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THREE-WAY PLUG THREE WAYS: CONSERVATION TREATMENTS OF THREE EDITIONS OF CLAES OLDENBURG'S COR-TEN STEEL AND BRONZE *GIANT THREE-WAY PLUG*

MARK ERDMANN, ADAM JENKINS, ROBERT MARTI,
AND MARIANNE RUSSELL MARTI

ABSTRACT

Claes Oldenburg created his monumental COR-TEN and bronze sculpture *Giant Three-Way Plug, Scale A* in 1970. He viewed the piece as a coming together of the mechanical and the organic, and he anticipated the evolution of its patina as a reflection of the "events of nature" around it. However, almost immediately after installation, efforts were being made to arrest these evidences of nature and maintain a current image, free from further deterioration. The artist himself recognized the tension between a philosophical ideal and the reality of gradual deterioration when he stated his preference for either pristine polished bronze or completely oxidized brown or green, but nothing in between. The in-between state of streaked and pock-marked COR-TEN, graffiti- and corrosion-marred bronze, and muddy footprints all distract from the conceptual nature of the monumental banal. Three editions of one artwork—in different settings and with different treatment histories—have over the course of four decades been subjected to efforts to create a balance of acceptable deterioration with respect to the artist's vision and preservation of an artwork as an investment or permanent member of a collection and community.

The sculptures, their locations, and the conservators who treated them are as follows: Edition 1 of 3, at Oberlin College, Allen Memorial Art Museum, Oberlin, Ohio, treated by Mark Erdmann of ICA-Art Conservation; Edition 2 of 3 at the Saint Louis Art Museum, Saint Louis, Missouri, treated by Russell-Marti Conservation Services, Inc.; and Edition 3 of 3, originally created for the private collection of David Pincus and now at the Philadelphia Museum of Art, treated by Adam Jenkins who, at the time of treatment, was working for Milner+Carr Conservation, now Materials Conservation.

Per the artist's instructions, the sculptures, intended for outdoor display, were partially buried in the ground as part of their installation. Contact with the earth resulted in accelerated corrosion of the COR-TEN steel. In addition, the welds between the bronze prongs and the COR-TEN body of the Plug were the sites of severe corrosion on two versions of the sculpture. Above-ground portions of COR-TEN weathered differently due to water run-off, prevailing wind, overhanging limbs, snow and leaf accumulation, and public interaction with the artwork.

This article explores the deterioration of each of the three sculptures prior to conservation treatment and the conservators' differing approaches to treatment of similar issues. Where applicable, earlier conservation treatments of each of the sculptures are briefly discussed as well.

1. INTRODUCTION

Claes Oldenburg installed the first of his planned edition of three monumental COR-TEN and bronze sculptures, *Giant Three-Way Plug*, *Scale A*, at the Allen Memorial Art Museum at Oberlin College in 1970 (fig. 1). The sculptures are hereafter referred to as the Three-Way Plugs. The second edition was acquired by the Saint Louis Art Museum in 1971 (fig. 2), and the third became part of the private collection of David Pincus in 1973 (fig. 3), then was donated to the Philadelphia Museum of Art (PMA) in 2010. Per the artist's design, the sculptures are sited directly on the ground, with portions buried.

While the Three-Way Plugs were intended to weather and adapt to their outdoor environments, unacceptable rates of corrosion and vandalism necessitated conservation intervention in the 1980s and in-depth treatment after 2000. During the various rounds of treatment, the owners and firms conducting the conservation of their respective sculptures exchanged information about condition issues and treatments. Over the course of more recent treatments, the idea arose to share this information with the larger conservation community.

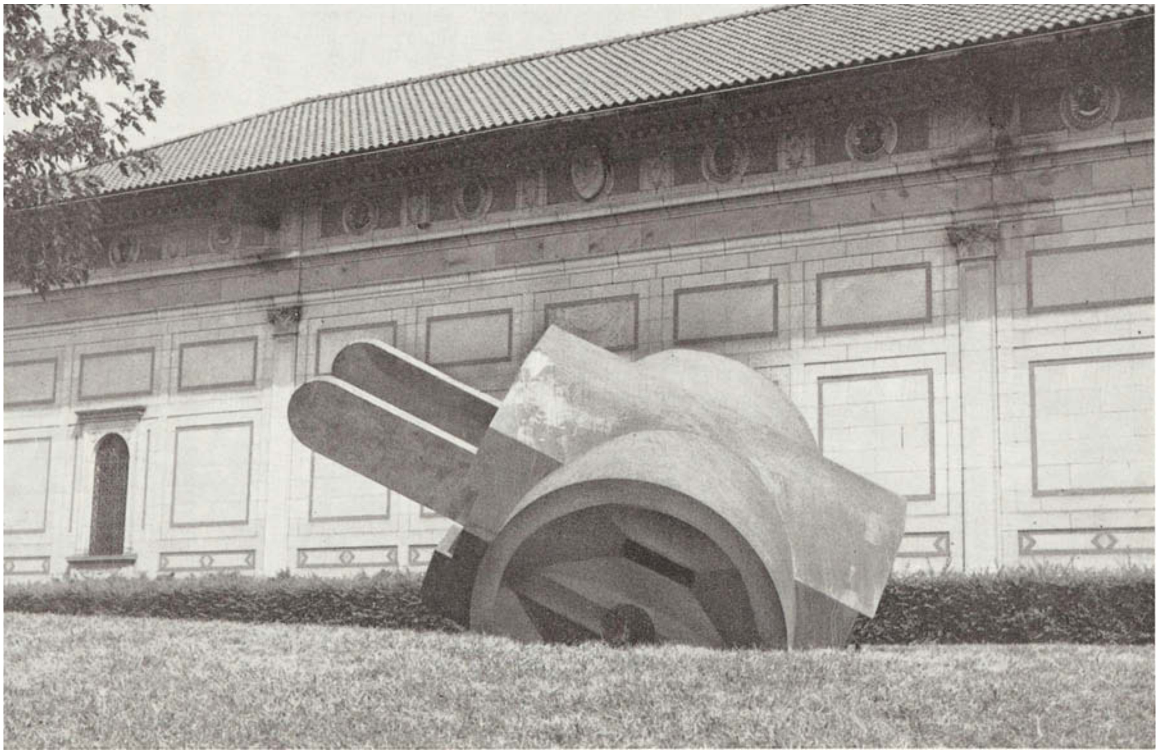


Fig. 1. Claes Oldenburg, *Giant Three-Way Plug, Scale A* 1/3, 1970, COR-TEN steel and bronze, 302 × 199 × 148 cm, Allen Memorial Art Museum, 70.38 (Courtesy of the Oldenburg van Bruggen Studio, © Claes Oldenburg 1970)

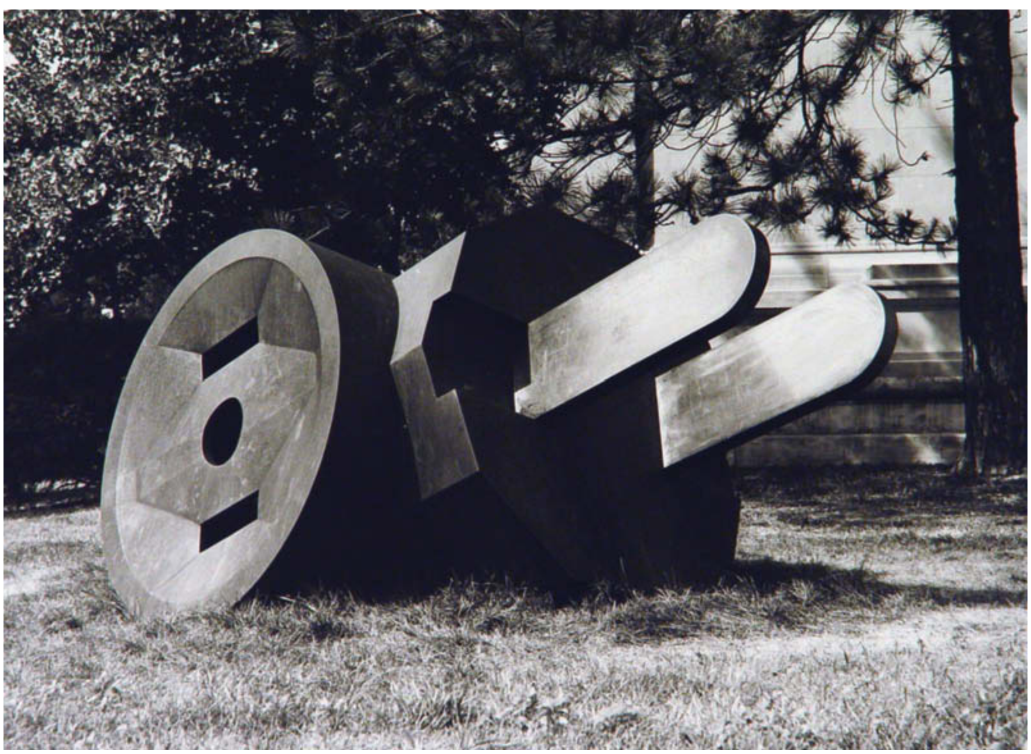


Fig. 2. Claes Oldenburg, *Giant Three-Way Plug, Scale A* 2/3, 1970, COR-TEN steel and bronze, 297 × 196 × 147 cm, Saint Louis Art Museum, 21:1971 (Courtesy of the Oldenburg van Bruggen Studio, © Claes Oldenburg 1970)

Fig. 3. Claes Oldenburg, *Giant Three-Way Plug, Scale A* 3/3, 1970, COR-TEN steel and bronze, 297 × 198 × 147 cm, Philadelphia Museum of Art, 2010-15-1 (Courtesy of the Oldenburg van Bruggen Studio, © Claes Oldenburg 1970)

In discussing the deterioration and treatment of the three editions of the Three-Way Plug, the conservators considered the conservation of the material artwork versus the artist's concept of the pieces, including the relationship with the environment and Oldenburg's thoughts about their deterioration. This article examines whether there are any differences at the time of installation among the three owners about how the Three-Way Plug was to be interacted with, how policies and perceptions have changed over time, and whether this has affected conservation treatments or projected maintenance plans.

