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Acquiring and Printing High Resolution Colorimetric Digital Images of Flemish Masterpieces: Presentation of the MARC-Book

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For those familiar with the conservation and examination of works of art the Doerner-Institut is a well-known institution. However, the institute has never produced an art catalogue of the type we have to talk about in this paper. The reader may think, just another publication, may not be worth mentioning? We however think so, and this paper will give you our subjective view about a 36 plus 8 months via dolorosa; it will share with you our daily experience with digital approaches and will finally try to find a balanced conclusion about the final deliverable from the ESPRIT project MARC (Methodology for Art Reproduction in Colour): a nicely made book on 'Flemish Baroque Painting, Masterpieces of the Alte Pinakothek München' with 82 colorimetric digital reproductions, one black-and-white image, not too much text. Published by five authors, supported by the MARC family consisting of several industrial, university and museum partners in three European countries. When all is said and done, a common effort, a European experience, a family of MARC IT products (digital, electronic, future, hyper) and finally an art book (analogue, on paper, old-fashioned, past, boring?).

Since the 'fabulous' VASARI era, digital imaging techniques find their frequent application at the Doerner-Institut. The Munich VASARI scanner was developed into a powerful tool to produce digitised infrared reflectographies (with automatic mosaicing of up to more than 500 single images)\(^{11}\), it has been successfully used during the MUBINI project for imaging spectroscopy\(^{9}\) and served as a platform to acquire digital images of the VASARI type for art in transit condition control\(^{9}\).

Why didn't we stay with these applications which are all related to the original areas of activity of our institution? There have been several reasons for this:

1. Once we produced these VASARI images we got the feeling that the digital images may serve for more than the search for underdrawings or cracks. They may be useful for any sort of internal documentation and for the reproduction of our paintings. However, technical drawbacks such as the poor colour quality\(^{1}\) of the VASARI images (in Munich) or the low speed of the acquisition process prevented their broader use. Additionally, the VASARI camera showed low dynamics (7 to 8 bit) and the system was not able to mosaic single grabs to one large format digital image.

2. Although our VASARI scanner is modular, its dimensions of about 3 x 2.5 x 2 m prevent it from being taken to our photographic studio or somewhere in the gallery. If the digital

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\(^{1}\) This refers to the Munich VASARI scanner developed for other applications as indicated above: the National Gallery, London and Uffizi VASARI scanner systems were developed with colour as the prime factor, and the results have been much better in this regard (Editor). Based on information from Dr. David Saunders, National Gallery, London.
images should have any future, the acquisition unit has to be portable and should be easily usable by the museum photographers.

3. The main disadvantage of the VASARI camera (Kontron ProgRes 3000) was its low digital resolution. Its about 2.400 by 3.000 picture elements (pixels) correspond only to a 24 x 36 mm colour slide. However, ektachromes of 13 x 18 cm (corresponding to 14.400 x 19.200 pixels) with the same spatial resolution as the slide are standard for reproduction purposes. The additional requirement to have a free choice of any detail at a later stage without a new acquisition led to the requirement to use a camera with ‘as much resolution as possible’.

4. The same requirement was given for the colour accuracy: The colour deviation from the original should be ‘as little as possible (invisible)’.

5. Last but not least, digital techniques help to prevent repeated photographing of the originals. The digital ‘mother’-image which can be stored and copied without any loss of image information in resolution or colour may serve in the future to preserve the European cultural heritage better - which is the major task of this institution.

But, how should we - as a museum - do all this necessary R & D work, with a small annual budget, with the small permanent staff we have, without computer engineers ... what a dilemma! The request of the European Commission to submit another proposal related to ‘digital images and art’ seemed to give a slight chance to overcome all those technical drawbacks. If we go for EC money - and this is rather fair - we had to accept the EC rules: to jump headfirst into the wonderful and promising IT world, the information society. We did, and the water wasn’t as soft as we expected and the pool was rather shallow.

