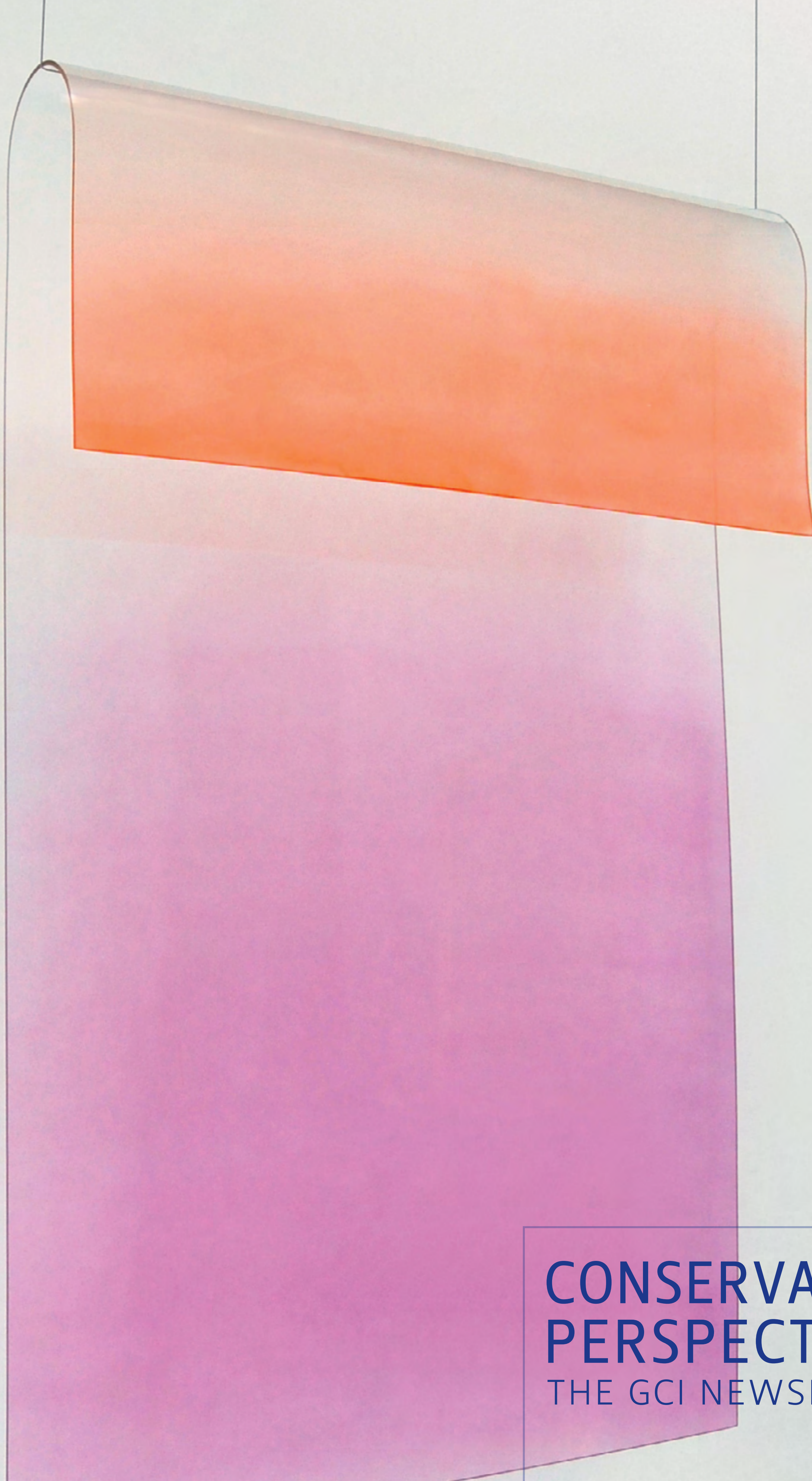


CONSERVATION PERSPECTIVES

THE GCI NEWSLETTER

SPRING 2014

CONSERVATION OF PLASTICS

The Getty Conservation Institute

A Note from the Director

Photo: Anna Flavin, GCI

The word *plastic* evokes mixed feelings, and over the decades it has assumed, for some, a slightly pejorative connotation. However, a walk through the Architecture and Design Galleries at the Museum of Modern Art can leave one with a strong sense of the beauty and innovative quality that characterize many objects made of plastic. Collections such as MoMA's not only remind us of plastics' ubiquity, but also demonstrate the remarkable and compelling ways artists and designers have employed and exploited this material. Curators identify and collect, but conservators are obliged to understand how to care for, preserve, and conserve a material that is not well understood. We need to know more, and with our colleagues and partners we are trying to untangle the complexities of the varieties of plastic.

In this issue of *Conservation Perspectives* we explore this diverse group of intriguing but challenging materials, highly prized for their versatility but often problematic from a conservation standpoint in ways not initially recognized with their early use. In their feature article, Odile Madden of the Smithsonian Institution and Tom Learner of the GCI examine the extent to which plastic materials have permeated art and design, as well as our lives in general, and they go on to provide a general overview of the challenges and successes of plastics conservation.

Critical to understanding the nature of plastic materials is the ability to test those materials. The GCI's research collaboration with the Disney Animation Research Library (ARL), which is focused on historic animation cells in the ARL collection—described in the article by Kristen McCormick and Michael R. Schilling—has enabled the Institute to sample and analyze several different kinds of plastics commonly used in the first part of the twentieth century; at the same time, this research has aided staff at the ARL in gaining a more complete understanding of their collection. Yvonne Shashoua's article on storage conditions for plastics offers insights into current research on how best to store particular plastic material and points toward areas where further research is needed. The treatment of plastic objects that have been damaged by either chipping or scratching is a significant issue facing conservators, one that research conducted at the GCI attempts to address, as described in the article by Anna Laganà and Rachel Rivenc. Finally, in our roundtable, Tim Bechthold, Roger Griffith, and Thea van Oosten—three leaders in the field of plastics conservation—explore in conversation a myriad of topics related to plastics and their preservation.

I hope that this edition of *Conservation Perspectives* will enhance appreciation not only of the marvelous objects made from this material but also of the comprehensive and dedicated efforts being made to preserve those objects for the future.

Timothy P. Whalen

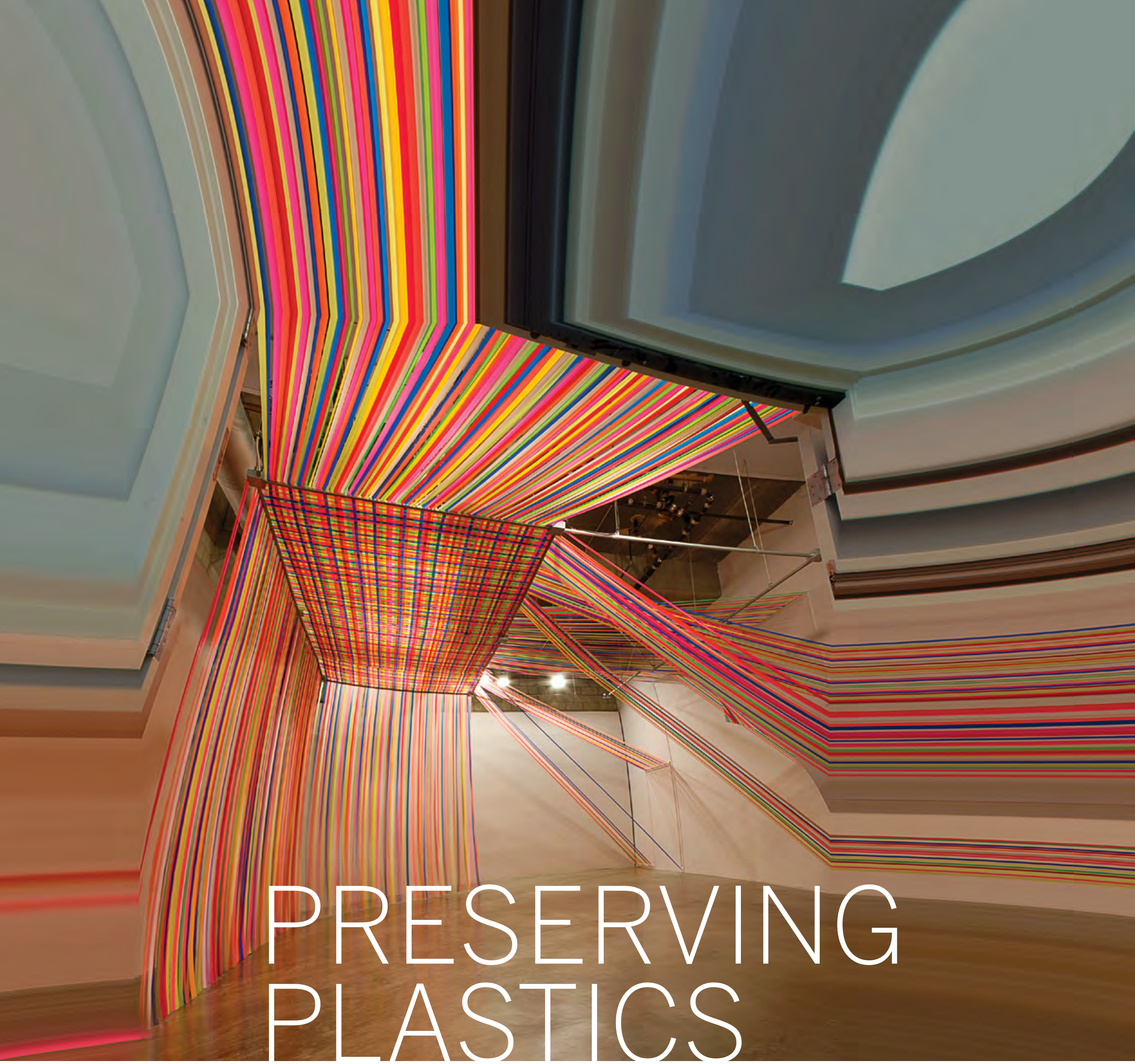
Contents

CONSERVATION OF PLASTICS

THE GCI NEWSLETTER
VOLUME 29 • NUMBER 1 • SPRING 2014

ON THE COVER
Untitled (1969) by Craig Kauffman, from the collection of the Estate of Craig Kauffman. Acrylic lacquer on plastic, 73 x 47 1/4 x 9 in. (185.4 x 120 x 22.9 cm). Image courtesy of the Estate of Craig Kauffman. Photo: Vicki Phung Smith.

www.getty.edu/conservation



PRESERVING PLASTICS

An Evolving Material, a Maturing Profession

BY ODILE MADDEN AND TOM LEARNER

There is always a temptation to make some quip about the film *The Graduate* at the beginning of any article about plastics. It is surprising how often the subject of the movie is raised when someone outside the profession hears about our work, as if conservation scientists would never make the connection between plastics research and a memorable line from an iconic movie.

Megan Geckler's *Every Move You Make, Every Step You Take*, ©2010 megangeckler.com. This work—created with flagging tape, a mass-produced colorful plastic ribbon—was an installation at the Pasadena Museum of California Art in 2010. Photo: Courtesy of Megan Geckler.

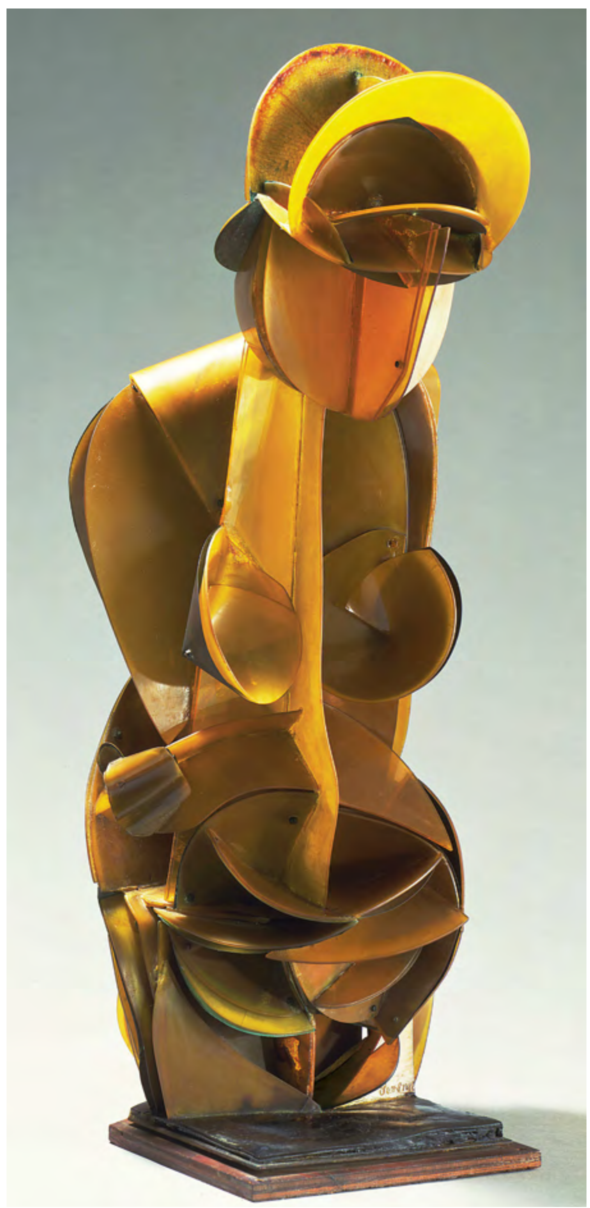
"Yes, yes, you've got one word for us! Yes, we do know that scene. Yes, it IS priceless!" The truth is, as Mr. McGuire in the film declares, "There's a great future in plastics," and there clearly is much more to come. McGuire is a poolside prophet in a navy blazer who captures the vision and irony of plastics in one sentence.

