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Authors: Megan Randall, Lynda Zycherman, and Roger Griffith
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727 15th Street NW, Suite 500, Washington, DC 20005 (202) 452-9545
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CONSERVATION OF JOAN MIRÓ'S BRONZE SCULPTURES AT THE MUSEUM OF MODERN ART

MEGAN RANDALL, LYNDA ZYCHERMAN, AND ROGER GRIFFITH

The Museum of Modern Art owns three major bronzes by Joan Miró: *Lunar Bird* (1966), *Solar Bird* (1966), and *Personage and Bird* (1968). This article will examine the sculptures' original casting and finishing processes, compare variations within their editions and metallurgical analyses, and review their condition and corresponding treatments. At the beginning of this project, both *Solar Bird* and *Personage and Bird* were deemed unexhibitable due to serious condition issues. *Solar Bird* was acquired in 2005 and came into the museum after decades of outdoor exposure without regular maintenance; as a result, its patina was significantly degraded. Treatment involved steam cleaning and applying tinted hot wax layers to revive saturation and appearance. *Personage and Bird* had a lifting surface that was consolidated and losses were toned.

KEYWORDS: Joan Miró, Bronze, Susse Foundry, Parellada Foundry, Patina, Metallurgical analysis, Hot wax

1. OVERVIEW

Joan Miró (1893–1983) was one of the most eminent and prolific artists of the 20th century. He utilized a wide range of mediums and artistic practices, and within his sculpture worked in stone, wood, plaster, ceramics, assemblages, and bronze. This article focuses on Miró's bronzes from the 1960s. The Museum of Modern Art (MoMA) Miró holdings include three important bronzes: *Lunar Bird* (fig. 1) and *Solar Bird* (fig. 2) (both edition 2/5) cast in 1966 at the Susse Foundry in Paris, France, and *Personage and Bird* (figs. 3a–c) (edition 1/2) cast in 1968 at the Parellada Foundry in Barcelona, Spain. At the time of this project's inception in fall 2014, both *Solar Bird* and *Personage and Bird* had never been displayed at MoMA and were considered unexhibitable due to severe condition and appearance issues. The goal of this research was to produce and execute treatment plans so that both sculptures could be displayed.

MoMA's three sculptures only represent a small sample of Miró's bronze making. Throughout his lifetime, Miró worked with seven different bronze foundries in Europe. In France, Miró collaborated with Susse Foundry from 1962 to the late 1970s, the Scuderi Foundry from 1971 to 1977, the Clementi Foundry from 1963 to 1973, and the Valsuani Foundry for a short period from 1971 to 1973. In Barcelona, Spain, Miró first worked with the Gimeno Foundry from 1945 to 1956 and then the Parellada Foundry from 1965 until his death in 1983. Miró also worked with the Bonvicini Foundry in Verona, Italy, from 1970 to 1981 (Fernandez Miró, Ortega Chapel, and Martinez 2006). The majority of Miró's relationships with foundries lasted a decade or more, and Miró produced bronzes at these foundries simultaneously. Miró's selection of foundry was likely based on its location, as well as its casting and finishing techniques. Given the number of bronzes that Miró produced in his lifetime and the variety of foundries he employed, we can assume that Miró had a deep understanding of foundry casting technology and was able to communicate his desired results to individual founders.

The two foundries represented in this study are the Susse Foundry in Paris and the Parellada Foundry in Barcelona. At the Susse Foundry, Miró produced large-scale smooth-formed sand-cast bronzes with traditional dark patinas. These large-scale sculptures are a well-recognized type of Miró bronze casts. The editioned *Lunar Bird* and *Solar Bird* are both collected and displayed by major institutions, as are the other versions that Miró made of these forms in marble, wood, plaster, and in bronze at different scales. In contrast, the Parellada Foundry provided an outlet for Miró's more experimental casting and produced sculptures smaller in scale, formed from assemblages of found objects with highly unique and expressive, streaky patinas over a rougher, textured surface

Fig. 1. Joan Miró, *Lunar Bird*, 1966, bronze, 228.5 x 198.2 x 144.9 cm, The Museum of Modern Art, 636.1994 (Courtesy of The Museum of Modern Art)

Fig. 2. Before treatment. Joan Miró, *Solar Bird*, 1966, bronze, 120 x 180 x 101.9 cm, The Museum of Modern Art, 242.2005 (Courtesy of The Museum of Modern Art)

Fig. 3a. Before treatment, front; 3b. Side; 3c. Back. Joan Miró, *Personage and Bird*, 1968, bronze, 102.9 x 59 x 19 cm, The Museum of Modern Art, 635.1994 (Courtesy of The Museum of Modern Art)

(Fernandez Miró, Ortega Chapel, and Martinez 2006). Despite the popularity of the Susse Foundry casts, Miró produced relatively few individual bronzes with this foundry, in comparison to the 90 different editions (over several hundred bronzes) cast at the Parellada Foundry. These casts are less well known in the United States because they are more often collected privately or remain in Europe.

2. *LUNAR BIRD* AND *SOLAR BIRD* OVERVIEW

The forms of *Lunar Bird* and *Solar Bird* were first made in bronze in 1946 at the Gimeno Foundry in Barcelona. These casts were small in scale with *Lunar Bird* and *Solar Bird* at 20 and 13 cm tall, respectively (Fernandez Miró, Ortega Chapel, and Martinez 2006). *Solar Bird* was modeled first, followed by *Lunar Bird*. These forms were considered a pair by Miró, like the sun and the moon, or woman and man (Fernandez Miró, Ortega Chapel, and Martinez 2006).

Twenty years later in 1966 at the Susse Foundry, Miró produced these forms again in large scale with *Lunar Bird* over 2 m tall and *Solar Bird* 1 m tall and almost 2 m long. Both of these MoMA sculptures are edition 2/5 and came into the collection from their original owners. *Lunar Bird* (along with *Personage and Bird*) was gifted to MoMA in the Gordon Bunshaft Bequest of 1994. *Solar Bird* was acquired by MoMA from the Cigna Corporation in 2005. They were no longer a matched pair visually due to their differing exhibition and environmental histories. The following sections describe the two sculptures and will give details on the research and treatment steps we took to return *Solar Bird* to an appearance and condition that matched *Lunar Bird*.