2. THE *GIANT THREE-WAY PLUG*

Oldenburg began exploring the three-way electrical plug as an inspiration for his art in the mid-1960s. The Plug made its first appearance in his work in a 1965 lithograph (Johnson 1971), followed by pencil drawings, and eventually, three-dimensional realizations in a variety of materials, including vinyl and wood. Finally, the common little household plug gained truly monumental stature in 1970 with Oldenburg's large-scale COR-TEN and bronze version.

The first edition of the Three-Way Plug came into being as a result of a commission by the Allen Memorial Art Museum at Oberlin College, in Oberlin, Ohio. The museum had early on recognized Oldenburg's emerging stature in contemporary American art and in 1969 commissioned the artist to design and fabricate a work of outdoor sculpture. Oldenburg made many visits to the campus to select a site for the sculpture and submitted several proposed models. After a final agreement in April 1970, the piece was fabricated by Lippincott, Inc. of North Haven, Connecticut—the renowned fabricator of many major large-scale works in the 1960s and 1970s—and the Three-Way Plug was installed on August 10,

1970. From the outset, the large-scale COR-TEN and bronze sculpture was intended to be one of an edition of three.

In an informal talk given on September 14, 1970, on the occasion of the Oberlin sculpture's inauguration, Oldenburg described the process leading to the fabrication of the COR-TEN and bronze version of the Three-Way Plug:

> … my preparation begins with the recognition of the piece and then progresses through a lot of drawings back in 1965 … and then … a cardboard model, which was about this big … and then … as it happened, this cardboard model was crushed in a show and I had to rebuild it. And I got interested in the subject again. This was only last year. And while building this cardboard model again I had a wooden model built by my assistant who was working in the same studio as I was. And then this wooden model was submitted to Lippincott who fabricates art sculpture—exclusively, and he took the dimensions and measurements and built this thing. (Oldenburg 1970)

2.1 CONSTRUCTION OF THE PLUG

The body of the sculpture is fabricated of COR-TEN B (ASTM A588) weathering steel plate, 1/8- in. and 3/16-in. thick.[1] It is composed of three major sections: a central 10-sided cylindrical shape forming a large central chamber and two smaller circular side chambers fitted onto opposite sides of the central chamber (fig. 4). The three sections form the general shape of a Greek cross in plan view. For purposes of orientation, the face of the Three-Way Plug with the prongs is referred to as the front of the sculpture, the side opposite the prongs is referred to as the back, and the two side chambers are referred to as the proper right and proper left sides, respectively.

All of the steel-to-steel joints are welded. Inside the large central chamber, a steel shaft runs the length of the chamber, terminating in a large eyebolt protruding through the center of the rear face of the sculpture (figs. 5, 6). Apart from this shaft, there is no internal armature; the exterior COR-TEN skin is the main structural support of the sculpture.

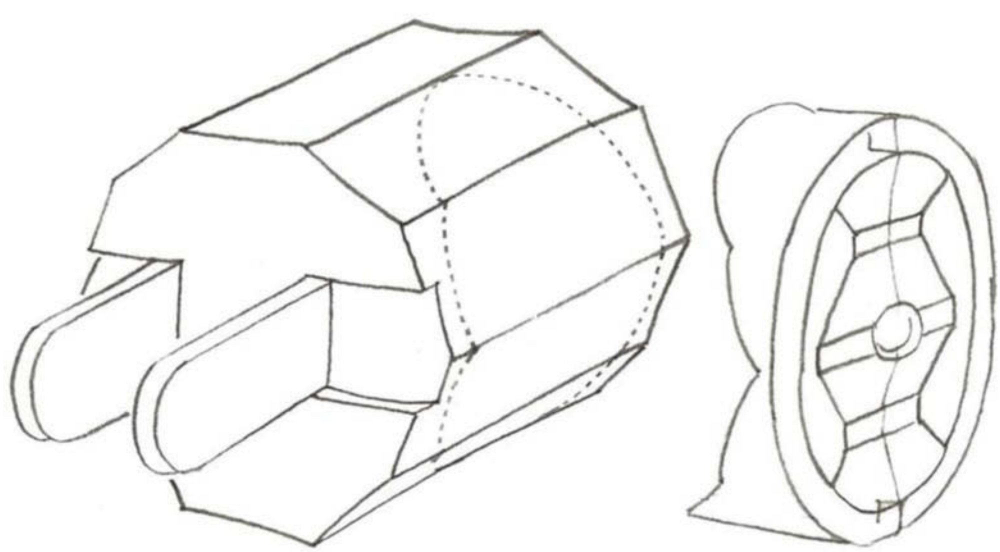


Fig. 4. Schematic drawing showing the basic construction of the Three-Way Plug, consisting of a large 10-sided central chamber and two side chambers (Courtesy of Russell-Marti Conservation Services, Inc.)

Fig. 5. View inside the large central chamber of the Saint Louis Plug, showing the central shaft running horizontally through the body (Courtesy of Russell-Marti Conservation Services, Inc.)

Fig. 6. The back of the Saint Louis Plug, showing the eye bolt at the termination of the central shaft (Courtesy of Russell-Marti Conservation Services, Inc.)

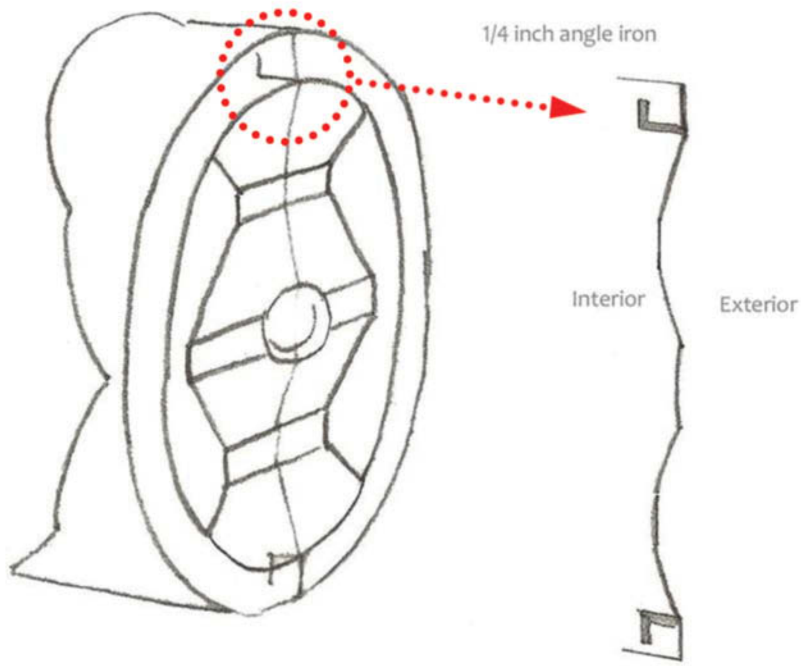


Fig. 7. Schematic drawing showing the location of the circle of angle iron, just behind the left and right faces of the Plug (Courtesy of Russell-Marti Conservation Services, Inc.)

A circle of angle iron is welded to the interior of the proper right and left faces of the Three-Way Plug. The angle lends structural support to the circular face planes of the two side chambers and also would have kept the COR-TEN plate from warping during fabrication (fig. 7).

Two horizontal slots representing electrical receptacles are built into the back, as well as the proper right and left faces of the Three-Way Plug (figs. 1–3, 6). There is a circular opening on each of the left and right faces in between the horizontal slots. The slots and the circular openings provide visual access to the interior, an important component of the overall design.

Two hollow bronze prongs fabricated of 3/16 in. Everdur silicon bronze sheets are fitted into slots in the front face of the Three-Way Plug, extending forward. The prongs on the Oberlin Plug are brazed into "pockets" of COR-TEN just behind the front face. Those on the Saint Louis and Philadelphia Plugs are brazed with bronze wire directly to the adjacent COR-TEN fabric and to two horizontal angle iron braces welded in position on the sculpture's interior directly behind the front face (fig. 5).

Small holes for drainage were originally drilled into the bottom edges of the three chambers. The COR-TEN components of the sculpture were left uncoated.

2.2 ARTIST'S VISION

Oldenburg had definite ideas about the siting of *Three-Way Plug*, its surface finish, and its ongoing relationship to the environment. Of primary importance to the presentation, Oldenburg dispensed with the traditional pedestal and instead sited the sculpture directly on the ground, or more specifically, partially buried *in* the ground. As the artist explained at the Oberlin Plug's inauguration ceremony, "I had thought of it as kind of having fallen out of the sky like an acorn or an apple or a piece of Russian satellite or something or a meteor" (Oldenburg 1970). In a series of small models, we see the artist's exploration of possible positions for the sculpture (fig. 8).