Results of Esprit projects should now be ready for marketing within the run-time of the project or should at least create a new market immediately after the completion of the project by offering IT products with improved performance which can be produced and sold cheaper, used more easily leading to ‘glossy brochures and streamlined salespersons’. We don’t want to go into details because our museum never had the intention to create any markets. We believe, that the materialistic and economic society needs niches of uselessness. Art is a useful counterbalance, but art itself is economically useless. The visitors to our museums are not ‘consumers’, they just enjoy the paintings, they sometimes spend a little money for a cup of coffee, may buy one of the galleries art catalogues. Not more. They search the silence and commune with the art object. And we don’t want to interfere.

Art catalogues are not a big market, especially not for high-end products such as the MARC book described here. The art book is an important medium: portable, usable at home, in the train and in your bed. It does not need a power supply, without help-pages and no internet-connection is needed; old-fashioned. Most of these catalogues live from the quality of their reproductions. Reproductions based on high-quality photographs, slides and ektachromes which are - in our case - produced by the photographic department. The huge number of photographs produced shows how productive this department is. What the number does not reflect is the number of objects handled. This leads us to the core problem: Each handling of the ‘original’ is a burden to the object which is one of our institute’s concerns. And this is the reason for our - the Doerner-Institute’s - involvement in MARC.

The steady aim to improve the quality of the reproductions implies frequent re-photographing. The reasons are manifold. The existing photograph is unsatisfactory, it shows the ‘wrong’ detail, the photograph is too old and has lost its colour or has been treated badly by a repro-house. Finger prints and scratches document the transitory nature of any film material. The use of digital images for the purpose of art reproduction would overcome most of the problems mentioned. The other dilemma are copyright concerns and our position not to market the museum prevents a world-wide
distribution of these digital images. Our recent decision is firm. Not to go with those images into the network, not to provide these images to everyone in his home, not to sell them to distributors. But instead to use them more and more to preserve the paintings better, to avoid frequent photographing, to improve the quality of our catalogues and to use all the other well-known benefits of digital images.

As mentioned, the VASARI images did not fulfil our expectations and turned out to be inappropriate for reproduction purposes. Low resolution and low colour accuracy². A new METHODOLOGY FOR ART REPRODUCTION IN COLOUR was intended to overcome these draw-backs: MARC. Very high resolution and colorimetric digital images. Portable, usable by photographers. We don’t want to repeat all the declarations of intent which have been presented on other occasions³, we don’t want to repeat the philosophy poured into glossy hand-outs. This is the third dilemma: R&D projects force you to present marketing studies a long time before the idea has completely matured. We always found it frivolous.

Now that we know what the MARC consortium has been, now that we are able to present the MARC book, let us consider the perspectives of this new technology, the changes it may bring to the future production of art reproductions and, last but not least, critically evaluate the quality of the MARC book. Most of our museum’s visitors do not have any idea how art books and catalogues are produced and what their strengths and weaknesses are. The traditional procedure is discussed in great detail in the MARC book itself⁴⁵ and shown in the Figure at the end of the paper. The main points are:

1. The images are taken on film material which is an analogue medium.
2. There is no means to control the colour in a physical sense. The colour accuracy is controlled by the eye and a three wavelength measuring tool using a small number of colour patches.
3. To get rid of the gloss on varnished paintings, a polarising filter is commonly used. Thereby, all the colours of the painting (especially in dark areas) appear richer and darker and the overall contrast is considerably enhanced.
4. Although the resolution of the 13 x 18 cm ektachromes is very high, details of a painting are photographed again which requires another exposure.
5. The photographic film material is carefully kept in air-conditioned and dark archives which may not prevent the film from ageing and changing its colour.
6. Once the ektachrome has left our museum, the possibilities to take further care of them are very limited.
7. In the repro-house, all the films are scanned on a drum-scanner. The films may have come not only from one museum but from many different institutions which used different film materials, different lamps or colour-temperatures during exposure, as well as different sets of filters.
8. For each of the single images a separate and independent colour correction is done during the colour separation step. This is mainly done to fit the colour space of the image into the printable colour space which sometimes leads to serious colour changes for all tones and not only for those which are unprintable.