2.1 *LUNAR BIRD* AT MOMA

Since its acquisition in 1994, *Lunar Bird* has been periodically on view in the MoMA sculpture garden for an approximate total of seven years (Museum of Modern Art 2016). While on view, the sculpture has been regularly maintained with annual cleaning and wax treatments. This sculpture is in excellent condition and retains the original surface qualities as produced by the Susse Foundry. *Lunar Bird* has an even, dark patina, and the surface is smooth without any disfiguring scratches or marks. There is some slight wear that is consistent with its age, time spent outdoors, and visitor interaction; however, the overall appearance of the patina is uniform. The sculpture's appearance is consistent with other casts of the edition, including cast 1/5 at the Hirshhorn Museum and Sculpture Garden, 4/5 at the Nasher Sculpture Center, 5/5 at the Foundation Beyeler, and E.A. I/III at the Broad.

2.2 *SOLAR BIRD* ACQUISITION AND CONDITION

Solar Bird's outdoor exhibition and maintenance program prior to coming into MoMA's collection was a dramatic contrast to that of its partner *Lunar Bird*. *Solar Bird* was purchased from Miró's Paris gallery, Galerie Maeght, by Cigna Corporation (Fernandez Miró et al. 2006). The sculpture was first installed in Philadelphia before being moved to Cigna's headquarters in Bloomfield, Connecticut, and regular maintenance was likely not performed. Decades of northeastern outdoor exposure resulted in a streaky, chalky, light green corrosion product spread across the surface. Throughout the years, visitor interaction resulted in small scratches on the side of the sculpture and light graffiti on the top of the horn (figs. 4a, 4b). Tenacious black patches were also present on the horn of the sculpture. They appeared to be either an old coating or localized patination effort of a previous restoration campaign. The unsatisfactory visual appearance of *Solar Bird* needed treatment prior to exhibition. Although the edition of *Lunar Bird* was consistently dark brown/black in appearance, the following research into the edition of *Solar Bird* showed that its surface was intentionally varied with the earlier editions 1/5 through 3/5 dark green in appearance and the later editions 4/5 and 5/5 nearly black.

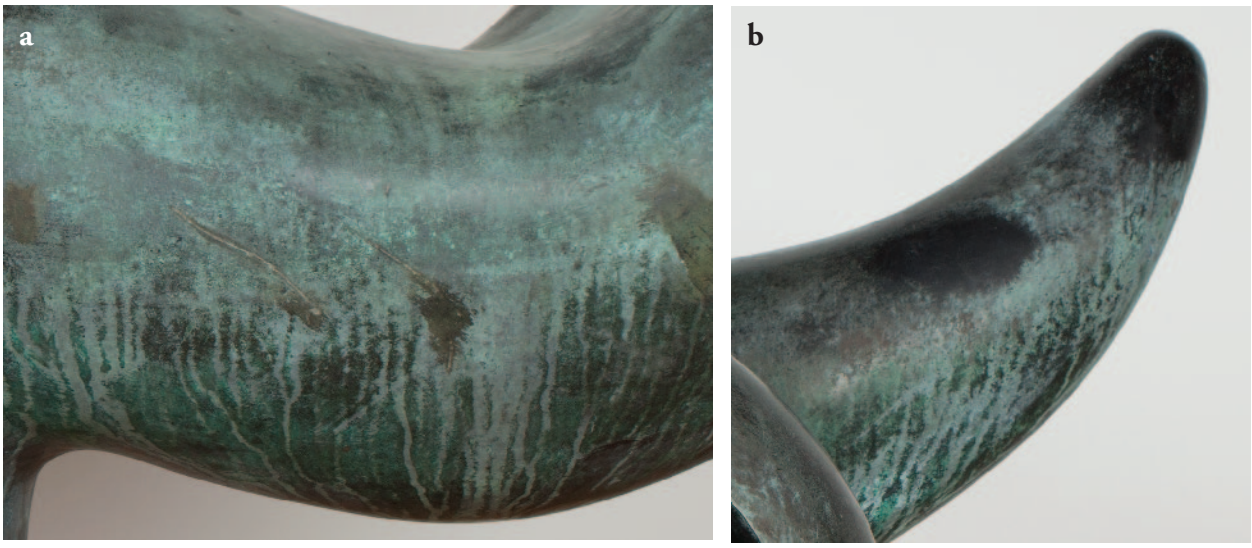


Fig. 4a. Detail of scratches and streaky surface on *Solar Bird's* body; 4b. Detail of dark patches, possibly prior to the restoration campaign (Courtesy of The Museum of Modern Art)

2.3 SOLAR BIRD FOUNDRY INFORMATION

Henri Lacroix, manager of Susse Foundry (2003–present) shared information from the Susse Archives through letters and a personal interview conducted with Megan Randall at the foundry in April 2016. Edition 2/5 (MoMA's) was the first bronze cast. It left the foundry July 27, 1966, for Galerie Maeght; it weighed approximately 272 kg, and its patina took the patinator Rospabe 15 hours to complete. Oddly, although the Susse Foundry ledgers list the patina color for the other four examples in the edition, it unfortunately did not list the patina color for this one (Susse Foundry Archives n.d.).

The other casts from the *Solar Bird* edition had more complete information entered into the Susse Archive notecards. Edition 1/5, owned by the Art Institute of Chicago (AIC), had a patina applied cold that was dark green in color. Communications with AIC in 2005 revealed that the sculpture was treated in 1993 due to degradation of the surface from outdoor exposure and visitor interaction. Areas were selectively repatinated, and the entire sculpture was waxed (Zycherman 2004). Edition 3/5, owned by the San Diego Museum of Art (SDMA), also had a cold, dark green patina. This cast was on display outdoors at SDMA, and large sections of the surface patina were worn away from heavy visitor interaction. In 1994, SDMA treated this sculpture by locally repatinating areas of loss, coating the sculpture in Incralac, then coating it with wax (Wharton and Stofflet 1994). Editions 4/5 and 5/5, owned by The Broad and the Locks Gallery, respectively, were originally patinated using a hot process and were listed as black in color. After interviewing Mr. Lacroix and reviewing the Susse Archives, we determined that the foundry typically produced identical patinas for their editions. In the event that different patinas were applied to different casts from the same edition, they would almost always vary gradually as exemplified by the shift in patina in *Solar Bird.* We concluded that MoMA's edition 2/5 would probably have matched editions 1/5 and 3/5 in its patination process and final appearance.