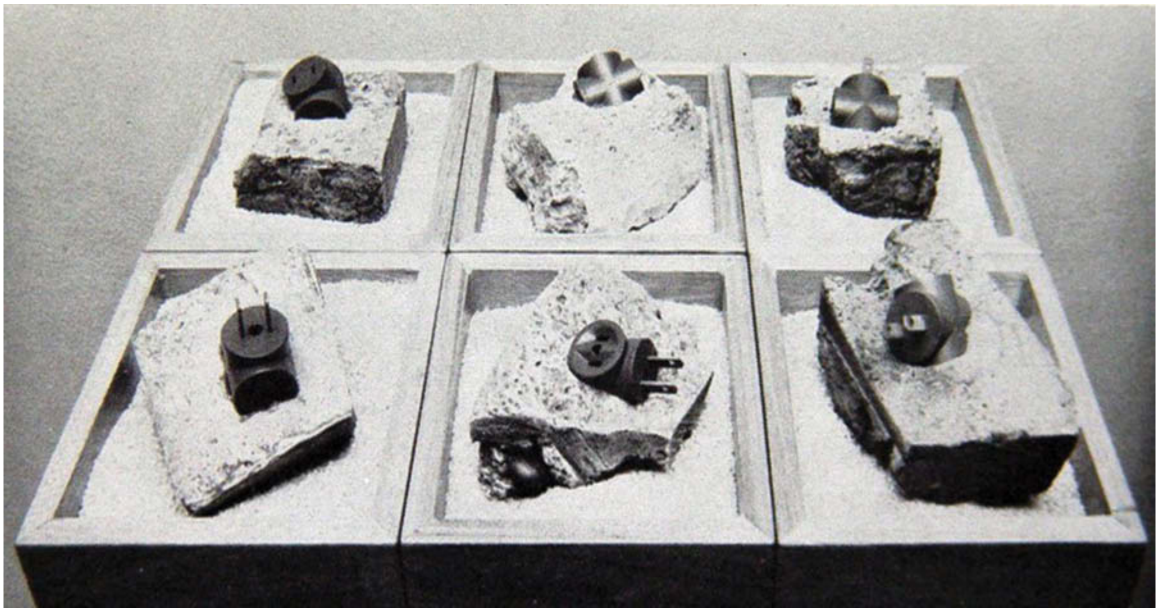


Fig. 8. Several small models made by Oldenburg exploring possible orientations for siting the Three-Way Plug (Courtesy of the Collection of Parks and Christie Campbell)

Regarding the COR-TEN steel body of the sculpture, Oldenburg anticipated the development of the mature, protective corrosion crust common to weathering steel. At the Oberlin inaugural ceremony, he stated, "…this piece is going to turn color. It's going to turn sort of a purple color … eventually. It starts off this way [powdery orange] (fig. 3) and over a period of about two years it gets a kind of a purple color" (Oldenburg 1970).

For the bronze prongs, the artist stipulated pristine, polished yellow metal (fig. 3), stating that if that was not possible to maintain, then the other option was highly corroded bronze. Again, speaking at the Oberlin inaugural ceremony:

> Now we have a choice about the prongs. … either leave [them] the way they are now or let them go and tarnish and they might get to be a green color ... [The surface could remain bright if] they were polished and covered with a plastic coating … […] this is the way I wanted them … as long as they can be maintained this way … if it starts to go the other direction I think we should go all the way in the other direction. (Oldenburg 1970)

His last statement implies that perhaps the bronze ought to be allowed to develop a characteristic blue/green and black streaked patina typical of neglected outdoor bronze sculpture.

The artist continued with his vision for the sculpture:

> … one of the central thoughts about the piece is that it's a mechanical object in a very organic setting—so that it's … behaving like … something natural. It's changing like the trees will change and it's changing like the ground will change. And it will deteriorate in relationship to its surrounding and will take the color of this deterioration. So it's a coming together of the mechanical and the organic. (Oldenburg 1970)

While Oldenburg anticipated and accepted incremental patination and weathering as part of the life cycle of the artwork, he did not want the Plug to be subjected to major, cataclysmic damage. As a precaution against damage from anticipated freeze/thaw activity, he had the Oberlin Plug partially filled with rocks. He explained this approach in the inaugural address, "… if you don't fill it with rocks it fills up with water and then it would ice up and it would burst apart in the winter time, which would be too much of a deterioration" (Oldenburg 1970). Although ultimately the rocks were not necessary or desirable due to the issue of moisture retention on the Plug's interior, the reasoning illustrates the artist's philosophy about acceptable damage.

3. THE THREE EDITIONS OF THE THREE-WAY PLUG

Several months after the Oberlin Plug was installed, the second Three-Way Plug was completed in March 1971 for the Saint Louis Art Museum. The third edition, dated August 1970, was installed in June 1973 in a private collection at the home of David Pincus in Philadelphia. The sculpture was deinstalled in 2008 for conservation treatment and kept in storage until Mr. Pincus donated it to the PMA in 2010. It is currently on display in the PMA's Anne d'Harnoncourt Sculpture Garden.

All three versions of the sculpture are sited outdoors, partially buried, following the artist's original conception. They were installed in gravel beds, constructed to promote drainage away from the sculptures. Both the Oberlin and Saint Louis Plugs were originally placed in similar positions, with the proper left rear corner sunk lower than the rest of the sculpture. The Oberlin Plug had a more prominent backward lean, with the bronze prongs jutting upward at an angle of approximately 25°–30°. The Saint Louis Plug was initially placed at a similar angle, but when it was reinstalled after treatment in 1982, it was sited at a much more conservative 10° angle. Most striking is the current Philadelphia installation, with the Plug heeling dramatically on its right side chamber, two-thirds of the underside exposed, and the prongs angled at a rakish 30°–35°.

During the inauguration ceremony for the Oberlin Plug, the artist described his initial thoughts about the proposed edition of three:

> I had some rather romantic notions about this piece and I was going to build three of them and they were going to be placed in different areas of the United States which would have different climates so that one would be in a very wet area like Oberlin, another one would be in a very dry area somewhere out in the desert, and a third one could perhaps have been made to float or be more seriously affected by water, so that at the end of, say, twenty-five or thirty years each one would look entirely different, and I was thinking that it would be very nice if one of them (I don't know which one it would be), would deteriorate to the point that the whole ground part underneath would be missing and then it could be taken up and shown in a museum as sort of half missing and the mechanical part would still be over here and the other part would gone like a cavity. (Oldenburg 1970)

His comments speak of an inquisitive, playful approach to the idea of three similar Plugs, and further underscore the potential problem of reconciling the opposing forces of deterioration and preservation. As it happened, there was no orchestrated master plan for the placement or subsequent treatment approaches to the three Plugs. In fact, the Plugs were placed in fairly similar, temperate environments, with hot, humid summers and a wide range of temperatures through the winter, and from the outset the owners endeavored to preserve their sculptures as initially installed.

4. PRIOR CONSERVATION TREATMENT

The recent treatments of the Three-Way Plugs are not the first time that their deterioration has been addressed. By the early 1980s, corrosion of the COR-TEN body and the bronze prongs as well as disfiguring vandalism had progressed to the point that the Allen Memorial Art Museum and the Saint Louis Art Museum took their sculptures off view. Condition reports for both the Oberlin and the Saint

Louis Plugs document severe scaling and pitting of the underground portions of the COR-TEN, though the corrosion had not progressed to the point of creating holes through the metal. Advanced corrosion of the bronze prongs was noted, as was scratched graffiti in both the COR-TEN and bronze. Records show that the Oberlin Plug was treated in 1983, and the Saint Louis Art Museum Plug, removed from display in 1977, received treatment in 1982. The Philadelphia Plug was treated in 1986 by a professional conservator working directly with Lippincott, Inc.

The 1980s treatments of all three sculptures took similar approaches, though they differed in choice of protective coatings. Corrosion products on the below-grade areas of the COR-TEN bodies of each Plug were sandblasted off. A moisture barrier consisting of Densyl tape and mastic (a waxy, petrolatum product formulated for protection of above- and below-ground pipelines) was applied to the below-grade exterior surfaces of the Oberlin Plug. On the Saint Louis Plug, the interior walls of the large central chamber and the bottoms of the side chambers were primed with Carboline Carbomastic 15 aluminum-pigmented epoxy mastic primer and then painted with a topcoat of Carboline Polyclad 936 H561 toned red-brown to cover the silver color of the Carbomastic. Below-grade exterior surfaces were primed with Carboline Carbozinc 11 and painted with Carboline Polyclad 936 H561 toned to approximate the color of the COR-TEN patina. Below-grade portions of the Philadelphia Plug were coated on the exterior only with a Tnemec zinc primer and high-performance epoxy paint.

In treating the bronze prongs, corrosion products on the Oberlin Plug were removed by sanding and polishing by hand. The prongs on the Saint Louis Plug were cleaned by glass bead peening followed by sanding and polishing by hand, then were coated with a spray application of Incralac. The prongs on the Philadelphia Plug had been treated to remove green corrosion in 1984–1985 using formic acid followed by hand polishing, treatment with 2% benzotriazole, and then coating with Acryloid B44. They were treated again in 1986 when the sculpture was treated at Lippincott. According to the conservator, the lacquer was removed with solvents and the prongs were "polished mechanically." At some point in the life of the object, the two inner faces of the prongs were surfaced with a grinder, leaving deep marks in the surface of the bronze.

The original drain holes in all three Plugs were enlarged in the 1980s treatments to provide better water drainage from the interiors. On the Saint Louis Plug, the drain holes were made into rectangular slots to better accommodate variations in positioning of the sculpture. Following treatment, the sculptures were reinstalled outdoors in gravel beds.

After the 1980s treatments, each Plug received periodic maintenance, including surface cleaning and removal of accumulated debris from the interiors. On at least one occasion, the bronze prongs of the Saint Louis Plug were stripped, hand polished, and recoated by museum conservation staff. Because of the manner in which the sculptures are sited, it generally has not been possible to maintain the corrosion-inhibiting coatings on the COR-TEN surfaces (Allen Memorial Art Museum Archives, Saint Louis Art Museum Archives).[2,3]

5. CONDITION BEFORE RECENT TREATMENT

The application of protective coatings retarded corrosion of both the COR-TEN and the bronze components. However, over the 20 years since receiving treatment, the condition of all three sculptures had deteriorated to the extent that the owners again requested thorough condition assessments and conservation treatment.

While the above-ground, exterior portions generally held up well, corrosion of the COR-TEN in areas of the interiors and below-grade level was alarming, with holes occurring through the metal in the Saint Louis and Philadelphia Plugs. The structural integrity of the bronze prongs on the Oberlin and Philadelphia Plugs were compromised by extensive corrosion in the crevices between the prongs and the

COR-TEN body. The bronze prongs on all three sculptures were moderately corroded. Scratched graffiti caused localized damage to both the COR-TEN and the bronze.

Condition reports for all three sculptures noted accumulation of debris in the interior, including mud, leaves, grass, trash, and rocks. Blocked drain holes and standing water inside the sculptures was also reported for each and was the major cause of damage to the Philadelphia and Saint Louis Plugs.

