Suffering from exposure to the elements, the unidentified woman was wrapped in a blanket and shipped across the English Channel to an undisclosed location in Paris, her exact age and identity unknown. Later, traveling with a French passport, she arrived in the United States and made her way through the streets of Manhattan to an elegant building on the Upper East Side. Standing in a hallway there on a cold December afternoon, the woman’s discolored appearance and awkward pose attracted little attention (fig. 1).

The story of the Roman marble statue of a woman that is the subject of this article has the plot twists and intricacies of a popular novel. Although the very beginning remains unwritten, the ending is a happy one for Yale. The current chapter begins when the sculpture was at an English country house and considered to be an eighteenth-century garden statue. It was auctioned as such by Sotheby’s of Sussex in 1987. A photograph of the statue from the auction catalogue reveals that the sculpture must already have been displayed outdoors for many years. It was purchased by a French private collector who placed the statue in a Parisian garden, where it endured two more decades of outdoor exposure to urban pollutants and acid rain. In December 2007, the piece was shipped to Sotheby’s in New York to be sold at an auction of Greek and Roman antiquities.

Looking beyond the superficial, curators and conservators from the Yale University Art Gallery discerned the figure’s full potential as a fine example of Roman sculpture and arranged for its final journey to New Haven, Connecticut. There, the story would continue to unfold through scholarly research, scientific analysis, and a lengthy conservation treatment.

The six-foot-tall marble statue of a woman is an early Roman portrait, possibly from the eastern Mediterranean, made in the first century B.C. or early first century A.D. The body type, the so-called pudicitia, was commonly used for female portrait statues at that time and was intended to express highly valued characteristics such as modesty, purity, and serenity. The complex drapery patterns on this example are particularly detailed and skillfully carved, with the thicker folds of the tunic visible beneath the thinner mantle that envelopes the body (fig. 2). Elements such as the luxurious fringe on the mantle and the closed-toe shoes are individualizing features that mark the image as a portrait, while the...
idealized face and hair rely on strong Hellenistic artistic traditions. Overall, the object is a stunning work of art, its quality and elegant composition merely obscured temporarily by issues of condition and later restoration.

The statue’s first temporary home at Yale was the Gallery’s off-site storage and conservation facility. The figure, weighing in at close to a ton of marble, was immediately dubbed the “Green Lady” by Gallery staff owing to the predominantly green growths of mildew, algae, and lichen that covered the surface. A veritable ecosystem was evident: traces of plant life as well as of insect and bird populations could be found on upper surfaces, undercuts, narrow crevices, and even between the individual grains of marble (fig. 3).

Standing in the conservation laboratory, the statue became the focus of intensive examination sessions and discussions among the Gallery’s curators and conservators. Initial analyses were performed using the naked eye and a binocular surgical microscope, as well as ultraviolet light and X-radiography. Over the course of the next two years, more elaborate scientific testing would be done by removing small samples of marble, iron, lead, and other old restoration materials from the

Fig. 2. Detail of the statue before conservation, showing carving of drapery folds

Fig. 3. Detail of the statue showing condition of surface before conservation, including green algae, dirt, and iron-oxide stains
statue in order to seek more information about its history and provenance. Meanwhile, the statue was featured in the Gallery’s summer 2009 exhibition *Time Will Tell: Ethics and Choices in Conservation*. Installed prominently near the entrance to the exhibition, the statue was a highlight of the show and personified one of its primary themes: the collaborative decision-making process that is so essential for museum curators and conservators today. The statue impressed visitors with its dramatic before-and-after state of surface condition and in-progress treatment, effectively symbolized by the obtrusive wood splint still supporting the restored right arm (fig. 4).

As presented in the exhibition, the statue had undergone at least two major phases of restoration before being acquired by the Gallery. In the first, marble additions were used to replace extremities that had been lost or damaged in antiquity or burial: arm, fingers, chin, and nose. Broken surfaces were recarved to receive the marble restorations, which were attached with small iron pins for smaller marble restorations and large iron pins for structural marble restorations. The large iron pins were secured with lead, which provided both physical stability and galvanic protection of the iron. The use of lead in such joins to prevent corrosion of the iron is a technique known and used since ancient times. Restorers in the eighteenth and nineteenth centuries frequently applied these methods to restore fragmentary ancient sculptures, at a time when completion was considered to be more important than origin or accuracy.