The alloy listed by the foundry was 75% copper, 21% zinc, 2% lead, and 2% tin. Quantitative XRF[1] performed at MoMA on the horn of *Solar Bird* generally supported the foundry alloy proportion at 83% copper, 15% zinc, 3% lead, and 2% tin (table 1A). The higher ratio of copper in the XRF spectra could be a result of dezincification, a process that occurs in copper-zinc alloys when the percentage of zinc is above that of 15 weight percent as seen in *Solar Bird*. In dezincification, the zinc preferentially corrodes out of the alloy in the presence of oxygen and water, leaving behind a copper-rich surface (Young et al. 2009). The years of outdoor exposure on the surface of *Solar Bird* could have caused this

Fig. 5. Steam cleaning *Solar Bird* in the MoMA sculpture garden (Courtesy of The Museum of Modern Art)

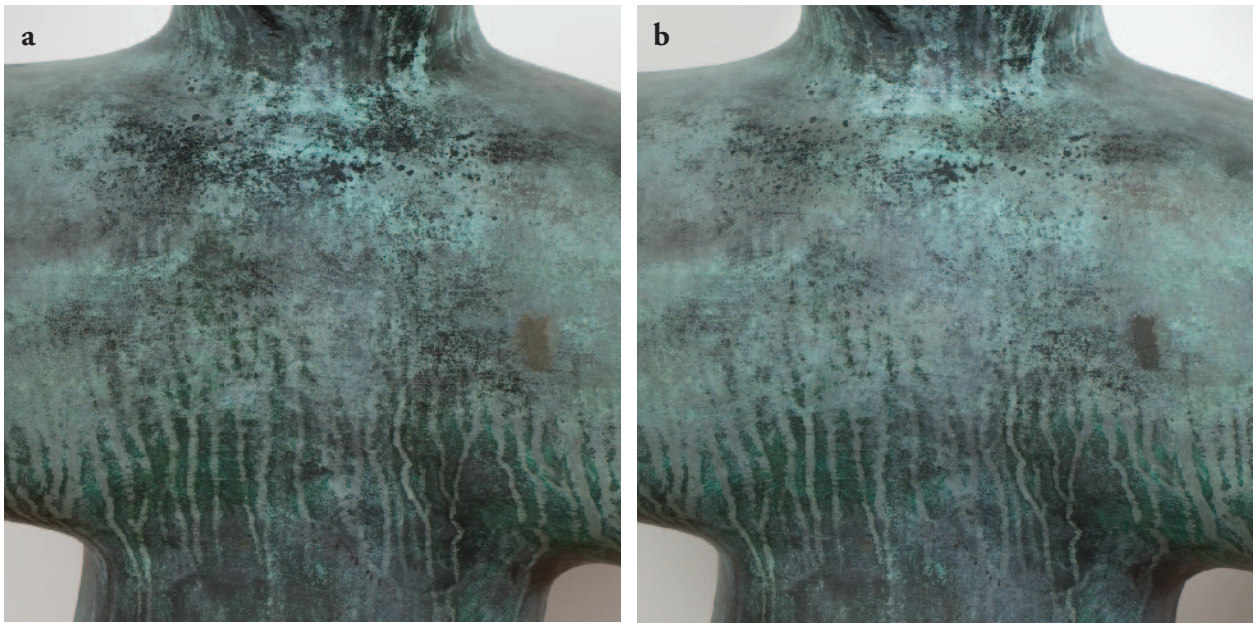


Fig. 6a. Before steam cleaning; 6b. After steam cleaning, the surface is more even and lighter overall (Courtesy of The Museum of Modern Art)

Fig. 7. Application of tinted hot wax layer to *Solar Bird* in the MoMA sculpture garden (Courtesy of The Museum of Modern Art)

phenomenon. Radiography and visual examination showed that the sculpture was cast in three parts: base, body, and horns.

2.4 *SOLAR BIRD* TREATMENT

Ultimately, MoMA's treatment goal was to achieve a dark green and relatively uniform surface, consistent with the appearance of editions 1/5 and 3/5. Early correspondence in the late 1960s between Susse Foundry and the owners included directions to maintain the sculpture with silicone waxes, which are notoriously difficult to remove. Indeed, treatment reports of the 1/5 and 3/5 editions of *Solar Bird* at AIC and SDMA included the removal of notably tenacious wax coatings. Localized repatination on the 1/5 and 3/5 editions were necessary due to areas of the surface that were worn completely bare due to visitor interaction. Fortunately, MoMA's 2/5 edition did not contain any silicone wax or other old tenacious surface coatings, allowing us to clean the surface easily with steam. The surface exhibited some evidence of visitor interaction in the form of scratches and graffiti; however, they were shallow and small enough to blend into the surrounding surface after the wax application. The overall chalky, light green areas were even and well adhered enough to the bronze substrate that stripping or additional patination were judged unnecessary. Areas of intact dark green were used as a guide for the final overall surface appearance.

The sculpture was steam cleaned with an industrial 3,500 psi unit. This phase was accomplished over a morning in MoMA's outdoor sculpture garden (fig. 5). This combination of pressure and heat was successful in removing any remaining residue from old protective coatings, as well as any dirt, grime, guano, or other accretions on the surface. The result from the morning cleaning was an overall evening and lightening of the surface (figs. 6a, 6b).

The second stage of treatment was the tinted hot wax application followed by cold wax. Again, the sculpture was treated in the MoMA sculpture garden. After heating with a torch to drive off any residual moisture in the bronze, a layer of paste wax tinted with burnt umber was applied to the hot surface and then heated again overall with the torch (fig. 7). After the surface was cool enough to touch, the wax layer was buffed by hand. A second layer of wax tinted with lamp black was then applied, again to a surface preheated overall, and was buffed by hand after cooling. The sculpture was brought into the MoMA sculpture conservation lab, where two more coats of clear paste wax were applied and buffed by hand. The resulting surface was significantly more even, dark, and saturated in appearance. Although

Fig. 8. *Solar Bird* after steam cleaning and hot and cold wax treatment (Courtesy of The Museum of Modern Art)

some of the drips and streaks from its original condition are still visible through the tinted wax coatings, it reads as relatively uniform from a normal viewing distance (fig. 8).

3. *PERSONAGE AND BIRD* OVERVIEW AND PROVENANCE

Miró's *Personage and Bird* presents a contrast to the casting methods, condition issues, and treatment of *Solar Bird*. MoMA acquired this sculpture in 1994 as part of the Gordon Bunshaft Bequest, which also contained *Lunar Bird*. Prior to entering MoMA's collection, the work was on view inside Bunshaft's Travertine House in East Hampton, New York (Lange 2014), and in the *Miró Sculpture* exhibition at the Pace Gallery in New York in 1984 (Schjeldahl 1984). Images of these installations do not offer a clear picture of the sculpture's condition at the time of the photographs.