Of course, the term *plastics* describes an extraordinary range of materials that emerged relatively recently, spread incredibly quickly, and continue to develop at a lightning pace. They are a stunningly versatile group of products entering most, if not all, museum collections as artifacts or as the materials used to preserve, store, and exhibit them.

Creations in plastic have shaped our culture, values, and abilities. We have turned various forms of natural and synthetic polymer goo into paints, coatings, adhesives, moldable sheets, cars, boats, airplanes, movie films, billiard balls, dice, chairs, tables, combs, telephones, screwdriver handles, Kewpie dolls, Barbie dolls, eyeglass lenses, contact lenses, clock radios, computers, plastic wrap, soda bottles, and takeout containers. There are many surprising uses of plastics in materials that would not initially appear to be part of this club, such as laminate structures created by combining natural and synthetic polymers with wood, glass, paper, and textiles: plywood, windshields, cell phone screens, countertops, and waterproof bedding, all of which can be found in museum collections. And now we face another big stage of development with new plastics engineered at the molecular level, which use new feedstocks or are intended to biodegrade. Others are designed for rapid prototyping, 3-D printing, and nanotechnology.

Listing innumerable examples is futile. Plastics are everywhere, and it is nearly impossible to imagine life without them.

Plastics have been used in truly ingenious ways. The first artificial heart implanted in a human patient, by Denton Cooley in 1969, was a pump developed by Domingo Liotta that incorporated textiles of Dacron, a polyester fiber created by DuPont, and embedded in Silastic, a silicone elastomer from Dow Corning.[1] Today the Liotta-Cooley heart is in the Smithsonian's National Museum of American History, and, while to some people it might look like an old sneaker, it clearly is one of the most important artifacts of human achievement. Later in 1969, astronauts Neil Armstrong and Buzz Aldrin walked on the moon in self-contained, life-sustaining suits mainly constructed of synthetic polymers: polyamides, polyester, neoprene, polytetrafluoroethylene, polyimide, heavily plasticized polyvinyl chloride (PVC), polyurethane, polycarbonate, and silicone rubber; these were used as textiles, coatings, sheets, tubing, and foam.[2] The development of artificial organs and the exploration of space are feats of human ingenuity that were almost unimaginable until they were achieved; they became possible in large part because of synthetic polymers. Plastic artifacts associated with these triumphs are valuable historical objects, and we want to preserve them for posterity.



Torso (1924–26) by Antoine Pevsner (1886–1962). Plastic and copper, 29 1/2 x 11 5/8 x 15 1/4 in. (74.9 x 29.5 x 38.7 cm). Katherine S. Dreier Bequest. The Museum of Modern Art, New York. For Antoine Pevsner © 2014 Artists Rights Society (ARS), New York / ADAGP, Paris. Photo: Digital Image © The Museum of Modern Art/Licensed by Scala / Art Resource, New York.

Unfortunately, the news on longevity has not been great for many plastics. Some synthetic polymers deteriorate rapidly in ways that fall nothing short of catastrophic, and these problems have driven conservators (and journalists) to sound the alarm that all plastics are unstable—and to tremble at how to cope. For certain categories of plastics—in particular, the cellulose esters, polyurethane, and plasticized PVC—the alarm bells undoubtedly are justified. Objects made of these compounds often quickly exhibit severe symptoms of degradation, such as discoloration, embrittlement, distortion, cracking, stickiness, or the reek of vinegar or vomit. On the other hand, many plastics seem to age just fine—although in the large scheme of history, there hasn't really been enough time to know for sure.

In terms of the prospects for advancing conservation of plastic, the news remains mixed. We are faced with the challenge of learning about a diverse, rapidly evolving category of materials with which we have limited experience. How, for example, can we expect to have the same level of knowledge and experience we have with oil paint, bronze, or stone? Not only are there hundreds of types of plastic, each is rarely composed of a single compound. For each polymer, countless modifications are possible;

polymers frequently are blended as mixtures or copolymers in different proportions, with different microstructures. Any number of additives can then be compounded into their formulations to facilitate manufacture, alter flexibility, or provide flame resistance, stability, color, or texture (to name just a few)—and each addition can significantly alter the overall material properties and stability of the final product. Manufacturers can suddenly substitute additives with completely different chemicals; for example, the current development of alternatives for phthalates (a ubiquitous family of plasticizers) can result in plastics that have the same trade name but that are likely to age quite differently.

Many processing technologies produce different materials from the same ingredients, such as sheets, fibers, and other extrusions; molded objects; foams; and printed objects. There is the added complication of many processes changing over time and becoming obsolete and forgotten. Beyond mass-produced items, particular processes of individual artists and designers kick in a whole new set of variables, as the possibilities of these extraordinary materials are explored and their performance is pushed in ways rarely imagined by their manufacturers. Will this intricate landscape be simplified any time soon? For the time being, developments in plastics technology will likely outpace advances in conservation research.

Space suits worn by Neil Armstrong and Edwin Aldrin when they climbed down from their lunar module "Eagle" in July 1969 to become the first humans to walk on the moon. These suits are mainly constructed of synthetic polymers. Photo: Eric Long, National Air and Space Museum, Smithsonian Institution.

Why do plastics seem inherently less secure than other materials we encounter as artifacts? One reason is that their technology is relatively immature. For most traditional cultural heritage artifact materials, such as stone, wood, bone, ceramics, glass, metals, oil paint, and paper, the technologies used to modify them developed over a long period of time. Generations of practitioners have worked by trial and error and weeded out the processes that resulted in inferior products. Slowly and through repetition, these technologies have tended to evolve toward those that favor stability. Moreover, older artifacts fashioned from traditional materials seem to be durable because they are the ones that survived. In essence, time has selected the sound examples while the unsound have returned to the earth. We also have had plenty of time to observe these survivors under a range of stressors and have experienced how variations in their makeup can affect longevity. We have figured out environmental conditions that can slow change and have come up with methods to address deterioration when it occurs.

For all these reasons, extant traditional artifacts tend to behave more predictably and cause fewer problems. Plastics are different. Our experience with them is much shorter, and the objects being nominated for cultural heritage status were made only recently. We have limited understanding of how they will behave, and, in contrast to antiquities, we are tasked with stewarding the unstable and stable alike.

ACHIEVEMENTS

Research into plastics has received significant attention in recent years, and despite a continued cloudy outlook, it is important not to lose sight of the fact that much has been achieved. Plastics are now taken seriously by the cultural heritage field, and this advance is important. Gone are the not-so-distant days when a few diehards sat in small meeting rooms discussing sticky PVC tubing or crumbling cellulose acetate film, occasionally joined by conservators working on more traditional materials who wandered in for a bit of light relief. The Modern Materials and Contemporary Art working group of ICOM-CC (International Council of Museums—Committee for Conservation), for example, has expanded more than any other of the twenty-one ICOM-CC working groups over the last ten years, and it is now one of the largest in the organization, up there with the long-established groups of Paintings, Preventive Conservation, and Scientific Research. There is now genuine interest in the conservation issues of plastics within the cultural and scientific fields; this attention can only bring more resources for much-needed research.

Our understanding of plastics behavior has been enriched through the transfer of knowledge from other fields. Conservation scientists have followed the evolution of synthetic polymers since their creation in order to advise about and improve upon the range of adhesives, coatings, and paints that conservators select for treatments. Our research into the technologies and stability of artifacts is no longer driven only by reaction to failures of materials

A plastic chair, designed by Patrick Jouin (Solid C2, 2004) and in the collection of Die Neue Sammlung, The International Design Museum Munich. Photo: Die Neue Sammlung, The International Design Museum Munich (A. Laurenzo).

like cellulose nitrate and sticky PVC. Nowadays research is also driven by interest in the technology of an artifact per se. We have learned about a set of degradation processes to which particular polymers are prone (hydrolysis and oxidation, for example) and about the factors that drive them (light, temperature, moisture, and oxygen). The degradation of certain artifacts has been attributed to specific processes, and attempts have been made to demonstrate the connection analytically. As a consequence of this knowledge transfer process, we have identified environmental conditions that we believe slow deterioration of certain unstable plastics. We use this information for basic storage strategies: to segregate certain classes of plastic and rubber artifacts (particularly if they are degrading); to understand which absorbents will work better on certain classes; and to decrease temperature and remove light (and, in some cases, oxygen).

Another achievement has been the development of analytical techniques to identify and characterize plastics. Theoretical models of degradation mean little if we do not know the materials composing the artifact. Identifying and even quantifying the main constituents are now routine procedures in some larger analytical laboratories. Optical spectroscopy (Fourier transform infrared spectroscopy, Raman, and near-infrared spectroscopy), separation techniques (gas chromatography and evolved gas analysis), mass spectrometry, elemental analysis, thermal analysis (thermogravimetric analysis and differential scanning calorimetry), and mechanical testing—all have been applied to plastics with great success. One of the most comprehensive assessments of the information that can be gleaned about plastics with specific analytical methods was carried out during the POPART project by a consortium of European research institutions and the GCI (see sidebar). The field certainly can benefit from further collaborations in which expertise and resources are shared, but such projects require considerable effort and management to maximize their efficiency.

An extraordinary amount of quality information can be gained from instrumental techniques. In addition to identifying the polymer(s) and a host of additives, certain analyses can elucidate how components are structured and how they interact. These analyses can also measure chemical and physical changes (including oxidation, hydrolysis, fragmentation, increase in molecular weight, change in volatility, loss of components, and phase changes). In-depth, highly resolved analyses can be noninvasively performed in laboratories or executed on microscopic samples, and mobile instruments allow for rapid on-site surveys of large collections.

Just as significant has been a shift in our approach to research—to tackle the issue of plastic stability in a broad way. An excellent example is the Smithsonian Museum Conservation Institute's 2012 symposium, "The Age of Plastic: Ingenuity + Responsibility," which took the position that scientific studies benefit from cross-disciplinary approaches.[3] Presentations concerning remarkable and ingenious productions like the space suit were juxtaposed with more mundane topics like the rise of plastic packaging, which has transformed commerce, our eating habits, and even our garbage. Unlike some art, neither space suits nor Styrofoam clamshell hamburger boxes were designed to last in perpetuity, but now these products have become icons for us to preserve. Concepts in material innovation were explored through examples of successful and failed ventures in "bioplastics"—materials derived from agricultural feedstocks, including cellulose, soy, latex, milk, and animal body parts, rather than materials derived from fossil fuels. The complex relationship between plastics and the environment was probed further, and perspectives were gained on pollution, the value of plastics for living zoological collections, and recycling. The symposium made clear that plastics are now integral to the artifact record as markers of achievement and of the innovation process. But their materials, processing methods, intended service life, and conservation treatments make their preservation complex.

CHALLENGES

Despite advances that the conservation profession has made with plastics over the past twenty years, considerable challenges remain for research, conservation, and the allocation of resources. What effort should we expend on preserving objects that are inherently unstable? One could take the long view and see these unsound objects as examples of experimentation in an ongoing innovation process that could take decades or centuries before we hit stasis. Collecting archetypal examples and masterpieces that mark important milestones, and often come with inspiring creation stories, certainly is key. (John Wesley Hyatt's nineteenth-century development of a celluloid billiard ball is one example.) However, a balance must be struck between preserving important examples and keeping a record of the technologies that failed. Should we also focus on documenting some of the mutating objects, letting them degrade, and learning from the process how their materials behave over time? Would that improve our understanding of and ability to preserve them?

The Liotta-Cooley heart—the first artificial heart to be implanted in a human body. It included plastic components and kept the recipient alive for sixty-four hours until a human heart was available for transplant. Photo: Division of Medicine and Science, National Museum of American History, Smithsonian Institution.

Even with knowledge transfer and recent advances in material characterization, our understanding of plastics stability remains rudimentary. We have a menu of mechanisms that potentially explain degradation, but there is a tendency to default to them and recite them, rather than investigate skeptically what is actually going on. We also need to study the complex systems that result when several degradation mechanisms occur simultaneously. This challenge includes understanding the chemical mechanisms involved, the conditions under which they occur, the rates at which they transpire, and their interplay. Similarly, we must continue to generate data about the environmental conditions that favor (and hurt) plastics—particularly in storage (see page 13)—and we need to explore best practices for stabilization, cleaning, and repair.