² c.f. comment on page 1: not applicable to National Gallery, London and Uffizi scanners.
9. Frequently, the lightest point in the image is set to the white of the paper to be used for the book.

10. To finally produce more brilliant reproductions and to please the public, the contrast is deliberately enhanced often without having any knowledge of the original painting.

11. Following fashion trends, a glossy or non-glossy paper and an appropriate set of printing inks are selected. Both of them considerably influence the final reproduction quality.

12. Proof printing is the last step where the customer can do some colour corrections. In practice these are analogue corrections done by eye for a printing press which is different from the final press, in some cases on different paper, with different printing inks ... and, this is the main restriction, with a considerable lack of time and money which frequently prevents additional colour correction cycles.

13. The control of the proof prints is sometimes done in front of the originals, sometimes not. The comparison is difficult because most of our paintings are glazed with non-reflective glass which make the colours appear richer and alters the colour to a more greenish-blueish tone.

14. Additionally, the comparison is done under day-light, whereas the photographing takes place under HMI light or flashlight with a different colour-temperature.

15. During the final offset print-run the printer who does not know the original, uses the possibly faulty proof prints for colour control. During the print-run a colour correction is difficult because several images and text are mounted on one printing form. If the images show different colour shifts, the adjustment of one image will not necessarily cause an improvement for the other ones.

16. Because the colour treatment is different for each reproduction in the book, this finally leads to an unpleasant colour throughout the book. Whereas one illustration is more or less satisfying, another one is slightly too red, a third one completely beyond good and evil.

At the end, MARC had to face all these problems. How did the MARC consortium react? To our personal impression two layers of solutions and difficulties - one more political the other one more technical - could be identified:

1. Only during the project and not on the level of the Technical Annex which is submitted with the proposal, the partners became really aware of complexity of the MARC task. It is perhaps a misinterpretation, but even after the project is finished not all the partners seemed to have a full understanding of the complex process in all the details. This is not a reproach, but the loss of an illusion.

2. This effect was increased by the structure of the consortium. Whereas in other projects the partners’ work is in quite close or even competitive, the MARC partners activities were spread along the line from the digital acquisition to a publisher (however, a printer was not included). None of the partners spoke the language of the others or had practical experience in the partners’ fields. The resulting difficulties were completely underestimated.

3. One may argue, this is why you had a consortium, but the divergent interests of the partners did not allow us to finally reach one unified MARC concept. But not only this, the divergent interests produced so-called ‘spin-offs’ such as a rostrum camera and two competitive human-computer interfaces. All of them have their indisputable value, but did not help us to (re)focus the project to one single and final aim and to concentrate the man-power remaining on the production of the MARC book. Finally, the immense pressure by the EC to produce
something marketable and at the same time to present up-dated market studies etc. diverted attention from the key problems which were technical in nature.

4. Due to unforeseeable events, the Alte Pinakothek, where most of the paintings were on exhibition, had to be closed before the acquisition campaign was started. This had the advantage that many of the paintings were available on call in the depositories of the same building in which the photographic studios are located. However, for two huge paintings by Rubens and Jordaens, the acquisition had to take place at an early stage. This caused severe difficulties to the company producing the MARC camera as well as to the partners who had to deliver the software at a far too early date.

5. This was not the only change in timing: due to economic difficulties one of the partners delayed all its tasks. Instead of informing all the partners, the situation was disguised. This caused delays amounting in the end to 8 months for the project as a whole and additional costs to our institution of about 50,000 ECU.

6. Besides all these difficulties, there have been numerous small problems: the company name of the prime contractor changed three times - and not only the name but also the priorities -, we had two project managers. Three partners gave the project obviously much lower priority than they did during the proposal phase and some competent people were withdrawn during the project. All these events were not sudden but occurred in slowly corroding processes which did not at all reinforce the idea of a common European effort.