The right shoulder and chest of the figure were considerably recarved to receive a replacement right arm, but one that was completely inappropriate for the portrait type, oversize and extending down and away from the body. The original right arm of the statue would have been bent sharply at the elbow, with the hand raised demurely to the chin or touching the edge of the veil. Some understanding of what the statue would have looked like was gleaned by using computer technology to manipulate its digital image (fig. 5). The ancient statue type was meant to represent a woman in a self-contained, balanced pose, and the inaccurate restoration created an entirely different effect, distorting the aesthetic poise of the composition.

The second major phase of restoration to the statue included a sloppy application of epoxy putty (fig. 6). Epoxy resins were developed in the 1930s and went into commercial production in the 1940s as a strong, waterproof adhesive. This putty was used on the statue to seal and conceal many cracks and joins. It was applied in such a haphazard manner that the work appears more likely to have been done by the estate gardener than by a trained restorer. At that time, epoxy was also used to create crude reconstructions of the nose, the mantle, and the left index finger and thumb (fig. 7). The marble replacements that had been made for these body parts in the first phase of restoration had since gone missing; only their corroded iron pins remained.

Gallery conservators used gentle steam for initial surface cleaning of the sculpture, effectively removing years of accumulated dirt, biological growth, droppings, and debris. Once this was complete, Gallery curators and conservators began to consider the statue’s various restorations and to discuss options for treating them. The aesthetic and art-historical advantages of removing the old restorations needed to be weighed carefully against any physical risks to the statue that might result from their removal, along with the historical significance and structural advantages of retaining them.

Numerous museums have been faced with similar dilemmas in recent decades. In the 1960s and 1970s, there were many programs of “de-restoration,” in which additions to ancient sculptures were removed. The motivation for this was based on principles of both art history and conservation, since the restorations not only were not original to the work of art but also sometimes threatened the stability of the object through deteriorating
Fig. 4. Statue installed in *Time Will Tell: Ethics and Choices in Conservation*, Yale University Art Gallery, New Haven, Conn., May 22–September 6, 2009

Fig. 5. Digital reconstruction of the statue, showing original position of the right arm
adhesives or corroding metal attachments. The situation was complicated by the fact that some of these de-restored objects were rendered unintelligible and unfit for exhibition. Mette Moltesen, Curator of Ancient Art at the Ny Carlsberg Glyptotek, in Copenhagen, explains that “many of the statues have profited from the rigidly enforced policy of removing restorations, others have suffered, some have become ruins, and still others have come out as very harmonious fragments.”

One example of the damaging effect of such campaigns is the Lansdowne Leda in the collection of the J. Paul Getty Museum, Los Angeles, which emerged from de-restoration as “an unexhibitable, cannibalized torso with unsightly iron pins protruding in all directions.” In that instance and others at the Getty, curators and conservators decided to treat the previously de-restored objects with carefully considered reattachment of their eighteenth- and nineteenth-century additions so that the statues could be exhibited and understood by viewers.

This issue of restoration, de-restoration, and re-restoration has become even more complex in recent years because of legal and ethical issues of cultural property and provenance studies. In some instances, the presence of historical restorations can provide crucial evidence that an object has spent many years in a collection, possibly extending the modern history of the piece beyond its preserved paper trail. The retention of such restorations in a museum setting is important at a time when the public is becoming increasingly aware of repatriation claims from Mediterranean countries and the need for antiquities to have a secure and unblemished provenance. Before any of these restorations are removed, they must be thoroughly researched both art historically and scientifically.

