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The use of photography for manuscript preservation

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The objective of this report is to briefly illustrate the experience acquired during the works of photographic reproduction of the manuscripts of the Vatican Library in view of their physical preservation.

We'll start with a small digression on the Vatican Library collections:

The Library contains hundreds of thousands of volumes printed during the last centuries, tens of thousands of ancient engravings and drawings, and one of the most important numismatic collections in the world with more than 400,000 coins and medals. Even with such richness of art work and cultural artifacts, the patrimony of manuscripts and the collection of ancient printed books are the most important in terms of value, prestige and rarity. The ancient printed books – that means incunabula and 16th-century-books - are tens of thousands, while the

manuscripts amount to about 150.000, half of which are of an archival nature. The other half is represented by manuscript books. With this the Library continues its long tradition of service (only interrupted now because of urgently needed building repairs) for the common use of learned men “pro communi commodo doctorum virorum”, established right from the beginning, with provident and generous attentiveness, by its modern founder, Pope Nicolò V, and then continued by his successors.

Nevertheless, these precious relics should not only be accessible and consultable but also adequately preserved, together with their contents. Books are fragile: evanescent writings, inks that corrode paper, pigments that come off: together with needed restoring interventions, reproductions are necessary so that the possibility of consulting and studying the manuscript is not necessarily related to its physical state and preservation problems.

Handwritten books are considered to be part of the “cultural heritage”. But generally they have been thought to be part of this category much later than other objects, as compared to, for example, drawings or sculptures. Why is this? The reason is connected to its material dimension: books are not inseparably connected to the texts that they contain. The text which is the real “cultural heritage”, can be memorized or exist separately from its holder, but the material piece of the book, per sé was generally not considered to have the same importance for a long time. This can be seen clearly from the fact that in many manuscripts, especially medieval ones, in order to fit them better on the shelves there they were supposed to be placed, the parchment pages were sometimes cut at the edges, at times also cutting away part of the decorations. But now, as the manuscript (meaning the codex together with the text contained in it) has gained the status of a piece of “cultural heritage”, new questions arise. Beyond the questions of how to evaluate it and how to make it the object of the appropriate paleographical, philological and codicological research, there are also the questions of how to protect it and how to conserve it over time as a precious and unique physical unit which is a witness to culture and which in its materiality is truly “cultural heritage”. How can photography be useful to conservation? Only by reproducing the manuscript in the best way possible, with as high a resolution as possible and reliable chromatic performance.

In this way images can be produced that can not only gradually replace the originals for study and in scientific research, but that can satisfy any possible future need for use (facsimiles, art prints, reproductions for scholars, multi-page files in a PDF-format, images to be published on the internet and many more). In this way master files are acquired that can correspond to all necessities of storage and long-time conservation and so protect the original. Furthermore, photography can assume the function of an investigatory and experimental instrument when it doesn't try to reproduce reality, but tries to investigate and to discover things which are invisible to the human eye. I will return to both points afterwards.

First of all, to make sure that the digital acquisition of a manuscript is durable and reliable over time, it is necessary to consider the standards of "best practice" of digital photographic capture of Cultural Heritage. Such standards have been actually more or less established. During the last years uncertainty regarding resolution, file format, color management, bit depth, calibration of monitors and printers and other parameters of acquisition and handling of digital images has actually been very great, but fortunately relatively certain standards have been now developed. Many research projects and institutions are involved in this scientific field of study. National and international projects of Digital Library Development created a shared set of guide lines and standards for the digitizing of cultural heritage. The European projects MINERVA and MICHAEL, which are contributing to the realization of Europeana, the European Digital Library, are engaged in this sense.

While questions regarding application of photographic parameters have been, more or less, resolved, there are still some doubts regarding the file format to use. A question which is of fundamental importance for conservation is the following: Is it really worth choosing the TIF format for long term preservation, as the most important libraries in Europe are currently doing and as the most wide-spread guide lines recommend? Or should we ask ourselves if this is perhaps a choice determined by habits and probably influenced by commercial strategies? TIF is not yet a registered trademark but it is a property format, and this brings with it a certain amount of doubts and uncertainties regarding its use over the middle and long term. At the worst, one day it could be impossible to open such files without paying a certain amount established by the owner of the trademark. This situation puts the

TIF format in that of a visualization format more than in the category of a storage format.