And now, with the proliferation of plastic pollution, the value of longevity is being questioned. Biodegradable and recyclable plastics that may help reduce our waste stream are engineered to fail. Biodegradable plastics are deliberately manufactured to be susceptible to heat, light, moisture, and microorganisms; recycled plastics are prone to weakness, increased oxidation and diversity in polymer weights, and contamination. As opposed to the desired stability of traditional artifact materials, here we may be moving toward enhanced instability, a property that will have interesting consequences for cultural heritage preservation. Some of these materials are already entering collections.

IMPROVING STEWARDSHIP

Practical conservation concerns will no doubt continue to dominate our attitude toward plastics, as we strive to make significant advances in understanding them. Perhaps we as a profession are also growing up a little and expanding our philosophy of the plastics paradigm. Of course we will bemoan the things that turn yellow and sticky, but we also should embrace the excitement of being in the midst of plastic's invention period. It began in the mid-nineteenth century and will continue for the foreseeable future. If we accept that this is a time of evolution and experimentation, we might acknowledge the inherent instability of some artifact compositions and their obsolescence. If we also become more willing to make tough decisions about objects that just will not survive, resources can be reallocated for investigation and documentation of the technologies these objects represent and of their paths to failure. Compiling these histories, tracking stability, and figuring out causes of and remedies for entropy are valuable contributions that our profession can make to the Plastics Age. These efforts, of course, take time and require taking action under conditions of uncertainty. There will be many failed attempts along the way, but slowly and iteratively we will improve our stewardship.

So maybe Mr. McGuire's prophecy still holds true. Despite all the conservation headaches that are bound to continue and despite the seemingly thankless task of trying to preserve a class of material that almost defies preservation—there really is a great future in plastics. Shhh! Enough said.[4]

Odile Madden is a research scientist with the Museum Conservation Institute of the Smithsonian Institution. Tom Learner is head of Science at the Getty Conservation Institute.

1. Denton A. Cooley, Domingo Liotta, Grady L. Hallman, Robert D. Bloodwell, Robert D. Leachman, and John D. Milam, "Orthotopic Cardiac Prosthesis for Two-Staged Cardiac Replacement," *American Journal of Cardiology* 24, no. 5 (November 1969): 723–30.
2. Bill Ayrey and Linda Hughes, paper presented at "The Age of Plastic: Ingenuity + Responsibility," June 7–8, 2012, Smithsonian Museum Conservation Institute, Washington, DC.
3. Papers presented at the symposium are intended for publication by Smithsonian Institution Scholarly Press.
4. www.youtube.com/watch?v=PSxihhBzCjk

A model of a British Airspeed Horsa. Models like this were used to teach aircraft recognition during World War II. Seven decades later, many of these early examples of injection-molded cellulose acetate plastic are disintegrating spontaneously in the National Air and Space Museum collection. Photo: E. Keats Webb, Museum Conservation Institute, Smithsonian Institution.

THE POPART PROJECT

THE PRESERVATION OF PLASTIC ARTEFACTS IN MUSEUM COLLECTIONS (POPART) project was a major international research effort running from 2008 to 2012 and involving twelve research institutions. Collectively, they aimed to: (1) identify appropriate methods of analysis for plastics; (2) investigate plastics degradation; and (3) provide practical guidance for conservation issues and collections management of plastic cultural heritage objects. POPART remains the largest, most coordinated research effort in this area to date; it demonstrated the benefits of groups of professionals tackling conservation issues together. There were a number of salient results of the project:

- A variety of handheld analytical instruments were found to be particularly effective for rapid, on-site surveys of collections, but sampling was needed for a full characterization, including the detection of additives.
- A reference survey form was established and tested on different collections; it is available on the POPART website (http://popart.mnhn.fr/) and can be used as a template for plastics collection surveys.
- A reference plastic "doll"—made from a variety of different plastics—was placed in different museums to monitor environmental impact on natural aging; it was found to be an effective tool for monitoring dose-response functions.
- Cleaning techniques were evaluated for their effectiveness at removing dust, as well as for their effect on plastics. Consolidation of polyurethane foams with a number of new materials was also investigated.

One of the main achievements of the project was the publication of *Preservation of Plastic Artefacts in Museum Collections*, a 325-page overview of the main research areas (available at http://popart.mnhn.fr/). This book was published at the same time as an international conference held in Paris, where the key researchers presented their work; these presentations are viewable online (http://popart-highlights.mnhn.fr).

The partners in POPART were Centre de Recherche sur la Conservation des Collections (France); Laboratoire du Centre de Recherche et de Restauration des Musées de France (France); Victoria and Albert Museum (UK); National Museum Denmark; Instituto di Fisica Applicata "Nello Carrara" (Italy); Cultural Heritage Agency of the Netherlands; Polymer Institute, Slovak Academy of Sciences (Slovakia); Atelier Régional de Conservation Nucléart (France); Morana RTD (Slovenia); SolMateS BV (Netherlands); University College London (UK); and the Getty Conservation Institute (US).

ANIMATION CELS

Preserving a Portion of Cinematic History

BY KRISTEN MCCORMICK AND MICHAEL R. SCHILLING

CINEMA HAS BEEN ENRICHED BY STORIES AND CHARACTERS brought to life in animated films, which evoke memories and emotions of our past and are time capsules of the prevailing attitudes of their eras. Although animation today is ubiquitous, it has a relatively brief history. In the 1930s, short animated films, shown in theaters before a feature film, emerged as a popular form of entertainment. The enjoyment of watching animated characters was a much-needed diversion for the public during socioeconomically difficult times. Arguably, animation advanced as an art form with the 1937 release of the first American full-length animated feature, Walt Disney's *Snow White and the Seven Dwarfs*. The characters in that film were imbued with real voices, emotions, and thoughts within a well-crafted and fanciful story. Since then, audiences of all ages have been captivated by the stories and characters of animated films.

In traditional hand-drawn animation, each moment in time was captured on an individual sheet of thin, transparent plastic. Outlines of the characters were meticulously drawn in ink on the fronts of the sheets, while the colors and details of the characters were painted on the reverse sides. The plastic sheets, known as cels, were then placed face up over painted backgrounds and photographed by a movie camera one cel at a time. Playing back the sequence of images on a movie projector produced the illusion of motion. An enormous amount of time, effort, and resources was expended by artists and craftspeople to create full-length animated features.

Without advances in the plastics industry, animation as we know it could never have developed. Although many types of industrial polymers were manufactured in the twentieth century for a multitude of purposes, only a few possessed the physical properties necessary for animation cels—colorlessness, transparency, and flexibility. Colorlessness and transparency were essential for the painted background to show through clearly, free of distortion, allowing the characters to be placed in their proper positions within the scene. Flexibility was important because cels needed to be manipulated easily during inking, painting, and photography, and later stored with minimal risk of damage. Flexibility was imparted to polymers during manufacturing by the addition of chemicals known as plasticizers, which separate the long polymer chains and

An animation cel from the Disney film *Alice in Wonderland* (1951) exhibiting delamination of the paints, among the problems that afflict some of the historic cels in the collection of the Disney Animation Research Library. Photo: © Disney Enterprises, Inc.

cause them to slide smoothly past one another, thus transforming otherwise rigid polymers into flexible plastics.

The earliest plastic used for cels was cellulose nitrate, plasticized with camphor and triphenyl phosphate, a white, waxy solid that reduced flammability. Over time, this plastic proved highly unsuitable for cels and films because of its inherent flammability and its tendency to yellow, wrinkle, and generate hazardous gases with age. Eventually, cellulose nitrate was replaced by the safer and more chemically stable cellulose acetate, plasticized with a variety of phthalates (typically colorless oily liquids) and triphenyl phosphate. Cellulose acetate comes in two formulations—diacetate and triacetate—that vary chemically and have different mechanical behaviors and plasticizer requirements. Unfortunately, cellulose acetate was also found to degrade (albeit much more slowly than cellulose nitrate) by a chemical reaction called hydrolysis, which releases acetic acid, a pungent chemical commonly known as vinegar. In fact, the deterioration of cels and other objects made from cellulose acetate was known colloquially as vinegar syndrome. Like cellulose nitrate, cellulose acetate is also susceptible to wrinkling and discoloration as it ages, as well as oxidation from light exposure. Eventually, cellulose acetate was replaced in animation by polyester, a film that does not require plasticizers. Today, animation is done almost entirely on computers, thus severing the connection between animation and the world of plastics.

THE DISNEY ANIMATION ART COLLECTION

Originally, the collection of animation cels, drawings, and other materials related to Disney animated films was housed in what Walt Disney called the "morgue"—a term from the newspaper business for the place where old articles and files were kept. The art morgue on the Disney Studio lot was located in a basement where all artwork from completed animated films and shorts, as well as unproduced animated projects, was stored. As years passed, some production cels were given away or sold at Disneyland Park. Other cels from early productions were cut up and glued to monochromatic backgrounds for sale by the Courvoisier Galleries. Nonetheless, many cels in the collection remained intact. In the early 1990s, all animation artwork was relocated from the studio lot morgue to the Disney Animation Research Library (ARL), a state-of-the-art, climate-controlled facility (the cels are currently stored between 62°F and 65°F and at 50 percent relative humidity, in vaults equipped with carbon filtration). In this new location, the collection could be spread out, organized by film and year, and stored in archival containers. Today, the ARL collection comprises sixty-five million pieces of art, including more than two hundred thousand animation cels from the 1920s to 1989, when Walt Disney Studios released *The Little Mermaid*, its final full-length animated film made with hand-inked and painted cels. The collection also contains a small number of hand-drawn replica cels (some created after 1989) produced on polyester for commercial purposes or traveling exhibitions.

Preserving such a large collection presents the ARL conservation staff with a variety of challenges. One challenge is identifying the type of plastic used for each cel. Previously, visual and tactile clues had been the only methods available to the ARL. In addition, although the vast majority of the cels in the collection remain in good condition, some show evidence of buckling, yellowing, and off-gassing from hydrolysis and oxidation. Moreover, some paints (made with plant gum binding media) are prone to cracking, flaking, and delamination. A key preservation concern for cels is finding the optimum storage temperature and relative humidity that preserve the plastic with minimal negative impact on the paints.

To address these preservation issues, the Getty Conservation Institute (GCI) and the ARL initiated a collaborative project in 2009 whose aim was to study production and replica animation cels from the ARL collections dating from 1929 to 2000 using various scientific techniques and to relate the test results to the purported age of the cels. Knowledge obtained from studying the ARL cels would be relevant not only to animation cels from other studios who bought materials from the same suppliers but also to modern sculptures and design-art objects made from the same plastics. Thus, the ARL cel collection provided an ideal reference set and case study for broader museum conservation studies.

On a study group of more than a hundred cels, noninvasive analyses of color and gloss were performed with UV-Vis spectrophotometry, while the plastic types were identified using Fourier-transform infrared spectrometry. Other analytical methods were invasive and thus could be employed only on minute samples. These methods included gas chromatography–mass spectrometry for measuring the extent of hydrolysis of the polymers and, with a pyrolyzer added to this instrument, identifying cel plasticizers. Thermomechanical analysis and dynamic mechanical analysis measured the mechanical response of the cels to changing temperature. For the invasive tests, at least two film productions from each decade were studied, yielding a total of eighty-one physical samples removed from the cel edges.

A detail of an animation cel from the Disney film *Pinocchio* (1940). The cel displays buckling, another problem affecting some cels in the ARL collection. Photo: © Disney Enterprises, Inc.

Kristen McCormick, manager of Art Collection and Exhibitions at the ARL, examining an animation cel in the ARL collection. Photo: © 2014 The J. Paul Getty Trust and Disney Enterprises, Inc.

RESEARCH FINDINGS

The results from the GCI-ARL research were revealing. For instance, the premise that cellulose acetate replaced cellulose nitrate in the mid-1950s was exposed as a misconception. In the cels analyzed, it was found that cellulose diacetate use began as early as 1929, whereas cellulose nitrate was last used in 1942. Also significant was that not every cel in a production was made from the same type of plastic. For example, both cellulose diacetate and cellulose nitrate cels were used for different scenes in *Fantasia* (1940), *Snow White and the Seven Dwarfs* (1937), and *Bambi* (1942). Perhaps the animation industry practice of scrubbing and reusing cels from older productions when blank cel supplies ran low explains this finding. More unexpectedly, there appeared to be a period of transition from cellulose diacetate usage to cellulose triacetate between *The Fox and the Hound* (1981) and *Mickey's Christmas Carol* (1983). The two types of plastic were found to differ in their acetyl contents, thermomechanical properties, and plasticizer contents and compositions. Undoubtedly, these differences will be reflected in the long-term behavior of the cels during storage.

From the standpoint of chemical composition, the test results suggest that the cels remain in generally good condition. Only the most volatile phthalate plasticizer (diethyl phthalate) showed any evidence of slow evaporative loss over time, reflecting overall stability of the plasticizer composition in most cels. Overall, there appeared to be a slight reduction in acetyl content with age, although the exact extent of the hydrolysis reaction in any single cel was difficult to gauge because of batch-to-batch variations in the original acetyl content of the cellulose diacetate and triacetate sheets.