5.1 CONDITION OF PROTECTIVE COATINGS FROM PRIOR CONSERVATION TREATMENTS

Aside from some localized failure, the protective coatings applied to below-grade exterior surfaces in the 1980s had functioned well on all the Three-Way Plugs. However, major deterioration had occurred from the inside out. There was severe corrosion of the COR-TEN due to prolonged contact with moisture, especially from standing water and wet organic debris inside the sculptures.

5.1.1 Oberlin

The coatings on the exterior of the horizontal surfaces below ground were still intact and protective, however corrosion was actively occurring on buried vertical surfaces, where moisture had been allowed to reach. The Densyl tape was detached mainly at and just below the ground line. In some areas, the Denso paste was gone, allowing moisture to reach the surface of the steel.

5.1.2 Saint Louis

While the exterior painted surfaces were generally very well preserved, interior areas had been severely compromised where water continually pooled due to lack of drain holes or where moist earth and organic debris was held in prolonged contact with the COR-TEN. Scattered areas of localized corrosion had occurred on exterior surfaces, with small sites of breakthrough rusting. Some of the corrosion appeared to have occurred where sharp rocks in the gravel bed abraded the sculpture as it settled. The interior of the large central chamber was in excellent condition, with only scattered areas of flaking topcoat over an intact application of Carbomastic 15.

5.1.3 Philadelphia

The paint coatings on the underside were failing and had caused a variety of problems. First, the sculpture had sunk slightly and groundcover had been permitted to grow over the gravel against the COR-TEN surface. Constant moisture contact with the metal had caused aggressive oxidation and pitting in these areas. Paint had been undermined at the edges owing to encroaching oxidation and large areas of blister rust were pushing off the coatings. While most of the aggressive corrosion occurred around the perimeter of the coatings, there were several small areas of blister rust at topographical points and edges. These were probably either natural points of coating failure or where the paint had been abraded during installation or settling.

5.2 CORROSION OF THE COR-TEN

5.2.1 Oberlin

There was blister rust on interior welded seams. The interior of the proper right side chamber suffered severe corrosion and delamination due to debris and water collecting inside it. Blister rust had also occurred on the exterior surfaces near the ground line and on undersides of the side chambers and front end since they were uncoated and subject to contact with organic debris and snow buildup (fig. 9).

Fig. 9. The Allen Memorial Art Museum Plug (Oberlin) after removal of the Densyl tape from the previous conservation treatment (Courtesy of John T. Seyfried, ICA)

5.2.2 Saint Louis

Corrosion on interior surfaces that had resulted from standing water and prolonged moisture was extreme, with scaling and extensive metal loss, as well as holes through the metal in several locations. As noted above, the interior construction of the interface between the side chambers and the side chamber faces is reinforced with angle iron, which created an enclosed space (fig. 7). This space was left unpainted in the 1982 treatment due to its inaccessibility. There was severe scaling on the back side of the steel wall and the interior surface directly below it, resulting in pronounced thinning of the COR-TEN (fig. 10). Several of these areas in particular were found where the bottom of the two side chambers meets the side faces.

Below-ground surfaces of the sculpture showed deep pits and nearly paper-thin metal walls in some areas due to advanced corrosion (figs. 10–12). The heaviest metal loss was along the lower edges of the bottom surface and the proper right side chamber. The corner where the planes of the bottom and the right chamber intersect also had several holes, including a void measuring more than 1.5 in. in diameter. In the area where the proper right side chamber connects to the central chamber, there was severe corrosion for an area of at least 4 square ft., with pronounced areas of delaminating metal. In addition, the area between the front plane of the right side chamber and the interior reinforcing angle iron was actively corroding along a 180º arc. There were holes and extremely thin metal at the bottom of the arc, with corrosion gradually diminishing in severity, moving up along the sides away from the bottom. The same condition was found on the proper left chamber, in the area of a drain hole near the outer lower edge, within the area of reinforcing angle iron. The lower outer edge of the left chamber was severely compromised due to corrosion, with flaking and delaminating metal, for a length of approximately 2 ft. In areas with the most extensive corrosion, there was localized deformation and collapse of the COR-TEN steel structure.

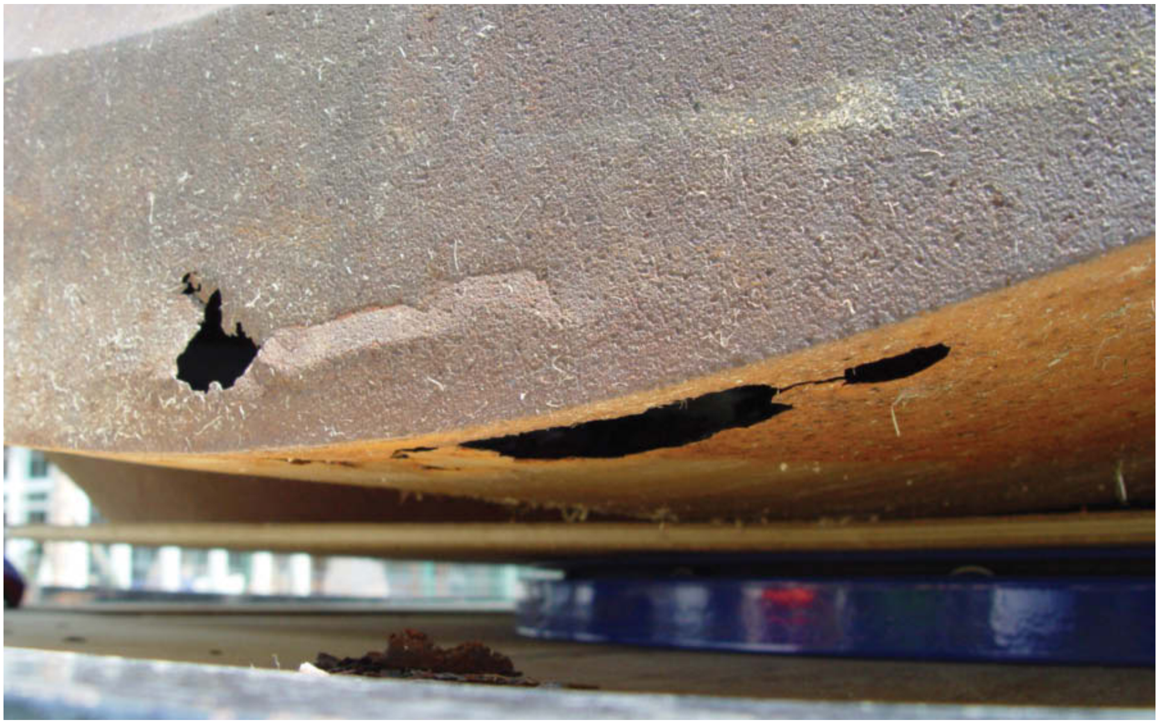


Fig. 10. Severe corrosion at interface between side chamber body and face of the Saint Louis Plug, due to humid micro-environment in the space created by the internal angle iron (Courtesy of Russell-Marti Conservation Services, Inc.)

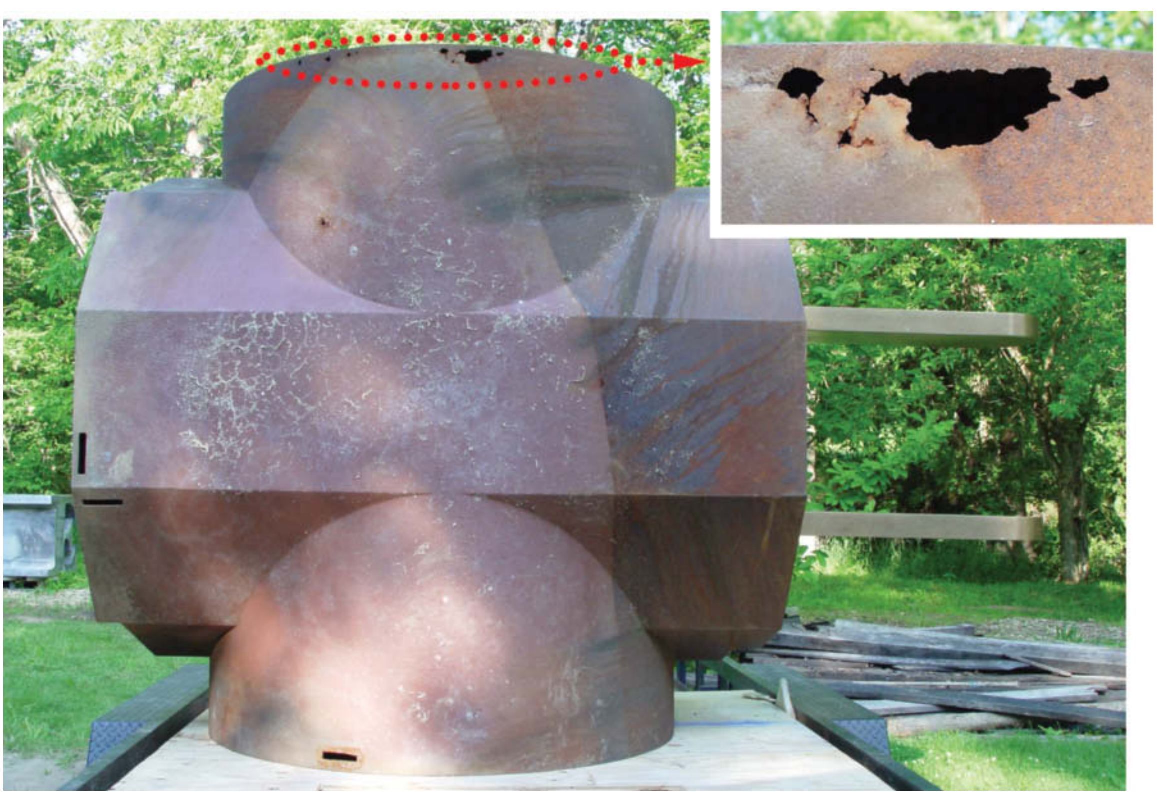


Fig. 11 (left) and Fig. 12 (inset). Severe corrosion along the bottom edge of proper right side chamber of the Saint Louis Plug. The extremely thin metal extended along a 180° arc along the edge of the chamber. (Courtesy of Russell-Marti Conservation Services, Inc.)

