THE DAGUERREOTYPE

THE ONGOING PURSUIT TO FULLY UNDERSTAND A FASCINATINGLY COMPLEX PHOTOGRAPHIC OBJECT

BY INGRID FORSTER

The daguerreotype is a completely one-of-a-kind photographic object; there really is nothing else like it. If you have ever had the opportunity to see a daguerreotype in person, you might have noticed its rather magical quality. Daguerreotypes are meant to be held in your hand for viewing—an intimate experience. The reflective image can appear as a positive or a negative depending on the viewing angle. In most cases, the image is laterally reversed, like in a mirror image. When you look at a daguerreotype, the light is reflected and scattered back to you, making it difficult to judge the depth of the dark areas. As soon as you hold it at the proper viewing angle, the image appears, and it's quite mesmerizing.

We've asked experts from the fields of chemistry, photograph conservation and daguerreotypy to share their knowledge and weigh in on the use of synchrotron technology to further understand the materiality of daguerreotypes.

THE HISTORY

DAGUERRE'S INVENTION

The daguerreotype process is named after its inventor Louis-Jacques-Mandé Daguerre. Although a number of individuals experimented with photosensitive materials before Daguerre, the daguerreotype is considered to be the first practicable, publicly available and commercialized photographic process. On August 19, 1839, the French Académie des Sciences held a meeting to publicly present the daguerreotype process. Daguerre sold his invention to the French government, which made it available to the world for free—except in England, where you had to pay a fee. Soon the process became widely used throughout Europe and the United States. Daguerreotypy remained the dominant photographic method until the mid-1850s, when it was replaced by more convenient and less expensive processes like the ambrotype and tintype.

THE PROCESS

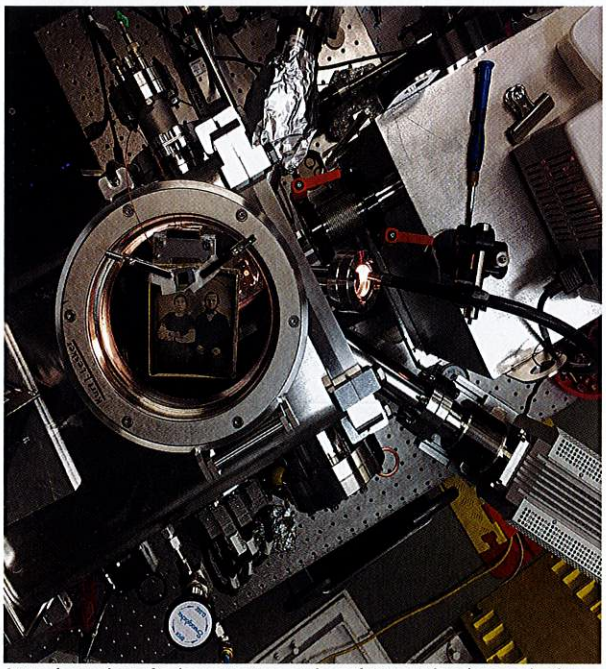
The daguerreotype process produces a single, direct photographic image. The image material sits on a finely polished silver-coated copper plate. Making a daguerreotype begins with the laborious process of polishing a plate to perfection. Producing a successful image is very much dependent upon how well the plate is prepared. The plate is made photosensitive by exposing it to iodine vapour, producing a thin layer of silver iodide. After a plate is exposed in a camera, it holds a latent image. The image is only revealed after developing the plate in heated mercury vapours, which causes microparticles to form in areas where light has interacted with the plate. The result is whitish-looking microparticles that diffuse light—a mercury-silver amalgam which forms the image highlights. Following development, the plate remains photosensitive until it is immersed in a sodium-chloride solution (table salt) and then thoroughly rinsed in water, known as fixing.

Subsequent improvements to the process included the use sodium thiosulfate (hyposulfite in the 19th century) instead of sodium chloride as the fixer and the introduction of toning/gilding with a gold-chloride solution. Gilding improved contrast and helped solidify the microparticles to protect the image. Prior to this, an image could literally be wiped right off the plate.