A second layer is related to more technical issues:

1. One of the core elements of the MARC philosophy is that the digital image is taken from the original object and not from a photographic image of the object. This requires very high resolution and led to the development of a new CCD camera. As described elsewhere, the MARC camera fulfills this requirement with a resolution up to 20,000 x 20,000 pixels. For the MARC book, the typical resolution was 10,000 x 12,000 pixels.

2. Another user specification was that the light level during acquisition should not exceed 2.500 lux. During the first tests the camera sensor turned out to be far too insensitive: This is why an integration feature had to be implemented, which allowed the prolongation of the exposure time by a maximum factor of 10. During the acquisition campaign even this long integration factor turned out to be too short. Therefore the aperture had to be opened to 4.0 which resulted in a very poor depth of field. And in fact, for some paintings painted on panel or on metal which were not perfectly flat, unsharp areas in the digital images were observed.

3. During the long nights at the Alte Pinakothek where the Rubens and the Jordaens were taken a provisional piece of software served for acquisition. All other acquisition work was done by using the MARC software package ACQUIRE. As with all other projects it was not perfect from the beginning but improved step by step until the end of the project - when ACQUIRE was of no longer use for the project because the acquisition campaign had been finished many months before.

4. From the proposal to the end of the acquisition campaign all partners concentrated on the digital acquisition, the camera, the optics etc. Comparatively small problems such as the failure of a single image processing tool or failures of the human-computer interface received careful attention, whereas relatively large technical problems were not identified. Without diminishing the achievements of the first part of the MARC project, the second part such as colour calibration, colour separation as well as printing was 'not completely satisfactory'. As mentioned, this was partly due to absence of a printing-house in the consortium as well as the
fact that some partners involved had significant internal and external difficulties. The resulting
changed priorities led to the delayed delivery of non-tested or faulty software and to
permanent communication problems between the partners.

5. Due to limited space not all the problems we suffered can be reported: There was out-dated
advice to use a distinct but unusable set of inks for the four-colour printing, a PCR of 70%,
an endless series of software bugs in the colour separation software, extremely slow 'express'
postage from town to town (5 days) as well as from one floor to another within the same
company (16 days), un-tested software versions, tapes with information not at all linked to
MARC or at least not readable and other inefficiencies caused a delay of several months, to
one set of 81 x 4 litho films to be completely thrown out after the first proof prints on the
rotation press and to an increase beyond the budget.

6. Surprisingly, however, our institution drew much benefit from those difficulties: We had to
learn and take over most of the tasks of the repro-house such as the colour-separation and
how to organise lithographic films. This led to a decrease of the final reproduction costs.
More importantly, we tackled the copyright problem: due to the fact that the data which left
our institute had been calculated for a distinct paper, ink set and printing press and were
delivered after colour separation, their use was just for this distinct print run. The use on
another paper with different inks and at another printer's press would result in noticeable
colour deviations. An illegal copy of the data would be of no value because the data cannot
be re-calculated to provide the original data without the knowledge of the separation data.

So finally, the MARC process segmented into the following steps as shown in Figure 2 (a) digital
acquisition of the painting and colour control charts under controlled conditions, (b) colour
 calibration, (c) data storage, (d) image processing such as choice of the required detail compression
into the final printing size etc., (e) colour characterisation of the printing press, (f) colour separation
and preparation of the separated image for the lithographic exposure, (g) production of the
lithographs and (h) the final print run. It is important to mention that some costly and time-
consuming steps of the conventional procedure such as scanning the analogue image on the drum
scanner, film-by-film adaptation of the whole image to the ink colour space, proof printing and visual
colour adjustments are no longer required.

Now, after the MARC book has been delivered, the time for evaluation has come.

1. The book as a book itself is well made. Its traditional lay-out, colour-reproductions
throughout the book and its attractive (political) price are good arguments to buy it.