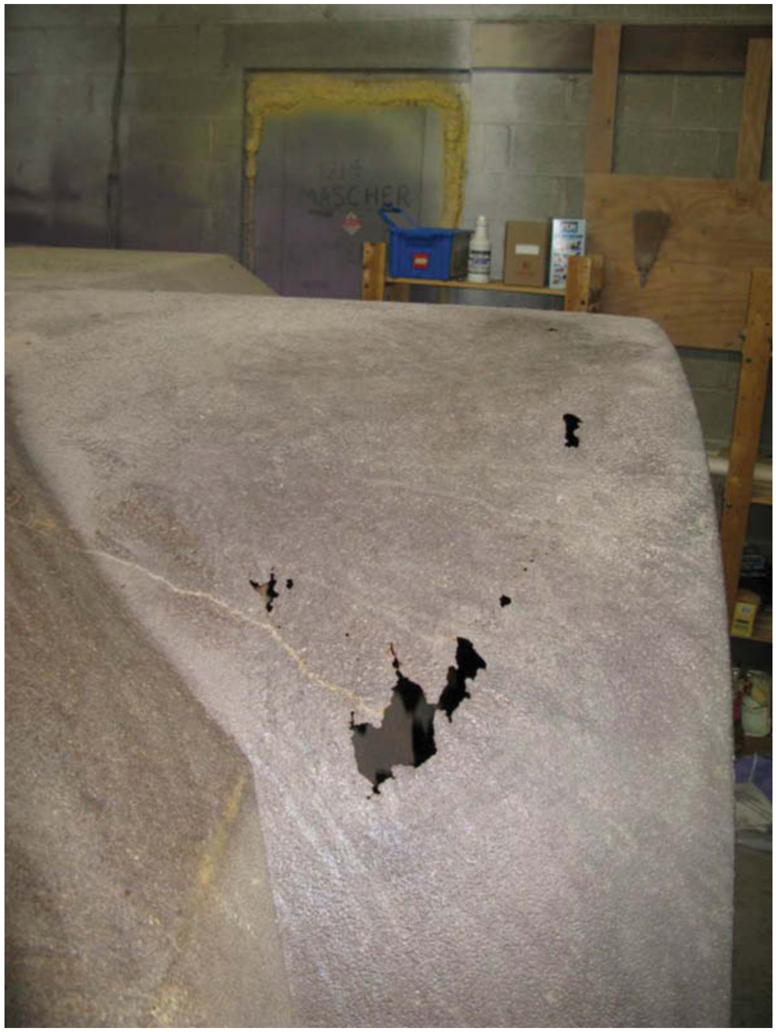


Fig. 13. The Philadelphia Plug showing severe corrosion of the proper left side chamber, due to moisture retention on interior (Courtesy of Materials Conservation, Philadelphia, PA)

5.2.3 Philadelphia

There was considerable interior corrosion with several holes above the gravel line on the underside of the proper left chamber (fig. 13). The wall of the sculpture was severely thinned in this area, with much of the compromised metal averaging less than .030 in. thick. Two small holes had corroded through beneath the gravel line as well. The bulk of the damage in the proper left chamber was caused by damp plant matter sitting against interior surfaces, clogging weep holes, and rusting through from the interior. The two small holes on the underside were probably points of coating failure, as they appeared to have corroded from the outside.

5.3 CORROSION OF THE BRONZE PRONGS

The protective lacquer coating on the bronze prongs was failing on all three sculptures due to a combination of weathering and handling by the public. On the Oberlin Plug, the coating on the bronze prongs was scratched and abraded, allowing a semitransparent film of blue–green copper corrosion products to form over much of the surface (fig. 14). General weathering of the Incralac on the Saint

Fig. 14. The bronze prongs of the Oberlin Plug with corrosion in scratches and graffiti as well corrosion related to general weathering of the protective coating (Courtesy of John T. Seyfried, ICA)

Louis Plug resulted in heavy tarnishing of the bronze in tide lines of water droplets and scattered dark spots of tarnish. On the Philadelphia Plug, weathering reinforced and outlined brush marks where corrosion occurred in the striations of thinner lacquer. The prongs on the Oberlin and Saint Louis Plugs had deeper scratches and graffiti in the bronze caused by vandals (fig. 14).

5.4 CORROSION AT CONNECTION OF THE PRONGS TO THE BODY OF THE PLUG

Corrosion in the narrow joints between the bronze prongs and the COR-TEN body was present on all of the sculptures. However, while a considerable amount of active corrosion had occurred in these areas on the Saint Louis Plug, it was not nearly as severe as that on the Oberlin and Philadelphia Plugs. On those, corrosion products were exerting tremendous pressure on the bronze prongs, causing them to bow inward by as much as ½ in. (fig. 15) and to crack along their seams (fig 16).

Several seams on the prongs of the Oberlin Plug were cracked, allowing moisture to enter the hollow structures. On the Philadelphia Plug, the pressure was such that one of the prongs cracked in two places (fig. 16).

Difference in installation angle could account for the varying condition of the prongs among the sculptures. The Oberlin and Philadelphia Plugs were more steeply angled than the Saint Louis Plug (as installed in 1982), likely allowing for longer moisture retention and accelerated corrosion in the joints between the COR-TEN and the bronze. Another factor leading to increased corrosion around the prongs could be lack of air circulation. The Saint Louis Plug was most recently sited in an open, unshaded area that was relatively dry. The Philadelphia Plug, on the other hand, was under tree cover and surrounded by plantings in its original installation at the Pincus residence. This environment led to more consistently

Fig. 15. Inward bowing of the bronze prongs on the Oberlin Plug due to expansion of iron corrosion products in the gap between the bronze and the COR-TEN steel (Courtesy of John T. Seyfried, ICA)

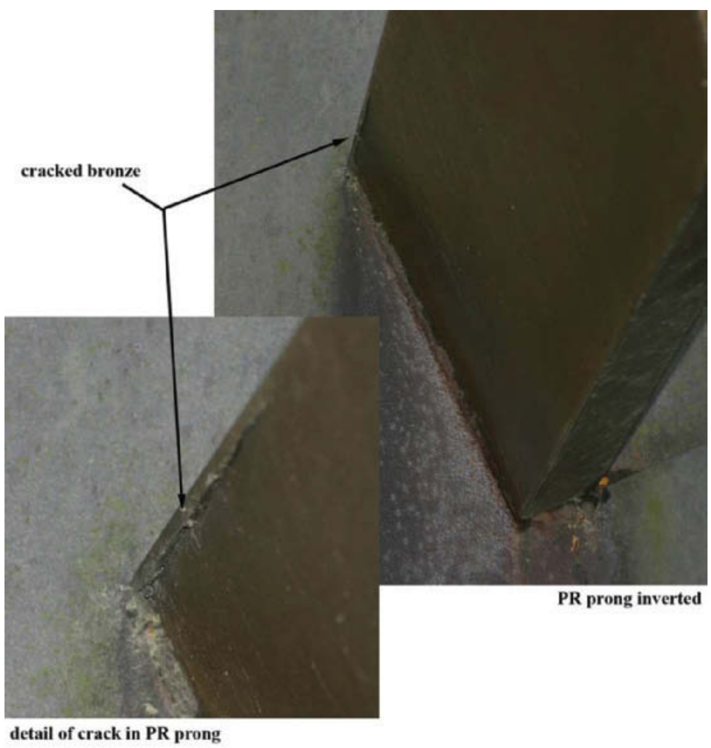


Fig. 16. Detail of expansive iron corrosion products in the gap between the bronze prongs and the COR-TEN body on the Philadelphia Plug. The pressure from the expanding rust in the gap between the bronze and the COR-TEN was so extensive that both prongs had deformed and one had cracked along its welded seams in two places. (Courtesy of Materials Conservation, Philadelphia, PA)

damp conditions for several months of the year, made evident by biological growth on the surface of the sculpture.

5.5 GRAFFITI

Graffiti scratched into both the COR-TEN and the bronze was a problem on the Oberlin and the Saint Louis sculptures. Graffiti has not been a problem on the Philadelphia Plug due to its having been in a private collection for most of its existence. In its new location in the PMA sculpture garden, however, the sculpture is frequently climbed on, leading to significant wear on the prong coating.

6. RECENT CONSERVATION TREATMENT

As with the treatments carried out in the 1980s, the recent conservation treatments of the three sculptures shared a number of similarities, though, also as before, they differed in choice of materials and methods.

All three sculptures were removed from their installations and taken to off-site conservation facilities for treatment. Once deteriorated coatings were removed and corrosion products cleaned off areas to be recoated, new protective coatings were applied. Steps were also taken to improve water drainage. In addition to the surface treatment of the COR-TEN body, the Oberlin and Philadelphia Plugs required extensive repairs related to deformation of the prongs caused by rust expansion, as described below. The Saint Louis and Philadelphia Plugs had deteriorated to such an extent that partial replacement of the COR-TEN body was warranted.

6.1 REMOVAL OF DETERIORATED COATINGS AND LOOSE CORROSION PRODUCTS, CLEANING OF THE INTERIOR CHAMBERS

6.1.1 Oberlin

The Densyl tape and mastic from the 1983 treatment were removed by scraping with wood and plastic tools. Remaining residues were removed with mineral spirits, agitated with scrub brushes. Finally, the surfaces were degreased with acetone.

6.1.2 Saint Louis

A methylene chloride-based paint stripper was used on lower exterior surfaces to remove the Carboline Polyclad 936 H561 topcoat applied in 1982. The loosened paint was then removed with pressurized water. The topcoat sloughed off while the Carbozinc primer remained adhered to the surface; it was removed later by blasting just prior to application of a new paint system, described below.