The study of the ARL animation cels altered some perceptions of the collection. It is now clear that appearance, tactile behavior, and production date are insufficient means of differentiating. This inadequacy illustrates the types of problems curators, registrars, and conservators face when cataloguing a collection without more sophisticated analytical tools. No simple relationship existed between the type of plastic and production date. Furthermore, the collection actually contained four types of plastic (cellulose nitrate, cellulose diacetate, cellulose triacetate, and polyester)—not three as once thought. The lessons learned from this study are relevant to animation cels from other studios, museums, and private collectors.

As is often the case in conservation research, the findings raised further questions, which we will pursue in the next phase of our project. To what extent are deterioration rates for the four plastics affected by environmental conditions present in storage? A vast amount of scientific research, most notably by the Image Permanence Institute, has shown that the life span of cellulose nitrate and cellulose acetate used as film supports for photographs and motion pictures could be greatly prolonged by lowering the temperature and controlling the relative humidity in storage. But are these conditions optimum for conserving animation cels for which extremely cold and dry conditions could exacerbate paint damage? In addition, are the cels off-gassing vapors that might impact their stability? If so, are there sorbents that could effectively remove them from the storage environment? Exploration of minimally invasive methods for reattaching cracking and flaking paints is another much-needed area of research.

Clearly, many of these issues extend to the display and storage of museum objects made from cellulose acetate and cellulose nitrate, such as sculptures by Naum Gabo and Antoine Pevsner, which face the additional environmental risk factor of light exposure. Because light levels are extremely low in the ARL storage vaults, photo-oxidation does not appear to be a major hazard.

Animation art archives like the Disney Animation Research Library strive to preserve a unique cultural legacy that is in danger of being lost forever. With the passing of time and the advent of computer animation, the medium itself is becoming obsolete, the remaining artists and technicians have fewer newcomers to train, and the art itself is slowly deteriorating. Yet there is hope that knowledge gained by this research will inspire other collaborations that lead to advances in storage conditions and conservation treatments. Preserving animation art for future generations is a worthwhile goal. Who could fault us for dreaming of a world in which characters like Snow White, beautifully rendered on animation cels, live happily ever after?

Kristen McCormick is the manager of Art Collection and Exhibitions at the Disney Animation Research Library. Michael R. Schilling is a senior scientist at the GCI.

Miriam Truffa Giachet, a visiting scientist at the GCI, samples plastics used for animation cels provided by the ARL. Photo: Scott Warren, for the GCI. © 2014 The J. Paul Getty Trust and Disney Enterprises, Inc.

A SAFE PLACE

Storage Strategies for Plastics

BY YVONNE SHASHOUA

PLASTICS CAN BE DEGRADED BY MANY FACTORS, including light, ultraviolet radiation, oxygen, water, heat, and pollutants. The pollutants can come from the atmosphere, sticky fingers, or storage and packaging materials that outgas acids.[1] Since many plastics collections spend most of their existence in storage rather than in exhibition, an effective conservation strategy can be based on slowing degradation while objects are stored. Such a strategy seeks to slow degradation by minimizing exposure to as many degradation factors as possible and by providing stable environmental conditions. The advantage of such a strategy for objects in storage is that no compromises need be made for human comfort or viewing, as would be the case under exhibition conditions. Consequently, temperature and light levels can be set with only the physical stability of the plastic in mind.

Since there are no international standards for storage environments for plastics, it is not uncommon for museums to apply those used to preserve both works of art on paper and other fragile organic materials: stable relative humidity (RH) maintained at around 50%, temperature of 18°C–20°C, light levels that are often zero and with a maximum of 50–100 lux, and the complete elimination of ultraviolet radiation.

Since the causes of degradation of the fifty best-known types of plastics are not identical, it is important to identify specific causes before defining the best storage conditions for individual plastic objects or artworks. For example, a plastic such as polyester that is prone to degradation by reacting with water (a process known as hydrolysis) would benefit greatly from being stored at a lower RH than those that degrade mainly by oxidation, such as polyethylene. In contrast, a plastic that is plasticized by water vapor, such as casein formaldehyde, would benefit from a higher RH, which would prevent cracking.

In many museum storage facilities, objects are grouped by historical period rather than material type. Macroclimates are therefore a compromise between the average requirements for all the materials in the location and the resources available. Although microclimates tailored to suit each plastic type would be optimal, costs often preclude them.

The storeroom of Musée d'Art Moderne de Saint-Étienne Métropole, France. Photo: Agnès Lattuati-Derieux, © Centre de Recherche sur la Conservation des Collections.

STORAGE WITH ADSORBENTS

Much attention has been given recently to the use of adsorbents. They slow the degradation of plastics by adsorbing either gases that initiate degradation or those that accelerate breakdown. Activated carbon, silica gel, and zeolites are the most frequently utilized adsorbents in museums. They are used commercially in cooker hoods, gas masks, and shoe insoles to remove odors; in foodstuffs to remove moisture; and in detergents to soften water. An adsorbent can be installed in a filter system or simply placed in a paper envelope inside a storage box holding a single object.

Because degradation often involves reaction with oxygen, the removal of oxygen is generally believed to limit breakdown. However, to date, only the crazing rate of natural rubber has been investigated in oxygen-free microclimates. Enclosing objects in nitrogen is the traditional method to exclude oxygen, but to be effective this method requires a perfect barrier to prevent the ingress of air. A more convenient option has been adapted from the food industry by conservators. Ageless and Atco, which adsorb oxygen, are among several similar commercial products designed to inhibit the oxidation or spoiling of meats and bread during transport. They consist of gas-permeable plastic sachets containing iron particles, which bind the oxygen by forming iron oxides in the same way that metal cars rust. Sufficient water is provided by potassium

Plastic objects from the collection of Musée de la Mode et du Textile de la Ville de Paris (Musée Galliera). Photo: Agnès Lattuati-Derieux, © Centre de Recherche sur la Conservation des Collections.

chloride in the sachet. Ageless reduces the oxygen concentration of an airtight container to 0.01% or less.

Objects can be enclosed in oxygen-impermeable transparent bags composed of Escal, a ceramic-coated plastic film, together with oxygen adsorbers; any remaining oxygen is removed by flushing bags with nitrogen before heat-sealing. In 1991 around fifty objects from the British Museum's collections—including catapults, rubber toys, sandals, and balloons—were enclosed with oxygen adsorbers.[2] Fifteen years later, visual examination and optical microscopy suggested that with the exception of objects enclosed in bags deliberately or inadvertently opened, the condition of the objects had remained almost unchanged. The study concluded that oxygen adsorbent sachets require replacement every five years because it is impossible to prevent the slow leakage of air even when bags are well sealed.

Activated carbon—which is used to filter toxic gases in gas masks and cooking smells in kitchen extractor hoods—has been utilized by museums since the 1990s to inhibit the degradation of cellulose nitrate objects. It is produced by treating wood, vegetables, coconut shells, or coal with heat or chemicals to remove volatile elements, and it has an enormous surface area. One teaspoonful of activated carbon pellets would occupy the same surface area as five soccer fields if each pellet were cut open and spread out. Activated carbon readily adsorbs organic molecules but not water. It adsorbs nitrogen oxides, the primary degradation product of cellulose nitrate, preventing those oxides from participating in autocatalytic breakdown or from corroding metals. When all the pores of the active carbon are filled, no further adsorption is possible. Because activated carbon is black and doesn't change color with an alteration in chemistry, it is not possible to see whether its adsorption capability is exhausted. It should therefore either be replaced with new activated carbon or be regenerated regularly by heating to 650°C.

Cellulose acetate was used between 1910 and the 1960s to produce movie film, spectacle frames, Lego bricks, and artworks. It degrades both by losing plasticizer and by hydrolysis, and it forms acetic acid in a process known as the "vinegar syndrome." Movie film in advanced stages of degradation can generate up to 1.5 teaspoons (about 2 mL) of acetic acid per foot (0.3 m). Degradation rates double if acetic acid is not removed from the vicinity of the object and the pH reaches 4.6. Cellulose acetate objects are often stored with adsorbents, which remove water vapor and acetic acid. The ability of adsorbents to interact with the degradation pathways of this plastic was researched by the author while a GCI scholar in 2012. The effectiveness of silica gel, activated carbon, zeolite 4 Å, and archival cardboard boxes to slow breakdown was determined by identifying and quantifying adsorbed material after exposure to undegraded and degraded cellulose acetate.

Silica gel sachets bearing the message "do not eat" are often added to packets of cookies or crackers to keep them dry during transport to supermarkets. Silica gel (silicon dioxide) is used in museums to control RH by adsorbing water. It can also adsorb formaldehyde and acetic acid. Water and pollutants attach to silica gel molecules by physical bonds, which can be broken or reversed on heating. Zeolites are another family of adsorbents used in conservation. They are porous crystals designed with a well-defined pore diameter. A zeolite with a pore diameter of 4 Å (4×10^{-10} m) cannot trap molecules larger than that. Because water and acetic acid molecules have a diameter of 4 Å, zeolites can be used to trap them and thereby slow the deterioration of cellulose acetate. However, the author found that plasticizers in cellulose acetate can also be trapped by zeolites. When plasticizer is adsorbed, there is an increased risk of cellulose acetate shrinkage.

The author's research suggests that in general, conservation adsorbents have limited effectiveness and become exhausted by adsorbing a wide spectrum of pollutants instead of just one. Archival cardboard boxes for storing cellulose acetate objects may be more effective for slowing degradation than are conservation adsorbents; however, further research on this subject is necessary.

LOW-TEMPERATURE STORAGE

In the same way that food is stored in a freezer to prolong its life by slowing degradation or spoilage, plastics storage at temperatures below −20°C has been proposed as a low-cost, maintenance-free technique for slowing the degradation rate. Cooling by 10°C halves the rate of all chemical reactions. Some physical degradation processes are also inhibited by cold storage. Reducing the storage temperature from ambient to that of an ordinary food freezer (−20°C) reduces the migration of plasticizer from polyvinyl chloride (PVC) more than tenfold.

Plastics materials exhibit both reversible changes, such as shrinking and stiffening, and irreversible changes, including chemical changes, on cooling. They contract or shrink considerably more than other materials found in museum collections such as metals, ceramics, and glass. A copper pipe will shrink by 0.01% if the temperature is reduced by 10°C. Under the same conditions, a high-density polyethylene pipe shrinks by 0.07%, and polypropylene and rigid PVC pipes shrink by 0.04%. Although shrinkage of plastics is unavoidable on cooling, it is reversible on warming to room temperature. Shrinkage by cooling has greater impact on composites—objects that comprise several materials in close contact. As a composite is cooled, each material will shrink independently but may then be restricted by the others.

A cellulose nitrate ruler from the 1920s displaying typical hydrolytic breakdown. The ruler is badly cracked and produces nitric acid as a degradation product. Photo: National Museum of Denmark.

Additionally, the influence of the accompanying reduction in moisture content of cold air surrounding plastic material must be considered. A temperature difference of 6°C–10°C between a plastic and its storage container should be maintained to avoid condensation. This can be achieved by surrounding the plastic with insulation material such as foamed polystyrene chips. Many plastics are permanently damaged by contact with water from condensation. To reduce the risk of water damage, thin-walled plastics may be safely stored in a freezer, protected only by a closed polyethylene bag. Thicker materials require gradual cooling by moving them from ambient temperature to a cooled room—to a refrigerator and then to a freezer. The reverse order of movement should be followed on rewarming.

There is not a single storage strategy that is ideal for every plastic. The plastic type and its behavior on degradation must be considered. However, all plastics will benefit from reduced light levels during storage and display; therefore, they should all be stored in the dark. Furthermore, storing plastics below room temperature—for example, in an ordinary food freezer that operates at around −20°C—will slow all chemical degradation reactions and thereby slow the rate of breakdown for many plastics in museums at a relatively low cost. The effectiveness of conservation adsorbents in slowing the rate of degradation of plastics by removing either materials that cause breakdown or acidic gases that accelerate the process remains uncertain and requires further research.

Yvonne Shashoua is a senior researcher in the Department of Conservation, National Museum of Denmark, where she researches the degradation and conservation of plastics objects and artworks.

1. Yvonne Shashoua, *Conservation of Plastics: Materials Science, Degradation and Preservation* (Oxford: Butterworth-Heinemann, 2008).
2. Joanne Dyer, Clare Ward, Nicole Rode, Marei Hacke, and Yvonne Shashoua, "Reassessment of Anoxic Storage of Ethnographic Rubber Objects," in *Preprints of 16th Triennial Conference, ICOM-CC, Lisbon, Portugal, 19–23 September 2011*, edited by J. Bridgland (Paris: ICOM-CC, 2011), www.icom-cc.org/51/news/?id=145#.Uz07wygcKdI.