Since silver iodide isn't actually that light sensitive, exposure times were quite long during the early days of daguerreotype practice. They ranged from a few minutes to half an hour depending on how much light was available. Taking a good portrait was a challenge. By the end of 1840, however, an important innovation reduced exposure times from minutes to seconds. The use of bromine and chlorine vapours, in addition to the iodine sensitizer, significantly increased the plate's light sensitivity. The faster exposure times made the commercialization of daguerreotype portraits possible and led to a boom in the industry.

GIRL WITH PORTRAIT OF GEORGE WASHINGTON, METROPOLITAN MUSEUM OF ART PHOTOGRAPHS COLLECTION. GIFT OF I. N. PHELPS STOKES, EDWARD S. HAWES, ALICE MARY HAWES, AND MARION AUGUSTA HAWES, 1937.

Daguerreotypes were only made for a period of about twenty years. After production ceased, no great effort was made to preserve them.



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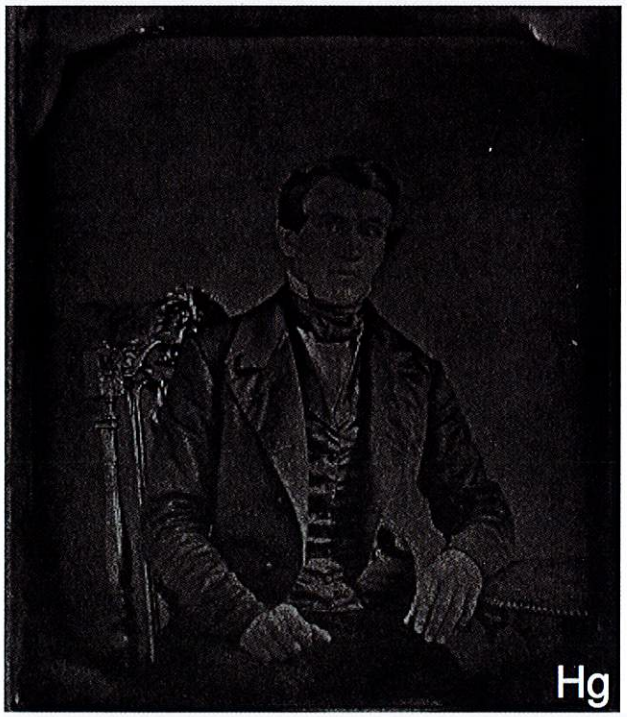
A top-down view of a daguerreotype at the Soft X-ray Microcharacterization Beamline at the Canadian Light Source in Saskatoon. The daguerreotype has been attached to the sample holder using alligator clips with thin paper placed between the plate and the clips. This image, titled *Couple's Therapy*, was included in an exhibition held at Quinn's of Tweed, a gallery in Tweed, Ont.

DAGUERROTYPE COURTESY OF THE CANADIAN PHOTOGRAPHY INSTITUTE AT THE NATIONAL GALLERY OF CANADA IN OTTAWA; IMAGE COURTESY OF MADALENA KOZACHUK.

An optical image of a daguerreotype. Evidence of localized electro-cleaning attempts is visible as circular spots in the top left and right corners.



DAGUERREOTYPE COURTESY OF THE CANADIAN PHOTOGRAPHY INSTITUTE AT THE NATIONAL GALLERY OF CANADA IN OTTAWA; IMAGE COURTESY OF MADALENA KOZACHUK.

An X-ray fluorescence image. Micro-X-ray fluorescence map of the mercury signal collected from a daguerreotype. This fluorescence image was acquired from the G3 line at the Cornell High Energy Synchrotron Source in Ithaca, New York. Each pixel in this fluorescence image is 20 × 20 µm. The collection time for this mercury map was 8.5 hours. Maximum relative counts of mercury are represented by white on the grey scale; the minimum amount of relative counts of mercury is represented by black on the grey scale.

BOSTON DOCTORS, METROPOLITAN MUSEUM OF ART PHOTOGRAPHS COLLECTION, GIFT OF I. N. PHELPS STOKES, EDWARD S. HAWES, ALICE MARY HAWES, AND MARION AUGUSTA HAWES, 1937.

