Conservation

The Getty Conservation Institute Newsletter ■ Volume 22, Number 3, 2007

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Volume **22**, Number **3**, **2007**

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The Getty Conservation Institute (GCI) works internationally to advance the field of conservation through scientific research, field projects, education and training, and the dissemination of information in various media. In its programs, the GCI focuses on the creation and delivery of knowledge that will benefit the professionals and organizations responsible for the conservation of the visual arts.

The GCI is a program of the J. Paul Getty Trust, an international cultural and philanthropic institution that focuses on the visual arts in all their dimensions, recognizing their capacity to inspire and strengthen humanistic values. The Getty serves both the general public and a wide range of professional communities in Los Angeles and throughout the world. Through the work of the four Getty programs—the Museum, Research Institute, Conservation Institute, and Foundation—the Getty aims to further knowledge and nurture critical seeing through the growth and presentation of its collections and by advancing the understanding and preservation of the world's artistic heritage. The Getty pursues this mission with the conviction that cultural awareness, creativity, and aesthetic enjoyment are essential to a vital and civil society.

Conservation, The Getty Conservation Institute Newsletter, is distributed free of charge three times per year, to professionals in conservation and related fields and to members of the public concerned about conservation. Back issues of the newsletter, as well as additional information regarding the activities of the GCI, can be found in the Conservation section of the Getty's Web site.
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Front cover: Testing an inkjet print to determine its coating. Inkjet papers often have special coatings that hold the colorants at the surface, resulting in a higher quality image. A spot test with a minute droplet of water, performed under a microscope, may help establish if the coating is a porous or polymer type. Porous coatings absorb water, while polymer coatings swell due to their high gelatin or polyvinylalcohol content. This distinction is useful in evaluating exhibition and storage conditions for these prints. *Photo:* Martin Jürgens.

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The **History** and **Conservation** of **Digital Prints**

Research in Progress

Feature

By Martin Jürgens

In the early 1980s my high school acquired its first computers, and I remember distinctly that the computer classes were poorly attended, attracting only the uncool. Little did we know that we were already in the midst of a decades-old development that would carry us into an age in which computers would become essential and omnipresent.

One goal from that era, a paperless society, has yet to be achieved, despite great advances in digital technologies and communication systems, such as the Internet. The opposite may even be true: dealing with digital files has created a number of unanticipated problems, such as the permanence of file formats and storage media and the obsolescence of software and hardware. The simple combination of ink on paper—an old but still very effective way of presenting and preserving information—maintains its position in today's world. Online news articles and the depiction of artworks in curated collections of images that are available through Internet portals (virtual museums) are commonplace, but the majority of Internet users still print out longer text passages to read them, since paper is kinder to the eye than the screen.

The advancement of printing technologies cannot be viewed apart from the evolution of office copying devices or apart from the evolving electronic information systems that have developed into present-day computers. The output of digital information to a material substrate, more simply designated digital printing, is now such an integral part of our lives that we often fail to notice it. It is used in many organizations that rely on paper documents, such as archives, businesses, public administration, hospitals, advertising agencies, and many other sectors. An increasing range of graphic documents is generated digitally, including books, letters, prints, journals, office documents, labels, and product packaging. The origins of digital printing can be traced back to the 1950s, but the past twenty years in particular have brought a great acceleration and proliferation in applications and technology, making it difficult to keep up with the newest trends. Inkjet, for example, has been the fastest-growing technology since the early 1980s, and it is now being used not only for printing text and images on paper but also in many industrial applications, such as the microfabrication of three-dimensional objects with minute droplets of polymer inks. The characteristics of the processes and materials of digital printing pose a great challenge to museums, since the many new inks, substrates, and surface coatings bring along their own sensitivities. Conservators will need to play a more active role in the acquisition, storage, handling, and exhibition of works of art produced through digital printing.

Computers, Copiers, and Art

Artists have followed the evolution of digital machines and photocopying devices from the start, but early attempts at connecting the technicalities of the computer world and the world of art received mixed reviews from critics, ranging from simple indifference to outright contempt. Artists were often hindered in using computers: the devices were rare, very expensive, and mostly accessible to governmental technicians, academics, scientists, space travel organizations, and the military. Early computers were also large and immobile and required programmers to manipulate them. Thus, artists needed technical assistants (essentially translators), a fact that necessarily would have impeded a personal and direct approach to their own work.

Sonia Landy Sheridan speaking at a workshop on the identification and conservation of digital prints at the Museum of Modern Art in San Francisco. Sheridan, a key artist in the development of the Copy Art movement in North America, discussed using photocopy devices in the 1970s to produce photographic work. *Photo:* Martin Jürgens.

William Larson, *Transmission 0035,* 1974, electrostatic print. In the 1970s, photographers began experimenting with various digital technologies, creating some of the first digital prints. This work was made with a Graphic Sciences Teleprinter, an early fax technology, which converted images to simple digital code for transmission. © William Larson. Reproduction courtesy George Eastman House.

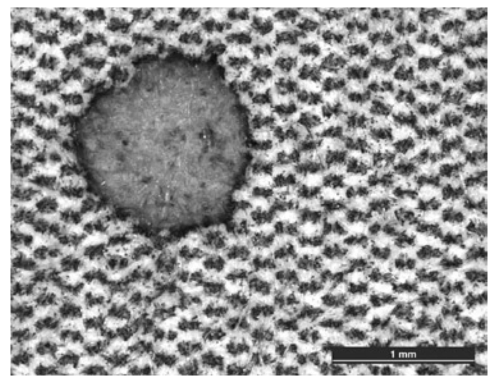
In the 1970s and 1980s, personal computers were introduced, and with them came software that was increasingly easier to use. The number of artists using computers grew steadily, and a recognizable community was producing what was collectively termed computer art. The use of commercially available software also meant a shift in the artists' personae: one no longer had to be a mathematician or programmer to create graphics; the new painting software enabled essentially anyone to draw lines or fill in boxes and circles. In addition, newcomers had less fear that the computer would impose control over their creativity, an argument that critics had long used against computer art. Another criticism—that much of the computer art looked alike—was surely a result of the limited number of computers and programs available throughout the 1960s and until the mid-1970s.

The efforts of programmers, technicians, scientists, and (later) animators for television graphics, video games, and animated movies advanced the graphic capabilities of computer hardware and software. At the same time, however, these efforts contributed to the confusion and criticism often associated with computer art. Today, however, the trend is often to hide the involvement of computer manipulations in a work; this tendency is best exemplified by the field of contemporary photography, in which, following heated debates on digital manipulation in the 1990s, the question is no longer even addressed. While many artists are fascinated with the concepts of mathematics and calculation in working with a computer, the machine's capability of producing random events and chaos have been equally compelling. Performance art, video, Internet, film, and conceptual art have all been influenced by computer art.

Students at the Academy of Fine Arts in Vienna examining a digital print sample collection during a seminar on paper conservation. *Photo:* Martin Jürgens.

A video monitor attached to a microscope, allowing participants to discuss a print during an identification practice session at a workshop at the Netherlands Institute for Cultural Heritage. Magnification can help to identify the screen pattern in modern prints. *Photo:* Martin Jürgens.

Detail of an IRIS print, showing a typical, regular screen pattern. Due to a spot of accidental spit (the circle in the image), the water soluble dyes have bled along the surface of the fine art paper. Originally developed for the printing industry, IRIS Graphics printers were embraced by photographers in the 1990s for their high-resolution printing on a variety of materials. *Photo:* Martin Jürgens.

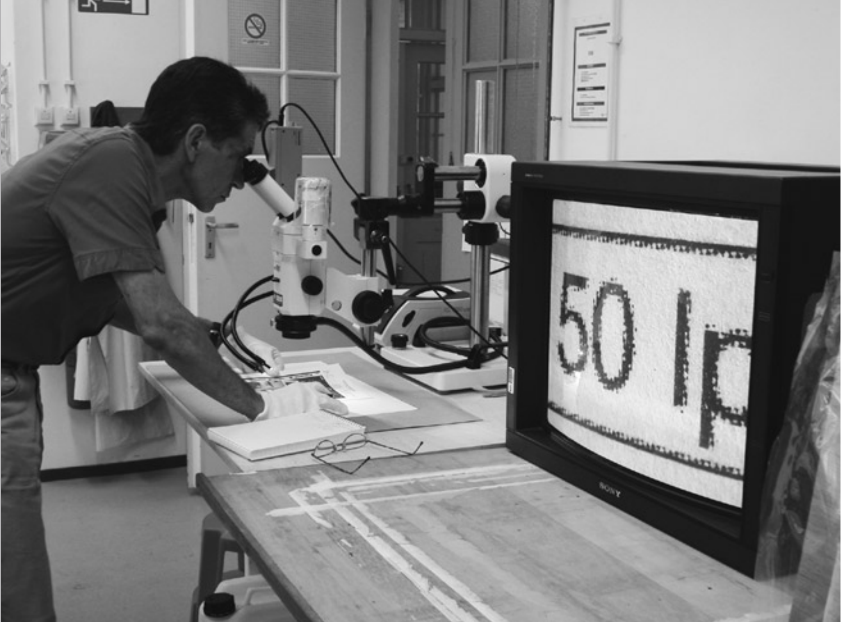


The late 1970s saw the start of the *copy art* movement, in which photocopiers were used (or perhaps misused) for the creation of artworks that were anything but simple copies. Artists exploited the fact that these machines, designed to make faithful copies of original documents, possessed their own aesthetic, distinct from that of the original source image. Through experimental manipulations, unique prints were being made on devices originally intended to create identical multiples. Although not termed *digital prints* at the time, photocopies and laser prints technically fall under the umbrella term *electrophotography,* which is considered today to be a digital print process. Copy art tends to be a dirty process—fixing a jammed photocopier exposes you to finely powdered toner dust. The opposite was the case for the various paint software packages introduced in the 1980s, which were thus named because they simulated actual painting: paintbrushes or airbrushes of various sizes could be chosen, colors could be picked, and the creation of a brushstroke could be correlated directly to the movement of an input device, such as a mouse. However, since digital printers of the mid-1980s were not capable of rendering highly saturated color images on paper, images generated in Paintbox (or similar software) were often simply photographed from the screen, a process that resulted in a distinctly technical appearance.

Photography

Vastly improved software, such as Adobe Photoshop (introduced in 1990), and new input techniques, such as desktop scanners, helped digital photography and digital imaging surge in the 1990s. Among the visual arts, photography has undergone the greatest technical evolution over the past fifteen years. Most amateur and professional photographers have already switched from film-based applications to digital cameras and printers. Indeed, a new generation of photographers is growing up who will never have loaded film into a camera. The concept of a negative is dated and, ultimately, doomed. Although the initial use of computers in artistic production tended to create its own aesthetics, today's digital systems are often considered tools that have no apparent impact on the end result. However, a more careful look shows this view to be simplistic. For example, since digital retouching is done frequently, the age-old task of retouching by hand to remove unwanted specks on prints is almost obsolete. As a result, digital prints often possess an almost uncanny technical perfection, untouched by any marks such as those created by manual spotting with a brush.