Similar questions do exist regarding the different RAW formats. RAW formats are owned by the corresponding digital camera producers and for this reason they are susceptible to certain characteristics which will limit their sure and reliable use and conversion over time. The RAW acquisition format of the camera permits the later adjusting of shooting parameters, making it possible to correct the white balance and the chromatic aberrations of the lens, and improve exposure, sharpness, contrast, brightness and saturation. It allows so the shooting of images without having adjusted these parameters perfectly. Unfortunately, however, sometimes certain RAW formats of the old generation, being owned by the acquisition system, also after only a few years are correctly decodable only by the specific firmware of the corresponding digital camera.

The compression format JPG is an open source format, but its byte number can change every time it is opened, and the loss of information grows every time it is saved; thus it cannot be considered a suitable format for conservation of digital data.

On the other hand, the JPG 2000 format - which is an ISO-standard - has been partially considered suitable to substitute the TIF as a storage format because of some of its particular characteristics, and first of all because it is based on the new concepts of multi-resolution and because, having the same weight as JPG, it supplies much higher quality levels. Nevertheless, because of the scarcity of software for visualization and elaboration and the present insufficient support from most of the major web browsers it has had a slow start and has not been used widely.

A well known and equally feared problem regarding primarily compression formats is data loss during the migration phase of the file from one storage support to another. During a physical migration phase of a file its decompression algorithm can encounter difficulty of correct execution. In our Library, corruption of digital images acquired from the Urbinate manuscripts which were the property of the Duke of Montefeltro, occurred. The images had been stored in TIF, a non compressed format which, anyway, may obviously encounter the same difficulties.

That having been said, a secure and reliable storage format for digital images must fulfill several quality requirements. It would have to be able to support 16 bits of color depth (which are not really necessary for the visualization of image but to guarantee greater precision in rounding off calculation values during elaboration). It would have to be able to receive descriptive and administrative metadata and an invisible watermark. It would need to be able to be compressed without any losses of quality. But above all, there should be the certainty that it is not encoded or tied to a commercial distributor.

The relative uncertainty of which digital storage format to adopt, the impending problem of the technological obsolescence of storage supports, and the need for constant and appropriate procedures of data migration, all impacted the decision-making process of the Vatican Library. The Library considered the necessity of acquiring a machine with the capacity to transfer digital images of its objects to analog support in order to ensure better conservation of its digital data and, as a result, of its originals. Actually a safer support than microfilm doesn't exist because it will always be able to be read at least with a pocket-lens and a light source. In our Library the awareness for the need for protection of the physical object of the codex as well as of its content, so the two real "cultural heritages" to be preserved and passed on to future generations, is always alive and present. For this reason since the 40's of the last century, reproductions on negative microfilms of texts have been made. Now about 70 % of the manuscripts in codex form are already reproduced in an analog way, and two big collections of ancient printed books – the Stampati Palatini and the Cicognara – have been entirely reproduced in microfiche. So, the rest of the collections will be reproduced digitally, and then stored on microfilm, using appropriate equipment, in order to guarantee long term preservation of digital data and provide for disaster recovery. In this sense, the project can also be seen as the ideal continuation of the microfilming campaign of Vatican manuscripts desired by Pope Pius XII. Led by the material destruction of the last world war, a large microfilming project of the Vatican manuscripts was done, and a secure deposit of these microfilms was created overseas during the 1950's. This collection of microfilms is now consultable at the *Vatican Film Library*, created especially at Saint Louis University in the United States.

The passage from digital to microfilm using special equipment makes it possible for digital formats in black and white, grey scale and color to 16 and 35 mm microfilm with a 11.000 by 7.000 pixel resolution on film and with a production speed of ca. 1.000 images in one hour. Automatic fade-in of the metadata is possible. Obviously file quality has a considerable impact on the definition and legibility of the image stored on microfilm. Considering the ultimate purpose of this operation which is the conservation of originals, high quality digital acquisition of objects which have to be stored has become an almost indispensable condition. [But normally microfilms should give access to texts: so also lower resolution in some cases is acceptable]. The choice of black and white microfilm instead of color microfilm was inspired by the same principle, because black and white microfilm has a much higher guaranteed duration over time than the colored one.