3.1 *PERSONAGE AND BIRD* CONDITION AND VISUAL ANALYSIS

When the sculpture was uncrated for an internal photography request, significant and alarming areas of flaking surface were found on the pedestal of the sculpture (fig. 9). The sculpture was immediately sent to sculpture conservation for analysis, stabilization, and treatment. In our laboratory, we had not seen a sculpture with such unique condition issues before. We initiated research into the materials and manufacturing process of the bronze.

The model for *Personage and Bird* comprises found materials, such as a flattened basket for the head, with the handles as the ears; the eyes, nose, and limbs were taken from a deconstructed celluloid doll. The body is an undulating wax sheet, and a roughly molded iconic bird sits atop the head. Miró wrote about his process of creating sculptures from found objects, stating that he would "create a phantasmagoric world of living monsters; use things found by divine chance, bits of metal, stone etc"

Fig. 9. Detail of pedestal of *Personage and Bird* containing surface flakes (Courtesy of The Museum of Modern Art)

(Rowell 1986, 175, 191). The patina, executed by Josep Parellada who created all of the Parellada patinas from the 1960s and 1970s (Penrose 1970), was applied in drips of light and dark green, yellow, and black, which extend from the basket down to the base, as if the patinator used a sponge saturated with chemicals and squeezed it out over the head of the sculpture. In crevasses throughout the sculpture, particularly concentrated in the texture of the basket, there is a pink, powdery substance (fig. 10). The bronze appears to have a thin "skin" (Jeffett 1990, 19), granular and sandy in texture, covering much of its surface, which when seen in raking light before treatment was lifting significantly away from the

Fig. 10. Detail of pink investment embedded in basket texture of *Personage and Bird* (Courtesy of The Museum of Modern Art)

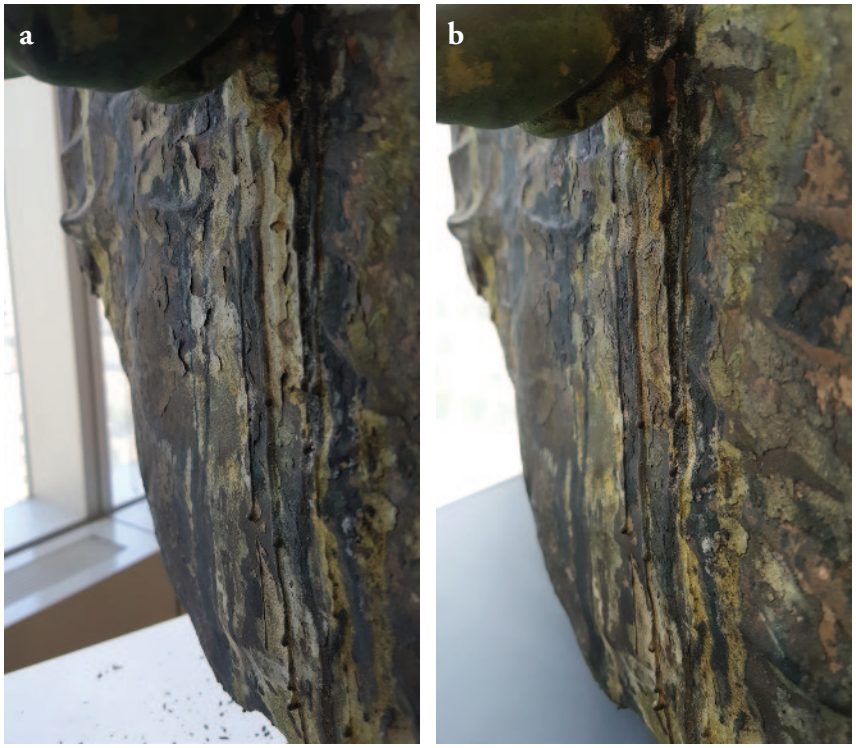


Fig. 11a. Before surface consolidation in raking daylight of *Personage and Bird*; 11b. After surface consolidation in raking daylight (Courtesy of The Museum of Modern Art)

bronze substrate (fig. 11a). Reflectance transformation imaging (RTI) taken on the back of the sculpture captured the severity and topography of this flaking (fig. 12). This process helped highlight not only the lifting of the surface but also subtle tenting over many areas not readily apparent in the normal documentation photographs.

Fig. 12. Screen shot of RTI viewer application of back of *Personage and Bird* (Courtesy of The Museum of Modern Art)

Fig. 13. Mosaiced radiograph of *Personage and Bird* (Courtesy of The Museum of Modern Art)

A systematic catalog of the various patination colors and surfaces over the sculpture revealed trends in the condition and stability of the surface. Dark brown smooth surfaces near the top of the basket and along the edges of the body on the front and the back were areas of old patina loss that had oxidized and darkened over the years. The middle of the body on the front and back of the sculpture contained the highest percentage of recent surface loss, characterized by a now visible light pink smooth surface. A set of radiographs taken over the top half of the sculpture showed the weld joins of separately cast pieces in the basket and the bird, and also revealed some porosity through the center of the body (fig. 13). Unfortunately, neither visual examination nor radiography explained the severity or cause of the flaking surface.

3.2 PARELLADA FOUNDRY VIDEO

To better understand the process of manufacture and how it impacted the condition of the sculpture, we studied a 1987 video (in Catalan) of the Parellada Foundry, produced by the Miró Foundation. This provided insight into the unusual casting techniques of the foundry (Fundació Joan Miró 1987). Narrated by Manel Parellada, son of Josep, the video reveals details of their casting process from the creation of the rubber mold through the finishing of the bronze surface. The molten bronze was poured into pink investment molds, and after cooling the solid sculpture was broken out of the mold and cleaned until approved by the foreman. At this point, the sculpture was brought into the finishing room where the gates were cut and the surface was finished using a variety of electric (or pneumatic) and hand tools.

Fig. 14. Joan Miró, *Personage*, 1968, bronze, Nasher Sculpture Center, NC.1985 (Courtesy of Megan Randall)

Of particular importance in this video was the lack of any chemical or power wash of the bronze surface prior to finishing. Clean surfaces are usually preferred for finishing work and welding/soldering, as well as for stable patination results. The pink powder on the lowest areas of the surface texture of *Personage and Bird* clearly indicates that a layer of investment was intentionally left on the surface of the bronze after casting and the patina was applied over this surface. Given that bronze shrinks a small percentage upon cooling, the cast would be slightly smaller than the wax model around which the investment was built. This would explain the tenting and flaking of the surface, as the investment was originally formed around a slightly larger wax model.