Inkjet printing has captured a large portion of the photographic printing market. Inkjet printers, first developed in the 1940s and 1950s, evolved for practical use alongside computer technologies from the 1960s onward. In the 1970s two technologies emerged as the most promising: continuous inkjet and piezoelectric drop-on-demand (DOD) inkjet. The continuous inkjet process, used in a voltage signal recorder invented in 1963, involved the selective electrostatic charging and subsequent deflection of ink droplets in midflight. The droplets hit the paper surface and formed tiny dots. This mechanism is found in all subsequent continuous inkjet printers, among them the famous IRIS Graphics printer. This device was originally developed for the printing industry, but because of its capability of printing in high resolution on a great number of different materials, it was adopted by photographers in the early 1990s. Printing a color image of high quality with inkjet on a fine-art, watercolor-type paper was a novelty, and it soon became a profitable business. Prints made on IRIS printers may be found in many museum collections. It is important to identify them as IRIS prints,



since they were made with inks that contain dyes (as opposed to prints from other, more modern inkjet printers that may contain pigments) and are thus quite sensitive to light, atmospheric humidity, and water. Special consideration must be given to IRIS prints during transport and exhibition.

Large DOD inkjet printers of the 1970s were able to print only black-and-white images—a capability that, for text applications, was sufficient. Hewlett-Packard launched its ThinkJet printer in 1984, which was innovative in that it used disposable cartridges that contained the printheads, a milestone in the ensuing rapid spread of inkjet printers. The DeskJet printer, introduced in 1987/88, made the desktop printing of office documents reliable and set a standard for single-sheet paper feed mechanisms. New competitors in the market introduced new printers at a rapid pace: every two years in the late 1980s and at ever-shorter intervals from the 1990s onward. Printing in color became a major area of research: Canon's 1984 Bubble Jet printers had four printheads with twenty-four nozzles each for cyan, magenta, yellow, and black (CMYK) inks. The jump from office-application printing to large-format printing was made in 1992, with the Encad NovaJet wide-format color printer. This series of printers used four colors and roll-fed paper to produce large images, creating a class of its own—wide- or large-format inkjet—that today serves the important advertising and fine-art printing market sectors.

In the mid 1990s, the terms *photo quality* and *photorealistic* became buzzwords in inkjet advertisements. The printing industry realized that if shares were to be gained in the profitable amateur photographic market, it had to produce prints that not only *looked* like photographic prints, in terms of color and image quality, but also *felt* like photographs. Thus, glossy, resin coated (RC) papers, typical photographic papers of the time, were introduced for inkjet applications. Soon, however, a major deficit in the new inkjet prints became apparent: inks were fading too fast and coatings were simply not stable enough to withstand the physical demands of amateur use. Hanging a print on the side of a refrigerator is still a pretty good test for survival amid harsh conditions: the print is subjected to handling (fingerprints, dirt, abrasion), fluctuating humidity and temperature (steam from cooking), volatile organic solvents (vapors from cleaning liquids), vibration, and prolonged light exposure.

As the inkjet market grew and as the number of manufacturers and resellers increased, so did the quest for print permanence. The common chromogenic color print, never a shining example of color stability itself, became the new benchmark for image permanence that inkjet prints had to live up to. Today, with the use of advanced dyes, pigments, and complex surface coatings, many inkjet systems have overtaken photographic materials with regard to image stability under light exposure as well as long-term dark storage. Accelerated aging tests are the most common methods of evaluating these prints; because of their complexity, however, an International Organization for Standardization (ISO) standard on the testing procedures has yet to be published, and the results are often open to discussion.

In addition to inkjet, other processes are used for outputting images. One process exposes photographic paper to a laser or an array of light-emitting diodes (LEDs); the paper is then processed conventionally. Dye sublimation printers are common in photo stores and in the photographic printing industry. A number of thermal processes are available, including direct thermal, thermal transfer, and photothermographic transfer; each technique has a range of applications, image qualities, and aesthetic characteristics. Artists in particular, of course, have been experimenting with these new printing techniques, and their work will often end up in a museum or private collection.

Terminology, Identification, and Conservation

Because digital prints, both in art and in business and industrial usage, constitute a major part of our current and future social and cultural heritage, it is important to understand their structure, materials, and long-term stability issues. The first step is the identification of processes, which is a prerequisite for all decisions on preservation. For example, if the substrate of a print can be identified as one prone to rapid deterioration, then different archival environments, housing, or exhibition parameters might be chosen by the conservator than if the print were on a very stable material. Although not yet standardized, practical recommendations for storage and exhibition have been compiled for each process.* These guidelines indicate that most digital prints should basically be handled as complex paper objects; their individual sensitivities to heat, light, abrasion, and moisture may vary.

*Martin Jürgens, Preservação de cópias digitais em arquivos e coleções de imagens, in *Cadernos técnicos de conservação fotográfica,* vol. 5 (Rio de Janiero: Fundação Nacional de Arte, 2004), 3–15.

With a technology that is evolving as rapidly as digital printing, it is easy to lose track of the many processes and of the many variables contained in each process. For this reason, it is essential to establish a categorized hierarchy of processes, structures, and materials. This approach also relieves conservators of the otherwise continuous necessity of updating their knowledge whenever a new printer appears on the market. It also avoids proprietary terms and simplifies decisions regarding exhibition and long-term preservation issues. In order to facilitate communication between conservators and manufacturers, the terminology used by the industry has been adopted. However, some terms have not been easily accepted, such as the use of *print media* as a generic term for anything that is being printed on. There has also been much discussion about the industry's current use of the term *photograph* for any print that looks or feels like a traditional black-and-white or color photograph. Critics in the conservation community point out that the word *photograph* indicates the action of light in the production of the print; its use for other prints, such as high-resolution inkjet prints on glossy RC papers, is thus inaccurate. Although it is desirable to be able to communicate with amateurs and manufacturers in a common language, it is equally important to the conservation community to use a highly accurate language that relates primarily to the materials involved and thus to their preservation.

An accurate, common terminology also plays an important role in the internal registration systems of museums. Information pertaining to acquired artworks is entered into a database, and it is common to use standardized terminology. Not only does this standardization allow for efficient searching within the museum collection, but, in the case of loans, it also facilitates communication among curators, registrars, and conservators of different museums. A consistent set of terms is also recommended for gallery labeling, which at present is very confusing; a great range of different, often proprietary terms is currently used in exhibitions.

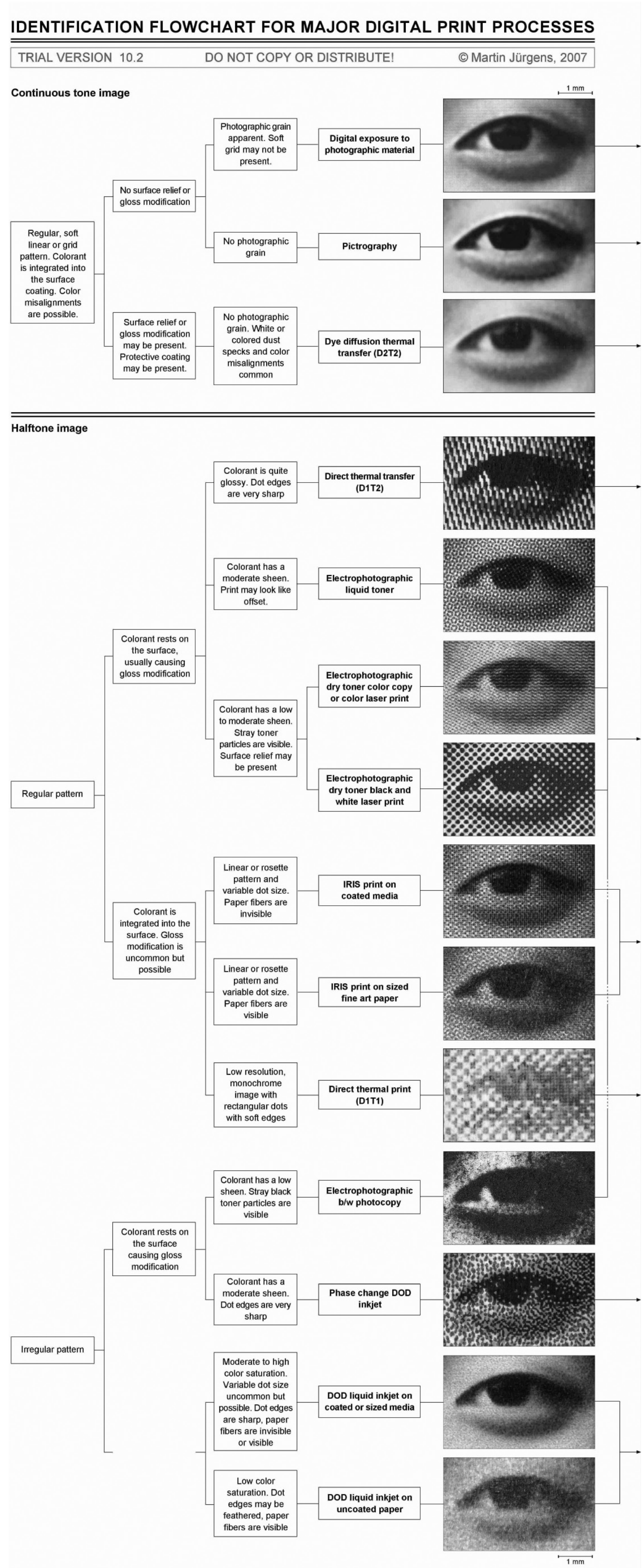
With an established system based on accurate and common terminology, museums will occupy a more authoritative position in relation to the artists from whom they are currently buying digital prints. It has been common in the past for a collection to acquire digital prints from artists or photographers without obtaining information about the materials used. Over the years, a number of questionnaires have been developed at different institutions, and ideally, such a questionnaire will be filled out by the artist for an acquisition of a digital print. It addresses information on the printer, the ink or toner, the print media, the finishing techniques, and mounting or framing. As much detail as possible is requested, since the more information one has on a print, the more informed will be the decisions pertaining to the print's ultimate exhibition, storage, and possible treatment.