LESS IS MORE

Exploring Minimally Invasive Methods to Repair Plastic Works of Art

BY ANNA LAGANÀ AND RACHEL RIVENC

SINCE THEIR INTRODUCTION IN THE TWENTIETH CENTURY, unsaturated polyester and acrylic plastics (polymethyl methacrylates) have become increasingly popular with artists and designers for their versatility, optical properties, and ability to be shaped and colored. Initially frowned upon for art, these plastics are now ubiquitous in art and design collections.

For conservators, plastics entail a whole new set of challenges. Objects made of polyester or acrylic plastics often have smooth and seamless surfaces, which are easily harmed and tolerate very little damage: the smallest scratch can be so conspicuous that it affects the entire perception of the artwork, especially if the piece is transparent or translucent. In addition, selecting suitable conservation materials and methods to repair mechanical damage—such as scratches, abrasions, cracks, chips, and broken parts—is difficult. Many factors must be considered. For example, adhesives that contain solvents or produce heat during curing can damage plastics or cause alterations such as stress crazing. Repair materials often have compositions similar to the original plastics, making reversibility a challenge; for this reason, their behavior upon aging is an especially crucial factor to consider. Moreover, making repairs invisible is as difficult for transparent plastic objects as it is for broken glass. Because of their low tolerance for damage and the difficulty of achieving inconspicuous local repairs, damaged polyester and acrylic objects often undergo very invasive treatments, such as extensive re-sanding, or partial—and, in extreme cases, total—refabrication.

As part of its Modern and Contemporary Art Research Initiative, the Getty Conservation Institute (GCI) began its Art in L.A. project to study art, including works in plastic, created in 1960s and 1970s Los Angeles by "Finish Fetish" artists, and to highlight the conservation issues.[1] The GCI exhibition *From Start to Finish: De Wain Valentine's Gray Column* explored the dilemma surrounding the conservation of Valentine's massive work: Should the surface be re-sanded to reflect the artist's intent, bringing it closer to the original aesthetic concept, or should it be preserved with its original toolmarks and the signs of the passage of time? Over the years, many Finish Fetish works have been "refinished" or "resurfaced," treatment that entails removal of significant quantities of original material.[2]

Anna Laganà, a private conservator working with the GCI, experiments with new methods to repair a polyester test sample in the GCI laboratories. Photo: Anna Flavin, GCI.

An important objective of the GCI project is therefore to investigate less invasive repair methods for polyester and acrylic objects, with the goal of providing conservators a wider range of options than currently available. Besides GCI Science staff, the project team includes Anna Laganà,[3] a private conservator, and John Griswold, a private practitioner who also serves as the Norton Simon Museum's conservator. The project specifically explores additive methods—as opposed to subtractive methods like sanding or polishing—to mitigate the visual impact of scratches and abrasions, as well as methods to repair chips and losses.

Pristine-looking polyester mock-ups (pigmented and unpigmented and with different thicknesses) were prepared by Eric Johnson, a Los Angeles–based artist working in polyester, and acrylic test samples were purchased from a local company. These were then damaged in various ways, including deep scratches, webs of superficial scratches, chips, and large losses. Researchers tested different treatments on the mock-ups and acrylic samples, utilizing both traditional and novel methodologies, and the results were analyzed and compared.

Several methods were explored to fill deep scratches and chips with a variety of instruments such as small brushes and needles. Resaturating the surface by applying coatings on large abraded and scratched areas was also investigated. To fill in losses, direct and indirect casting techniques (generally derived from glass conservation) were tested. The materials for filling and casting were selected based on their refractive indexes, as well as on their transparency, low viscosity, compatibility with the original materials, and aging properties.

In collaboration with several commercial companies, 3-D scanning and printing technologies were also explored as possible rapid and high-precision methods to reproduce missing parts or produce molds for missing parts without direct contact with the object. Avoiding contact would be especially useful in treating very fragile works. The application of 3-D printing for conservation is in its early stages, and costs currently can be prohibitive; however, techniques improve every day, and the technology is extremely promising.

The suitability and stability of the materials and methods used for such repairs were evaluated in GCI laboratories using a wide range of instruments and techniques. The initial results are encouraging, as they showed the potential of using additive methods to mitigate the visual impact of scratches, abrasions, chips, and losses in transparent cast polyester objects. Details of the research will be presented during the International Council of Museums—Committee for Conservation (ICOM-CC) 17th Triennial Conference in Melbourne and published with conference preprints. Meanwhile, the project continues. The materials and techniques providing the best results will be used on case studies of original fragments, rejects, and deaccessioned works of art gathered as part of the Art in L.A. project.

It is hoped that this research will help increase the range of options for conservators to repair art and design objects made of plastic. Instead of having to choose between preserving the original materials and re-creating the original intended appearance—an irreversible action, when materials are removed—conservators may employ additive repair techniques to achieve a more satisfactory outcome.

Anna Laganà is a private conservator based in the Netherlands. Rachel Rivenc is an assistant scientist at the GCI.

Polyester test samples being used in GCI research exploring minimally invasive techniques to repair plastic works of art. Photo: Anna Flavin, GCI.

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2. Tom Learner, Rachel Rivenc, and Emma Richardson, *From Start to Finish: De Wain Valentine's Gray Column* (Los Angeles: Getty Conservation Institute, 2011).
3. Anna Laganà and Thea B. van Oosten, "Back to Transparency, Back to Life: Research into the Restoration of Broken Transparent Unsaturated Polyester and Poly(methyl Methacrylate) Works of Art," in ICOM-CC, *Preprints of ICOM-CC 16th Triennial Conference*; Thea van Oosten and Anna Laganá, "Mending Broken Pieces: Research into Methods and Materials for Adhering Broken Unsaturated Polyester Artworks," in *Future Talks 009: The Conservation of Modern Materials in Applied Arts and Design*, edited by Tim Bechthold (Munich: Die Neue Sammlung, The International Design Museum, 2011), 70–77.

THE MATERIAL OF MANY POSSIBILITIES

A Discussion about the Conservation of Plastics

TIM BECHTHOLD is head of conservation at Die Neue Sammlung, The International Design Museum Munich, and previously worked at the Vitra Design Museum, Weil am Rhein, Germany. He organizes the Future Talks conference series, which focuses on technology and conservation of modern materials in design.

THEA VAN OOSTEN is a former senior conservation scientist with the Cultural Heritage Agency (RCE) in the Netherlands. She led the RCE's effort in POPART, an international collaborative research project that addressed the preservation of plastic artifacts in museums.

ROGER GRIFFITH is an objects conservator at the Museum of Modern Art (MoMA) in New York and has also worked in furniture conservation at the Metropolitan Museum of Art. He is developing a conservation strategy for MoMA's collection of design objects.

They spoke with **TOM LEARNER**, head of Science at the Getty Conservation Institute, and **JEFFREY LEVIN**, editor of *Conservation Perspectives, The GCI Newsletter.*

JEFFREY LEVIN Is there something distinguishing about plastics as a material for creating objects that causes you to treat it differently in terms of conservation?

ROGER GRIFFITH *Plastic* by definition means "flexible" or "malleable," which perhaps sets it apart from some other materials. I think that's why designers use this material—because it has possibilities that other materials don't have. But from a conservation point of view, I don't know that this sets it apart from other materials.

TIM BECHTHOLD Plastics are not just one material. There are so many different plastics, so you can choose what you like as your medium. Flexibility is one possibility with this material, but you might also like a shiny surface or something very strong. If you had asked the question, "What are the characteristics of metal?" it would be difficult to answer because you have different kinds of metal. It's the same with plastics. I would prefer to talk about characteristics of the materials.

THEA VAN OOSTEN Plastics are so widespread and have developed so much from their beginnings one hundred fifty years ago. Life would not be possible anymore without plastics, because plastics are everywhere—in design, in households, in the medical industry. Modern and contemporary art and design are part of that, because of the possibilities of the material. When plastics were first invented, they said it was the material with a thousand uses. Now it's the material with a million uses. You have it in every form—big, small, nanoparticles, chips in your computer. When you speak to people from the industry, they say "plastic" doesn't exist, because most of the time they take plastic material and add some reinforcement directly, such as glass fiber reinforced polyester. We in museums have to make better definitions because there are so many plastics. If you call them thermoplastic, people understand that they're flexible. If you say thermosetting plastic, you are talking about a rigid material.

GRIFFITH Certain types of objects, like chairs, were made of composite materials in the past, but ultimately designers were able to produce an object out of one material—for example, polyurethane foam in the 1960s. Of course, that has its own problems because polyurethanes are one of the more problematic polymers. They degrade more quickly than some others. It's interesting to view this from a historical standpoint and see the changes. Today we're looking at carbon-infused plastics and rapid prototyping—again, it's one material for one object.

LEVIN The irony here is that we want to preserve in collections many everyday items that were created out of plastic and that were never intended to last hundreds of years. Isn't that a major challenge?

BECHTHOLD It definitely is a challenge for a museum collection, because we have to think in longer time periods. Industry does not necessarily look for the best material and the maximum life span.

GRIFFITH In the past, things did last longer, but now we're seeing change in a shorter amount of time. They are organic materials, so they're going to change, and people have to understand that. To last three or four hundred years? I don't know if that's even possible.

Photo: Tim Bechthold

It is worth mentioning in the context of design production that when it comes to models, prototypes, and studio pieces, we confront a range of multiple, often unstable, materials. From a conservator's point of view, these are the most challenging objects.

TIM BECHTHOLD

VAN OOSTEN If you look at how museums exhibited materials seventy-five years ago, it's so different from now. Today, on your computer, you can look at the texture of a Rembrandt and see how it was made. So there will be a change in what you show and how you show it. We still have this vision of museums keeping everything. Maybe there will be another way of showing what was in the past and that doesn't exist anymore.

BECHTHOLD There is already a switch to more virtual documentation of objects we know won't last a long time. Some objects pose real problems, and so you think, "At least let's document it technologically."

TOM LEARNER From your experience, do the conservation issues connected to this group of materials enter into the thinking of the contemporary artists and designers using them?

GRIFFITH Artists like Matthew Barney, Robert Gober, and others employ conservators to help them choose materials. They've had enough time as artists to know that certain materials won't last. For artists whose work is in museum collections, they want that work to last as long as it can. When artists are younger and don't have the financial wherewithal, they can't choose certain materials or employ a conservator. As for designers, some of them with a certain level of success—Patrick Jouin comes to mind—will communicate with the manufacturing companies to choose specific materials that will last.

BECHTHOLD At the moment, it is still a one-way street. As conservators, we collect as much information as possible about an object we're working on. In this context, it is quite important to consider interviewing the designers. But there is more to this. The production of design is always a combination of creative persons, engineers, the industry, and producers—so there are different points of view to consider. Nevertheless, we are not going to ask the designer which conservation treatment we should practice on their objects.

GRIFFITH With some designers, the ephemeral quality of these materials is part of the work. In contemporary art, you have artists like Eva Hesse, who understood the ephemeral aspect of the material and chose it because of that—or at least they accepted that.

VAN OOSTEN I have this example of a Hella Jongerius–designed vase. The manufacturing company advised on the material for the vase, and they used polyurethane elastomer rubber. The vase went into production in different colors and it came out beautifully. Ten to fifteen years later, the first vases came into the laboratory with tears, and we tried to conserve them. Last year we looked in the box where we put them and they were totally gone. The material was not appropriate for the design, and no one at the manufacturer or the designer realized that at that time. The properties of the material were too unknown for them to understand that the material was too heavy for the vase. Over time, the vase could not withstand the weight, and it collapsed.

GRIFFITH People didn't know that some plastics, such as the early polyurethanes, would degrade so quickly. Only time tells us that. Nearly twenty years ago we had an exhibition called *Mutant Materials*, and the idea was to display new plastic materials being used by designers. Just last week we went through storage where some of these things that were not acquired for the collection were stored, and when we opened their boxes we found that they'd turned to dust.

LEVIN Is there a sufficient body of knowledge that can guide artists and designers in the choice of materials—or is there still too much that's unknown?

GRIFFITH I think you can take the different polymers and categorize them. It's kind of true that there are "good guys" and "bad guys." Acrylics, PMMA, polyester—these are ones we know are quite stable because enough time has passed. Polyurethane, PVC, cellulose nitrate—some of these we know have problems more quickly.

VAN OOSTEN Designers and artists are educated. They go to academy and are educated in the materials—but once they're out, they don't know the new materials. So it's a matter of learning and doing.

BECHTHOLD It's also a question of how much money will be spent on product development. If we are talking about large-scale fur-

Photo: Suzan de Groot

> Life would not be possible anymore without plastics, because plastics are everywhere—in design, in households, in the medical industry. Modern and contemporary art and design are part of that.
>
> THEA VAN OOSTEN

niture production, then a lot of money is spent on material and technology, and the expertise of engineers and technicians is considered. This results in products that last longer because they were developed very well. But for sure, cheap objects made with low-cost material will certainly last a shorter time.