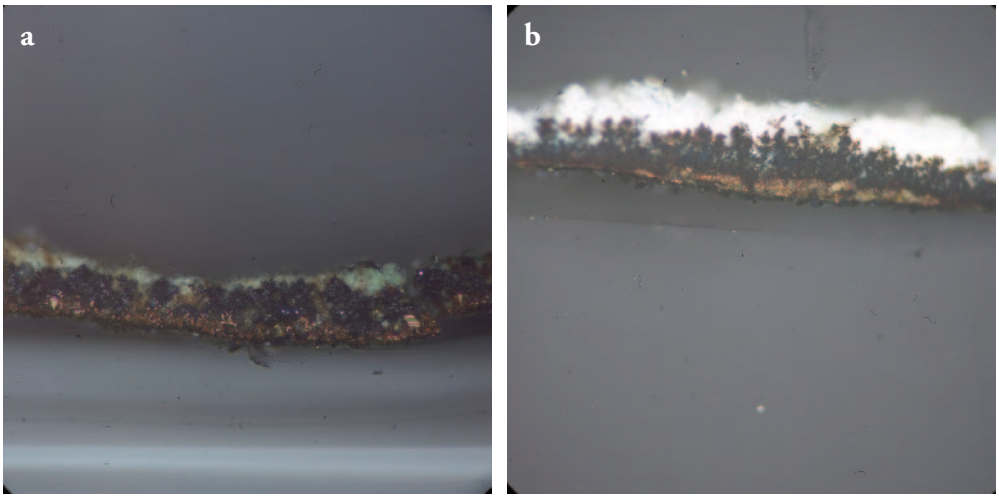
3.3 OTHER PARELLADA CASTS, *PERSONAGE AND BIRD* 1968

To verify these observations and conclusions regarding the unusual manufacture and patination, we were able to examine another 1968 Miró cast from the Parellada Foundry: *Personage*, edition 2/2 from 1968 (fig. 14), belonging to the Nasher Sculpture Center. Although the Nasher *Personage* does not exhibit the bold, drippy patina application over the body, the texture, quality, and color of the surface of the basket appears almost identical to the basket in MoMA's *Personage and Bird* (figs. 15a, 15b). Darkened areas of old surface loss and a light green sandy skin were preserved in the recesses along with the characteristic pink powder. Slight lifting along the edges of the skin was visible on the Nasher *Personage*; however, little or no new loss was observed. We hypothesize that the contours and shape of the bronze mechanically locked the investment in place, whereas the smoother, flatter areas of the body did not provide such support.

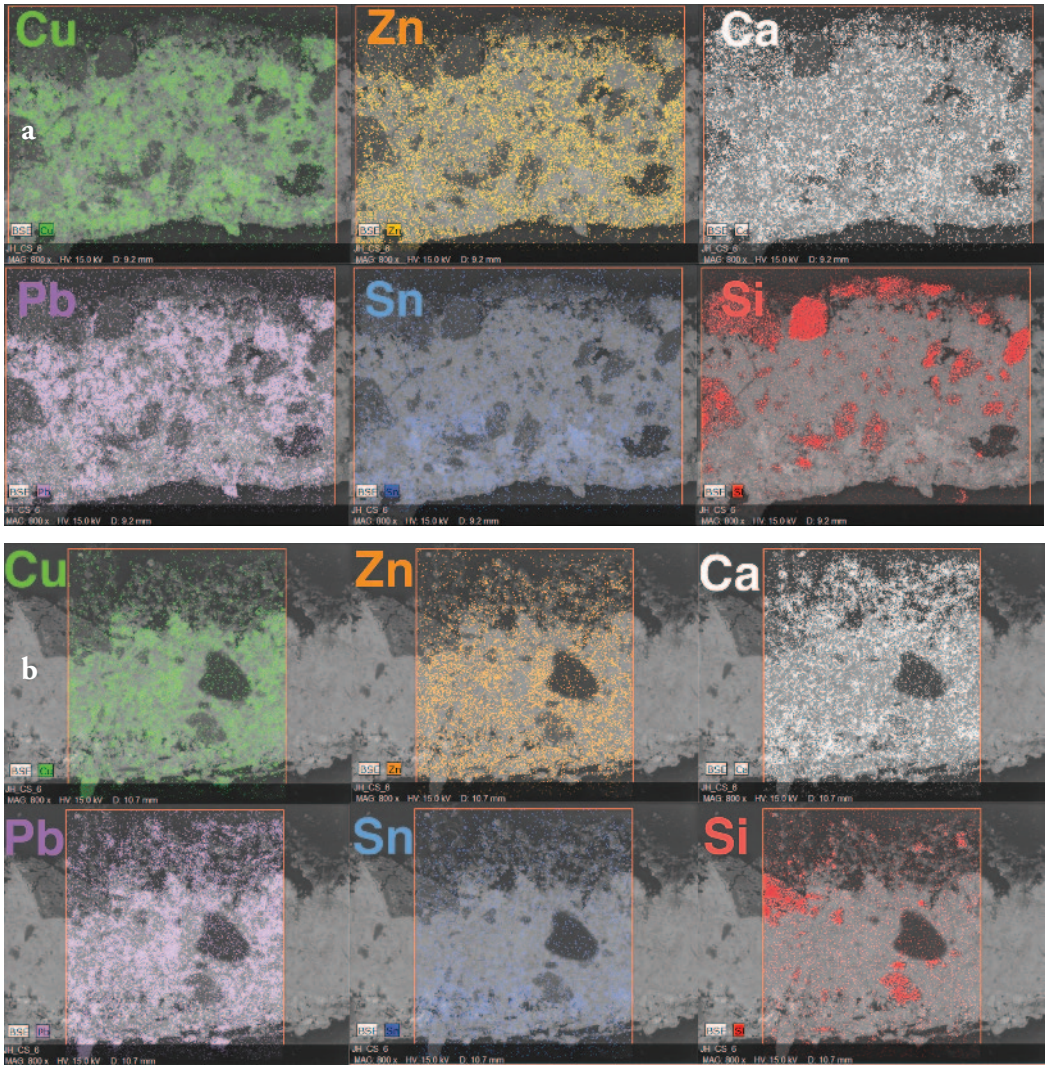
Fig. 15a. Surface detail of *Personage*. Nasher Sculpture Center, NC.1985 (Courtesy of Megan Randall); 15b. Surface detail of basket surface on *Personage and Bird* (Courtesy of The Museum of Modern Art)

3.4 VISUAL CROSS SECTION ANALYSIS OF *PERSONAGE AND BIRD* AND *PERSONAGE* SURFACE FLAKES

While uncrating the Nasher *Personage*, a small flake was found in its packing material. Nasher gave permission to take the sample back to New York to mount it and compare it in cross section to a flake from *Personage and Bird*. Microscopically, both samples appeared similar. Each sample displayed a loose stratigraphy of dark gray metallic material around a copper-like strip with white powdery material on top (figs. 16a, 16b). Given that these samples were representative of what we thought was a discrete layer of investment, it was interesting to find what appear to be alloying components within the cross section.