Aware that due diligence in transactions involving antiquities increasingly relies on scientific techniques, including those used by forensic scientists, Gallery curators and conservators decided to conduct further analyses on the statue. Contact was initiated with
several laboratories, both at Yale and at other institutions, to explore possibilities for identifying various materials in and on the statue. The resultant dialogue among curators, conservators, and other scientists combed the extent of how science might aid and complement art history. Many questions were asked in choosing what tests to perform and which laboratories to engage. Issues including sample size, sampling technique, cost, and schedule were considered, always keeping in mind the ultimate goal of preparing the statue for exhibition at the Gallery.

During the months required for all of the above analyses, in-house conservation treatment on the statue continued. Because the restored right arm was so clearly inappropriate for the figure, its removal was a high priority for Gallery curators. Recognizing the need for something to support the arm from below during its removal and prevent any damage to the body in the process, staff members devised a wood crutch based on orthopedic models. Using microdrills and surgical scalpels, conservators meticulously removed the modern epoxy that was smeared across the gap between the replacement arm and the body. A marble restoration plug in the upper arm near the shoulder was extracted, exposing an iron pin surrounded by soft lead. The lead was removed using drills and chisels, and slight movement of the arm was eventually achieved. Gallery art handlers slowly and gently coaxed the arm away from the body by using thin wedges of pine and poplar that were inserted into the ever-widening space between the arm and body (fig. 8).

When the arm finally could be removed from the body of the statue, the conservators discovered that the pieces had been joined not only by the visible iron pin but also by a second pin, several inches below. This pin had gone undetected when the statue was initially X-rayed because the thickness of the stone had prevented penetration of the X-rays through the arm. Examining this new evidence, curators and conservators finally were able to understand the complete technique that had been used to attach the arm to the body. First, the broken arm socket on the body was reworked, leaving a rough, chisel-marked, concave surface where the new arm would attach. Then, two holes were drilled in the body to receive two iron pins. The lower pin was inserted into the lower hole in the arm and secured with lead. The upper pin was likewise inserted into the upper hole and also secured with lead. A soft marble dust putty was applied inside the lower hole on the body and over the surfaces to be joined. As the arm was placed in position, excess marble putty probably oozed out from the gap between the parts (presumably wiped away after the joining procedure was complete). Finally, molten lead was poured through a hole in the arm to secure the upper pin, which was then concealed by a carved marble plug. Together, the two pins provided complete physical support for the new arm and prevented it from slipping or rotating in its socket over time.

Once the restored arm was removed, Gallery staff decided to leave the exposed recarved surface on the figure’s proper right side with very little further treatment. The two iron pins (fig. 9) that had been used to attach the arm were cut down to the level of the surface but were deliberately left visible as an interesting and significant feature of the sculpture’s history. Such evidence of restoration, recarving, and tool marks not only is interesting to general museum visitors but also is of high value for teaching.

After the statue’s inappropriate restorations were removed, the surface condition was reevaluated. The initial steam cleaning of the beautifully carved surfaces had removed almost all of the green biological growths. Some reddish orange stains, however, had been caused by iron (as confirmed by a portable X-ray fluorescence unit), and these remained visible. The Gallery curators decided that these stains were relatively unobtrusive and were consistent with the aesthetic goal for the statue. A slightly blemished or imperfect appearance, particularly
for an ancient statue, is far preferable to the harshly white, soapy surface that can be caused by zealous mechanical cleaning, strong chemicals such as acids and bleaches, and even high-tech laser cleaning. Experimental refinements to the last technique continue to be studied.9

The next step in the treatment of the statue involved the meticulous removal of the discolored and disfiguring epoxy that had been applied to the broken neck, face, and veil. This was done using scalpels and a precision grinding and polishing micro-unit designed for very fine surface finishing.10 A network of cracks and breaks was uncovered, as well as small fragments that had been inserted into damaged areas to create the illusion of a complete statue. This process made it clear to conservators and curators that the head and the body definitely do belong together. Though the joins of the many fragments between the head and body are not perfectly aligned, they are structurally sound. It was determined that the risks of disassembling the pieces were greater than the possible gains to be had if efforts to reconstruct the neck and head were attempted. The iron restoration pins were corroded but were not contributing to further damage, especially given that the sculpture will remain in a stable museum environment where corrosion will be inhibited. If the sculpture had been deemed structurally unstable, it would have been disassembled, the iron pins removed, and new pins made of stainless steel or titanium installed. Such invasive treatments are undertaken only when the condition of an object is critically unsound.11