GRIFFITH In the military and the medical industry, they do a great amount of research to make things last. There's a lot of money poured into those industries, and artists sometimes reach into those areas. Matthew Barney is an artist who uses different types of polymers that come out of the medical industry because he knows they'll last, and their materiality dovetails into his artist practice, which references plastics found in the prosthetic industry.

BECHTHOLD It is worth mentioning in the context of design production that when it comes to models, prototypes, and studio pieces, we confront a range of multiple, often unstable, materials. From a conservator's point of view, these are the most challenging objects. Furthermore, these material choices often represent cutting-edge technology at the time they were designed. Unfortunately, with these kinds of objects we have to accept that they won't last forever.

LEARNER There are certainly some advantages when conservators advise designers and artists on what materials to use or not. But isn't it also interesting when designers push the limits of materials in ways that were not intended? Even if something only lasts a few years, it might inspire other designers, who go on to do new things.

GRIFFITH You're interfering with the design process if you say to them, "No, you can't use that material." That's true in the art world, as well. That's why artists and designers are the same. They're choosing the materials for a specific reason. If it's because it's cheap, that's one reason. If it's because it looks good, that's another reason.

LEARNER There is often considerable pressure within the art profession that many modern and contemporary works of art should forever remain as pristine as the artist first intended—which, of course, is impossible. But does this intolerance to signs of age relate to design collections?

BECHTHOLD In our collection, we usually try to keep traces of use. But what if the damage or modifications are so grave that the designer's intentions are no longer readable? For example, we have a Le Corbusier kitchen that for many years had been extensively used, and which was over painted many times, resulting in a change of the original color concept. The edges became worn off, and some original elements were modified. In this case, we decided to go back to the original version through thinning and removing later paint layers. Via reconstructions, both on colored surfaces as well as on structural elements, we are now able to educate the visitor about Le Corbusier's original color concept and the innovative design, related to other kitchens of that time.

GRIFFITH Sometimes it's about educating the curator regarding the signs of use. Because you have to accept this—that use of the object. There are pieces in our collection we got directly from the manufacturer, but they, too, show signs of use just from the fact that we're moving them from exhibition to exhibition. With most artifacts in museum collections—and in particular those that have been used—you also have to educate the public that these are of a certain age. It's hard, because some things are still in production. The public can buy that Marcel Breuer chair that was actually designed in the Bauhaus period. But the one in the museum collection is from the 1920s, and many people expect it to look new because they saw it in the shop around the corner.

BECHTHOLD The challenge is finding the right balance. As long as traces of use don't interfere with the original design, it is fine. The funny thing is that sometimes signs of use, like a later addition of a knob on a drawer, illustrate functional aspects that didn't work in the original design.

GRIFFITH Sometimes curators are considering acquiring an object, and they'll send us to look at it, knowing full well that it "needs to be gussied up" to look a little better. The fact is that many design objects are in multiples. They're not singular art pieces produced by a fine artist. So I might say, "Let's see if there's another one out there that's better." And curators like that—I think they almost want to hear you say that.

VAN OOSTEN If you can find a better one, that's good. But that makes me think of the early computers—the first Apple Mac, for instance. They were white but they've aged now, and started to yellow. You cannot do anything about it. You have to accept that at a certain point they will have the patina of old plastic and that you won't find one that is pristine.

LEARNER In terms of the changes in appearance that can affect plastic design objects—do you consider aging differently than damage? For example, you can still be struck by the design of a plastic object, even if it has turned from white to yellow. In fact, that change may even add to its authenticity.

VAN OOSTEN If it's yellowing but doesn't break if you touch it, then it's aging gracefully. But sometimes objects are degraded, and you have these crumbs on them—then they're not aging nicely. If something tears apart, that's not nicely aged, and you have to repair it. Sometimes that's possible, sometimes not. If it doesn't break or fall apart when you touch it, it has aged well. But if it fades and you see different colors in it, then it's discoloration, and that's not nicely degraded.

BECHTHOLD For a design collection, yellowing can be a problem. Imagine, for example, a corporate identity of a company that was labeled in blue—and with yellowing it now has turned green. Things like that can lead to a grave change in perception.

VAN OOSTEN We have to learn the patina of the plastic. If they're from the 1940s, they'll look like this in the 1980s, and like this in 2014. Sometimes they'll age nicely with a patina. Others don't have a patina and they're degrading. So there is a difference. You have to learn it—and accept it.

BECHTHOLD In some cases, this is challenging. For example, some 1960s objects with these wet-look surfaces were really glossy. Nowadays they don't have the glossy surface anymore. But generally we don't reconstruct this glossy appearance. Here it may be helpful to support the object with a visualization of its original characteristics.

LEARNER For objects that once were functional—like a radio or a watch—and then, as part of a collection, become more like artworks that can't be touched or experienced, do you look for ways that visitors can have a more tactile experience of the object?

BECHTHOLD In the entrance area of our permanent exhibition space, we had sofas from Zaha Hadid where visitors could sit. Now we have Ron Arad chairs. In my opinion, it's nice to give visitors an immediate experience of good design. On the other hand, this can be difficult because visitors don't distinguish between what is an exhibit and what is a temporary furnishing—especially if it's an open exhibition space without barriers. Related to function, museum conservators have a big advantage: the chairs we conserve are no longer intended for use. That's why we don't have to care so much for the structural stability. The same for a radio that doesn't work. Instead of function, we focus on the conservation of form, color, and material.

VAN OOSTEN When new things come into museums, I don't fear so much for them, even if you touch them or use them. Museum life is okay for an object. But if you acquire an object and you don't know its exact history and the potential problems it has inside, then you have to take care.

GRIFFITH It's true that you may have no idea where an object's been over its existence. Maybe it lived in someone's house and was by a window where it was blasted by light. There's this chance it has been abused or misused and then you're taking that on, whereas if it comes directly from the manufacturer and goes right into a good environment, it has a better chance.

LEVIN So it's not always immediately apparent what difficulties an object may have encountered before it comes to you?

GRIFFITH Sometimes it's apparent. Let's say it's a polyester or polyurethane chair that was blue but you realize that the color has changed slightly over time. It's faded or it's yellowed—those are some physical signs of use. That's what you have and there's not much you can do about that. We look for objects that are still in their box or have sat on someone's shelf or in a closet—but they're rare.

LEARNER Tim, could you talk a bit about the Future Talks symposia, and why you started them?

BECHTHOLD I was a bit dissatisfied with conferences mainly discussing ethical questions of conserving modern materials. I intended to create a conference that focused more on practical issues, with inspiring topics and a friendly atmosphere. Launching the conference in 2009 was the result of numerous exciting projects we'd engineered years before and that were related to the degradation of polymers. Last October, we had our third conference with more than two hundred bookings from twenty-one countries, and we did workshops for the first time. There were designers and engineers, as well as conservation scientists. Moreover, a broad number of colleagues from the fine arts section are following the Future Talks. The material doesn't know whether it's an art object or a design object.

VAN OOSTEN We regard them as different but they're not.

GRIFFITH It was a breath of fresh air to have an international conference with people from around the world exchanging ideas. There are conferences all the time, but not one specifically focused on design. At the first conference, people talked more about the problems and less about the doing. People were afraid, because some of the problems are a bit frightening to conservators. But now you're seeing more talks where people get up and say, "This is what I tried, this is what I did, this is how I think we should do it—or at least I've done this." I think that's great.

VAN OOSTEN That's why it would be nice to have a conference ten or twenty years after the first restorations and see how these plastics survived the treatments—because you cannot always do a test to see if your treatment will work well over twenty years.

LEVIN On this issue of treatment, Roger, I've heard you talk about a shift from reversibility toward "retreatability." Could you explain what you mean by that?

GRIFFITH Reversibility was a major tenet in university programs teaching conservation. But in the modern and contemporary context, that's not always possible. That's why I think it's shifted to this idea of retreatability. A perfect example is consolidation. If you're going to consolidate something that's porous and you put a consolidant into it, there's really no way to "reverse" that. There are times when the only way to make an object exhibitable is to intervene in such a way that in the future someone can treat it again. Maybe they have to treat on top of what you've done, but we just have to accept that.

BECHTHOLD If you have a brittle foam, sometimes it's the last chance to consolidate it. Otherwise it crumbles and is lost.

GRIFFITH What about the idea of replacement parts? A perfect example is the fillings of furniture. Once those foams have failed, the object no longer represents what the designer wanted. Now that's an important part of the object, but many would say, "You can throw that away and replace it." Others might think, "Why would you do that—that's part of the original object." We had this Bell helmet, where we really had no option other than to make a new face guard out of a similar plastic because one polymer had degraded and stained another one. Now the object can be viewed as it was originally intended. I don't have a problem with that, as long as we document it and keep the original as a document to study in the future.

VAN OOSTEN This is a change. About twenty years ago, at the beginning of plastics conservation, they didn't dare do this replacement, because of a lack of knowledge of plastics.

BECHTHOLD I would say it's still a bit like this in Europe: reconstruction equals ultima ratio.

GRIFFITH There's been a sort of backlash on this. With historic upholstery, there was this idea that you replaced it completely—replacing horsehair, say, with polyester foam and not putting the tacks back in the holes from where you've taken them. But then the object isn't under the same kind of tension, so it doesn't read the same. Now they're going back to using more traditional-style upholstery materials because they're realizing that the profile doesn't look correct.

BECHTHOLD We try to keep the object together as a whole as long as possible. But if a brittle foam leads to a disintegration of form, we obviously have to consider treatments like replacement.

GRIFFITH It's a case-by-case discussion, and it's collaborative. We don't make the decisions alone. The collaboration involves the curator and many others within the institution.

LEARNER Looking to the future—3-D printing, for example. Do you think the profession will move more toward collecting digital files from which a given design object could simply be printed when it's needed for display or loan? Or will established conservation protocols for an "original" object still apply?

GRIFFITH I think we'll be keeping both the file and the object.

BECHTHOLD Which could be quite difficult because of copyright issues. Even if you get the files, you'll need a person who knows how to deal with them. Technology is changing so fast. Even if you can migrate the data and want to "reprint" the chair in ten years, I'm sure it will have a different surface structure because of changing printing technology. These are things to keep in mind if we're thinking about conserving data.

GRIFFITH This makes me think of artists' interviews and talking to the designers to ensure that if we do that in ten years' time, it will be acceptable. Is that new printed object the same as the original?

LEVIN It raises the question of what you're trying to preserve—the design or the physical object? What if the original object is made of a plastic material that turns out to be inappropriate, and you can re-create it with a more stable plastic?

VAN OOSTEN As you were saying this, I thought of the Panton chairs. They were remade with new materials, and then there was a new Panton chair. That's a little bit the same as what you're describing. And when you have your chair, you don't even need a digital file. You scan the chair yourself and make another one.

LEARNER What is the best way to train as a conservator of design objects? Presumably conservators are mainly coming out of traditional objects conservation training programs—but could that be improved?

BECHTHOLD What we need to have, beneath the traditional objects conservation training, is a professional offering of relevant workshops and courses on polymer chemistry, plastics

Photo: Ellen Moody

Plastic by definition means "flexible" or "malleable," which perhaps sets it apart from some other materials. I think that's why designers use this material—because it has possibilities that other materials don't have.

ROGER GRIFFITH

technology, and conservation. At the Neue Sammlung we have two full-time furniture conservators, which is quite helpful because as a furniture conservator you deal with many different materials. But to conserve design objects means that one never stops learning about technologies and materials. What we do not have in Germany is the specialty of "objects conservator."

GRIFFITH Being an objects conservator in general means you are around all types of materials, so you can be an objects conservator but with a specialization. I trained as a furniture conservator like you, Tim, and then crossed over. When I got the job at MoMA, I was originally hired to serve the architecture and design department. We are only two objects conservators, so I have to deal with both the fine-arts sculpture and the design, which I'm happy doing. I get to see both sides of the coin.

BECHTHOLD I think it is helpful to be a furniture conservator—you're used to working on three-dimensional objects.

GRIFFITH If you just study objects conservation, at least in the United States, you may not even touch a design object or a furniture piece. You might work on fine-arts sculpture in bronze, marble, wood, or plastic. But unless you specifically focused on design, you probably wouldn't be handed that. Whereas as furniture conservators, you understand the idea of use better than somebody from an objects context.

VAN OOSTEN Most of the conservators I know around the world who ended up in plastics were furniture conservators.

BECHTHOLD If you're a furniture conservator and you're interested in the twentieth and twenty-first centuries, you somehow end up in plastics.

VAN OOSTEN I teach workshops in plastics around the world, so one might conclude there is still a need for training in plastics. There is obviously a lack of training in plastics in programs of the various conservation disciplines. However, in the Netherlands we have education in modern and contemporary art, and a big part of it is plastics conservation. We had a discussion a while ago at the Textile Conservation Centre in Glasgow, where they were thinking about setting up a plastics conservation specialty. A lot of people were involved in a roundtable discussion, and the first topic discussed was, "If we are going to teach plastics conservation, what is it we are going to teach?" We have to consider if there is a need for a specialty in plastics conservation. Conservators should be trained in plastics in general, and then in more specific plastics with respect to the various conservation disciplines. Moreover, this topic is still under discussion.