Outlook

In recent decades, three trends may be observed in the conservation community: the erosion of traditional boundaries between the individual specialized fields, in view of the complexities of contemporary art; the growing inclusion of scientists and professionals from the industry in conservation research; and the ease of communication and collaboration among international conservators in research and teaching, thanks to modern technology. Archives were among the first to realize that the nature of the documents entering their vaults was changing. In the museum world, the conservation specialty for contemporary art and modern media developed (although with a certain delay) parallel to the evolution of digital applications. Conservators, curators, museum registrars, and related professionals are still grappling with issues associated with the acquisition, preservation, and conservation of digital prints. Museum personnel are, for the most part, used to dealing with artists' techniques that are not subject to continuous change; it is precisely this characteristic of the digital world, however, that has delayed the conservation field from tackling the preservation issues of digital prints—some of them of fundamental novelty to the field.

A number of collaborative projects have been carried out that cross the boundaries between the conservation specialties, particularly between the fields of photography, painting, the graphic arts, and contemporary installation art. For example, a current German thesis project on discolored Scanachrome inkjet prints on canvas is being supervised by a paintings and a photograph conservator. Similarly, by including the research and development departments of major manufacturers of digital printing materials, conservation research projects have benefited greatly. Ilford Imaging Switzerland, for example, is currently involved in research at the Hochschule der Künste in Bern, Switzerland, that is examining stability issues of photographs and inkjet prints mounted to acrylic sheets (a finishing

The author (center) sorting digital prints during a workshop at the George Eastman House in Rochester, New York. In the rapidly evolving field of digital printing, it is necessary to establish a hierarchy of processes, structures, and materials to keep track of the many variables of digital printing and to aid the preservation of digital prints. *Photo:* Courtesy of Martin Jürgens.



A proposed identification flowchart for digital print processes. This guide closely follows the design used in the 1986 publication *Care and Identification of 19th-Century Photographic Prints* by James Reilly—a benchmark in print identification. *Chart:* Martin Jürgens.

technique widely employed by contemporary photographers). Also of great advantage was the ready acceptance of the importance of print stability by manufacturers in their quest for improving their products.

Being able to identify specific digital printing processes is a very valuable skill in conservation practice. To assist professionals to simplify and improve this skill, a guide to identification has been developed; it will become available in an upcoming Getty Publications book on the conservation and identification of digital prints. This tool allows the user to follow a yes/no decision tree that is illustrated with photomicrographs of the various print processes—the comparison of magnified screen patterns, for example, is helpful in identification. The use of a flowchart-type guide, however, may give its user a false sense of security, since there are many exceptions to the necessarily simplified guidelines that this format allows. Thus, it is important to build an in-depth understanding of the printing processes and materials before undertaking treatment of digital prints. Various methods of scrutiny—including the preparation of cross sections, different lighting techniques, and microscopic examination—have proven to be very helpful in the characterization process.

Over the past five years, consciousness has been raised in archives and museums regarding digital prints, and many conservators, with the help of sample collections, have been able to develop their own connoisseurship in the examination and evaluation of prints. As interest in seminars and publications on the topic grows, it is hoped that we will develop a wider and more profound understanding of both the challenges that digital prints pose and the best ways to address those challenges.

Martin Jürgens is a photograph conservator in Hamburg, Germany. The recommendations in this article will be available in an updated and expanded version in an upcoming book on the conservation and identification of digital prints, by this author from Getty Publications, anticipated in 2009.

Preservation in the Digital Age

A Discussion about Conservation in Libraries and Archives

Dialogue

Nancy Bell is head of research at the National Archives in the United Kingdom. In this role she is charged with developing and implementing a program of research, including conservation research. The conservation science agenda at the National Archives is focused on developing and translating predictive modeling techniques in order to address large-scale challenges in collections. Nancy is particularly interested in fostering better understanding of the role science can play in interpreting material culture.

Jana Kolar is head of the Institute for Cultural Heritage at the National and University Library, Slovenia. She is coordinator of the European Commission co-funded project PaperTreat, which aims to establish the effectiveness of various paper deacidification methods and cool storage. She also serves as coordinator of the ICOM-CC Working Group on Graphic Documents, as editor of e-Preservation Science *and as a member of the editorial board of the journal* Restaurator.

Dianne van der Reyden is the director for preservation at the U.S. Library of Congress, responsible for conservation, binding, and mass deacidification programs, as well as environment and storage; a reformatting program for digitizing newspapers; a research program studying longevity of traditional, audiovisual, and digital materials; and new technologies to digitally reformat damaged audio recordings. An author and speaker, she was an early lecturer for the "School for Scanning" lecture series organized by the Northeast Document Conservation Center.

They spoke with Jeffrey Levin, editor of Conservation, The GCI Newsletter, *and James Druzik, a senior scientist with the GCI.*

Jeffrey Levin: *Each of you is very involved in large collections of material that require a variety of ways to care for them. How well are libraries and archives coping with the challenge of dealing with large amounts of paper material that have become extremely fragile, such as brittle books?*

Dianne van der Reyden: An assessment on that topic was recently done in the United States—the Heritage Health Index—which looked at a cross section of institutions to see what the needs were. The British Library has sent out a questionnaire that seeks information from national libraries around the world on how they are dealing with some of these issues. One of the first steps, of course, is to get an assessment of the scope of the problem, and that's being done by a lot of places. There are also movements to share resources and to get help with funding mass treatments. Of course, the most cost-beneficial mass treatment you can do is appropriate storage. Whether we deacidify books or we digitize them, we still have to store things. And people forget that physical storage of electronic media is also important. The other important point here is the distinction between material that is born digital and material that has been converted to digital. Conversion is simply adding to the needs.

Levin: *Once something has been converted to digital media, from that point onward, doesn't it have the same issues as born-digital materials?*

Van der Reyden: Right. But for every dollar that is spent converting something, you've added to the challenge.

Nancy Bell: The National Archives, to some extent, is taking a risk-based approach toward paper material. We've undertaken a three-year risk assessment following Robert Waller's protocols. The brittle paper problem is not as acute here in the National Archives as it is in some libraries.

Jana Kolar: The National and University Library of Slovenia is a relatively small national library compared to some other national libraries, so it's somewhat easier for us to handle all of these materials than it is for bigger institutions. We've done a condition survey of our books collection, and the survey showed that about a third of the material is in poor condition. Per decade, roughly 5 percent of the books in our collection, printed on acidic paper, is expected to reach this condition over the next eighty years. This gives us the approximate time we have to solve this issue, either by transferring information to other media or by prolonging the life span of the originals. We are trying to use all of the approaches. We would like to deacidify books, which we think is a valid option, but we do not have all the information we would like—such as the cost-effectiveness of a variety of available processes—so we proposed that the European Commission co-fund a research project, and we've been working on the project for the last two years with eleven partners. The results should give us the cost-effectiveness of various mass deacidification processes, but they will also tell us the effect of storing a variety of paper-based materials at lower temperatures. So it will be easier for us to plan new storage areas, as well as to decide which materials to deacidify. We will be building a new library, presumably next year, where cool storage is planned for the majority of books.

Levin: *Are you suggesting that with improvements in storage, some materials slated for deacidification would be less likely to need that immediately?*

Kolar: I think at the end of our research project—which runs until August 2008—we will decide on a combined approach for our library. We ought to keep as many books at as low a temperature as possible, and at the same time, we should deacidify those books that still have some mechanical strength and those books which by law we are bound to preserve. We could do that by deacidifying about six thousand books per year for the next twenty-five years.

Van der Reyden: We have a thirty-year plan funded by Congress annually, and as part of that plan, we deacidify over a million manuscript sheets a year. In addition, we're doing at least a quarter million books a year. Combined, we plan by the end of the thirty-year period to have done about forty million items.

Levin: *Has your planning been affected by consideration of digitization for some of these materials?*

Van der Reyden: Thus far it has not been either-or but, rather, what's best for the problem. There is a program at the library, which I'm

Courtesy of Nancy Bell

"The three of us are of a generation that's used to looking at real objects. But we're working with a new generation of researchers who sometimes only know about an artifact through a virtual image."

— **Nancy Bell**

not involved with, called the National Digital Information Infrastructure Preservation Program, which is looking at best practices for digitization. We do some digitization as part of the Preservation Directorate, which includes a preservation reformatting division that does large volumes of microfilming of newspapers. We also have the National Digital Newspaper Program that is digitizing newspaper content not from the original newspapers but from microfilm. The newspapers themselves are kept and boxed. This particular project is a model because we have the originals, we have the "preservation copy" with microfilm, and we have the access version, which is digital. You can do searches with it that you could never do with the microfilm, so it's much more functional and much more accessible. But the microfilm is the preservation copy.

Levin: *The implication of what you've said is that you don't consider digitization as preservation.*

Van der Reyden: Digitization in libraries has more to do with information management and sustainability of information than with the materials science of substrates and media. When we in the Preservation Directorate talk about preservation of digital assets, we're talking about tapes, CDs, and DVDs. Eventually we'll look at flash drives and other sorts of storage media and substrates. When libraries talk about digital preservation, they are often referring to metadata and migration. One way to think about the distinction is that in the Preservation Directorate, we're dealing with the hardware aspects of things—the actual matter, not the development of software solutions.

Bell: I can agree with Dianne. We're engaged in massive digitization projects, but we do not see it as a preservation tool in and of itself. Because we are the archive of the central government, we have a statutory obligation to keep the original as well. One of the massive problems that we're going to face in terms of digitization and the preservation of born-digital material is just the sheer volume of it all. For example, just one of the many digitization projects we have going is the 1911 census, which is digitizing twenty-six thousand volumes of census material to be released in 2011.

Kolar: I agree with Dianne and Nancy with respect to the role of digitization in preservation. Digitization is, at the moment, still quite expensive, although the costs are decreasing rapidly. We are dealing with masses of materials, and that will probably be solved in the future with machines that will automatically scan books and create digital data from books when, for example, the customers return them into storage. Currently for our library, there is additional cost in maintaining this digital information because we still need to preserve the originals. We are bound by law to keep a copy of books written in our language, written by Slovenian authors, or published by Slovenian publishing companies in our national library as a legal deposit.

Bell: Certainly our digitization program aims to improve access. It's the National Archives' aim to have our online services as good as our on-site services. That means digitizing the most popular classes of material and also having the support online to help people unlock those collections. So, yes, digitization is not an end in itself. It's another tool.

Levin: *What you all are saying is that digitization is really for access and that it has not cut costs associated with preservation.*

Van der Reyden: Yes, although I need to add one point. Having digitization viewed as a preservation activity has allowed foundations to target digital projects for funding under a preservation umbrella. I think my colleagues would agree that whenever a digital surrogate eliminates the need to access the original object, you have helped preserve the object.

Bell: I couldn't agree more. It's preservation from that perspective.

Van der Reyden: The interesting thing about that is that studies have shown that once people know about the materials, then they want to access the originals.

Kolar: It's like the Mona Lisa in the Louvre. Most people have seen a digital copy. And they all want to see the original.