CONSERVATION

Due to their fragile nature, Daguerre recommended that daguerreotypes be protected under a cover glass. A mat was placed between the plate and the cover glass, and the three were bound together using paper tape to seal the package. This came to be known as the "daguerreotype package." The package—intended to protect the plate from oxidizing pollutants—would then be placed in some form of protective housing. Daguerreotypes made in the United States and Britain were often housed in hinged cases; the passe-partout was more commonly used in continental Europe. Before being packaged, daguerreotypes were sometimes hand coloured with a hint of reddish-pink on the cheeks. Gold was applied to buttons and jewellery, and other colours were added to clothing or accessories.

Daguerreotypes were only made for a period of about twenty years. After production ceased, no great effort was made to preserve them. They became objects of antiquarian interest and received limited attention for the next one hundred years. In the 20th century, all resources and attention were turned to refining the gelatin-silver print. The medium of photography was eventually accepted into the realm of art at an institutional level, at which time archives and art institutions began to collect and care for daguerreotypes.

The desire to properly care for and understand daguerreotypes was followed by a series of well-intentioned but ill-informed conservation attempts, leading to the loss or damage of some culturally significant daguerreotypes. For example, during the 1960s, it was common practice to attempt cleaning daguerreotypes with something called an acidified thiourea solution. Many of the plates treated in this manner now show significant deterioration and small brown spots on the silver surface, called the "Daguerreian Measles." The use of thiourea for treating daguerreotypes has now been abolished. Current conservation treatments like electro-cleaning show great promise when carried out properly within set parameters.

THE SCIENTIST
SYNCHROTRON TECHNOLOGY

Madalena Kozachuk, a PhD student in the Department of Chemistry at the University of Western Ontario, has spent that last few years researching how synchrotron technology can be used to learn more about the materiality of daguerreotypes and the chemical

changes that occur when they degrade. As part of a research group using synchrotron radiation as its primary form of instrumentation, Kozachuk employed rapid-scanning micro-X-ray fluorescence imaging to analyze heavily tarnished daguerreotype plates from the research collection at the National Gallery of Canada. Kozachuk discovered that an image buried under a layer of tarnish could be digitally recovered based on its chemical signature. "Even if you can't see a physical image on the plate, you can recover a chemical signature which follows the original image. You get a digital output, which provides you with a digital visualization of the image. In this case, it is the mercury particles that contain the image signature and seem to provide the greatest clarity," says Kozachuk.

AN INTERDISCIPLINARY APPROACH

Working with cultural heritage objects allows Kozachuk to combine her interest in chemistry and her passion for art. "My mom is a professional musician, so I have always been very creatively inclined." Kozachuk wanted to study photography at Ryerson, but her father, a blue-collar worker, strongly advised her to pursue a career in the sciences. She remembers googling "What can a chemist be?" and seeing art conservation as one of the results. "I felt like I hit the jackpot because I found a way to combine science and my passion for art." After completing a double major in chemistry and art history, Kozachuk went on to pursue her graduate studies in chemistry.

"I was quite lucky to join an interdisciplinary team at Western, which allowed me to pursue working with cultural heritage objects. I needed actual objects to study, so I started contacting institutions asking them to collaborate and got a response from the National Gallery of Canada. I connected with some conservators there, and they suggested that I consider working with daguerreotypes for my research." Kozachuk accepted the challenge.

HUTCHINSON FAMILY SINGERS, METROPOLITAN MUSEUM OF ART PHOTOGRAPHS COLLECTION, GILMAN COLLECTION, GIFT OF THE HOWARD GILMAN FOUNDATION, 2005.

Kozachuk and her team conducted their preliminary research at the Canadian Light Source (CLS)—the only synchrotron facility in Canada. The research, published in scientific journals in 2017 and early 2018, involved collecting chemical data from sections of daguerreotype plates and analyzing it to try to understand tarnish and deterioration patterns. They compared surface corrosion, hazing and degradation resulting from cover glass.

The team's research at the CLS led to a more recent publication based on data collected at another facility, the Cornell High Energy Synchrotron Source, where Kozachuk and her team were able to analyze entire daguerreotype plates. The published paper aims to further the chemical understanding of a daguerreotype image and how it is produced. She explains, "By mapping the mercury distribution with rapid-scanning, synchrotron-based micro-X-ray fluorescence imaging, full portraits, which to the naked eye are obscured entirely by extensive corrosion, can be retrieved in a non-invasive, non-contact and non-destructive manner." Kozachuk adds that this type of imaging provides curators with a digital image recovery method for degraded daguerreotypes, even if the artefact's condition is beyond conventional conservation treatments.