GRIFFITH With the American programs, you can only study furniture conservation at Winterthur at the University of Delaware. They do a unit on plastics conservation, but there's nothing in the collection for students to get experience with. At the Royal College of Art where I studied, we were tied to the Victoria and Albert Museum, which has a broad collection of modern and contemporary design objects. It was a wonderful joint program with three institutions—the Royal College, the Victoria and Albert, and the Imperial College of Science and Technology, all located in South Kensington, London. But that program has since closed. In the sixteen years I've been at MoMA, I have not seen many students come for an internship or a fellowship with us who want to focus on plastics conservation. We sometimes don't even have a student approach us in a year.

VAN OOSTEN I think that all conservators should learn about plastics in their education. Even if you're a metal conservator, you should know about them because of all the things, like adhesives, that are made up of polymers. Every institute needs to offer some training in the whole range of plastics.

KEY RESOURCES CONSERVATION OF PLASTICS

ONLINE RESOURCES, ORGANIZATIONS & NETWORKS

For links to the online resources listed below, please visit http://bit.ly/R1lYmm

Bewahren der DDR-Alltagskultur aus Plaste
A website dedicated to preservation issues concerning plastics used for common design objects in the former East Germany. In German.

Deutsche Gesellschaft für Kunststoffgeschichte
A website dedicated to all aspects of the history and conservation of plastics. In German.

From Research to Restoration
A comprehensive study of polypropylene (PP), including scientific study and evaluations of conservation treatments.

Future Talks
Extended abstracts and general information from all three Future Talks conferences.

ICOM-CC Modern Materials and Contemporary Art Working Group
The working group of the International Council of Museums, which aims to promote and facilitate the dissemination of research and discussion on the conservation of modern and contemporary art.

International Network for the Conservation of Contemporary Art (INCCA)
A platform for information exchange on all aspects of the conservation of contemporary cultural heritage, including plastics.

Plastics Historical Society
A resource for historical information on the development of plastics and identification of plastics by trade names.

POPART
Videos from talks at the "Preservation of Plastic Artefacts in Museum Collections" POPART project conference, 7–9 March 2012, Paris. Description of the POPART project and overview of relevant workshops and publications.

A portion of the 2013 exhibition *Essential Eames: A Herman Miller Exhibition*, copresented by the ArtScience Museum in Singapore and Herman Miller in collaboration with the Eames Office. Photo: Courtesy of Herman Miller, Inc.

BOOKS, JOURNALS & CONFERENCE PROCEEDINGS

Conservation of Plastics: Materials Science, Degradation and Preservation by Yvonne Shashoua (2008), Oxford: Butterworth-Heinemann.

Future Talks 009: The Conservation of Modern Materials in Applied Arts and Design, edited by Tim Bechthold (2011), Munich: Die Neue Sammlung, The International Design Museum.

Future Talks 011: Technology and Conservation of Modern Materials in Design, edited by Tim Bechthold (2013), Munich: Die Neue Sammlung, The International Design Museum.

Plastics in Art: A Study from the Conservation Point of View by Friederike Waentig (2008), Petersberg, Germany: Michael Imhof (originally published as *Kunststoffe in der Kunst*, 2004).

Plastics in Art: History, Technology, Preservation, edited by Thea van Oosten, Yvonne Shashoua, and Friederike Waentig (2002), Munich: Siegl.

Plastics: Looking at the Future and Learning from the Past, Papers from the Conference Held at the Victoria and Albert Museum, London, 23–25 May 2007, edited by Brenda Keneghan and Louise Egan (2009), London: Archetype Publications.

Preservation of Plastic Artefacts in Museum Collections, edited by Bertrand Lavédrine, Alban Fournier, and Graham Martin (2012), Paris: Comité des travaux historiques et scientifiques.

PUR Facts: Conservation of Polyurethane Foam in Art and Design by Thea van Oosten (2011), Amsterdam: Amsterdam University Press.

Saving the Twentieth Century, the Conservation of Modern Materials: Proceedings of a Conference, Symposium '91, Saving the Twentieth Century, Ottawa, Canada, 15 to 20 September 1991, edited by David W. Grattan (1993), Ottawa: Canadian Conservation Institute.

For more information on issues related to plastics conservation, search **AATA Online** at **aata.getty.edu/home/**

GCI News

Artist Peter Alexander after pouring a polyurethane work in an industrial facility in downtown Los Angeles. Photo: Jesse R. Fleming, for the GCI.

Project Updates

ARCHES SELECTED FOR GOOGLE'S SUMMER OF CODE

The Arches Project has been selected by Google for their 2014 Summer of Code program—a global endeavor that offers students stipends to write code for open source software projects.

Arches originated as a collaboration between the GCI and World Monuments Fund to develop an open source, web- and geospatially based information system purpose-built to inventory and manage immovable cultural heritage. Arches is built using open source software tools to make its adoption cost-effective, and to allow heritage institutions to pool resources to enhance Arches in mutually beneficial ways.

In addition to new features developed for Arches, the Summer of Code program will broaden recognition of Arches and contribute to the larger purpose of raising awareness of the ways information technologists can contribute to the protection of cultural heritage.

More information on the Arches Project is available at: www.archesproject.org.

ART IN L.A.

Formally launched in October 2012 by GCI Science, the Art in L.A. project is dedicated to exploring the innovative materials and fabrication processes used by contemporary Los Angeles–based artists from the 1960s onward—and the implications these materials and processes have for the conservation of their work.

In-depth technical studies have been completed on the work of four groundbreaking artists: Larry Bell, Craig Kauffman, John McCracken, and Robert Irwin. Larry Bell used a process called vacuum deposition of thin films to coat plate glass with micron-thin films of material that altered the way light was absorbed, reflected, and transmitted by the glass. Craig Kauffman employed vacuum forming, a process usually reserved for commercial signs, to form acrylic sheets that were then reverse-painted with a spray gun. John McCracken perfected a process of coating plywood with fiberglass and spray-painting it with many layers of automotive paints; he later replaced the automotive paints with poured polyester resin to achieve greater surface perfection. Robert Irwin used the finest colored mists to spray-paint discs of hammered aluminum or vacuum-formed plastics. He later developed, with his fabricator, methods to glue and polish his column of cast acrylic plastic.

These studies will be compiled in the book *Made in Los Angeles: Materials, Process, and the Birth of West Coast Minimalism*, to be published by Getty Publications in 2015. This volume will also explore the artists' attitudes toward conserving their work.

Art in L.A. is also investigating repair methods and materials for transparent and translucent plastic objects, focusing especially on alternatives less invasive than extensive re-sanding and repolishing. This invasive method is preferred by some artists because it imparts a pristine surface to the object, but its disadvantage is the removal of original material (see "Less Is More," page 16).

An important goal of the project is making relevant information on artists' processes and intentions easily accessible. To this end, Art in L.A. has created *Artist Dialogues*, an ongoing series of short videos featuring artist discussions and demonstrations of materials and processes, as well as their thoughts on questions of longevity and conservation. A recent addition to the series is *Peter Alexander: The Color of Light*, in which the artist discusses his exploration of transparency and color in his polyester sculpture and relates how a new material, polyurethane, allowed him to rekindle his sculptural practice decades after the toxicity of polyester forced him to abandon sculpture. Previous videos in the series include: *Larry Bell: Seeing Through Glass* and *De Wain Valentine: From Start to Finish, the Story of Gray Column*. Art in L.A. is a part of the GCI's Modern and Contemporary Art Research Initiative.

CONSERVING MODERN ARCHITECTURE INITIATIVE (CMAI) UPDATE

March 2013 Colloquium

The meeting report and session videos of the March 2013 Colloquium to Advance the Practice of Conserving Modern Architecture are now available online on the CMAI web pages (www.getty.edu/conservation/our_projects/field_projects/cmai/). The colloquium included invited experts and other participants from around the world who have supported conservation of modern heritage in recent decades.

Despite increased recognition of modern architecture's cultural significance, practical conservation knowledge that will help address the many complex challenges is lacking. A concerted effort is needed to bring together and distribute existing information, as well as to identify and fill information gaps.

To begin this effort, the Getty Conservation Institute convened a two-day event organized around four themes: (1) philosophy and approach; (2) physical conservation challenges; (3) education and training; and (4) identification, assessment, and interpretation.

The meeting report includes summaries of case study presentations and working group discussions, and position papers. The report also includes a proposed action plan to advance the field that was compiled by the GCI and that grew out of discussions during the meeting's final session.

Salk Institute for Biological Studies

The Getty Conservation Institute has partnered with the Salk Institute for Biological Studies in La Jolla, California, to address conservation problems of the Salk Institute's complex—a 1965 architectural masterpiece by Louis Kahn.

This second field project under the GCI's Conserving Modern Architecture Initiative aims to address the aging and long-term care of the buildings' teakwood fenestration windows, which are a major architectural element of the site.

The Salk Institute in La Jolla, California, where the teakwood windows of this Louis Kahn building complex are the focus of a GCI project. Photo: Jeffrey Levin, GCI.

The Getty exhibition opening of the newly conserved and scientifically studied Jackson Pollock painting *Mural* (1943). Painting: University of Iowa Museum of Art, Gift of Peggy Guggenheim, 1959.6. Reproduced with permission from the University of Iowa. Photo: © J. Paul Getty Trust.

Recent Events

EXHIBITION: JACKSON POLLOCK'S *MURAL*

On view at the Getty Center through June 1, 2014, is an exhibition focused on *Mural*, Jackson Pollock's seminal work from 1943. The exhibit draws on findings from a two-year project of conservation and research by the GCI and the J. Paul Getty Museum.

Mural, which is owned by the University of Iowa Museum of Art, is featured in its own gallery, alongside a second gallery where the materials and techniques used to create the painting are examined and some of the legends surrounding it are explored. The changes in the painting since its 1943 creation and its recent conservation treatment at the Getty are also detailed.

Scientific research undertaken by the GCI confirmed that high-quality artists' oils were used on most of the work, but the study also identified a water-based white casein house paint that Pollock used in numerous places across the canvas, possibly to quickly regain areas of white space in places already painted.

Although the idea that *Mural* was completed in one painting session has long been disproved, the Getty study found that Pollock's initial paint marks were made in four highly diluted colors applied wet-in-wet across much of the canvas, suggesting that Pollock did perhaps complete an initial composition in a single session.

Pollock's application techniques were also explored, especially for a stringy, pink oil paint with an appearance similar to that of the enamel house paints used in his later works for pouring onto a canvas on the floor.

The recent conservation treatment removed a synthetic varnish that had been applied during a treatment in 1973 and addressed the effect that a wax-resin lining had on the current appearance of the painting. Whereas the lining successfully mitigated a long history of flaking, it also locked in place a sag in the canvas, resulting in a misalignment of the painted image with its rectangular stretcher. As part of the Getty treatment, the stretcher was replaced with one that followed the existing painted edges, thereby returning all areas of unpainted canvas to the sides of the stretcher and reestablishing the original edges of Pollock's work.

The research and analysis can be found in detail in the related illustrated book, *Jackson Pollock's Mural: The Transitional Moment*, available at shop.getty.edu. Also available for online viewing are three short videos created for the exhibition. Watch them on the GCI's YouTube channel: youtube.com/gettyconservation.

CAPS WORKSHOP IN AUSTRALIA

In December 2013, the GCI and the Art Gallery of New South Wales welcomed eighteen conservators from Australia, New Zealand, and the Philippines to the fourth Cleaning of Acrylic Painted Surfaces (CAPS) workshop, held at the Art Gallery of New South Wales in Sydney. The CAPS workshop series engages conservators with current research into acrylic paints and explores the theory, design, and application of customized methodologies and materials for cleaning acrylic painted surfaces.

The workshop began with an overview of current knowledge and recent advances in the cleaning of acrylic paints given by the workshop instructors, all of whom are leading research in this area: Bronwyn Ormsby (Tate), Chris Stavroudis (independent conservator), and Alan Phenix and Tom Learner (GCI).

Through hands-on work with acrylic paint samples and acrylic paintings, the participants and instructors explored the formulation and use of a range of cleaning systems. During the week of the workshop, an evening lecture was

Participants in the fourth Cleaning of Acrylic Painted Surfaces workshop, which was held in Sydney. Photo: Sean Charette, GCI.

Tram Vo of the GCI (right) talking with participants at the MEPPI workshop in Amman. Photo: Hrair Sarkissian, for the GCI.

held for the local museum community, to make new research on acrylic paints available to a wider audience.

CAPS is part of the GCI's Research into Practice Initiative, which seeks to facilitate the practical application of new research to conservation problems. Since its inception in 2009, the CAPS workshop series has reached over eighty conservators around the world, and future workshops are planned for Canada (summer 2014), Europe, and Asia. In addition, selected teaching materials, including instructional videos, are available on the GCI website.

MEPPI WORKSHOP IN AMMAN

The third and final workshop on the preservation of photograph collections offered by the Middle East Photograph Preservation Initiative (MEPPI) began in January 2014 at Darat al Funun in Amman, Jordan.