Van der Reyden: Right. And this might be a good time to distinguish between the digital surrogate and the original. Sometimes people refer to the original substrate and media as the containers of content—content being the intellectual information that you can get from it. This is not completely accurate because there's much more to the original than meets the eye. No matter how well you digitize

Courtesy of Dianne van der Reyden

"The digital era is just one period of time, and with biotechnology and development of wetware and things like that, there are all sorts of potential solutions out there."

— **Dianne van der Reyden**

or scan, you're not going to capture the chemistry of the object. I once had a long conversation with a webmaster about this, and he said, "Our resolution is so good we can see the paper fibers." But you can't see the chemistry and the fingerprints of every author who wrote on the original. There's no way you're going to be able to digitize that. But one day, science will be able to access those fingerprints from the original object. We're not talking about the symbolic importance of the original. There's evidential value to the original, and it's not just the legal evidential value.

Bell: Artifactual value is the term I use. The original exists as an artifact, and that artifact conveys value that is important to a range of people and communities. And they all interpret the artifact in different ways. Too often people say it's only information that's required, but we all interpret in different ways—whether it's a file in an archive or a book or a photograph. That original conveys all sorts of meanings to all sorts of people at different times.

Levin: *So something critical is lost by removing access to the original object.*

Van der Reyden: Yes. The entire authenticity of the piece is lost.

Bell: I'm very interested in virtual collections and how they are interpreted. The three of us are of a generation that's used to looking at real objects. But we're working with a new generation of researchers who sometimes only know about an artifact through a virtual image. They're going to have a completely different interpretation of it. The context in which it is set will be lost. Color rendition isn't always the same. All sorts of artifactual values will be different. For the next generation, there will be a very different interpretation of material culture.

Van der Reyden: There is debris on these objects, evidence of what they've been through—pollen or smoke from fires or gunpowder from battles. Digitization simply cannot capture those three-dimensional chemical components of the materials, which have to be extracted through examination.

Bell: I'm concerned that context can be lost. The relationship of one item to the next—say, how a collection of prints and drawings is put together or how an archive is put together. If you look at a single image in isolation, you potentially lose how that single item relates to that which came before it or after it.

Van der Reyden: That associational value is very important. And done the right way, digitization can foster that. There have been some programs at the library that have tried hard to do things based on themes and topics. But every researcher will have a different context. You can't predict which associational value a particular researcher will want to extract out of a collection.

Levin: *One question we haven't addressed is the problem of data preservation and migration, which is posed by this large digitization of material.*

Van der Reyden: I was at a conference once where they asked what would it take for us to have confidence in digital preservation, and I thought to myself that what it would take is that the process be self-replicating, self-sustaining, and self-correcting. It's a medium like DNA—and there *is* DNA computing that's being done. Whether or not it will ever serve as a substrate remains to be seen. When I ask people about that, some say that it's twenty years in the future—as though that's so far off. The point is that we haven't reached the end in terms of types of substrates and systems. The digital era is just one period of time, and with biotechnology and development of wetware and things like that, there are all sorts of potential solutions out there. So I'm not pessimistic about storage mediums or substrates for digital-type information. We're going through a period that has certain problems, but it will be a finite period. I'm not sure that there's motivation at the moment to look at new technologies that go outside the realm of the ones they're using now and to change the whole paradigm.

Bell: A phenomenal amount of work has been done on digital mediums and migration and understanding systems. We've gone far in twenty years. But now we're facing new technologies. For example, government decisions are being sent by email. Decisions are being made through Facebook and text messaging. How do we capture another area of born-digital material, which is the history of the future? It's not just a question about preserving it—how do we get it in the first place? What are we going to keep? What is the record? It's hugely complex, and there will be black holes in our history if we don't face these things.

Van der Reyden: I agree. The born-digital issue is just what the research and resources should be going into. These are all machine-dependent technologies. When you start looking at the things that are being created on the Internet and how all these things inter-operate together, you're faced with huge complications.

Bell: We're all looking at questions of the preservation of Web sites, because increasingly they are the documentary evidence of our history. They have aspects to them that we want to preserve, but this presents huge storage requirements and is therefore resource draining in a major way.

Kolar: And they continue to change.

Van der Reyden: Exactly—what you capture today is not what's happening tomorrow.

Kolar: The Netherlands National Archives made a calculation on the cost per year of storing a terabyte of information, and their estimate is that it costs about ten thousand euros per year. Now, the number of images in a terabyte depends, of course, on the format and the quality of the image. But it's quite expensive.

Bell: I can add one staggering statistic. They're using 24 bit TIFF files in digitizing this 1911 census of twenty-six thousand volumes. The census currently takes up two kilometers of paper. The DVDs will also occupy two kilometers of shelving and require an estimated 512 terabytes of storage. And that's one tiny collection. I know there's talk about using digital video storage and retrieval. These things are very much driven by competition, so maybe future competition will create more alternatives.

Van der Reyden: That's a really good point. Right now the competition isn't looking at a stable substrate because manufacturers are more focused on new innovations in functionality. One thing we need to make clear—we all love the aspect of accessibility provided by digitization; they give you a lot of information very quickly and very conveniently, and there's never been anything like that in history. It's wonderful. But we're concerned because it's also so ephemeral.

Bell: And then there's this whole question of volume. In the National Libraries we're taking in books at a great rate, but we're also taking in data that's going to be very much a part of the collection. For example, we have police collecting all sorts of data from cameras that need to be used for criminal cases. These cameras are on the road, they're used for interrogation, and they even have them on dogs that go out sniffing. In the end, it's a selection process—and we really haven't tackled the selection element of it all.

Levin: *Hasn't selection always been an issue for custodians of libraries and archives?*

Van der Reyden: It always has been. It hasn't always been dealt with well, and the problems are even more massive now.

Levin: *So how are those decisions being made?*

Van der Reyden: What we recommend—and I'm not saying that people follow that recommendation—is to look at value, use, and risk. The value can be associational value, monetary value, research value, evidential value—there's a whole range of values one needs to think about. Examples of the risk could be video materials that are deteriorating or CDs being stolen. And use encompasses use by researchers, use for exhibition, use for digital conversion. We like people to consider at least those three things when making preservation selections.

James Druzik: *If the selection criteria are as simple as value, use, and risk, what stops retention policy from saving everything forever?*

Bell: Well, I don't think it's that simple. It's enormously complicated.

Druzik: *Those three simple words allow everything in the universe to be either valued by someone, used for some theoretical or practical purpose, and be at risk because—as we know in preventive conservation—there are more risks than we have solutions for.*

Van der Reyden: But each of those three factors can have hierarchal rankings that are dependent on the institution or the curator or the librarian.

Kolar: And then, of course, you have to get all of them to agree on the same priorities.

Van der Reyden: Yes. Wouldn't life be a lot more efficient if that would happen? That's exactly the problem.

Druzik: *And that's my point. The problem with agreeing is that you would like everyone to agree on what the values, uses, and risks are, but then you end up with an unresolvable problem.*

Van der Reyden: Agreement isn't what's necessary—it's understanding the consequences. As we all know, there's not a perfect solution here. There's probably not even a good solution. But there can be a solution, to the best of our abilities, if we understand the consequences.

Kolar: And there's also a good chance that because we're looking at the present value, use, and risk of a certain material, we're missing something. Because the value of something may turn up later—for example, in twenty years—and we've not preserved it because no one thought it was valuable.

Levin: *How often are those criteria effectively employed in making decisions about what you're going to preserve and what you're going to let go?*

Van der Reyden: In the Preservation Directorate at the library, it is how we decide what work we do. We have to work with the curators to determine their collections' values, uses, and risks, and then we have to look at all the things that fall out from that in terms of priorities. We have to make decisions, and we have to be able to justify them for the work plans of the preservation staff.

Bell: We're slightly different in that we have very strict appraisal and selection processes and guidelines in place. There are representatives from the National Archives working in government departments and selecting material following standard archival selection protocols. By the time their material gets into the archive itself, it's there for permanent retention. Then we have to balance the preservation equation within that framework.

Levin: *In terms of what you're receiving, have you seen a dramatic shift in the balance between materials that are on the old-fashioned medium of paper and materials that are digitally born? Can you quantify it roughly in percentages?*

Bell: It's hard to say off the top of my head. The emphasis of the organization is very much toward digital preservation at the moment, because we have such a long history of dealing with paper-based or analog records. As I said, we are facing such acute problems with electronic communications—that's where the resources and thinking are focused; it's about what we are going to select, capture, and preserve. Running parallel to that is preservation of paper-based collections. But at the moment, the balance has shifted toward digital, and it's always an issue keeping the problems of paper-based collections in the forefront of people's minds. We still do have problems with some modern materials, particularly photographs and the vulnerabilities of some photographic processes. We're getting more things generated in the last thirty years—for example, records with plastic components or architectural drawings on plastics.

Kolar: Preservation of library and archival materials is becoming so complex with all the new media, and there's no simple answer. We have one approach to paper-based collections, and we have another approach to preservation of digital information—what to collect, how to preserve, and so on. Regarding the paper-based collection, we would like a preservation program that allows us to preserve as much as we can with the given funds. And that's why we

Courtesy of Jana Kolar

"There are some key questions that have not been answered yet—like rate of degradation at room temperature of a variety of materials—and we absolutely need that data."

— **Jana Kolar**

still do materials research. There are some key questions that have not been answered yet—like rate of degradation at room temperature of a variety of materials—and we absolutely need that data in order to prepare effective preservation programs that involve those materials. When it comes to books produced from the 1990s onward, we're not dedicating any particular attention to those because most of the paper is alkaline. The technology has changed, and those books are stable.

Van der Reyden: Can I say something here? First, the amount of print material is increasing, not decreasing. While the number of digital materials is increasing—I think it's about 1 percent right now at the Library of Congress—the number of print materials is not being replaced or decreased by those media. A new problem that is looming with paper-based materials is recycled paper. While we have papers that are more alkaline, they may have a larger percentage of shorter fibers. This could be a problem in the future because of green technology. There's a move to use greater and greater amounts of weaker fibers, which is good for ecology, but it might not be good for document history.

Bell: One thing this dialogue hasn't discussed is the debate about the validity of international standards for the storage of paper-based collections in view of the impact of climate change. We all know things can be saved longer in colder temperatures—we're there on that one—but which is the greater risk to collections worldwide: global warming and the impact of that and the potential for 100 percent loss of archival collections, or perhaps taking a more flexible approach, based on a sound understanding of materials science, and reducing carbon emissions? We're going to need to address this at some point.

Kolar: This is a very important issue—and not just for library and archival materials. It is for museums and historical houses as well. In our case, as I mentioned, we are going to start building a new library, and storage is planned underground, where we estimate that the naturally ambient temperature will be about fifteen degrees centigrade. Because there will be an automatic delivery system, we can afford not to heat the naturally cool storage underground. But we will need to dry the air. So we do hope to really decrease energy consumption.