2. The quality of the colour reproductions should be our main interest, not the book itself. A
careful comparison of the reproductions in the MARC book with the originals in the gallery
proved, that in very many cases the colour quality is superb. However, this comparison
turned out to be difficult, because the paintings are glazed, the sizes are not comparable, the
colour temperature of daylight is different to D50 (5.000 K) and the angle of observation is
not always the same.

3. Some saturated yellows are not printable and appear less intense than they are in the original
painting. There is no solution for this problem. However, in contrast with the conventional
procedure, not the whole colour space of the image has been compressed to fit into the one
of the printing inks. In the MARC procedure only non-printable colours such as some bright
yellows are transformed into printable ones but all printable colours remain unchanged. This
explains why a few individual tones do not resemble the original whereas the greater part
shows a very good colour match.
4. Throughout the book the colour quality is very homogenous compared with conventional books. This is due to the fact, that all images are colorimetrically calibrated in the same way against the same MARC colour charts which have been acquired with the original paintings. The same colour separation is then used to separate all the calibrated images. Full-size reproductions or any detail are derived from one single digital ‘mother’-image. Especially this option is a further advantage.

5. In contrast to the conventional procedure the whitest white of the image is not automatically transferred into the white of the printing paper. The colour values of white remain as they are and are treated as all other colour tones. This is a further reason why the MARC reproductions look different to conventional ones.

6. Flesh tones and light areas are usually perfect in colour, sharpness and richness in details.

7. Throughout the book, details appear more attractive and more pleasing to the eye than the full-size reproductions. This effect is either due to the observer’s angle or to the white paper surrounding the illustration whereas in the former case the reproduction covers the whole page.

8. Some mentioned that the colour appearance in general is less effective than in conventional art books. This is due to the fact that usually the contrast of the illustration is increased which was not done for the MARC book. We believe, that this attitude to brighten the reproduction to please the consumer is not in the sense of the art object. However, consumers and the publishers are very much accustomed to the attitude to go for more saturated colours and higher contrasts. Even in our case, this was demanded by the publisher, but not done according to the puristic MARC approach.

9. A few of the reproductions appear rather dull. This is the case for some of the dark Brouwers and Teniers and is especially noticeable under low light levels. Up to now, we have no satisfying explanation for this effect. Control of the calibrated digital images showed that the colour match for the colour control patches was high, but the reproduction does not reflect this good colour match.

In conclusion, the MARC-project produced the first catalogue in the world based on high-resolution, colorimetric digital images taken from the paintings themselves. Its colour reproduction quality is far better than those of conventional printed products. To reach this goal the museum and our institute had to go outside its original areas of activities, which is seen to be a gain in know-how as well as a distraction. We expect future catalogues of our institution to use the MARC imaging and printing technique, although the staff problem (you still need computer experts) is not yet solved. While the colour accuracy and reproducibility is considerably increased by MARC, the handling of the huge MARC images at the reproduction houses (the bottle-neck of the data-input) is still a problem. Having all this in mind, we believe that the MARC effort is fully compensated by the superb colour quality of the ‘Flemish Baroque Painting, Masterpieces of the Alte Pinakothek München’.
Acknowledgements

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Bibliography

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THOMSON Multimedia (Rennes, F) as the prime, Hirmer-Verlag (München, D), Schwitter AG (Allschwil, CH), National Gallery (London, GB), Crosfield Electronics Ltd (Hemel Hempstead, GB), CCD Videometrie (München, D), Birkbeck College (London, GB), and Bayerische Staatsgemäldesammlungen (München, D)


H. Derrien, MARC, A New Methodology for Art Reproduction in Colour, EVA 93 (1993), 146-159.


The MARC book is offered for DM 48 at the museum and for DM 78 at any book shop.
MARC and Traditional Reproduction Chains

MARC Printer Characterisation

ANSI Chart → Offset Print → Colour Measure → Colour Cube

MARC Reproduction Chain

Painting → Digital Camera → Archive → Sharpen → Contrast → Ink Separation → Offset Print

Traditional Reproduction Chain

Painting → Film Camera → Archive → Drum Scanner → Ink Separation → Offset Print