ART + SCIENCE

Kozachuk's research is ongoing; she says she finds a great deal of meaning in the work she is doing and takes pride in knowing that her work contributes in some way to the historical record. She emphasizes that her team's success is due to collaborative efforts and an interdisciplinary approach. She continues, "I believe it's best if the work stays collaborative because that's what makes it successful. The daguerreotype is so complex that it requires minds from many different disciplines like metallurgy, chemistry, art history, conservation and the practice of daguerreotypy to work together."

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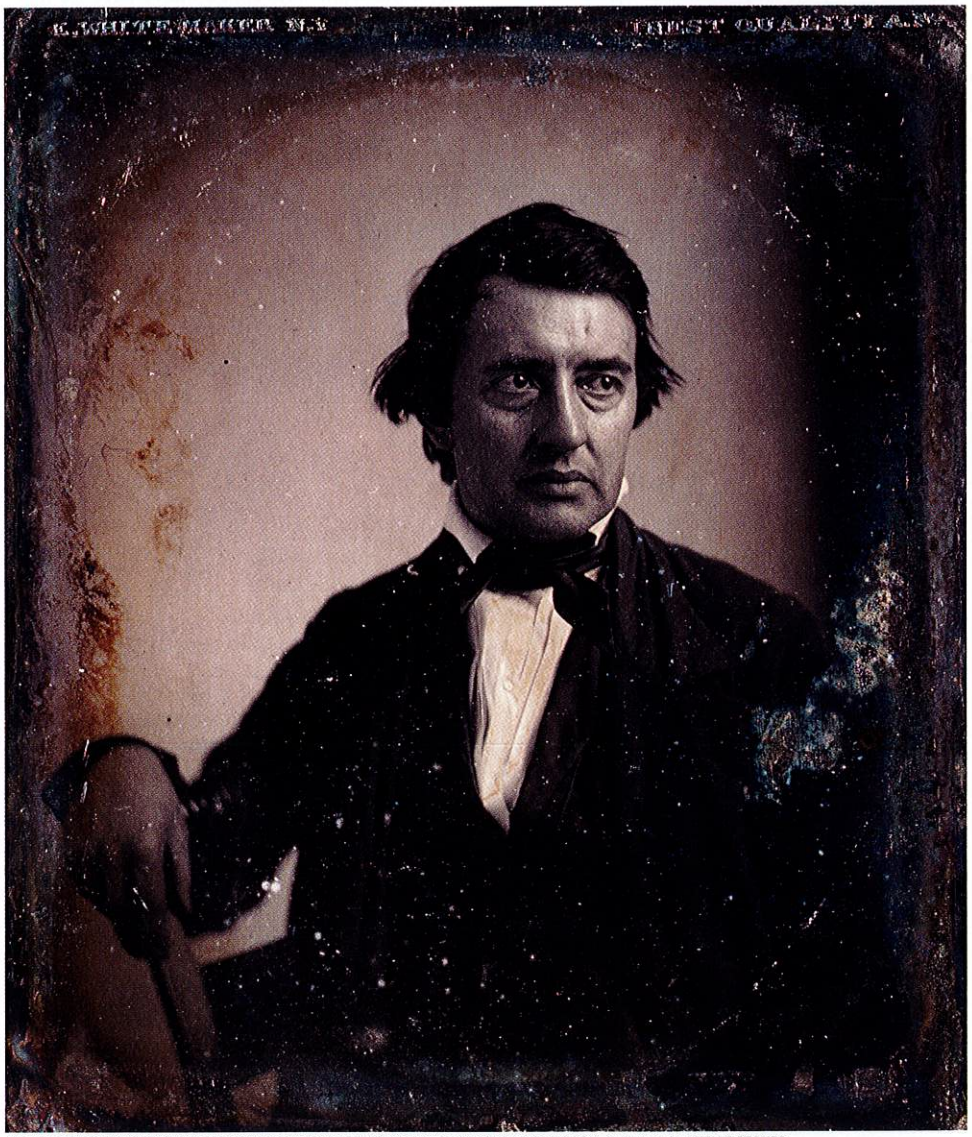
HARRIET BEECHER STOWE, METROPOLITAN MUSEUM OF ART PHOTOGRAPHS COLLECTION, GIFT OF I. N. PHELPS STOKES, EDWARD S. HAWES, ALICE MARY HAWES, AND MARION AUGUSTA HAWES, 1937.