Lectures and hands-on activities presented participants with an overview of the current state of photograph preservation. Topics included photographic processes, best practices for storage and display, emergency preparedness and prioritization for preservation, best practices for digitization, future directions, fund-raising, and methods of raising public awareness.

Five primary instructors led the course: Bertrand Lavédrine of the Centre de Recherche sur la Conservation des Collections, Paris; Debra Hess Norris of the University of Delaware; Klaus Pollmeier of the Staatliche Akademie der Bildenden Künste, Stuttgart; Nora Kennedy of the Metropolitan Museum of Art, New York; and Tram Vo of the GCI.

Participants are currently in a ten-month period of assigned practical work to be carried out at their own institutions using information and skills learned at the workshop. A follow-up meeting at the end of this period will allow instructors and participants to review progress and challenges over the previous months.

Through its activities, MEPPI is designed to stimulate the growth of professionals in the region who understand its photographic heritage and who are committed to advocating and caring for it over the long term. The initiative seeks to learn and share more about photographic heritage in the Middle East and to promote its value to the public and to decision makers. MEPPI is a key component of the GCI's Preservation of Photographs and Photograph Collections Initiative.

Upcoming Events

2015 INTERNATIONAL STONE COURSE

The GCI is pleased to announce the Nineteenth International Course on Stone Conservation, to be held at the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) in Rome April 15–July 3, 2015, and coorganized by ICCROM and the GCI in cooperation with Rome's Non-Catholic Cemetery.

Designed for midcareer professionals involved in the conservation of historic stone structures and artworks, the course adopts a multidisciplinary approach, providing participants with a holistic understanding of the decay and deterioration of stone, effective conservation methodologies, practical repair methods, and long-term management strategies.

Using ICCROM's facilities, including its scientific laboratories and library, and taking advantage of the distinguished architectural heritage of Rome and its legacy of conservation practice, participants will learn about all aspects of stone conservation, including the history and theory of conservation; material characteristics of stone; deterioration mechanisms and methods of survey and analysis; conservation interventions and criteria for selecting treatments; and the management of stone conservation projects within multidisciplinary teams.

Course instructors include internationally recognized experts in stone conservation who provide classroom lectures and discussions, conduct laboratory and fieldwork exercises, and lead site visits. A fieldwork practicum at the historic Non-Catholic Cemetery and a study tour to visit conservation projects throughout Italy offer substantial opportunities to learn hands-on conservation techniques and best practices.

A maximum of twenty participants will be accepted. The course is open to conservators-restorers, architects, archaeologists, conservation scientists, engineers, and other professionals involved in stone conservation, preferably with a minimum of five years' practical working experience in the field.

More information about the course, including application instructions and forms, is available on the ICCROM website (www.iccrom.org).

Rome's Non-Catholic Cemetery, where a fieldwork practicum of the 2015 international stone course will be held. Photo: Scott S. Warren, for the GCI.

Staff Updates

HEAD OF SCIENCE APPOINTED

Photo: Stacey Rain Strickler, Getty Museum

In January, Tom Learner was appointed head of Science at the Getty Conservation Institute. For the last seven years, Tom has served as a senior scientist at the GCI, leading the Modern and Contemporary Art Research Initiative.

In his new position, Tom will oversee the wide-ranging activities of the Science department, whose current work not only involves the conservation of modern and contemporary art, but also includes research related to photography, Asian and European lacquers, Athenian pottery, museum lighting, and the conservation of lifted mosaics.

Prior to his arrival at the GCI, Tom served as a senior conservation scientist at Tate, London, where he developed Tate's analytical and research strategies for modern materials and led the Modern Paints project in collaboration with the GCI and National Gallery of Art in Washington, DC. During this period, Tom also was a 2001 Conservation Guest Scholar in residence at the GCI.

Tom is both a chemist and a conservator, with a PhD in chemistry from Birkbeck College, University of London, and a diploma in conservation of easel paintings from the Courtauld Institute of Art.

DUSAN STULIK RETIRES

Dusan Stulik, a senior scientist with the GCI, retired in January 2014, after a quarter century with the Institute.

A Prague native, Dusan studied chemistry, as well as painting and art history, at Charles University. He went on to earn a doctorate in physics from the Czechoslovak Academy of Sciences and then worked in the Czechoslovak nuclear energy industry, lecturing part-time at Charles University. After leaving Czechoslovakia in 1980, Dusan came to the United States, where he taught analytical and nuclear chemistry at Washington State University.

In 1988 he joined the GCI, first as head of the analytical section of Science. In later years, he served for a time as deputy head and acting head of Science. Early on, he was involved in a number of research areas, including binding media, environmental research, environmental

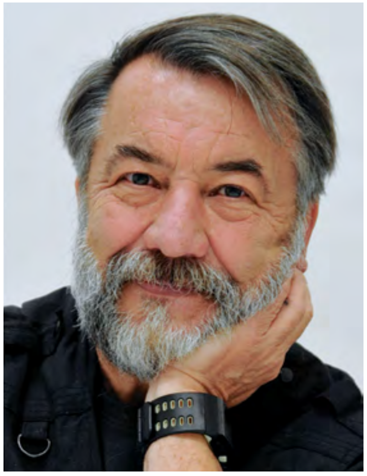


Photo: Sylvana Barrett

monitoring, adobe consolidation, and gels cleaning research. Beginning in 1992, he was instrumental in the development and implementation of the GCI's collaborative project with the Office of the President of the Czech Republic to develop and apply an appropriate system of protection for the fourteenth-century glass mosaic on the south facade of St. Vitus Cathedral in Prague Castle, a project that lasted over a decade. For his research relating to the conservation of the mosaic, he was awarded the Medal of Merit from the President of the Czech Republic, and together with the project team he won the Engineering Academy Prize in 2000, presented by the Engineering Academy of the Czech Republic.

In more recent years, Dusan was the project manager of the GCI's Research on the Conservation of Photographs project, which has focused on the application of modern scientific and analytical methodologies for identification and characterization of photographs and photographic material. Project highlights included the 2002 collaboration with the Harry Ransom Center at the University of Texas at Austin on the scientific analysis of Joseph Nicéphore Niépce's *View from the Window at Le Gras* (1826), the first example of a permanent image created by exposing a photosensitive plate in a camera-like device. Later work included collaboration with the National Media Museum in Bradford, United Kingdom, where, under Dusan's lead, the GCI team worked closely with museum curators to solve a number of photograph identification puzzles presented by some important historic prints in the collection.

A recent accomplishment of the project was the 2013 release of eleven volumes of the *Atlas of Analytical Signatures of Photographic Process*, which documents the chemical fingerprint of known, and some previously unknown, means of making photographs. This information will aid conservators, curators, and scientists in understanding the kind of photographs in their collections, which in turn can aid in their conservation (the *Atlas* is available on the GCI website at no charge).

Dusan's considerable impact on the field was recognized in 2011 when he was awarded the Royal Photographic Society's Colin Ford Award, given annually to honor individuals who have made a significant contribution to photographic curatorship. As a senior member of GCI Science since its early years, Dusan has also had considerable impact on the work of the Institute. His vast expertise and equally vast enthusiasm for conservation will be missed.

TRIBUTE

Alejandro Alva Balderrama, 1945–2014

Alejandro Alva, a pioneering conservation architect and valued colleague of the Getty Conservation Institute, passed away in March 2014 after a brief illness. An innovative thinker and inspiring teacher, Alejandro profoundly influenced the study and conservation of earthen architecture and trained a generation of professionals who continue to advance this important field. He had a significant impact on the professional lives of many at the GCI and collaborated with the Institute for a number of years.

Alejandro was born in Peru and educated as an architect in Lima. After working in the Andean region of Puno, he attended the ICCROM Architectural Conservation Course (ARC) in Rome in 1978, an event that changed his life. He subsequently spent more than twenty-five years at ICCROM, appointed first as the ARC course assistant, and he eventually became the director of the Architecture and Archaeological Sites Unit.

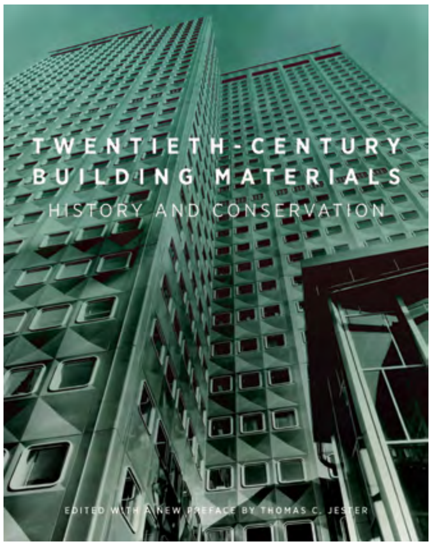
Photo: Claudia Cancino, GCI

In that time, he brought substantive change to many aspects of training in architectural conservation, but his most important contributions were in the approach to the conservation of earthen building materials and technologies.

Long before it was commonplace, Alejandro recognized the critical connection between conservation and development—the need to preserve both the earthen architectural heritage and the building tradition that created it. In 1984 this vision led him to an association with CRATerre, the International Centre for Earth Construction in Grenoble, France, and to a series of courses on the Preservation of Earthen Architecture (PAT) in Grenoble that were characterized by strong team teaching, a fundamental connection between theory and practice, and an emphasis on critical thinking. In the mid-1990s, striving to build on this approach by adapting the PAT curriculum to a regional, site-based program, Alejandro sought collaboration with the GCI, which had been working in earthen architecture conservation since its early days. The resulting three-way partnership among ICCROM, CRATerre, and the GCI evolved into the Terra project, a model of interdisciplinary collaboration that strengthened capacity and advanced knowledge in earthen architecture for nearly a decade. Among Terra's most important accomplishments were two pan-American PAT courses, hosted at the archaeological site of Chan Chan in Trujillo, Peru, in 1996 and 1999. The didactic materials and pedagogy developed for these courses have provided a basis for the teaching of earthen architecture conservation on an international level ever since. Through these and other activities, the Terra project also created a strong community of practitioner-educators who are now training the next generation.

Alejandro was a creative and passionate conservation professional who played a fundamental role in promoting our earthen architectural heritage and in developing better ways to conserve it. He was an extraordinary teacher who not only provided his students with professional competence but convinced them that they could make a difference. A private person with a keen imagination and a love of music, Alejandro leaves behind a significant legacy in his writings and the professional community he helped to create. He will be warmly remembered as a colleague, friend, and mentor by many at the GCI and sorely missed by all those who had the privilege of knowing him.

New Publication



Twentieth-Century Building Materials: History and Conservation
Edited with a new preface by Thomas C. Jester

Over the concluding decades of the twentieth century, the historic preservation community increasingly turned its attention to modern buildings, including bungalows from the 1930s, gas stations and diners from the 1940s, and office buildings and architectural homes from the 1950s. Conservation efforts, however, were often hampered by a lack of technical information about the products used in these structures. To fill this gap, *Twentieth-Century Building Materials* was developed by the US Department of the Interior's National Park Service and was first published in 1995. Now this invaluable guide is being reissued—with a new preface by the book's original editor.

With more than 250 illustrations, including a full-color photographic essay, the book is an indispensable reference on the history and conservation of modern building materials. Thirty-seven essays written by leading experts offer insights into the history, manufacturing processes, and uses of a wide range of materials, including glass block, aluminum, plywood, linoleum, and gypsum board. Readers will also learn how these materials perform over time and will discover valuable conservation and repair techniques. Bibliographies and sources for further research complete the volume.

The book is intended for a wide range of conservation professionals, including architects, engineers, conservators, and materials scientists engaged in the conservation of modern buildings, as well as for scholars in related disciplines.

Thomas C. Jester, AIA, formerly an architectural historian with the National Park Service, is a senior architect at Quinn Evans Architects, Washington, DC, where he specializes in historic preservation.

This publication can be ordered at shop.getty.edu.

For more information about the work of the GCI, see getty.edu/conservation and

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Conservation Perspectives, The GCI Newsletter is distributed free of charge twice a 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 website, www.getty.edu/conservation/.

The Getty Conservation Institute works to advance conservation practice in the visual arts, broadly interpreted to include objects, collections, architecture, and sites. It serves the conservation community through scientific research, education and training, model field projects, and the broad dissemination of the results of both its own work and the work of others in the field. In all its endeavors, the Conservation Institute focuses on the creation and dissemination of knowledge that will benefit the professionals and organizations responsible for the conservation of the world's cultural heritage.

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.

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The Getty Conservation Institute
1200 Getty Center Drive, Suite 700
Los Angeles, CA 90049-1684
Tel 310 440 7325
Fax 310 440 7702
gciweb@getty.edu
www.getty.edu/conservation

CONSERVATION PERSPECTIVES
THE GCI NEWSLETTER

A gallery in Die Neue Sammlung, The International Design Museum Munich. Photo: Rainer Viertlböck, © Rainer Viertlböck and Die Neue Sammlung, The International Design Museum Munich.

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