As a conservation treatment progresses, decisions regarding new fills and restorations are made collaboratively along the way by the curators and conservators. Examining the newly cleaned surface and visible restorations, Gallery staff made the decision to retain the historic marble restoration chin and two fingers on the left hand and to secure them using a stable mixture of acrylic resin, glass microspheres, and dry pigments. The same compound material was used to fill the hole in the figure’s nose, which once held an iron pin and marble restoration, as well as the numerous cracks and losses around the broken neck.

Meanwhile, the scientists who had been consulted for analytical testing on various material samples began to submit reports, and these results yielded significant information regarding the statue’s historical past. Each analytical technique provided evidence for the overall technical study of this ancient sculpture and its restoration history. When combined, the results of the various analyses helped complete the sculpture’s story.

The first question about the statue that Gallery curators hoped to answer was what marble quarry had provided the ancient...
sculptor with his raw material. The corollary question involved the source of the marble that had been used for the later restorations, particularly the right arm. It would be interesting to see whether the scientific tests would be able to fingerprint the stones, what degree of error would be present in the test results, and how the analysis would compare to visual and art-historical determination about the marble and its source.

Attempts to identify marble quarry sources to determine the provenance of ancient Greek and Roman sculptures were initiated by Harmon and Valerie Craig in 1972. Their method, involving the use of stable isotope ratios of carbon and oxygen, was further refined and developed by Norman Herz, a geologist at the University of Georgia. The concept of having scientific evidence that might reveal information about the quarry source for a marble sculpture immediately attracted the attention of art historians and museum curators worldwide. During his career, Herz was consulted by numerous museums to run tests on works of art in their collections, including the British Museum, London; the Musée du Louvre, Paris; the Ny Carlsberg Glyptotek; the Art Institute of Chicago; the J. Paul Getty Museum; the Metropolitan Museum of Art, New York; the National Gallery of Art, Washington, D.C.; and the Walters Art Museum, Baltimore. Although he is now retired, Herz’s pioneering research in this field has been continued by many other scholars. The Gallery contacted several laboratories currently doing stable isotope analysis on marble and chose to have samples from the portrait statue tested by one of Herz’s former students, Scott Pike, now at Willamette University, in Salem, Oregon.

Pike’s analysis was performed using continuous flow mass spectroscopy at the Stable Isotope Laboratory, Department of Geology, University of Alabama. In preparation for the testing, Gallery curators and conservators decided to remove small samples from three different locations on the statue: the head, the body (where it was prepared to receive the restored arm), and the restored right arm. These locations were carefully chosen with the hope that the marble isotope analysis results would provide information not only about the quarry source for the original sculpture but also its restorations and later history.

The marble isotope analysis measured the ratios of carbon (13C/12C) and oxygen (18O/16O). Although the results were not definitive, owing to overlapping of quarry signature fields, they were insightful nonetheless (fig. 10). They suggested that the likely marble source for the sculpture was the Choradaki quarries on the Aegean island of Paros, where marble was quarried from the sixth century B.C. through Roman times. The Aliki quarries on Thasos, an island in the northern Aegean

Fig. 9. Detail of right shoulder of statue where restoration arm was attached
Sea, were also consistent with the isotopic results, but the maximum grain size of the marble samples as measured in the laboratory (1 mm) is well below the maximum grain size of the Aliki marble, making this an unlikely source for the statue. The head and body had extremely similar isotopic values, suggesting that they were carved from the same block of marble. This confirmed the belief, based on visual observation, that they were carved from a single block, despite the damage and repairs to the neck. The right arm showed a surprisingly similar isotope ratio, suggesting to Pike that it was likely the same marble type, but less likely from the same block.

