdetail.phtml?Part=AJE004&Category=59181
Power Mac G5 Dual 2.0G	· CPU dual 2.0GHz PowerPC G5 · L2 cache 512K (per CPU) · Standard memory 512MB PC3200 (400MHz), supports up to 4GB of memory · Hard drive capacity and interface 160GB Serial ATA; 7200 rpm · Graphic card ATI Radeon 9600, equipped with 128MB DDR SDRAM, two single-link DVI ports Please refer to the website for more detailed specifications.	NT74,900	OBuy – Macintosh's Store http://sh2.obuy.com.tw/macshop/item.asp?item_id=1038938

Equipment Name	Specification	Price	Source
Apple 20 Inch Monitor	· Monitor Size: 20 Inches · Monitor Weight: 6.6 Kg · Display Area: 20 Inch · Dot Pitch: 0.258 mm · Recommended Resolution: 1680x1050 pixels (Best Resolution) · Highest Resolution: 1680x1050 pixels · Vertical Frequency: Vertical 170° · Horizontal Frequency: Horizontal 170° · Color support: 16.7 million colors · Brightness: 270 cd/m2 · Contrast: 400 : 1 · Response Time 16 ms Please refer to the website for more detailed specifications.	NT27,900	OBuy – Macintosh's Store http://sh2.obuy.com.tw/macshop/item.asp?item_id=1038965
Hasselblad H1D Medium Format Digital Single-lens Reflex Camera	· 22 mega pixels · CCD area is 49x36.7mm, roughly two times that of a 135 frame · Can output 66MB (8-bit) or 132MB (16-bit RGB) images Please refer to the website for more detailed specifications.	NT 850,000	Photosharp http://digital.photosharp.com.tw/DIGITAL/Content.aspx?News_No=2261&Lang=0



【Appendix 4】Related Websites of Painting and Calligraphy Digitization Standards

1.	National Digital Archives Program http://ndap.org.tw
2.	National Digital Archives Program Content Development Division http://content.ndap.org.tw
3.	National Digital Archives Program Painting and Calligraphy Thematic Group http://content.ndap.org.tw/main/vision_brief.php?class_vision=12
4.	National Digital Archives Program Content Development Division Subproject 3: Union Catalogs of Digital Archives System Establishment Project http://catalog.ndap.org.tw/
5.	National Digital Archives Program Research and Development of Technology Division http://dats.ndap.org.tw/
6.	National Digital Archives Program Metadata Architecture and Application Team http://www.sinica.edu.tw/~metadata/
7.	National Digital Archives Program Applications and Services Division http://turing.csie.ntu.edu.tw/aps/
8.	National Digital Archives Program Training and Promotion Division http://dlm.ntu.edu.tw/dlm/
9.	National Palace Museum Cultural Artifacts Digital Archives System Development – Painting and Calligraphy Digital Archives Subproject http://www.npm.gov.tw/dl/03/index03.htm
10.	Digital Collection System of the National Museum of History http://nmh-ndap.nmh.gov.tw:8080/index.htm
11.	Chinese Culture University Development of a digital archives system for modern precious artifacts http://140.137.11.178/hkm/System/public/index.jsp
12.	China Institute of Technology Department of Visual Communication Design Lee Shih-Chiao Digital Museum Project http://dnastudio.ckitc.edu.tw/li-digital/
13.	National Repository of Culture http://km.cca.gov.tw/
14.	Photosharp http://www.photosharp.com.tw/photosharp/
15.	Keystone (Specializes in photography equipment) http://www.kphoto.com.tw/front/bin/home.phtml
16.	Arclink http://www.arclink.com.tw/

Painting and Calligraphy Digitization Procedures Guideline

Publisher: Taiwan Digital Archives Expansion Project

Editor-in-Chief: Peng-Sheng Chiu

Executive Editor: Huei-Jing Lin

Author: Hsiu-Hua Chen

Copy-Editor: Shun-Tzu Tsai

Transfer: International Collaboration and Promotion of Taiwan e-Learning and Digital Archives Project

Typesetting: Ya-Chen Tsai

Printing Co: Hegu Exquisite Printing Co., LTD.

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Publish Date: 1st Edition November 2008

ISBN: 978-986-01-4420-8（平裝）