In the last few years many efforts have been made by the International scientific community to once again gain access to the palimpsest scripts. Also the Vatican Library has undertaken a project of this kind in the planning of which, the aspect of the material conservation of the palimpsest manuscripts has had a determined influence. We considered the fact that the treatment of palimpsest sheets with Gallic acid, applied during the XIX century in order to make the writing underneath visible, is making the scripts more and more illegible, resulting in the irreversible advancing of the oxidation processes caused by the Gallic acid itself. An example of this is the Ciceronian palimpsest Vat. lat. 5757, of which, at times, the analog reproductions made in the 30's of the last century were much more legible than the original and the digital reproductions made recently of the same folios.

This makes it necessary to acquire images as quickly as possible. For this reason, neither a multispectral acquisition system (which uses different kinds of visible and invisible light and filters, then placing one image on another and integrating them) was chosen, nor a scientific-experimental system (where analysis of the different wave-lengths of the visible and invisible electromagnetic spectrum can be done in a selective way, "cutting up" the spectrum in many side by side bands and analyzing them "on the fly"). Both of them would be time-consuming,

and at least the second one would also require the presence of specialists in paleography and philology during the shootings. For this reason we chose an acquisition system made of two very high resolution scanners which capture with natural light and ultraviolet light at fixed frequency, producing two identical images of the same palimpsest page. In this way, with our system, images can be stored, and the analysis of the writings can be done afterwards, sometimes even after many years. This particular aspect has made it indispensable to adopt a resolution with much thrust (1.200 dpi on an A4, that means a spatial resolution of ca. 10.000 by 14.000 pixels) in order to effectively utilize the pictures in the future. Regarding the deciphering of the writings, an *ad hoc* written software program allows the two images to be superimposed, processed and integrated in order to isolate and extrapolate the various levels of script, the upper, under, and, if it exists, also the median one.

There are cases in which our scanning system at the fixed frequency of 254 nm of ultraviolet light gave scarce results because of the great presence of Gallic acid on the sheets making them very dark and impenetrable at determinate wave lengths also in the ranges of the invisible spectrum. I am referring to a palimpsest manuscript which contains, in the “scriptio inferior”, the letters of Frontone, a text which has been discovered and treated with chemical reactants, like the Ciceronian one which I mentioned before, by Angelo Mai. Therefore it was necessary to fall back on multispectral imaging, doing several acquiring experiments using further light sources, like infrared, and then ultraviolet fluorescence. Surprisingly, the acquisitions on infrared ranges didn't supply better legibility, while the reproductions with fluorescence gave very good results. The fluorescence is the property of some substances to re-emit at higher frequencies the received radiations, especially to absorb ultraviolet light and to re-emit it in the visible spectrum. The re-emitting of fluorescence depends on the contribution of the work's external layers, that means in our case on the chemical compounds of Gallic acid and on the ink composed by pigments and binders and on their chemical interactions. This principle of absorption and successive re-mission of light was the right approach that allowed us, working with a digital camera of 12 MP equipped with Kodak Wratten filters for the ultraviolet and with a special lighting system in ultraviolet fluorescence at 366 nm, to get into the dark layer of Gallic acid, consequently obtaining a good restitution of the submerged writings. So in this case

a compromise was reached. The very high resolution of the usual scanning system was sacrificed in favor of the greater legibility obtained with a digital camera with minor resolution.

Please allow me to illustrate for you an example of a high quality reproduction of a parchment manuscript sheet of the XI. Century, containing the Chronicle of Marianus Scottus. In this case, image quality – due to very high resolution and good color fidelity of the acquiring device – permits not only the examination of the writing in great detail, but also the lining as well as the pricking at the border of the sheet. Using a good reproduction the scholar will also be able to distinguish the flesh side of parchment from the hair side.

Writings that have been impressed by a dry point technique onto the membrane (like in this example in the marginal notes of the famous manuscript of late antiquity, the so called “Palatine Virgil”) although practically non-existent to the naked-eye, have been made visible in a digital reproduction which used oblique incidence of ray of illumination, so-called raking light. In this way exposition of the codex to long and potentially damaging examinations by autopsy can be avoided.