ALBERT SANDS SOUTHWORTH, METROPOLITAN MUSEUM OF ART PHOTOGRAPHS COLLECTION. GIFT OF I. N. PHELPS STOKES, EDWARD S. HAWES, ALICE MARY HAWES, AND MARION AUGUSTA HAWES, 1937.

Kozachuk hasn't given up on her photography dream. She recently had her first solo exhibition of photographs at Quinn's of Tweed, a private gallery in Tweed, Ontario. The exhibition, titled *Material Culture: Images to Make You Wonder*, included photographs she took at the Canadian Light Source. Like her career path, her photography work is an intersection of art and science. Kozachuk says, "When I go to these scientific facilities or labs, I see art first and then information second, which is probably odd for someone doing a chemistry PhD to say. I have taken a lot of photographs of the work I do at synchrotron facilities, and I enjoy documenting the process from an artistic perspective."

MADALENA KOZACHUK

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THE CONSERVATORS PRACTICAL APPLICATIONS

John McElhone, now retired, was the Chief of Conservation at the Canadian Photography Institute of the National Gallery of Canada (NGC) at the time Kozachuk was looking for collaborators. McElhone met with Kozachuk and her supervisor Tsun-Kong (T.K.) Sham, Canada Research Chair in Materials and Synchrotron Radiation at Western University and co-author of the research, to discuss her interest in working with cultural heritage objects. McElhone worked at the NGC for thirty-one years and is a co-author of Kozachuk's most recent paper.

"Over the last thirty-five years, a range of analytical techniques has been used to characterize the daguerreotype's materiality and the daguerreotype surface and sub-surface. As the technology associated with analytical chemistry has improved, the physical profile of the daguerreotype has become clearer and more refined. We were interested in working with Madalena and T.K. because we felt that this type of technology, in combination with their analytical approach, could be very useful to conservators," says McElhone.

According to McElhone, Kozachuk's research is helpful because the visualizations and associated chemical data made available by use of synchrotron technology can assist in verifying if there is actually an image to see on a daguerreotype plate obscured by deterioration. Being able to analyze the materiality of a daguerreotype on a microscopic and nanoscale level is also useful for conservators who want to understand how the chemicals are arranged on the surface of a plate, how degradation happens, and how it can be treated—or not.

CONSERVATION CONCERNS

While McElhone agrees that the simulacra created by these digital visualizations are useful to conservators, preserving the physical object is always a priority. McElhone notes that one of the major challenges conservators currently face is defining, in clear terms, what the standardized procedures are when it comes to daguerreotype preservation. Although there are practices in place for housing/re-housing, storage environments, cover-glass replacement, conservation treatments, and cleaning procedures, a total consensus among conservators has still not been reached. He stresses, "The conservation community should be focusing on assembling and providing a coherent manual to the custodial community. It is an issue because, although we have come a long way, we still have not completely agreed amongst ourselves how to best care for these objects."

Zach Long is the Assistant Conservator at the Kay R. Whitmore Conservation Center at the George Eastman Museum (GEM) in Rochester, New York. Long explains that some of the primary conservation concerns pertaining to daguerreotypes are the plates themselves—limiting the exposure of humidity, atmospheric pollutants and dust into the plate packages, which can all lead to tarnish. Long specifies that the most common cause for treatment is case damage, like broken hinges and cover-glass deterioration.

The GEM has one of the largest collections of daguerreotypes in the world. The collection contains over 3500 daguerreotypes, a number of which are priceless, like the iconic Jean-Baptiste Sabatier-Blot portrait of Daguerre himself, taken in 1844. All daguerreotypes at the GEM are stored in a climate-controlled vault. The type of housing used depends on the format of the object. "Stereo daguerreotypes in a passe-partout will be treated differently than a half plate in a case. When rebinding plates, we use only non-hygroscopic materials and cover glasses of high chemical stability," says Long.