Figs. 16a–b. Photomicrographs of surface flakes at 100x of MoMA's *Personage and Bird* (a) and Nasher's *Personage* (b) (Courtesy of Megan Randall)



Figs. 17a–b. SEM-EDS element maps of copper, zinc, calcium, lead, tin, and silicon of MoMA's *Personage and Bird* (a) and Nasher's *Personage* (b) surface flakes at 800x (Courtesy of Megan Randall)

3.4.1 SEM-EDS Cross Section Analysis of *Personage and Bird* and *Personage* Surface Flakes

At the Conservation Center at New York University, both samples were examined under the SEM and analyzed using energy dispersive spectroscopy (EDS). In both samples, the alloying elements of copper, zinc, tin, and lead were identified, along with investment elements of calcium and silicon. At 800x, the elements previously identified were mapped across the width of both samples. Although each element is distributed across the width of the cross section, the distribution of each element placement differs (figs. 17a, 17b). The "surface" of the sculpture was essentially formed from a layer of metal mixed with investment. The poor adhesion of the investment and the slight shrinking of the bronze cast upon cooling as mentioned earlier contributed to its tendency for flaking.

3.5 XRF ANALYSES OF *PERSONAGE AND BIRD*

Quantitative XRF[1] was performed on two areas of the sculpture (on the body and on the exposed metal on the rim of the base), and a metallographic section was taken from inside the bottom rim. The goal of the analyses was to interpret the metallurgical aspects of the cast. The first set of quantitative XRF

Table 1. Results of the XRF Quantitative Analysis on MoMA's *Solar Bird* and *Personage and Bird*

Average percentage	A. *Solar Bird*	B. *Personage and Bird* (base)	C. *Personage and Bird* (body)
Fe	—	—	2 ± 1
Cu	83 ± 1	81 ± 3	68 ± 8
Zn	14 ± 1	8 ± 2	14 ± 12
As	—	1 ± 1	2 ± 1
Pb	3 ± 1	5 ± 1	3 ± 1
Sn	5 ± 1	4 ± 1	5 ± 1

Note: Ten readings were taken from the horn and body of *Solar Bird*. Four readings were taken from exposed metal on the bottom surface and eight readings on the body of *Personage and Bird*.

spectra were recorded on four areas of the front of the body where the outer skin of the bronze had flaked away, leaving a large enough section to accommodate the 5-mm spot size of the instrument (table 1C). The alloy percentages from these readings were approximately 68% copper, 14% zinc, 5% tin, and 3% lead; however, the standard deviation associated with these results shows that the percentage of the metals varied significantly, which was representative of an irregular surface and did not characterize the internal alloy percentages. This is likely a result of a variety of factors, including the amount of residual investment embedded in the surface and the use of patination chemicals. The four readings taken across the cleaned, unpatinated bottom rim of the sculpture, however (table 1B), were 81% copper, 8% zinc, 5% tin, and 5% lead. The composition of the base was much closer to the known Parellada Foundry alloy recipe of 85% copper, 5% zinc, 5% tin, and 5% lead (Parellada Site Visit and Interview 2016). Given the exposed metal of the base and the alignment of the acquired XRF data with the archival recipe given by Parellada, the quantification of the XRF data is likely representative of the *Personage and Bird* alloy.

3.6 SEM-EDS METALLOGRAPHIC SECTION ANALYSIS OF *PERSONAGE AND BIRD*[2]

As a way to examine the interface of the bronze alloy with its surface, a metallographic section was taken out of the bottom rim of the bronze. This sample was extracted so that it would not be visible after the sculpture was remounted on its base. As a result, it only contained a preserved portion of the interior surface interface and not the exterior surface. This sample was mounted and examined with the SEM-EDS unit at 1000x at both the interface of the interior surface and within the bulk of the metal sample. The element maps of the edge of the sample showed a copper deficiency at the interface that was filled with a concentration of both zinc and lead. In the center of the sample, the alloying elements were evenly distributed (figs. 18a–c).

The cleaning and finishing practices of Miró with the Parellada Foundry were anything but usual. Without the cleaning that would normally take place after casting (acid bath, power wash, sanding), a casting skin of investment mixed with metal and oxides that was probably always formed during casting (representative of figure 18b) was not removed. This layer was naturally very porous, and further elemental migration likely occurred as a result of the acid attack during the patination process.

3.7 COMPARISON OF OTHER CASTS FROM *PERSONAGE AND BIRD* EDITION

Fortunately, we had access to two other casts from the edition for comparison of their surfaces and states of preservation. A nominative cast licensed by the artist's estate in 1987 for the Reina Sofia,