Based on the necessarily small (30 mg) and unobtrusive samples taken from the ancient sculpture, the marble was characterized in the laboratory as showing no gray banding. However, gray veins in the marble are clearly detectable by visual examination of the sculpture, especially when it is wet. The gray veins might suggest that the marble could be from Carrara or Hymettian quarries—in Tuscany, Italy, and Attica, Greece, respectively—which are also close matches to the isotope ratios.

While undeniably interesting and useful, the marble isotopic analysis performed on the Yale statue has shown that curators and conservators must be careful not to rely on any single test or method in determining provenance. As other scholars and scientists have found, “it is now commonly agreed that the most reliable results are obtained by combining two or more different analytical techniques in a multivariate approach to the problem.”16 In this instance, several different scientific analyses were consulted, and all of these results were integrated with art-historical observation and expertise. It may also be possible to further refine the scientific tests, although currently there are no plans to do so. If additional studies on the marble were indicated, for example, samples could be analyzed for their strontium isotope ratios ($^{87}\text{Sr}/^{86}\text{Sr}$) as well as for other accessory minerals that may be present.17

Like marble, lead has also been used successfully in isotopic studies to trace source materials and to provide data for dating and provenance. Archaeologists have used such analyses to trace ore sources, primarily galena (lead sulfide), as well as trade patterns of lead-containing artifacts from around the
Mediterranean during the Bronze Age. The technique has also proven to be useful for tracing lead ore sources in the United Kingdom. In an attempt to obtain more information about the possible location of the workshop where the marble restorations were made for the Yale figure of a woman, curators and conservators sent a small sample of the lead used in the restoration to Jane Evans at the NERC Isotope Geosciences Laboratory (NIGL), in Keyworth, Nottingham, England. Their results showed a strong correlation between the Yale sample and the lead composition of the Pennine lead mines in northern England, which were in commercial operation from about 1850 to 1910 (fig. 11). This analysis would suggest that the statue received its restorations in the late nineteenth or early twentieth century, perhaps prior to or upon its arrival at an English country house.

The encouraging results of the lead isotope analysis promoted the decision to solicit analysis on the two iron pins that had been used in conjunction with the lead for attaching the marble restoration arm. Parts of the pins that had already been cut away from the statue were sent to Robert Gordon, Department of Geology and Geophysics, Yale University. Together with Colin Thomas, a graduate student in archaeometallurgy, Gordon examined the two iron pins. The team then cut cross sections from the pins and mounted, polished, and etched them for closer analysis. The results of their observations provided interesting additional information about the history of the sculpture.

There are several visual differences between the two pins, beginning with their size. The upper pin is approximately ½ inch square, with facets hammered into it and with several seams of unwelded material evident. The lower pin is more evenly square and smaller, approximately ⅜ inch in width. Both pins were badly forged of wrought iron that was probably made by bloom smelting, a process that gives a porous structure of iron and slag. Bloom smelting was used in England into the late eighteenth century, although the crudely fabricated pins could have been wrought at a later date by an inept blacksmith, perhaps as might be found working on an English country estate or in a nearby village.

To tease out as much information as possible from various other materials accumulated by the statue over time (both
through weathering and through restoration), Gallery staff sought the expertise of forensic scientist Virginia Maxwell of the Henry C. Lee College of Criminal Justice and Forensic Sciences, University of New Haven. Maxwell routinely uses instrumental techniques for examination of trace evidence in materials such as paint and soil. The ancient sculpture provided her with a welcome diversion from crime scene research. Samples of old fill material, epoxy, and garden dirt were analyzed using Fourier Transform Infrared spectroscopy (FTIR), X-ray diffraction (XRD), and scanning electron microscopy (SEM). The old claylike fill material used in the earlier marble restorations was identified as a mixture of calcium carbonate, iron oxide, and magnesium and was possibly made from ground dolomitic marble or limestone with iron-oxide earth pigment added for tinting and/or iron-oxide staining caused by corrosion of the iron pins. The more modern epoxy putty was found to contain calcium carbonate and quartz. Again, ground limestone or marble as well as sand was probably added to bulk the epoxy and perhaps give it an appearance that would have been closer to that of the original marble before discoloring over time. In general, soil is difficult to identify unless there is some unusual mineral present; dirt is basically dirt. In this instance, therefore, science could not reveal the exact location of the statue’s past outdoor settings.