Van der Reyden: We also have an underground storage facility, and many other agencies are moving in that direction. You can create a good, fairly controlled passive environment without a whole lot of mechanical overhead, and that will help you preserve things that are already on a somewhat stable substrate. The problem with digital materials is that they're already on an inherently unstable substrate, and they require huge mechanical intervention both to preserve them and to access the data on them. So that's an interesting cost differential to think about in the future as well.

Levin: *We talked a bit about things that might offer promise for dealing with some of these issues in the future. Are there any other things that have the potential for confronting some of these problems?*

Van der Reyden: I think dialogues like this help a lot.

Bell: The first word that comes to my mind is *global.* One of the really positive things that has happened in this profession is that none of us thinks local anymore. Whether we're in London or Washington or Los Angeles or Slovenia, we have very similar problems. There might be different solutions, but we're all grappling with the same problems, so it's a very positive step having dialogues in this way.

Kolar: I think there are many more international projects now than there were in the past because, as Nancy said, we're dealing with similar problems. It's absolutely the way to go.

Van der Reyden: Yes. Because these problems are going to take big groups to solve them.

Research on the Conservation of Photographs

A PROJECT UPDATE

By Jeffrey Levin and Dusan Stulik

For photography, this is a time of transition. In recent years, chemical photography, which characterized classical photographic image making from its embryonic days, has abruptly given way to digital photography. With astonishing speed, the dominance of film in photography has come to an end.

The work produced by that age, however, remains with us. Millions and millions of photographs from film exist in libraries, archives, museums, and private collections around the world, documenting over a century and a half of public and private life, as well as constituting an important record of places, people, and things that have long since vanished. Preserving this significant segment of the world's heritage that depicts our past requires a comprehensive understanding of both the materials and the processes that went into the making of these photographs.

During the chemical photography period, there were several processes that were widely used, some of which are fairly well researched by photography conservators. These include albumen photographic prints, commonly produced in the nineteenth century, and silver gelatin black-and-white printing, used pervasively in the twentieth century. But these are only two of approximately one hundred fifty photographic processes that were developed and utilized during the nineteenth and twentieth centuries as inventors and artists searched for ways to improve upon existing photographic technologies. Connecting a particular photograph with a particular process can present a real challenge—but one that must be addressed if a photograph is going to receive appropriate treatment. Identifying the specific material in a photograph and the process by which a photograph was created is a critical first step in a photograph's conservation.

Indeed, at a 2000 meeting the Getty Conservation Institute organized with the Image Permanence Institute (IPI) in Rochester, New York, the development of better methodologies for the detailed characterization of photographic material was singled out as one of the highest priorities in photographic conservation. The meeting, which included more than thirty experts from around the world, led to the 2001 initiation of the GCI's Research on the Conservation of Photographs project, in partnership with the IPI and the Centre de recherches sur la conservation des documents graphiques (CRCDG) in Paris, as well as with the Department of Chemistry at California State University, Northridge, and the Paper Conservation department of the J. Paul Getty Museum. In the years since then, the project has researched and refined techniques that can help to identify more than fifty photographic processes. In addition, the project has grown to include other related initiatives that seek to improve the practice of photography conservation.

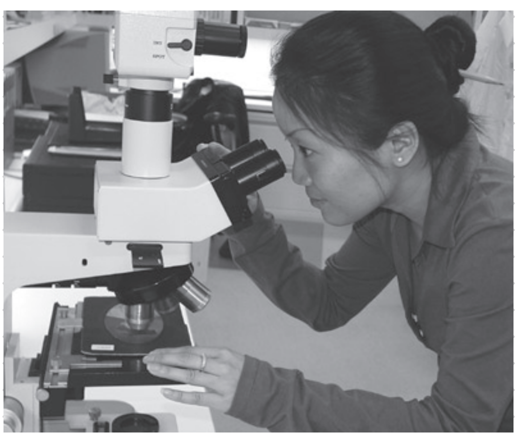
Identification of Materials

Visual and microscopic observation are important starting points in the examination of photographs, but they cannot identify all photographic processes. Photographs can include inorganic and organic materials, often composed in complicated layered structures that sometimes can be more complicated than those of paintings. For example, among the most complicated photographic prints is a Polaroid, which is composed of up to nineteen layers of inorganic and organic materials—complex layers, many with a submicron thickness.

A major part of the research project has been the development of scientific methods for the characterization of photographs and photographic material, using nondestructive analytical tools that the Institute has employed in other work—including X-ray fluorescence spectrometry (XRF) for the identification of inorganic materials and Fourier-transform infrared (FTIR) spectrometry for identifying organic materials. These tools provide us with analytical signatures that are associated with different photographic processes. The GCI is collecting these markers into an atlas of analytical signatures that, when complete, can assist curators and scientists in identifying the photographic processes that produced the images in their care—information that will be an important resource for photograph conservators and an aid to conservation.

The project has also developed a portable laboratory capable of conducting XRF, FTIR, and digital microscopy, and this has enabled the GCI to work with several different institutions with diverse photographic collections. No single collection includes images with all of the one hundred and fifty different processes represented, so the portable laboratory—which can be assembled in approximately forty minutes and can fit on a three-by-six-foot table—provides the opportunity to take the analytical tools to the collections rather than bringing photographic works from elsewhere to the GCI laboratories. This work has been conducted at the National Media Museum in Bradford, UK; the Société Française de Photographie in Paris; the George Eastman House in Rochester, New York; the Harry Ransom Center at the University of Texas in Austin; the Moravian Gallery in Brno, Czech Republic; and the Dresden Krone Archive at the Institüt für Angewandte Photophysik of Technische Universität Dresden in Germany.

One important aspect of the GCI's research on materials is investigation into the baryta-layer coating, which began to be incorporated into black-and-white photographic paper by the end of the nineteenth century. There are two main reasons the coating was used: first, it sealed the paper, which might contain some impurities that can destroy photographic emulsion, and second, it produced a more brilliant image. In its research, the GCI has discovered that different photographic papers have different quantities of barium in the baryta layer. For example, modern photographic papers have a different amount of barium than those used in the beginning of the twentieth century, and an amount much different than that applied in the nineteenth century. This finding has great benefit for curators, because analysis of the baryta layer can help identify the age of a photographic print. It could, for instance, demonstrate that a print has been mistakenly—or fraudulently—identified as being much older than it actually is. GCI research has also found strontium in the baryta layer. This discovery is significant because the difference between the barium and strontium concentrations in papers varies greatly, and determining the ratio between those two elements in a particular paper can help to identify it.



Photograph conservator Tram Vo studying microscopic signatures of photographic processes. Identifying the specific material in a photograph and the process by which a photograph was created is a critical first step in a photograph's conservation. *Photo:* Dusan Stulik.

GCI senior scientist Dusan Stulik training future photograph conservators in advanced techniques for identification of photographs and photographic processes at the Academy of Fine Art and Design in Bratislava, Slovak Republic. *Photo:* Tram Vo.

Brian Liddy of the National Media Museum at Bradford in the United Kingdom (left) and Art Kaplan of the GCI analyzing photographs from the Royal Photographic Society Collection. The GCI has developed a portable laboratory to analyze photographic collections in situ. *Photo:* Dusan Stulik.

In January 2006, the GCI and Boston-based independent conservator Paul Messier presented a daylong symposium at the Getty Center on the scientific investigation of the baryta-layer coating and its role in the identification, authentication, and provenance of twentieth-century silver gelatin photographs. More than eighty conservation scientists, photography conservators, photography historians, museum curators, photographers, and auction house representatives from North America and Europe attended. At the symposium, GCI staff and Messier made presentations on their independently conducted scientific investigations, which have identified a number of chemical and physical markers of baryta-coated black-and-white photographic paper (see *Conservation,* vol. 21, no. 1).

GCI research involving some specific photographs has yielded information that contributes to knowledge of the history of photography. For example, GCI scientific analysis of a gold-toned portrait of Abraham Lincoln, held in a private collection, resulted in a fuller understanding of the little-known auratype photographic process. In another instance, infrared and XRF analysis of a William Henry Fox Talbot experimental photograph dated 1854 at the National Media Museum in the United Kingdom indicated the use of collodion on the paper as well as the application of a baryta layer; if future research confirms that the print was indeed made by Talbot in 1854, this information would push back the date for the first known use of both of these processes.

Initiative in Central, Eastern, and Southern Europe

A major new component of the GCI's photography conservation project is an initiative to improve the conservation of photography collections in central, eastern, and southern Europe. Photograph conservation as a field of practice and study is relatively well developed in western Europe, but it is either in its infancy or nonexistent in these other regions of Europe. There are no university-level or other academic programs to prepare conservators for working with photographs and photograph collections. The needs of photograph collections in museums, archives, and private collections are only partially covered by paper conservators and other heritage preservation specialists—or not covered at all.

In 2006 the GCI conducted a feasibility study, surveying countries located in central, eastern, and southern Europe with a goal of determining how best to improve photograph conservation practice and education in the region. This study found significant interest among various cultural heritage organizations in the area to establish photograph conservation programs and practice. As a result, the GCI formed a partnership with two organizations in the Slovak Republic—the Academy of Fine Art and Design in Bratislava and the Slovak National Library in Martin—to develop a program of photograph conservation for the region.

The first program of this partnership was a four-day international symposium held in November 2007 in Bratislava, focused on developing preservation and conservation strategies for photograph collections located in central, eastern, and southern Europe, as well as encouraging photography research in the region. The goal of this symposium was to serve as a catalyst for an international collaboration to establish photograph education and training programs to preserve the region's photograph heritage.

The symposium was also an important first step in the development of the Institute's educational initiative for the region, scheduled to begin in summer 2008. The initiative involves a series of summer schools focusing on the theory and practice of photograph conservation, the organization and logistics of photograph conservation practice, and the development of photograph and photograph conservation research. The summer school program is being developed for conservators, art conservation educators, and cultural heritage specialists who are responsible for the care and preservation of photographs. Participants—who will ideally be midcareer conservators or cultural heritage specialists—will be chosen on the basis of their professional experience, the size of their photograph collections, and the likelihood that they will be able to

An 1854 photograph attributed to William Henry Fox Talbot. The GCI conducted infrared and XRF analysis of the photograph, which is part of the Royal Photographic Society collection of the National Media Museum at Bradford in the United Kingdom. *Photo:* Dusan Stulik.

A selection of materials from the GCI Reference Collection for Photographic Material. This reference collection will allow future generations of photograph conservators and scholars to research and authenticate photographs from the first century and a half of photography. *Photo:* Dusan Stulik.

disseminate the information through their own teaching and professional activities. Each multiweek summer school will be followed by a ten-month program of coordinated and mentored activities that participants will pursue within their own institutions, as well as through some targeted workshops and trips, as they apply the ideas and information presented during the summer sessions.