Pressurized water was also used on the interior of the central chamber to remove areas of peeling, loosened paint, revealing the intact layer of Carboline Carbomastic 15 aluminum epoxy primer below.

6.1.3 Philadelphia

The perimeter of the previous paint coatings applied to below-grade areas of the underside was masked, and the paint blasted off with 46-grit aluminum oxide using 40 psi average pressure and a stand-off distance of 8–14 in.

6.1.4 Cleaning of Interior Chambers

For all three sculptures, the interior cavities were cleaned out by hand with brushes on extension poles, and vacuumed to remove gravel, dirt, debris, and leaves.

6.2 STRUCTURAL REPAIRS TO THE COR-TEN BODY

As noted above, corrosion had progressed to such an extent on the Saint Louis and Philadelphia Plugs that substantial areas of COR-TEN were severely compromised, having developed extremely thin passages and holes. To ensure structural stability, these sections of deteriorated metal were removed and replaced.

6.2.1 Saint Louis

Three degraded sections were replaced: the complete lower half of the cylinder behind the proper right face; a 3.5-ft. section of the lower outer rim of the proper right face; and a 24-in. section from the lower rim of the proper left face, where the face meets the cylinder.

After making a paper pattern for each section to be replaced (fig. 17), the degraded areas were precisely cut with a plasma cutter and removed.

A new piece of 1/8-in. thick COR-TEN was purchased from a commercial distributor. For the cylinder repair, the steel was rolled to the proper degree of curvature on a metal roller (fig. 18). The replacement piece was cut out using the paper pattern as a guide, and then was clamped to the sculpture and tack welded in place (fig. 19). A smaller section of the rolled COR-TEN was used to replace the

Fig. 17. The Saint Louis Plug, prior to reconstruction of the bottom half of the proper right side chamber, which had been severely compromised due to corrosion on the interior. A paper template is being made of the section to be replaced. (Courtesy of Russell-Marti Conservation Services, Inc.)

Fig. 18. Rolling the new section of COR-TEN steel to the exact curvature of the original (Courtesy of Russell-Marti Conservation Services, Inc.)

Fig. 19. New sections of COR-TEN steel tack welded in position on the Saint Louis Plug (Courtesy of Russell-Marti Conservation Services, Inc.)

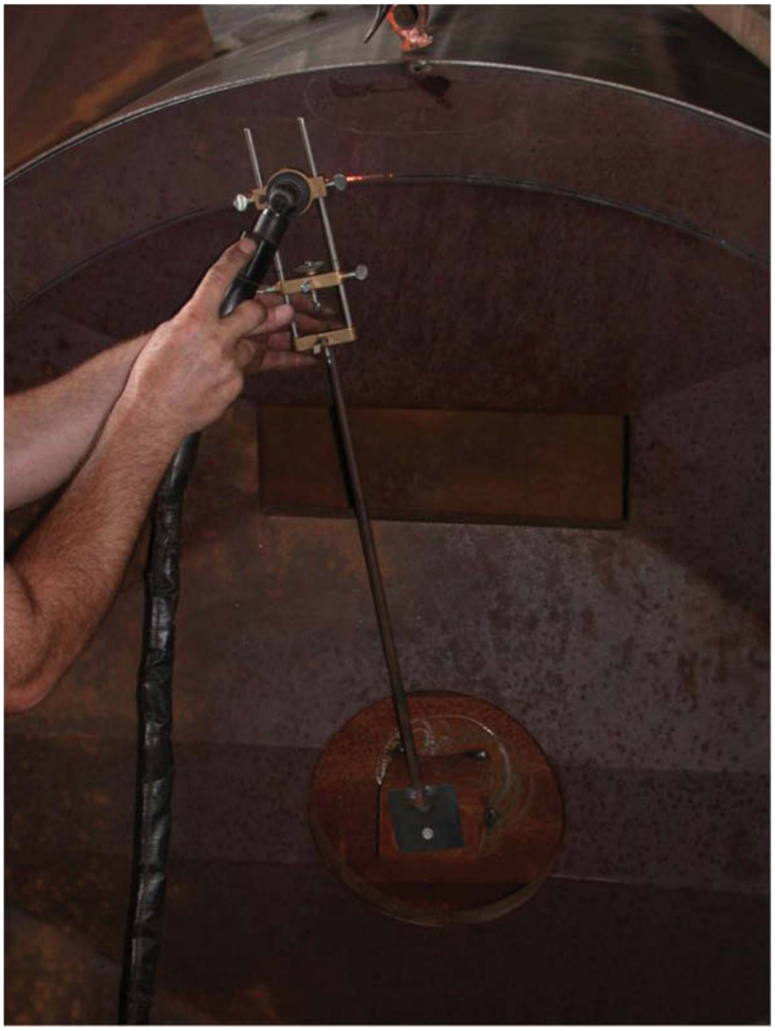


Fig. 20. Using a custom jig—a radius swing arm—to precisely cut away a degraded section of COR-TEN on the Saint Louis Plug (Courtesy of Russell-Marti Conservation Services, Inc.)

bottom section of the drum adjacent to the proper left face. Deteriorated metal from the outer edges of the proper right and left faces was precisely cut out using a custom jig (a radius arm) and a plasma cutter (fig. 20). New sections of COR-TEN were cut out and fitted, and then tack welded in place. After all the new sections were tack welded in position, they were welded with continuous seams. ER70S-6 welding wire was used throughout. Once the structural repairs were finished, the welds were ground smooth and chased to blend with the surrounding metal and to follow the surface planes and edges of the sculpture. The new COR-TEN replacement sections were also textured to match the pitted, weathered surfaces of the surrounding metal.

6.2.2 Philadelphia

The underside of the proper left outlet was rusted through in several areas and the intact areas were too thin to weld properly. In order to ensure structural integrity to the area, the minimum amount of deteriorated metal was cut away. A new piece of ⅛-in. COR-TEN was rolled to give a 58-in. diameter curvature. A paper template was made, and the new piece was cut to shape with an angle grinder and TIG-welded in place using 3/32-in. WB6512 filler rod (fig. 21). WB6512 is certified by the manufacturer to be compatible with COR-TEN and weather appropriately.

Fig. 21. The new COR-TEN patch on the Philadelphia Plug, prior to final texturing (Courtesy of Materials Conservation, Philadelphia, PA)

Weld lines on the exterior were ground smooth with an angle grinder to reintegrate the surface. The mill scale was ground off the exterior of the new metal patch to promote patination, and the surface was "pecked" with a rotary burr to simulate the fine, localized pitting of the surrounding metal.

6.3 ADDITIONAL METAL WORK

6.3.1 Oberlin

An existing drainage hole on the bottom of the proper right chamber was enlarged by cutting with an oxy/acetylene torch. The interior of this section was heavily corroded, but not deemed severe enough to warrant replacement.

6.3.2 Saint Louis

As degraded steel sections were removed during structural work on the COR-TEN body, underlying interior surfaces were exposed for further examination and treatment. Corrosion products were removed using a wire brush wheel on a handheld air tool.

Extensive corrosion had taken place in the cylinder behind the proper right face as a result of standing water that accumulated due to the fact that there were no drain holes in this area. To ameliorate this issue, three rectangular drain holes were cut using a plasma cutting torch into the inside wall of the central chamber, adjacent to the lowest area of the cylinder behind the proper right face. Three rectangular slots were made instead of one long cut to keep the heat at a minimum to avoid warping of the metal, as well as to maintain the structural integrity of that area.

6.4 SURFACE PREPARATION AND APPLICATION OF PROTECTIVE COATINGS ON THE COR-TEN: EXTERIOR SURFACES

For all three Plugs, surfaces that were to be in contact with the ground were cleaned and given protective coatings.

6.4.1 Oberlin

The portion of the steel to be recoated was brush blasted with 125–250 micron glass beads to remove flash rusting that occurred after the coatings were removed, and to remove any loose rust particles.

Two coats of Carboline Carbomastic 15 aluminum-filled epoxy primer were applied (fig. 22), followed by two coats of Carboguard 890 epoxy tinted to FS color standard 10080 (fig. 23). Although the COR-TEN steel patina is quite variable in color, this was chosen to be as close a match as possible using a single color. The aluminum-filled primer is suitable for application over minimally prepared surfaces and has excellent barrier protection provided by the aluminum flakes. The epoxy topcoat has excellent abrasion resistance and performs well in an immersion environment, although it will chalk in sunlight. The decision was made to prioritize underground performance over above-ground appearance, since only a few inches at most will be visible. After five years of exposure, the color has faded to a light tan, which coincidentally matches the color of the river gravel surrounding it. In retrospect, a UV resistant topcoat, at least above ground, may have been desirable.

Fig. 22. The Oberlin Plug after application of the Carboline Carbomastic 15 aluminum-filled epoxy primer. The Plug is inverted in this image. (Courtesy of John T. Seyfried, ICA)

Fig. 23. The Oberlin Plug after application of the Carboline Carboguard 890 epoxy topcoat (Courtesy of John T. Seyfried, ICA)

6.4.2 Saint Louis

The area to be in contact with the ground was isolated using plastic and tape, and was sand blasted with silica sand 4010 to remove all traces of old paint and primer, corrosion products, and to give the surface "tooth."

The surfaces were painted with Carboline Carbozinc 11 primer and a topcoat of Carboline Carbothane 133 HB applied by spray. The painting was carried out soon after the abrasive cleaning, per the manufacturer's instructions. The Carbozinc 11 primer, also used in the 1982 treatment, was chosen again as it afforded excellent protection to the metal. Carbozinc 11 is 85%–90% zinc solids in an inorganic silicate binder, offering galvanic protection to the steel.

Different from the 1982 treatment is the use of Carbothane 133 HB, an acrylic-polyester polyurethane topcoat recommended by Carboline as a long-lasting, abrasion-resistant coating. The color of the Carbothane topcoat was selected to approximate the general color of the COR-TEN corrosion products. Although most of the painted portion is to be buried, several inches of painted surface are visible above ground, hence the effort to make the paint visually unobtrusive.