It is clear that the integration of art history and science has tremendous potential for increasing knowledge about the date, history, and provenance of many works of art. The application of such interdisciplinary analysis to the study and treatment of Yale’s marble figure of a woman is a vivid example of how this can work. It is essential, however, that the curator and conservator carefully examine the results of each individual test, understanding such tests’ limitations and challenges. It can be tempting to put blind trust into the scientific results for the simple reason that they are “scientific,” a term that tends to carry with it the weight of accuracy and authority. Problems, however, can arise from misinterpreting such results, or from not accounting for variation or error, so connoisseurship and art-historical expertise remain critical as well. In the end, the eye and instinct of an experienced scholar prove to be at least as valuable as any scientific analysis.

Now that she has undergone sophisticated testing and a thorough conservation treatment, the no-longer-green “Green Lady” will soon stand in a place of honor as a focal point of the ancient Mediterranean installation at the Gallery, scheduled to reopen in 2012 after the completion of major building renovations. This high-quality example of ancient Roman portraiture and Hellenistic-style carving of drapery will engage scholars and students as well as the general public. Her idealized facial features and draped body type reflect strong Hellenistic artistic traditions and express personal qualities of purity, modesty, and sincerity. Her long dress and fringed mantle typify wealth and luxury, while her closed, soft leather shoes indicate a metropolitan Roman status. All of these elements are much more evident and elegant now that the statue’s shroud of green algae and disfiguring restorations have been removed (fig. 12).

The Yale University Art Gallery’s newly acquired marble statue of a lady will provide viewers with a glimpse into the past—the world of antiquity as well as the worlds of early modern collecting and restoration. Since the inscribed pedestal upon which the statue originally stood does not survive, the woman’s name, family, home, and status are unknown. The figure, however, is no longer quite the mystery that she was when she arrived at Yale. Close collaboration between Gallery curators and conservators has allowed several aspects of her history to be reconstructed through art-historical and scientific analysis, so that she now has an identity and understanding appropriate to her new home.

Fig. 12. Statue after conservation treatment
We would like to acknowledge several individuals at the Yale University Art Gallery who participated and assisted in the treatment of this object. Very special thanks go to Patricia Sherwin Garland, Senior Paintings Conservator, for pushing the limits of the painting conservation X-ray unit in order to obtain X-ray images of the marble statue. Jeremy Bell, Conservation Technician, applied his highly refined woodworking skills to the task of fabricating an orthopedic crutch for the statue's seventy-five-pound arm. After Christopher Sleboda, Director of Graphic Design, used his Photoshop expertise to digitally remove the statue's right arm and restore its original pose, Thomas Philips, Senior Materials Assistant/Lift Operator, and Jason DeBlock, Assistant Manager of Installations, worked as a team with gentle strength to expertly de-arm the statue in reality. Conservation intern Victoria Schussler mastered the use of the Eneska drill to meticulously remove epoxy from the statue's surface and vastly improve its appearance. We also thank the Susan Morse Hilles Chief Conservator Ian McClure, Chief Curator Susan B. Matheson, and the Henry J. Heinz II Director Jock Reynolds for their continuous support of collaborative, innovative projects such as this one and for guiding our museum in new and exciting directions.

1. Sotheby's, Sussex, sale cat., September 23–24, 1987, lot 598.
2. Sotheby's, New York, sale cat., December 5, 2007, lot 69.
4. The best X-radiographic image was obtained with the following exposure settings: 80 KV, 5 mA, 48 inches from tube source, for six minutes.
8. The X-ray fluorescence unit used was a Bruker Tracer III-SD handheld XRF system, Bruker Elemental, Kennewick, Wash.
10. ENESKA 3-1, Joisten and Kettenbaum GmbH and Co. KG, Bergisch-Gladbach, Germany.