YOUNG WOMAN SEATED NEXT TO A TABLE WITH ELBOW RESTING ON A BOOK, METROPOLITAN MUSEUM OF ART PHOTOGRAPHS COLLECTION, BEQUEST OF HERBERT MITCHELL, 2008.

The museum's conservators do all conservation treatments on-site. Long points out that a daguerreotype would only ever be cleaned at the museum under extreme circumstances. He adds, "This situation has never arisen in the years I've worked at the museum and, to my knowledge, not for a long time prior. None of the daguerreotype cleaning methods are without considerable risk to the plates. Many daguerreotypes are also hand coloured, and this can be easily removed in cleaning."

Long is familiar with Kozachuk's research and agrees that it could have some practical applications. "I think it's fantastic that there are techniques that can now document a daguerreotype image obscured by tarnish. In some instances, a digital image of this type may even be adequate for the end use and obviate the need for an irreversible treatment. At the very least, having images this detailed is great for before-treatment documentation. Unfortunately, synchrotrons are not exactly readily accessible."

DAGUERROTYPE EXHIBITIONS

Long and McElhone both agree on another key issue that confronts institutions with daguerreotype collections: how to properly exhibit them.

When displayed on a wall or in a display case, daguerreotypes need to be lit in a way that the viewer can properly see the image. "The National Gallery of Canada has perfected a method of lighting to ensure an optimal viewing experience for daguerreotypes that are being exhibited. The fact that daguerreotypes need a particular viewing environment is imperfectly understood by many art institutions. I often see them being displayed in such a way that they are not legible, and that's quite unfortunate," explains McElhone.

Long says, "The George Eastman Museum usually has at least one daguerreotype on display at any given time. Our exhibitions typically last from three to six months, but the light levels we display daguerreotypes at are quite low. The surface of a daguerreotype acts like a mirror, so lighting is always a challenge. If you want to see daguerreotypes at their best, wear black when you're in front of them."

THE DAGUERREOTYPIST
A MODERN DAGUERREIAN ARTIST

Dr. Mike Robinson is often found wearing black—he's been making daguerreotypes since the late 1990s. Robinson is a modern daguerreian artist, scholar

BOY IN WIDE LAPELLED COAT, SEATED IN CHAIR, METROPOLITAN MUSEUM OF ART. PHOTOGRAPHS COLLECTION, BEQUEST OF HERBERT MITCHELL, 2008.

DAGUERREOTYPE HINGED CASE, METROPOLITAN MUSEUM OF ART PHOTOGRAPHS COLLECTION.

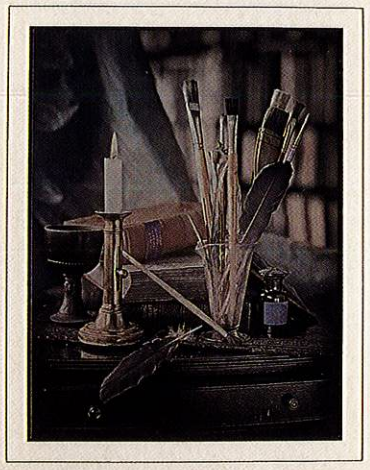
and leading expert on the process. His dedication to the artisanal craft has led him to lecture and teach workshops on daguerreotypy around the world. Robinson's daguerreotypes can be found in many institutional collections, and his work has been presented in exhibitions at prominent institutions including the Metropolitan Museum of Art, the Art Gallery of Ontario, the Fox Talbot Museum, and the Penumbra Foundation.

What has kept Robinson interested in making daguerreotypes for so long? "The materiality of the daguerreotype is a very strong draw for me. As a maker, I can fine-tune my materials to anything I want and get visual effects that you simply can't get with any other process. Daguerreotypes are unique, one of a kind, and they present a challenge. Every time you make a daguerreotype, you have to marry the subject and the process. Figuring out how to best design the process to fit the subject you are photographing effectively is what I find most fascinating," he replies.