Photographic Materials Archive

An important aspect of the GCI's photography research project is the creation of a reference collection of photographic material that will allow future generations of photograph conservators and scholars to research and authenticate photographs from the first century and a half of photography. Until now, no such archive has existed. Unfortunately for the field, the large photography companies—Kodak, Ilford, Fuji, Polaroid, and Agfa—did not save samples of the hundreds of different films and papers they developed for use in chemical photography. And although many museums have photographs collections, and some museums collect cameras and photographic equipment, there is no institution systematically collecting photographic materials.

For that reason, the GCI decided to create an archive of photographic materials that will be part of the Institute's existing Reference Collection of art-related materials. As part of that effort, the Institute is reaching out to the public to provide material for the archive. Through the project's Web site (www.getty.edu/conservation/science/photocon/photocon_wanted.html) and other venues, the GCI is seeking the public's help in saving photographic heritage by donating photographic materials, including samples of photographic paper and plates, film, and negatives, as well as sample books and dated photographs. The GCI is looking for examples of all types of materials dating back to the early nineteenth century, when photography began. The initial response to this appeal has been strong: people are sending materials from the United States and other areas of the world, including Europe and Africa. The growing archive of photographic materials is housed in the GCI's Reference Collection at the Getty Center in Los Angeles; it will be open to conservators, scientists, and researchers.

As chemical photography recedes in popular use, the critical moment to gather and disseminate information regarding this form of photography has arrived. Work must be undertaken now, before essential knowledge of the materials and processes that created these images is lost. It is hoped that the research efforts of the GCI, in partnership with other institutions, on the conservation of photographs will contribute to the preservation of this significant portion of our cultural heritage.

Jeffrey Levin is editor of Conservation, The GCI Newsletter. *Dusan Stulik is a senior scientist with GCI Science; he heads the Institute's research on the conservation of photographs.*

Some of the analytical data obtained during analysis of photographs. These data will be used in the *Atlas of Analytical Signatures of Photographic Processes and Process Variants.* When complete, the atlas will assist curators and scientists in identifying the photographic processes that produced the images in their care. *Photo:* Dusan Stulik.

Research on Museum Lighting

A PROJECT UPDATE

By James Druzik

Museum lighting is the most complex environmental parameter surrounding museum collections. Experience tells us that it ranks high in its potential to damage cultural artifacts through fading and other visible changes. But lighting can also introduce, into otherwise stable microenvironments, energy that may alter materials in less visible ways. Of course, museums cannot simply dispense with lighting. You can restrict the diffusion of oxygen into microenvironments, control the flow of water molecules, maintain temperatures at rock-solid levels, and set implacable limits for other factors—but excluding photons is simply inconsistent with exhibiting works of art and therefore with many of the educational functions of museums. Thus, we have come to accept a range of compromises that manage an acceptably slow rate of damage from light exposure. However, these risk management procedures would not make museum lighting any more remarkable than other environmental risk factors if human sensory and cognitive apparatus were not part of the equation.

Unlike pollution, incorrect relative humidity and temperature, shock and vibration, and museum pests, lighting is critical for communicating information about an object—e.g., its color appearance or patterns of contrast—or conjuring up visitors' associations with an object's historical milieu or aesthetic context. Lighting often complements the architectural environment into which objects have been placed and evokes a host of purely serendipitous personal responses in visitors. Complicating the myriad responses to design and communication elements are each visitor's perceptual constraints. Older visitors need more light to see the same level of detail as younger visitors. Their sensitivity to tonal contrast is reduced, their color perception is altered, and their acuity is frequently reduced; complex visual tasks take more time. Overlay these realities with curatorial decisions on conservation lighting practices—some of which affect the visitor's experience even further—and it becomes clear why lighting is so complex. For a variety of reasons, much of this complexity is simply not addressed by museums. If one wishes to improve existing practices or to examine this medium—which both communicates and destroys—in any detail, the complexity almost immediately rises up as a barrier to progress.

Investigating Museum Lighting

Since 2002 the GCI has been investigating museum lighting in some depth. Initially the research questions were about reducing the total energy flux to objects on display beyond what we have been able to achieve thus far by lowering light levels, reducing exposure time, and removing ultraviolet light. But one cannot reduce energy and preserve the color appearance of valuable artifacts without a fundamental understanding of color science and optical physics. We had to consider visual performance and aesthetic satisfaction, particularly with regard to lighting systems that diverge from well-used and understood lighting techniques. It was also necessary to explore materials damage anew. Our knowledge of how most pigments, dyes, and substrates react to "blackbody radiators" such as sunlight and incandescent light sources, especially with unknown historical light or pollution exposures, is sadly incomplete. The profession of conservation has managed to create a sufficient number of heuristic procedures to approximately manage the problem. And as a profession, we have recently seen the creation of new tools (and the improvement of old ones) that greatly enhance the early detection of light-sensitive colorants. But this body of knowledge is based on three spectra profiles: daylight, low-color-temperature incandescent, and low-to-high correlated color temperature fluorescent illuminants. To diverge from these three classes is to enter poorly explored territory in materials damage, visual performance, and aesthetics. Even the tried-and-true computational tools may not serve with the same relevance as they once did. Therefore, since 2002 the GCI's research has had to amalgamate all these factors into a museum lighting project that had originally (and naively) been thought to simply involve reducing the flux of energy to surfaces.

Another consideration is the current “change in the wind” with regard to energy policy that extends well beyond museum walls. Energy policy reform in the United States and other developed countries is merging with new technology to produce changes that will challenge museums. Incandescent sources are inefficient—what can be done with fifty watts is attainable with compact fluorescent lighting (CFL) at twenty. Light emitting diodes (LEDs) and other solid-state sources can do even better, and LEDs have almost no attendant waste management issues, unlike CFLs (in spite of their reduced mercury content). LEDs also hold out the hope for exceptionally long operational lifetimes. Because of recent experience in gallery remodeling at the J. Paul Getty Museum in Los Angeles, the Getty is especially aware of laws in California that now limit the amount of light used per unit of area in display situations, as compared with what was permissible in the mid-1990s. There is every reason to expect that policy extrinsic to museums and conservation practices will force the conservation profession to adjust. Thus, the tool sets and mind sets developed since 2002 as part of the Museum Lighting project will serve other purposes as well.

Work Conducted

The GCI and its research collaborators have developed methods for satisfactorily illuminating collections of artworks such as old master drawings—with clearly limited ranges of colorants and appearance properties—with lighting that reduces the intensities for some of the frequencies in the visible range (in contrast to the unfiltered quartz-halogen lamps often used in exhibitions). The principal collaborator for this research, Carl Dirk at the University of Texas at El Paso (UTEP), has developed multicoated glass filters that provide excellent color rendering of old master drawings while reducing irradiation. Various newly written mathematical models for calculating color appearance, color rendering of light sources, and spectral profiles have been combined with industrial engineering design software to produce testable filters that offer the desired discontinuous spectra.

GCI senior scientist James Druzik looking at a copy of an old master drawing hung in a specially designed display case. The light in the case, which passes through a filter designed by researchers at the University of Texas at El Paso (UTEP), projects less than half of the total energy of an unfiltered quartz-halogen light of equal illuminance. Human visual assessments were used to test the filtered light for visual satisfaction and color-rendering capacity. *Photo:* Emile Askey.

Over the last year, both at UTEP and at the GCI, work has progressed on two main fronts—validation of the visual appearance model predictions and testing of the effects of these filters on light-induced accelerated aging. The first aspect of this work nears completion for three of the experimental filters developed by UTEP. These filters have been assessed for visual satisfaction and subjective color rendering by more than a hundred individuals. Fifty of these assessors have been museum conservators, curators, educators, and library and facilities support personnel, and thirty were selected from the Getty Museum docent program. Capturing the younger demographics, UTEP's program used university students almost exclusively. This selection ensured a full range of professions associated with museums, as well as age groups of widely varying museum experience, visitation habits, and expectations.

A big challenge was how to carry out human visual assessment of lighting. Focus groups are popular, but they tend to suppress weak individual responses in favor of deriving consensus; they can bias some of the members, and thus, members cannot statistically be treated evenly. It is far better to poll assessors singly and treat responses as independent statistical units. Internal checks and balances can be built into the assessment form to ensure that the data derived are fair for what is being evaluated, and collecting unformatted comments about the assessment process helps to determine if a line of questioning is garnering weakened or useless data. Thus we have employed a combination of psychophysical testing (for color-anomalous vision and intensity-matching experiments), color discrimination of light source chromaticity ("Is light source A redder than light source B?"), and visual satisfaction assessment ("On a scale of one through seven, how would you rank your satisfaction of light source A?"). The American Society for Testing and Materials (ASTM) has a standard for color assessments that can be used to inform museum lighting assessment procedures, but there is no standard for solely judging museum fine-art aesthetics.

The human visual system is tricky to test. First, the level of brightness adaptation must be controlled. It is easy to understand that we need to adapt to darker environments when coming in out of bright sunlight, but this phenomenon also holds true when we move from high light levels for paintings to low light levels for dark or low-contrast artworks on paper. We are also seldom conscious of how chromatic adaptation modifies our perceptions. The human visual system successfully and rapidly white-balances many light sources—i.e., it corrects for excessive color casts such as blue, red, or green—in such a way that we hardly notice their significant chromatic differences. In other words, this chromatic adaptation makes familiar and common objects appear natural through an extremely rapid, and usually unconscious, reflexive action. To compare two light sources fairly, we need to allow the viewing

The author preparing to measure the color change of a sample after exposure to light filtered through a UTEP-designed filter. Highly light-sensitive colorants may not be appreciably helped by the exclusion of UV wavelengths from illumination. *Photo:* Emile Askey.

environment to permit this adaptation as if nothing about the light sources differed. In what we call the threshold test, assessors are given a false acuity task and then, once they are removed from the test environment, they are asked what they remember about light intensity, evenness of illumination, and chromaticity—aspects of the test they were not previously told to pay attention to. When we combine this test with the other evaluation criteria, we believe we are able to determine how acceptable the filtered light sources are, compared to conventional lighting, for a cross section of museum professionals and visitors (given the limitations of our sampling); assessors are not told which lighting setup is which, and their order is alternated. At UTEP, test subjects uniformly could not distinguish between the UTEP-designed filtered and unfiltered lighting. This finding was true, regardless of age, sex, or background.

Long-term and accelerated testing of the UTEP-designed filters suggests practical lifetimes for the filters that exceed at least six years of typical use, with an upper temporal lifetime limit yet to be determined. The manufacturing techniques and materials appear to be robust.

During the last year, we began measuring the effects of two of these filters on several sets of pigments—compared to no filtration or compared to filtration that removed only ultraviolet wavelengths. These tests fall into the realm of accelerated light aging, but they are performed at light levels low enough to require rather lengthy periods of exposure. We have known since the early 1950s (from independent researchers such as McLaren, Morton, and Taylor) that highly light-sensitive colorants may not be appreciably helped by the exclusion of UV wavelengths from illumination. Compounds like rhodamine, methyl violet, and some color toners continue to be added to artists' paints and are so light sensitive that probably nothing, save darkness, will keep them from extinction.