Because of major construction related to a multiyear expansion project that has been taking place at the Saint Louis Art Museum, the Three-Way Plug has not yet been reinstalled. The sculpture has been stored outdoors at Russell-Marti Conservation Services, affording the benefit of observation and review of the treatment by the conservators.

It has been several years since the sculpture was painted. The coating system is holding up well in the outdoor environment. There is no apparent deterioration of the paint, and the topcoat retains its gloss. While this is encouraging, in discussing the treatment with colleagues, the issue was raised as to whether urethanes will provide sufficient abrasion resistance in a below-grade, semi-immersion environment. Even though the system had been recommended by Carboline, the company was contacted again to review the treatment. The technical service engineer responded that the Carbozinc 11/ Carbothane 133HB combination is an excellent system for UV environments (above ground), as well as a good one in a burial or immersion environment. However, the engineer thought that a better system for the Three-Way Plug would have been Carbozinc 11 primer with Carboguard 890 epoxy, followed by a Carbothane 133HB topcoat. This recommendation was made because the Carboguard has higher abrasion resistance and better performance in an immersion environment. Since the Carbothane 133HB had already been applied, the engineer recommended that Carboguard 890 be applied over it. This recommendation will be implemented, followed up with a final coat of Carbothane 133HB over the portion of the painted area that will be visible above ground.

6.4.3 Philadelphia

Surface preparation of the COR-TEN occurred during the removal of the paint, as described above, by blasting with 46-grit aluminum oxide. Immediately after blasting, the surface of the area to be installed below grade was primed with Tnemec Series 90-97 Tneme-Zinc moisture cured high zinc solids urethane primer. After this had cured, more was applied selectively to assure full coverage. The day after the final application of the primer, the area was remasked and coated with two applications of Tnemec Series 27 high-performance epoxy paint in a dark brown color (Campfire Coffee).

Once the Series 27 had hardened, areas of deep pitting were filled with successive applications of Tnemec 63-1500 Epoxy Filler and Surfacer. When the 63-1500 cured, it was sanded and another layer of Series 27 was applied as a topcoat. Since the painted surface was at and below grade, a UV protective coating of acrylic polyurethane was unnecessary.

The Tnemec coatings were chosen again for the Philadelphia Plug because these systems have a proven record in immersion situations and had there been adequate maintenance, treatment in 2010 would have been minimal. Only two small areas of rust could have developed as a result of coating failure—possibly from abrasion in resiting the sculpture.

6.5 APPLICATION OF PROTECTIVE COATINGS ON THE INTERIOR OF THE CHAMBERS

Because viewers are beckoned to peer inside the Three-Way Plugs through their various holes and slots, the issue of applying coatings to the interior chambers was carefully addressed by the conservators and stewards of all three Plugs.

6.5.1 Oberlin

Interior surfaces were thickly coated with Ship-2-Shore Industrial corrosion inhibitor, a petroleum-based gel with “oxygen scavengers” that has impressive field results. The Ship-2-Shore was thoroughly applied to every interior surface of the central chamber using flexible spray hoses and brushes on extension poles. The two side chambers were coated only on the lower surfaces where water is prone to pooling. The exterior of the central chamber was left uncoated, since it is clearly visible through the two side chambers and is considered a presentation surface.

6.5.2 Saint Louis

For the Saint Louis Plug, the issue of whether or not to coat interior chambers had already been resolved in the 1982 treatment when a number of interior surfaces were painted with Carboline Carbomastic 15 aluminum-filled epoxy primer. Since the paint had provided considerable protection (where standing water was not an issue), and since the partially painted appearance is already accepted for this edition, those surfaces were once again painted. The “floor” sections of the two side chambers, where standing water is a problem, were painted, including the lowest plane of the exterior of the central chamber. The other faces of the central chamber visible through the openings in the side chambers were left uncoated, as the COR-TEN corrosion products were stable and visually pleasing in these areas, and as mentioned above, these are considered presentation surfaces.

The Carbomastic 15 primer applied in 1982 to the interior of the large central chamber remained in excellent condition, even after the interior was cleaned with pressurized water. New Carbomastic 15 was applied to the area where the three new drainage slots were made, and along the weld that attached the new section of drum. An exterior-grade latex paint was applied to all interior surfaces of the central chamber to match the red-brown paint that was applied in 1982, using an extension pole to gain access to hard-to-reach areas.

Different from the 1982 treatment, the semi-enclosed space created by the circular interior angle reinforcement behind the right and left circular faces was also coated with the Carbomastic 15 aluminum-filled primer. The paint was applied to rags, with which one could reach in through the slots and gain access to the angle iron and adjacent COR-TEN body.

6.5.3 Philadelphia

The PMA chose not to coat the interior of their Three-Way Plug. After much discussion and consideration of several options, it was decided that the sculpture should be examined frequently and maintained as needed. To that end, the sculpture is examined weekly by a member of conservation and/or a member of the gallery maintenance staff.

6.6 PRONGS—REMOVAL OF CORROSION PRODUCTS AT JOINT BETWEEN PRONGS AND BODY OF THE PLUG, REPAIRS TO PRONGS

6.6.1 Oberlin

The crevices between the bronze and the COR-TEN were excavated with grinding wheels, drill bits, and chisels to remove as much impacted rust as possible and allow the bronze to return closer to its original position. The cracks in the seams of the bronze were repaired by TIG welding with silicon bronze rod. The weld joint was sanded smooth with a 100-grit sanding disc on an angle grinder, followed by 150 grit.

Complete removal of the prongs was considered as an option to allow for an alternative method of attachment that would isolate the bronze from the steel, preventing further galvanic corrosion, however this was rejected as overly intrusive and unnecessary. Sealing the crevice with silicone caulk was also considered but rejected. While it could initially prevent any moisture from entering the crevice, failure of the caulk joint would allow moisture in, but prevent drying, resulting in increased rate of corrosion. Furthermore, technical advice from Dow Corning on applying their silicone sealants on weathering steel indicated surface preparation of SSPC-SPC10 (near white blast cleaning) followed by a corrosion inhibiting coating such as an inorganic zinc primer. This kind of surface preparation was not possible, given the location of the joint to be sealed. Since the museum was unlikely to be able to provide adequate routine examination and maintenance to address future rust buildup, Ship-2-Shore was applied to the surface of the metal to inhibit corrosion, while allowing the gap to remain open to facilitate drying.

6.6.2 Saint Louis

The corrosion products in the gap between the bronze prongs and the COR-TEN were removed as much as possible using thin knife blades. While there was slight bowing along one of the prongs due to the expansive pressure of the rust, there was no damage to the welded seams on the prongs. A program of periodic monitoring and maintenance is recommended to keep the buildup of rust in the crevices to a minimum.

6.6.3 Philadelphia

The bulk rust in the slots next to the prongs was cleared mechanically. The adjacent prong face and COR-TEN Plug surface were protected with thin sheet metal and initial plunge cuts were made with a Fein Multimaster and metal cutting blades. The rust was then mechanically removed with hand tools. Removing the prongs and treating the join areas directly were considered. However, they are brazed to the adjacent COR-TEN and to angle iron on the interior, which is inaccessible without taking the sculpture apart and then cutting apart structural elements on the interior—an approach that was considered unnecessarily aggressive.

Once the gaps next to the prongs were cleared of rust, the cavity was thought to be open enough to permit adequate drying. Use of corrosion inhibitors was deemed unnecessary but can easily be employed in the future if the need arises.

Where the prongs had been crushed by encroaching rust, a hole was drilled and tapped to ¼-20 in. A long bolt was threaded in until it pressed against the opposite side, pushing the deflected metal back into its proper position (fig. 24). This area was then slightly v-grooved and TIG welded with silicon bronze welding rod. The tapped hole was TIG welded, then both areas were ground smooth and mechanically finished to match the polish of the adjacent metal (figs. 24, 25).

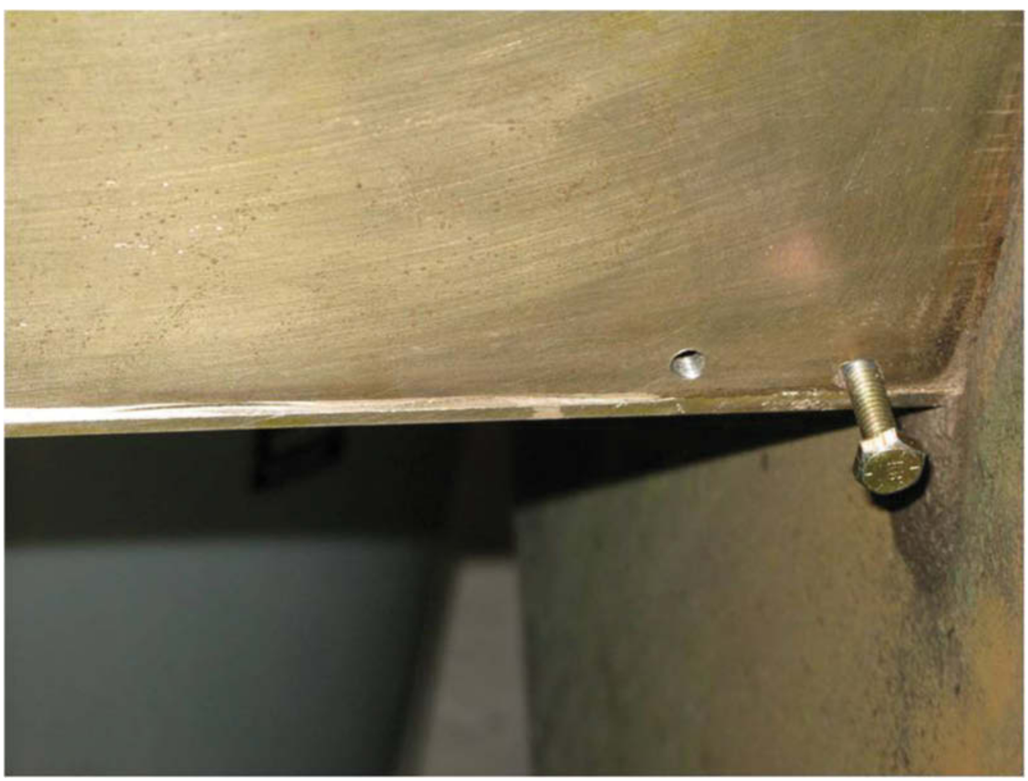


Fig. 24. Pushing the deflected side plane of the prong back into position using a threaded bolt inserted into temporary, tapped holes (Courtesy of Materials Conservation, Philadelphia, PA)