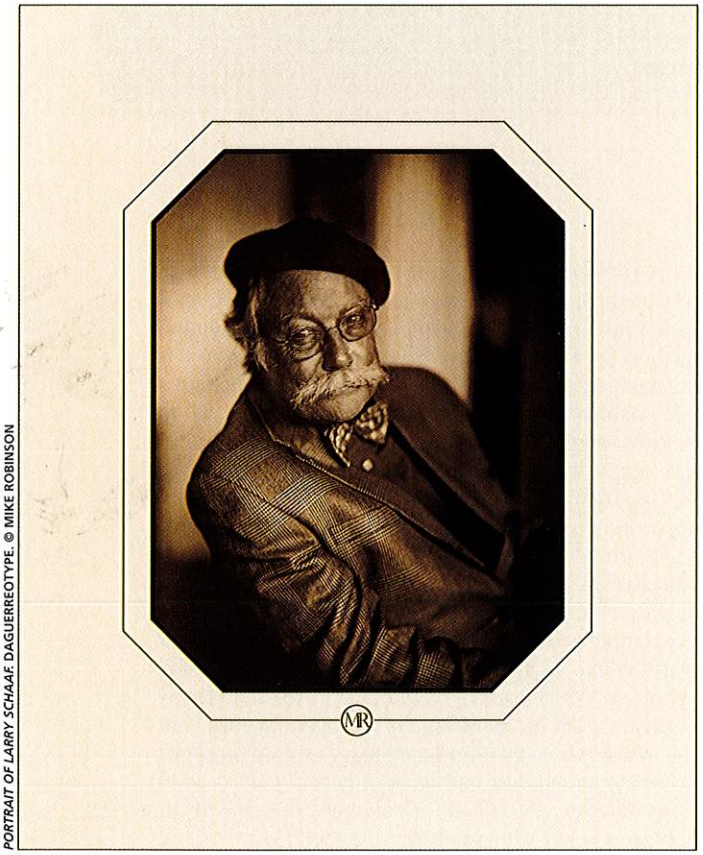
A HOLISTIC UNDERSTANDING

At John McElhone's suggestion, Kozachuk approached Robinson to learn more about the process of making daguerreotypes. Robinson provided some of the test plates for Kozachuk's earlier research. He sees value in applying Kozachuk's method to plates that have been completely obliterated by failed conservation attempts or plates that are heavily tarnished and beyond treatment but stresses that these plates are quite rare so there may not be too many images that would benefit from it. He continues, "It is interesting as far as its application to cultural heritage and could be used for some of the early daguerreotypes—particularly the ones that are not gilded—that are quite damaged. If they ever find any daguerreotypes from the Franklin expedition at the bottom of the Arctic Ocean, those plates would likely be heavily corroded, and it would be interesting to use that technology to see if there is anything left on them—there could be mercury still in situ, so that would be a great example of how Kozachuk's method could be applied."

Robinson believes in a holistic approach to understanding daguerreotypes. He warns, "There is danger in making conclusions based purely on scientific experiments that only analyze and look at one variable. It is important to understand what your tools are actually doing when you analyze a plate.



ARTS AND LETTERS. TINTED HALF-PLATE DAGUERREOTYPE STILL LIFE. © MIKE ROBINSON



PORTRAIT OF LARRY SCHAAF. DAGUERREOTYPE. © MIKE ROBINSON

It is critical that any scientific study of cultural heritage objects include someone with the skills and understanding of how the object is made; you can't get that from only reading the history books or technical manuals.

How you design the experiment is important. It's also very valuable to know how the object is made so you know what to look for and how to interpret the data."

In his PhD dissertation, *The Techniques and Material Aesthetics of the Daguerreotype*, Robinson emphasizes understanding the daguerreotype by replicating the art. He states, "It is critical that any scientific study of cultural heritage objects include someone with the skills and understanding of how the object is made; you can't get that from only reading the history books or technical manuals." Robinson's research aims to explain why daguerreotypes look the way they do by combining historical research, tacit knowledge gained by making daguerreotypes, and study of the methods and innovations of 19th-century daguerreotypy.

Robsinson adds, "Daguerreian J.J. Bardwell in 1854 said that in looking over a collection of pictures from different galleries, you will notice a peculiarity of tone—so much so, in some instances, that you could almost name the artist from whose hand the picture came. Every daguerreotype is unique in how it's made, as are the materials used to make it. Since they are completely handmade objects, the variables are infinite; these factors need to be understood when studying daguerreotypes, analyzing their chemistry and interpreting data, and evaluating conservation treatment options for deteriorated plates."