Even filters like the ones we have designed and fabricated may offer little or no help for some materials. Thus we need to proceed slowly and deliberately. The current set of filters consisted of prototypes, with the main aim being to reduce total radiant energy, preserve luminance, and maintain adequate color rendering. In this first stage of filter development, the principal challenges were the creation and implementation of new theory applicable to the problem, the creation of computational methods to address the problem, and the identification of adequate manufacturing methods. The research conducted as part of the UTEP-GCI collaboration has demonstrated that color and optical theory can be developed to control light in the key areas of color rendering, radiance, and luminance to yield spectral profiles optimal to preserving works of art. This research has demonstrated further that manufacturing techniques and materials can be identified to make long-life filters. In less than five years, UTEP and GCI researchers have assembled a complete set of tools—design concepts, software, and fabrication methods—that can help redefine how future museum lighting research proceeds. Once these techniques are published in the professional literature, other researchers in the field of museum lighting will have an enhanced ability to effectively evaluate their work, and this ability should assist in the continued evolution of improved techniques for illuminating works of art.

Our biggest challenge for the last and remaining year of this project is to be absolutely precise on the degree of benefit such strategies as these afford for the protection of light-sensitive works of art. Light aging must be pushed to higher degrees of precision than are frequently found, since valuable, often irreplaceable artifacts are at stake. Much work remains to be done to optimize color rendering, lower overall energy exposure, and ensure colorant permanence. We hope to be able to report in a future article that the filters we are designing and testing are ready for installation.

A view of an installation at the exhibition *Fade: the Dark Side of Light* at the California Science Center (CSC) in Los Angeles. This exhibition, coproduced by the GCI and the CSC, explores the destructive effects of light exposure on objects and the work of the Museum Lighting Project to reduce these effects while minimally affecting visual perception. *Photo:* Courtesy the California Science Center.

James Druzik is a senior scientist with the GCI. He oversees the Institute's Museum Lighting project.

Hieroglyphic Stairway at Copán

As part of its Maya Initiative, the GCI has been collaborating with the Instituto Hondureño de Antropología e Historia (IHAH) since 1999 to establish a long-term conservation strategy for the Hieroglyphic Stairway at the Maya site of Copán in Honduras, in order to ensure the stairway's preservation for future generations. In recent decades, the deterioration of the hieroglyphs on the stair risers has been a major concern for scholars, conservation specialists, and IHAH because it impacts the ability to read the carved stone text. The inscription, executed in the eighth century, is the longest known text from ancient Mesoamerica and provides a unique historical account of four centuries of the Copán dynasty.

In July 2007, three members of the GCI project team traveled to Honduras to present the findings and recommendations of the Institute's conservation report on the stairway. Presentations were made to the public at Tegucigalpa, San Pedro Sula, and Copán Ruinas, as well as to professionals involved at the site. At the presentation in Tegucigalpa, held in the recently restored Old Presidential Palace, the report was officially handed over to the minister of culture and the director of IHAH, in fulfillment of the GCI–IHAH institutional agreement.

A guide to the Maya site of Copán recommending more security guards at the site during a public presentation of the GCI's conservation report on Copán's Hieroglyphic Stairway. *Photo:* Shin Maekawa.

The Hieroglyphic Stairway of Copán after a cleaning of accumulated debris. *Photo:* Shin Maekawa.

The report presents the findings in three major areas of study conducted by scientists and conservators: archival research; laboratory analysis of biological specimens and samples of stone and mortar; and environmental monitoring at the site. In addition, the condition assessment and treatment trials carried out on the stairway were the basis for proposed short- and long-term conservation and maintenance programs.

The report also proposes improvements to the stairway shelter and the designation of a guard assigned to the stairway to prevent access at all times. These proposals include both preventive measures, which mitigate the factors contributing to the deterioration or loss of the stone, and direct remedial repairs to stabilize damaged and deteriorated areas, both now and in the future, following scheduled inspections and monitoring and recording of conditions.

Such a maintenance program of inspection, followed by repair as needed, requires trained personnel to carry it out regularly. The GCI project at Copán involved several local conservation personnel and training in photographic monitoring, but at present the site does not employ sufficient site conservation personnel to address maintenance needs. The training of maintenance technicians in the use of lime mortars for stabilizing stone surfaces and masonry—and in performing basic recording techniques—represents both the best short-term and most sustainable long-term solution to conserving the stairway and other monuments at Copán.

A copy of the report, *The Hieroglyphic Stairway of Copán, Honduras: Study Results and Conservation Proposals,* is available in English and Spanish in the Conservation section of getty.edu at: www.getty.edu/conservation/field_projects/maya/maya_publications.html.

Workshop in Tunisia

View of the ancient Roman coliseum at El Jem with the modern city in the background. Tourism and urbanization are greatly impacting the city's archaeological heritage. *Photo:* Beth Harrington.

In October 2007, the GCI and Tunisia's Institut National du Patrimoine (INP) conducted a five-day workshop entitled "Du Site à la Ville" ("From the Site to the City") for twenty-five young professionals from the INP who are responsible for archaeological sites and built heritage throughout Tunisia. All of the attendees were participants in a three-week workshop jointly organized by the GCI and the INP in spring 2007 (see *Conservation,* vol. 22, no. 2). This is the first of several mentoring activities that will reconvene these participants at a Tunisian site.

The October workshop's main objectives were to reinforce through practical application some of the lessons learned during the earlier workshop, to strengthen professional and personal bonds among the participants, and to demonstrate the value of multidisciplinary work through a series of exercises complemented by formal presentations and discussions.

Held in El Jem, a city where urbanization and tourism have exerted significant pressure upon archaeological heritage, the workshop began by focusing on the Roman mosaics found in the insula adjacent to El Jem's museum. Using a set of developed criteria, participants were asked to survey, inventory, and assess conditions and priorities for conservation. The workshop then moved beyond the historic Roman site to the city itself, where similar analytical skills were applied to the increasingly complex issues associated with preservation planning and urban development.

City officials presented workshop participants with current urban plans and policies, and INP officials explained to the participants how Tunisia's *Code du Patrimoine* (*Heritage Code*) related to those policies. Participants then discussed the implications of these policies for the conservation and management of heritage sites. After a culminating group exercise, participants were asked to consider how the El Jem case resonated with their own work.

For more information on the GCI's training and capacity building for technicians and site management professionals in Tunisia, visit the Getty Web site (www.getty.edu/conservation/field_projects/mosaics/mosaics_component2.html).

GCI staff member Thomas Roby instructing course participants on the conservation of mosaics at the House of Africa in El Jem, Tunisia. *Photo:* Beth Harrington.

OWHC World Congress in Kazan

The Ninth World Congress of the Organization of World Heritage Cities (OWHC) was held June 19–23, 2007, in Kazan, Republic of Tatarstan, Russian Federation. The Getty Conservation Institute, working with the OWHC, organized the conference's scientific program, as well as a pre-congress workshop for mayors of World Heritage cities.

This multinational forum, held every two years, brings together heritage professionals and decision makers responsible for the management of historic cities. The congress held in Kazan included approximately 350 participants, with 70 mayors from a number of important cities who gathered to discuss common issues and concerns related to the theme of the congress, "Heritage and Economics."

The pre-congress workshop, directed specifically to mayors, examined the reuse of historical buildings in an economic context. A case study, presented by representatives of the city of Kazan, illustrated some of the issues and ways they have been addressed.

The conference itself included four keynote presentations that addressed the heritage and economics theme. In addition to formal presentations, working groups were organized, which were structured to foster debate in small groups. Conference participants were also invited to present their projects through a poster session. In addition, a panel of five mayors discussed why tourism is insufficient to sustain economic development and support conservation endeavors in historic cities.

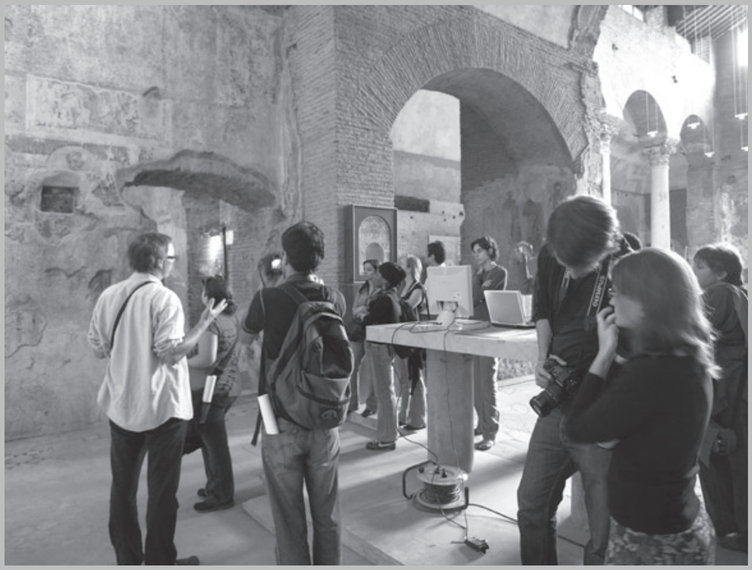
Kazan City Architect Olga Aksientieva leading workshop mayors on a site visit to the City of Kazan's case study project. ***Photo:*** **Jeff Cody.**

The OWHC congress in Kazan also included the culmination of a twelve-month program for Kazan university students to address how revitalization of historic traditions, historic buildings, and urban areas can promote economic development. This program concluded with the presentation of the twenty projects developed by groups of students from architecture, economics, and social sciences programs, among others.

The GCI's past work with the OWHC has included organizing the scientific program and the pre-congress workshop at the Eighth World Congress in 2005 in Cusco, Peru (see *Conservation,* vol. 20, no. 3).

ARIS 07

Werner Schmid, a lecturer at the ARIS 07 course, explaining challenges in wall paintings conservation to participants during a site visit to Santa Maria Antiqua. *Photo:* Rand Eppich.



From September 12 to October 12, 2007, in Rome, ICCROM (International Centre for the Study of the Preservation and Restoration of Cultural Property) and the Getty Conservation Institute conducted their jointly organized course on architectural records, inventories, and information systems for conservation (ARIS 07).

Sixteen midcareer conservation professionals and educators, from sixteen different countries, participated. Countries represented included Azerbaijan, Barbados, Brazil, Croatia, the Czech Republic, Egypt, Germany, Greece, Ireland, Japan, Lithuania, Nigeria, Pakistan, Serbia, Tanzania, and the United States.