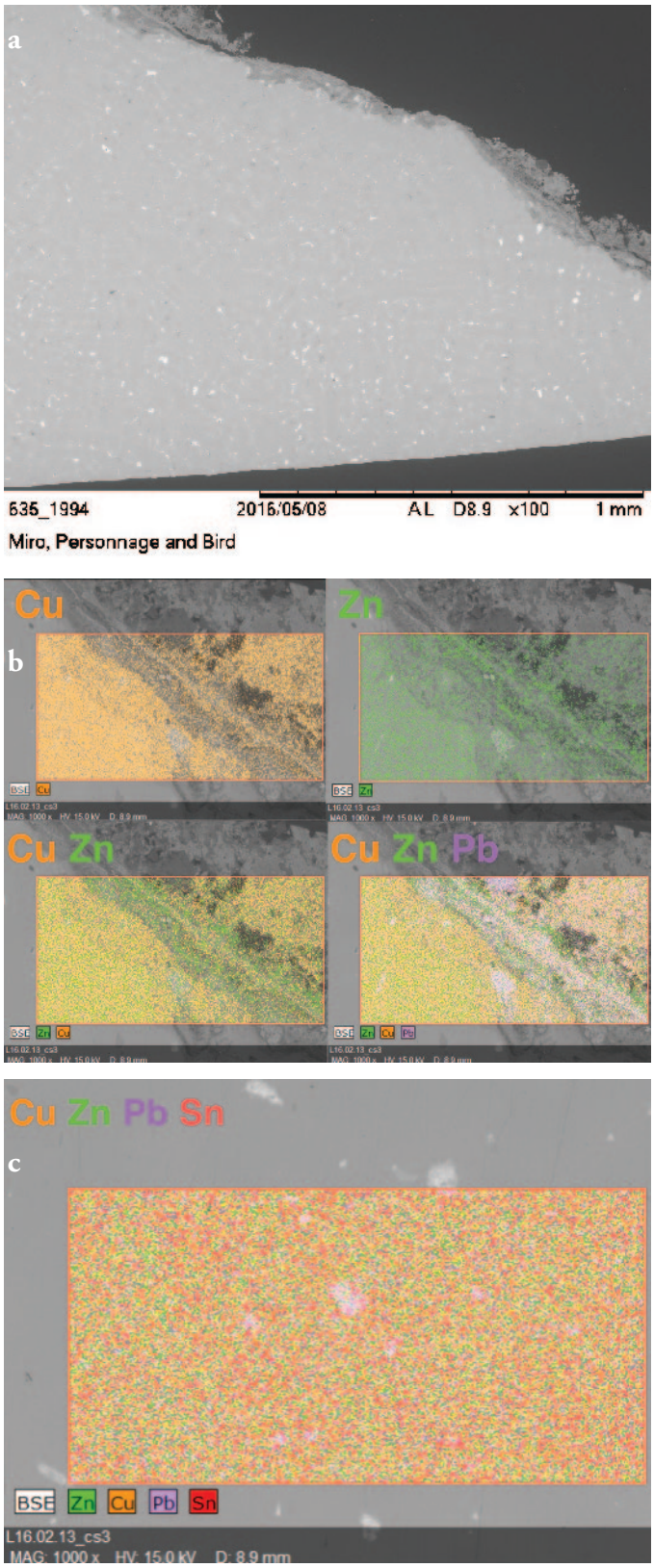


Fig. 18a. SEM image of metallographic sample at 100x; 18b. SEM-EDS element maps of copper, zinc, and lead at 1000x at the surface of the sample; 18c. SEM-EDS element map of copper, zinc, and lead at 1000x in the interior of the sample (Courtesy of Megan Randall)

cast and patinated by Manuel Parellada at the Parellada Foundry, was displayed at the Nasher Museum of Art at Duke University in 2014–2015. The surface and condition of the 1987 cast was considerably distinct from that of the 1968 MoMA cast. There did not appear to be any flaking or loose surface, and in general the texture was compact and smooth. The drips were concentrated in the center of the body, and they appear to be applied by splattering the chemical as opposed to the long drips of the 1968 MoMA edition patinated by Josep Parellada.

The 0 cast of the edition, also from the 1968 casting in the Parellada Foundry, owned by the Barcelona City Council, was on extended loan to the Miró Foundation. The surface appearance and texture are very similar to the MoMA example. Specifically, pink investment was seen embedded in the basket, the general texture was granular and sandy, old loss was visible near the edges of the body and the high points of the basket, and the pattern and color of the drips were similar to MoMA's edition. The condition of the cast was significantly better than MoMA's cast, with almost no new loss with the exception of an inch-wide circular loss near the bottom right section of the back.

3.8 PARELLADA FOUNDRY INTERVIEW

In the hopes of verifying the observations of materials and condition of Miró's Parellada casts, we visited the Parellada Foundry on April 12, 2016, to interview the third-generation owners Manuel and Jordi Parellada, grandsons of Josep and sons of Manuel Sr. (Parellada Site Visit and Interview 2016). As neither Manuel nor Jordi spoke English, Elisabet Serrat, paintings conservator at the Miró Foundation, joined the visit as interpreter. This visit confirmed several aspects of their casting process, most importantly that the casting skin and investment were left on the sculpture intentionally at Miró's request. Manuel and Jordi recalled that Miró was very strong in his idea that he did not want the casts to be "too clean," and that Miró frequently shouted "Don't touch it—I like it!" when a sculpture had achieved his desired appearance. They stated that Miró choose the Parellada Foundry specifically for the surfaces and patinas that they were capable of producing, and that some surface loss at the time of casting and finishing was expected and accepted by Miró.

3.9 TREATMENT OF *PERSONAGE AND BIRD*

There is an inherent contradiction between Miró's acceptance of some amount of surface and patina loss that inevitably happened at the foundry or later on, and his desire for the rough appearance of the patina that Parellada Foundry provided. Our treatment plan for the MoMA edition of *Personage and Bird* sought a balance between stabilizing and preserving the remaining rough surface and visually minimizing the areas of recent loss.

The first step of the treatment was the stabilization of the casting skin, which included both consolidating intact areas of casting skin throughout the sculpture and then setting down flaking and lifting areas of surface on the bronze substrate. The copolymer Paraloid B-48N was chosen for its stability and affinity for bonding to bare or primed metals (Down et al. 1996). A dilute (approximately 5% w/v) solution of B-48N in xylenes was applied to the surface using a soft-tipped syringe. The dilute consolidation did not noticeably change the appearance or saturation of the surfaces. The application of the resin in xylenes allowed the consolidant to penetrate through and under the casting skin and effectively connect the investment layer to the bronze substrate (see fig. 11b).

A more viscous solution (approximately 20% w/v) of B-48N in acetone was used to seal and set down flaking and lifting. The fast evaporation of the acetone and higher percentage of resin provided the necessary strength and tack to set down (and keep down) the lifting areas. Some sheen was evident in areas where the more viscous solution was used, and after the consolidation was complete, local reduction of the sheen was performed with foam swabs and acetone. Last, recent areas of loss on the surface were toned with Golden Matte Fluid Acrylic paints (figs. 19a, 19b, 20a, 20b).