A hint at the so called “virtual restoration”: the famous and in part autographic manuscript of the “Canzoniere” of Petrarca of the XIV century presents some deteriorated and less legible pages, mainly because of fading of the inks. These pages have been acquired with a special technique using ultraviolet light and elaborating successively the files, operating on contrast, luminance and other parameters, integrating virtually the missing ink parts. However, it must be said anyway that these operations, even if run very scrupulously, always leave a margin of arbitrariness. Certainly, it is difficult to establish how close the so-called “reconstructed” Petrarchian pages are to the primal ones. Certainly they are much closer than the current ones. Virtual restoration must be managed in any case, if it should be useful, with much prudence and humility, avoiding operations like the arbitrary integration of graphic signs. Otherwise this becomes an operation of virtual

“reconstruction”, more similar to a philological (and interpretive) operation than to a restoring one. In fact, scholars normally prefer to study the native high resolution files, instead of working with a product which has been elaborated afterwards, by the photographer or by the graphic designer. Returning to the “Canzoniere”, I propose a comparison between the analogical black and white reproductions made of the same pages in 1905, the present digital reproduction made nearly one century later in 2003, and the “virtual restoration” made on the digital reproductions of 2003. This comparison documents considerable and progressive damage to the text over the course of time. Photography can thus, also function as the bearer of historical memory.

A huge conservation problem which came up during the last decades concerning paper manuscripts and printed books is the extensive use made through the centuries and up till the XX, of iron gall ink. The marked acid and oxidant properties of iron gall ink can lead to a deterioration of the cellulose of the paper of the support to the point of making the text illegible. Together with the appropriate restoration interventions, acquiring techniques with infra-red lights can be used, which at specific wave lengths are able to penetrate into the superficial layer of stain and in so doing be useful to recover the corroded text; the same lighting gave good results in recovering texts which have been attacked by moulds, and in deciphering ostraca and papyri. So we hope to be able in the future to supply the laboratory with a digital camera modified to only record wave lengths in the infra-red range, which, together with the appropriate filters, could act as an experimental instrument of research and recovery of texts which present these kinds of conservation problems.

The papyrus material, probably the most ancient among the book materials, as well as the most delicate and fragile one present in the library, can be protected better and read better and deciphered in an appropriate manner by using digitisations at very high resolution, obtained, in this case, with a planetary scanner that achieves images at 400 dpi on a 50 x 70 cm format. This resolution is indispensable in getting very driven magnifications on the images, necessary to specialists that work on the form, on the *ductus* and on the line-drawing of single

letters. The digitisations can then be analysed by the papyrologist using appropriate programs able to move and virtually reset the single fragments.

As far as the conservation of handwritten and printed volumes, during the acquiring processes there are certain solutions which are able to guarantee the integrity of the original, as for example in the use of book holders which permit the photographing of books with a limited opening angle, or cradles which sometimes don't even require the use of a glass plate for leveling the sheets. Nevertheless, the decision to produce a facsimile of the digitized codex, made following a digitizing campaign which has been conducted with this criteria, has led us to reconsider the acquisition procedures of images. Not having flattened the sheets made it necessary to apply such details in a new digitalization campaign, carried out on the codex removed from its file. Thus, acquiring in the right manner, also using the glass plate - obviously with caution and only in the absence of any evident obstacles to conservation – the glass plate can guarantee a greater homogeneity of framing and fidelity to the original aspect of the sheet and can prevent further and repeated work on the manuscript which, as we said, will be protected in the best way when it is used less and less frequently.

Concerning conservation of manuscripts and printed books, in the heart of conservators of ancient and precious books is the awareness of the need to use it as little as possible in order to pass it on for the longest time in an undamaged way and this is largely achieved. Therefore photography is able to do a good service in this sense. But it is nonetheless true that it just isn't possible to reproduce a volume in its entire materiality. It is right to ask ourselves if it will ever be possible to finish the discussion of "the digitizing of manuscripts". As we said, it is necessary to make very high quality reproductions, but the rapid and constant progress of technologies in this field will push us probably during the next decades to use the originals again in order to produce increasingly better virtual copies. From this point of view, interdisciplinary comparison and cooperation at a national and international level are of vital importance, as indeed is happening today. Currently, we are at the "what next" stage. No one knows exactly what the future will bring in the technological

range. However, it must be foreseen wherever possible by us cultural operators who have the duty to acquire in the best way and to protect our analog and digital photographic heritage. Reproductions will never replace the originals completely, but they will be very useful to preserve them and to understand them better, therefore contributing to maintaining over the long term the spirit of the persons that created them.