The course goal was to improve conservation decisions through better information. Specific objectives included understanding emerging technologies, organizing data for easy access and use, and applying the most appropriate form of recording for conservation. Among the topics covered were digital imaging and lighting, thermal imaging, photogrammetry, data management, laser scanning, geographic information systems, inventory principles, and dissemination tools. Conservators, who were closely involved with the course, explored with participants how the resulting material can be incorporated into the conservation process.

The course was held at ICCROM, and fieldwork was conducted at the nearby church of Santa Cecilia. The course participants recorded and documented wall paintings, sculptural tombs, and vaults.

Participants process, study, and discuss data collected at the church of Santa Cecilia. *Photo:* Rand Eppich.

California Science Center Exhibit

As part of the Getty Conservation Institute's expanding public programming, the GCI has partnered with the California Science Center in Los Angeles to create an exhibition that blends science and art. *Fade: The Dark Side of Light* explores the destructive effects of light exposure and provides museum visitors with an introduction to conservation science.

Interactive exhibits explain the nature of light and how and why it may permanently alter the appearance of many objects—from priceless works of art to personal treasures—and effect changes down to the atomic level. Visitors will be able to learn what conservation scientists, conservators, and curators are doing to mitigate the damaging effects of light.

The exhibition also provides an opportunity for the public to learn about pioneering research undertaken by the GCI and the University of Texas at El Paso to develop filters to strip away unwanted parts of the electromagnetic spectrum that have a lesser impact on our vision (see p. 20). These filters substantially reduce the amount of energy hitting an object without greatly affecting our visual perception of it.

The collaboration with the California Science Center is an opportunity for the Institute to reach out to new audiences. Through this exhibition, visitors are given a view into the ways science helps preserve important cultural treasures.

Fade: The Dark Side of Light opened October 10, 2007, and runs through May 31, 2008, at the California Science Center in Exposition Park, Los Angeles. For more information, visit the California Science Center Web site at www.californiasciencecenter.org.

The exhibition *Fade: The Dark Side of Light,* coproduced by the GCI and the California Science Center in Los Angeles. *Photo:* Courtesy the California Science Center.

Publications

Modern Paints Uncovered

Proceedings from the Modern Paints Uncovered Symposium

Edited by Thomas J. S. Learner, Patricia Smithen, Jay Krueger, and Michael R. Schilling

Over the past seventy years, a staggering array of new pigments and binders has been developed and used in the production of paint, and twentieth-century artists readily applied these materials to their canvases. Paints intended for houses, boats, cars, and other industrial applications frequently turn up in modern art collections, posing new challenges for paintings conservators.

This volume presents papers and posters from "Modern Paints Uncovered," a symposium organized by the Getty Conservation Institute, Tate, and the National Gallery of Art in Washington, DC, in May 2006. It showcases the varied strands of current research into the conservation of modern and contemporary painted surfaces. These include paint properties and surface characteristics, methods of analyzing and identifying modern paints, aging behavior, and safe and effective conservation techniques.

Thomas J. S. Learner is senior scientist for contemporary art research at the GCI and former senior conservation scientist at Tate; Patricia Smithen is a conservator of modern and contemporary paintings at Tate; Jay Krueger is senior conservator of modern paintings at the National Gallery of Art; and Michael R. Schilling is a senior scientist and head of analytical technologies at the GCI.

372 pages, 9 × 11 inches
104 color and 64 duotone illustrations,
58 line drawings, 27 tables, paper, $75.00

New Department Heads at the GCI

In September Jemima Rellie joined the GCI as the new assistant director of Communications and Information Resources (formerly Dissemination and Research Resources). Jemima came to the Institute from Tate in London, where she had been head of Digital Programs since 2001. There she established the strategy, implementation, and delivery of the organization's public-oriented digital activities, increasing the range and quality of programs offered online. Previously, Jemima worked for art book publishers, including Phaidon Press and Macmillan Publishers. She holds a master's degree in the social history of art from the University of Leeds.

Jemima will be working to strengthen the impact of the GCI's dissemination activities, which include the Information Center; AATA Online and other bibliographic services; the GCI's book publications and ephemera; the Institute's presence online; and *Conservation: The Getty Conservation Institute Newsletter.*

She succeeds Kristin Kelly, who is now a principal project specialist with the Institute. Kristan oversees the GCI's public programming, the scholars and interns programs, and a range of special projects. Kristin had headed the department since December 2004.

François LeBlanc, who joined the GCI as head of Field Projects early in 2001, retired in September to return to his native Canada. François came to the Institute after more than twenty years of public service in Canada—first as chief architect at Parks Canada in Quebec, then as vice president of Heritage Canada, and, finally, as chief architect for the National Capital Commission in Ottawa. He also served as director of the International Council on Monuments and Sites (ICOMOS) in Paris. During his tenure at the GCI, the Institute continued its work on earthen architecture, on mosaics in situ, and on several projects in China, while initiating a project on documentation, a collaboration with the Organization of World Heritage Cities, and a new project in Egypt's Valley of the Queens.

The new head of GCI Field Projects is Susan MacDonald. Before coming to the GCI, Susan served as director of the New South Wales Heritage Office, Australia's lead government agency for all aspects of Australia's heritage—from museum collections to built and natural heritage. She was instrumental in developing heritage policy in New South Wales and at the national level, and she frequently represented her government internationally. With over twenty years of experience as a conservation architect, having worked previously at English Heritage in London and in private practice, Susan maintains particular interest in the conservation of twentieth-century buildings and modern materials, and she recently helped prepare the nomination of the Sydney Opera House to the World Heritage List.

As head of GCI Field Projects, Susan will provide leadership for the department. She will be involved in the development and implementation of projects in the context of overall institutional objectives, will forge partnerships with institutions in areas of mutual interest, and will represent the GCI in the international conservation community.

In October Kathleen Dardes was appointed head of GCI Education. A textile conservator by training, Kathleen held positions at the Metropolitan Museum of Art, New York, and the Boston Museum of Fine Arts before joining the GCI's Training Program in 1988. After a number of years in this role and subsequently as a project specialist in Field Projects, Kathleen was promoted to senior project specialist in 2001 to focus on the Institute's renewed education efforts. Since then, she has developed and led a number of initiatives—including the online Conservation Teaching Resource, the Directors' Retreats for Conservation Education, and efforts in preventive conservation and integrated emergency management. She has also been instrumental in identifying and hiring new staff. In her new role, she will provide leadership and vision for the newly independent Education department and will continue to define ways that the GCI might best serve the evolving educational needs of the conservation field.

Catherine Myers

Senior Project Specialist, Field Projects

Photo: Dennis Keeley

Catherine Myers began work at the GCI in April 2007. Previously, she served as the conservator in the Office of the Chief Architect of the U.S. General Services Administration, where she supervised contracts for the Fine Arts Program, overseeing the conservation of art in government buildings around the country.

After receiving a BA in art history from the University of North Carolina, Catherine carried out museum conservation apprenticeships and chemistry course work before beginning formal conservation training in 1981 as a Samuel H. Kress Fellow at the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) in Rome, and as a UNESCO Training and Research Fellow at ICCROM and the Istituto Centrale per il Restauro in 1982–83. She subsequently completed a master's degree in historic preservation, specializing in architectural conservation, at the University of Pennsylvania (she continues her association with the program as a lecturer). Shortly thereafter, as a U.S. Capitol Historical Society Fellow, Catherine applied her new expertise in a technical study of Constantino Brumidi's wall paintings at the U.S. Capitol.

After working as a paintings conservator for several institutions (including the North Carolina Museum of Art; Biltmore, Campbell, Smith Restorations Inc.; and the Brooklyn Museum), in 1992 Catherine founded Myers Conservation LLC in Washington, DC, specializing in the conservation of mural paintings and architectural finishes. Over thirteen years, she undertook a broad range of conservation assignments, including: the 1789 house of John Penn and New Deal murals at the U.S. Customs House in Philadelphia; the Neolithic archaeological site at Çatalhöyük in Turkey; architectural finishes analysis at the U.S. Treasury Building; mural paintings conservation at the U.S. Capitol; and work at many other sites across the United States. She joined the Office of the Chief Architect of the General Services Administration in 2005, after a long association as a professional peer and commissioned conservator.

At the GCI Catherine is involved in several projects. She is overseeing a new agreement with the Office of the President of the Czech Republic to monitor the *Last Judgment* mosaic on St. Vitus Cathedral in Prague Castle, in the wake of the Czech-GCI project that conserved it. She is also coordinating the field application of the Organic Materials in Wall Paintings project and working on a new project that examines maintenance and community programs for public murals. And she is collaborating with GCI Science staff on developing a project to compare historic architectural finishes with materials used to replicate them.

Alan Phenix

Scientist, Science

Photo: Dennis Keeley

In November 2006 Alan Phenix joined the GCI's Museum Research Laboratory. By then he was no stranger to the Institute, having spent October 2005 to July 2006 doing research at the GCI as a Conservation Guest Scholar.

Alan earned his first academic degree, in chemistry, from University of Leeds in the United Kingdom; he went on to earn a postgraduate diploma in the conservation of paintings from Courtauld Institute of Art in London in 1984. For the next four and a half years, he worked as a paintings conservator in Britain and then in Australia. In 1989 he returned to Britain and began his career as a teacher of paintings conservation, first at the Hamilton Kerr Institute, University of Cambridge, and then at the Courtauld Institute of Art, where he was a lecturer for ten years. After short periods at the joint Royal College of Art/Victoria and Albert Museum conservation program in London and at the University of Oslo, Alan joined the faculty of Northumbria University in the United Kingdom in 2002, where he served as senior lecturer in the conservation of easel paintings until coming to the Getty.

An important part of Alan's professional activities was his service between 1996 and 2002 as coordinator of the paintings conservation and restoration working group of the International Council of Museums Conservation Committee (ICOM-CC). Prompted by his continuing interest in the international conservation community, he became a member of the editorial board of *Studies in Conservation,* published by the International Institute for Conservation. He also regularly teaches courses and workshops for professional conservators.

Alan's work at the GCI focuses on paint analysis, primarily to assist Getty Museum paintings conservators and visiting conservators with paintings in their care, which recently included large works by eighteenth-century painter Jean-Baptiste Oudry and nineteenth-century landscape paintings by French artists Théodore Rousseau and Charles François Daubigny. He has also begun working with Decorative Arts and Sculpture Conservation at the Museum, studying the paints and coatings on outdoor works in the Museum's Fran and Ray Stark Sculpture Garden. Additionally, he is participating in the GCI's Modern Paints research project.

With regard to Alan's technical expertise, his experience includes visible/ultraviolet fluorescence microscopy of cross sections, Fourier transform infrared (FTIR) spectroscopy, scanning electron microscopy, and X-ray fluorescence. He is looking forward to continuing past research by conducting dynamic mechanical thermal analysis of artists' paints on newly acquired Institute equipment.