Figs. 19a–b. Front (a) and back (b) of *Personage and Bird* after consolidation and surface toning (Courtesy of The Museum of Modern Art)

4. CONCLUSION

The atypical processes of the Parellada Foundry under Miró's instruction produced incredibly expressive, textured, and colorful bronzes. These surfaces, or casting skins, routinely removed in most foundry practices, are not securely attached to the underlying bronze. The combination of inherent vice with time resulted in an unfortunate loss of surface and texture. The Susse Foundry, in contrast, employed fairly

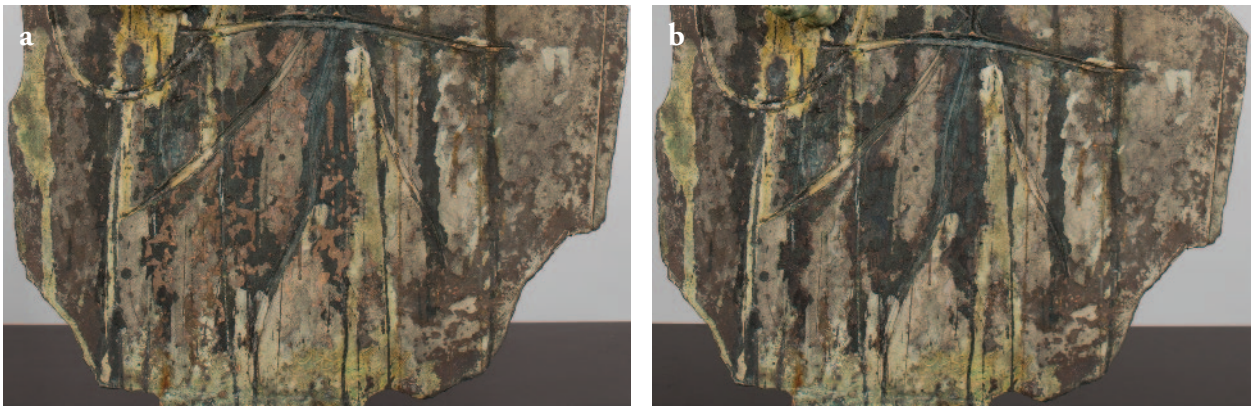


Fig. 20a. Before toning of *Personage and Bird*; 20b. After toning of *Personage and Bird* (Courtesy of The Museum of Modern Art)

standard practices of casting, finishing, and patination in their production of large-scale, uniform, and beautifully finished bronzes. However, lack of maintenance or periodic evaluations of condition ultimately resulted in *Personage and Bird* and *Solar Bird* both with severe condition issues.

Many of the conclusions and insights discovered during the research of this article would not have been possible without visiting the foundries in person. Both the Parellada and the Susse foundries communicated many details of technique and process through oral histories maintained throughout generations and owners. Although bronzes are often considered some of the more robust objects in museum collections, dedicated and concerted efforts to maintain, monitor, and understand their materials and surfaces can be essential to assessing their condition and future stability. Fortunately, thanks to the collaboration and generosity of numerous individuals and institutions, it is now possible to view more of the remarkable range of Miró's creative bronze making within MoMA's collection.

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NOTES

1. Conditions for quantitative XRF analyses: Bruker Tracer IIISD, Rh target, Si-Drift detector, 40 keV, 3 mA, 12-mil Al/1-mil Ti/1-ml Cufilter, 180-second data acquisition time, in-house empirical calibration developed with S1Cal and ARMI (Evergreen, CO) and CHARM (MBH Analytical Limited) certified reference bronzes. Results presented correspond to the average and standard deviation of 10 measurements on the body and horn of the sculpture for *Solar Bird*, 8 measurements on the body of *Personage and Bird* (in areas where the underlying metal is exposed), and 4 measurements under the base.

2. Conditions for SEM-EDS analyses and sample preparation: TM3000 Hitachi Scanning Electron Microscope coupled with Bruker EDS and Quantax software at 15 keV for 90-second data acquisition time, analytical mode. Buehler EpoxiCure resin and hardener (in 4:1) were used to mount the surface flakes of the Nasher *Personage* and MoMA *Personage and Bird*, as well the metallographic section. The metallographic section was extracted using a jeweler's saw with a 0.15-mm-wide blade. The sample was cleaned and degreased prior to mounting. All samples were polished in cross section. Sample preparation was considerably informed by chapters 13 and 14 of *Metallography and Microstructure of Ancient and Historic Metals* by David Scott.

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SOURCES OF MATERIALS

Buehler EpoxiCure 2 Resin and EpoxiCure 2 Hardener
Buehler
33 Lewis Rd., Ste. 2
Binghamton, NY 13905
847-295-6500
http://www.buehler.com

Crystal Clear Paste Wax
Woodcraft
215 Westport Ave.
Norwalk, CT 06851
203-847-9663
http://www.woodcraft.com

Golden Matte Fluid Acrylic paints
Dick Blick Art Materials
PO Box 1267
Galeburg, IL 61402
309-343-6181
http://www.dickblick.com

Paraloid B-48N
Talas
330 Morgan Ave.
Brooklyn, NY 11211
212-219-0770
http://www.talasonline.com

Pigments
Kremer Pigments
247 W. 29th St.
New York, NY 10001
212-219-2394
http://www.shop.kremerpigments.com

MEGAN RANDALL is a Sculpture Conservation Fellow at MoMA. She completed her conservation training at the Conservation Center at the Institute of Fine Arts. Megan spent her internship year at MoMA (2014–2015). She has also completed internships at the Chinati Foundation and the American Museum of Natural History. Prior to entering the field of conservation, she worked as a finisher at Modern Art Foundry from 2008 to 2011. She received an MA from Christie's Education in 2008 and a BA from Carleton College in 2007. Address: 25 W. 53rd St., New York, NY 10019. E-mail: randall.megan@gmail.com

LYNDA ZYCHERMAN is a Conservator of sculpture at MoMA. She received a BA from the City College of New York; an MA in Art History from the Institute of Fine Arts, New York University;

and the Advanced Certificate in Certificate in Art Conservation from the Conservation Center, Institute of Fine Arts. She interned at the Corning Museum of Glass and Metropolitan Museum of Art. In 1975, she became a conservator at the Freer Gallery of Art and in 1984 made the leap from ancient technology to modern and contemporary sculpture, when she joined the Sculpture Conservation Laboratory at MoMA. Over the past 30 years at MoMA, she has researched a wide variety of topics, including Matisse, The *Back I – IV* (bronze), Brancusi's bronze sculptures, Picasso plaster sculpture, new methods for packing sculpture using laser scanning and 3D printing, and the conservation of Jeff Koons's work. She is currently researching Picasso's bronze sculptures. E-mail: lynda_zycherman@moma.org

ROGER GRIFFITH is an Associate Conservator of sculpture at MoMA, where he has worked since 1998. He received his MA from the Royal College of Art/Victoria & Albert Museum Conservation Program (1997). Roger completed several internships, including the Sherman Fairchild Center for Objects Conservation, Metropolitan Museum of Art; the Stedelijk Museum Amsterdam; and the University of East Anglia: Sainsbury Centre for Visual Arts in Norwich England. He has published and lectured on various topics of conservation, and his recent research examines the nature of the collaborative process that art professionals employ in regard to the exhibition, installation, preservation, maintenance, and storage of ephemeral contemporary art. E-mail: roger_griffith@moma.org