Fig. 25. After welding the split seams on the prong (top and bottom edges). The weld has been ground smooth and the metal is being finished to match the polished surface of the prong. (Courtesy of Materials Conservation, Philadelphia, PA)

6.7 PRONGS—SURFACE TREATMENT OF THE BRONZE

6.7.1 Oberlin

The prongs were stripped of old lacquer coatings with 3M Safest Stripper and cleaned with ethanol to remove residues. The bronze was sanded to remove corrosion and the most blatant graffiti. The goal was not to completely remove all scratches, but to reduce the most noticeable writing to present a well-worn but not vandalized surface. Sanding was done with orbital and rotary sanders using 220-grit to 600-grit silicon carbide abrasive paper. The highly regular swirl pattern from the rotary sander was removed by hand sanding with 600-grit wet abrasive paper in a semi-random pattern, and the metal was thoroughly degreased with acetone.

Two coats of Permalac lacquer were applied by HVLP spray equipment, followed by two additional coats of two-part Permalac 2K, again spray applied. A final coating of microcrystalline paste wax was applied as a sacrificial layer over the lacquers.

6.7.2 Saint Louis

The deteriorated Incralac coating on the surface of the prongs was stripped using acetone applied with small hand garden pump sprayers and cleared with paper towels. After the prongs were cleaned of the old coating, the bronze surface was polished with successive grades of silicon carbide abrasive paper (3M Wetordry Paper Sheet 431Q, 320, 400, and 600 grit) to remove corrosion products and reduce scratches in the metal, and to bring the prongs to a more uniform finish. The prongs were washed with water and a nonionic surfactant and rinsed with water. Several coats of Permalac lacquer were spray applied.

6.7.3 Philadelphia

Old lacquer was removed with successive applications of xylol and acetone, and oxides were removed locally using 3% sulfuric acid in distilled water cleared with successive applications of distilled water. After selectively sanding with 400-grit followed by 600-grit abrasive paper, the surface was degreased with acetone and relacquered with two brush applications of Incralac.

6.8 ADDRESSING ISSUES OF COR-TEN CORROSION DEVELOPMENT/PATINA

6.8.1 Oberlin

One of the main concerns of the museum before the recent treatment was the streaked and pitted COR-TEN surface. Walnut shell blast media was tested to see if it could reduce irregularities and create a more uniform appearance. Test areas on the underside produced a uniform medium brown color, somewhat more matte than the existing patina. The appearance of dark pits and rusty streaks from water run-off was reduced. After this initial success, two areas on the front face were also blasted, with equally good results. However, after several cycles of wetting and drying, rusty streaks following the blast pattern began to appear. It was discovered that the blast pot was contaminated with glass bead media, which was more aggressive than the walnut shell. The blast pot was thoroughly cleaned out and refilled with new walnut shell, and the rest of the surface was blasted, keeping the nozzle 12–14 in. from the surface and maintaining an even speed without stopping. This produced a uniform appearance on all but the front face, where the blast pattern began to show up again as distinct lines and spots of freshly rusted metal. The patina was observed periodically over the subsequent four years, and it did not even out naturally (fig. 26).

Fig. 26. The Oberlin Plug, in situ, during development of the patina on the front face of the Plug. The mottled surface is the result of contaminated blast media, which resulted in an irregular cleaning pattern. (Courtesy of Mark Erdmann, ICA)

Fig. 27. The Oberlin Plug after further surface work to integrate the patina on the front face (Courtesy of Mark Erdmann, ICA)

In the fall of 2012 the front face was rubbed down by hand with type-A very fine Scotch-Brite pad. This improved the appearance of uniformity to some extent, however the areas that appeared as a "younger" patina had a rough surface compared to the older looking patina, which was quite smooth. In March 2013, the rough patches were sanded with 320-grit silicon carbide abrasive paper on an orbital sander, then rinsed with water. The results so far are encouraging and show signs of returning to the appearance of a naturally aged COR-TEN patina (fig. 27). The original goal of creating a more uniform appearance was not achieved however, as naturally occurring pitting and streaking reappeared within one year. For this reason, selective abrasive blasting cannot be recommended for the treatment of COR-TEN sculpture unless a particular point in time is otherwise preserved by clear coating—something clearly not desirable in this case.

6.8.2 Saint Louis

After the structural repairs to the COR-TEN body were completed, added elements were finished and textured.

The new metal, welds, and portions adjoining the welded areas were sandblasted with silica sand (4010) to remove traces of mill scale and to bring those areas to a clean, uniform surface. The cleaned metal was given a light spray application of dilute ferric nitrate to more quickly bring the steel to a more uniform corroded appearance. The surface was then washed with water and a nonionic surfactant and thoroughly rinsed with water. Over periods of time, the metal was wetted with applications of water and allowed to dry in between wetting.

It is inherently difficult to reintegrate disruptions in a well-developed weathering steel patina. Development of the COR-TEN corrosion to match the older, developed patina is progressing very slowly on the Saint Louis Plug (fig. 28). This might be due to the fact that the initial application of ferric nitrate passivated the steel somewhat, thus slowing further corrosion. In hindsight, this step likely should not have

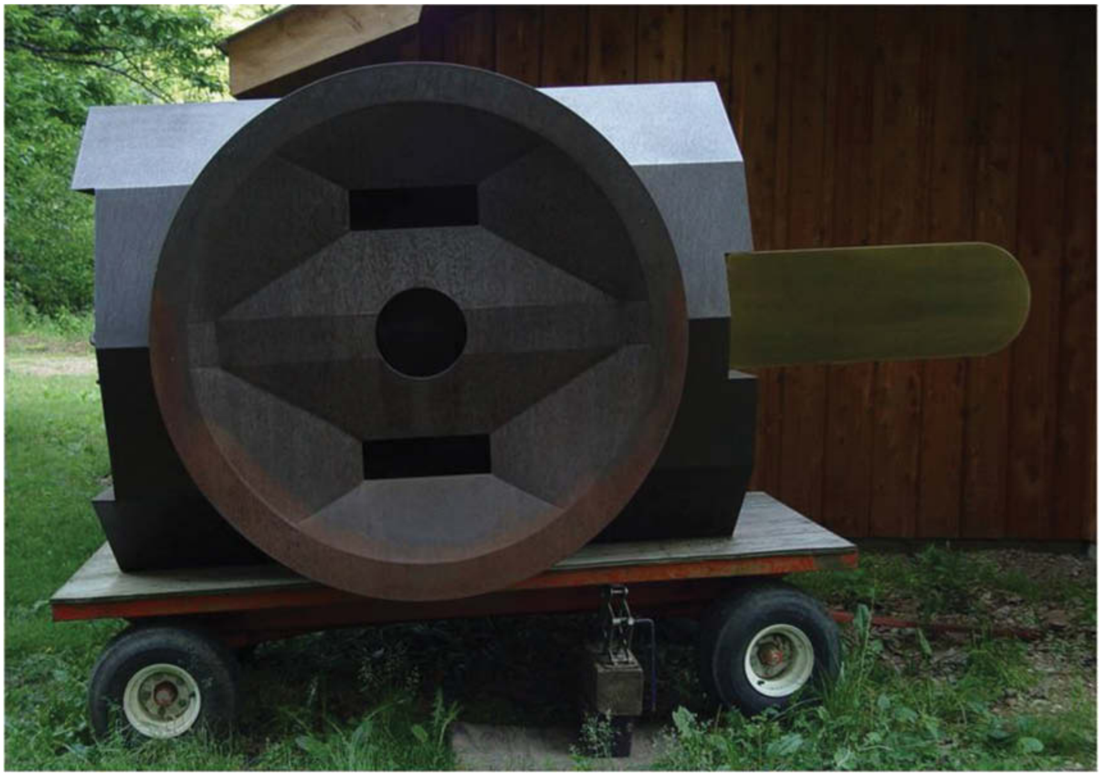


Fig. 28. The proper right face of the Saint Louis Plug, with development of the weathered patina in the areas of replaced metal and areas immediately adjacent (Courtesy of Russell-Marti Conservation Services, Inc.)

been carried out, and the steel should have been left to corrode naturally. The slow development of a weathered appearance may also be due to the fact that the sculpture is currently in a rural environment with little or no air pollution, which would affect the corrosion development differently than would an urban environment.

6.8.3 Philadelphia

As noted above, the surface of the new section of COR-TEN was ground free of mill scale before texturizing to promote patination. The surface was then sprayed six times over two days with acetic acid, allowing the surface to dry between applications. It was then sprayed with tap water daily for several weeks. When the sculpture left the Milner+Carr Conservation studio, there was an even medium orange-colored layer of rust on the surface. This approach served to accelerate the natural corrosion of the material rather than artificially patinate the surface (fig. 29).

6.9 RESITING

6.9.1 Oberlin

Prior to resiting the Three-Way Plug, extensive research was done into the use of cathodic protection. The soil was tested, and a corrosion control engineer was consulted to design a system of passive cathodic protection using two magnesium anodes. It included a test point for making yearly measurements of current to monitor effectiveness and predict the useful lifespan of the anodes. The system was ultimately rejected due to budget constraints.

The site was prepared with a French drain, which is a gravel-filled trench with a perforated drain pipe to redirect water away from an area. The site is on a hillside, which enables water to drain out of the gravel pit. The location and angle of the Plug remained the same as the placement prior to treatment (fig. 30).

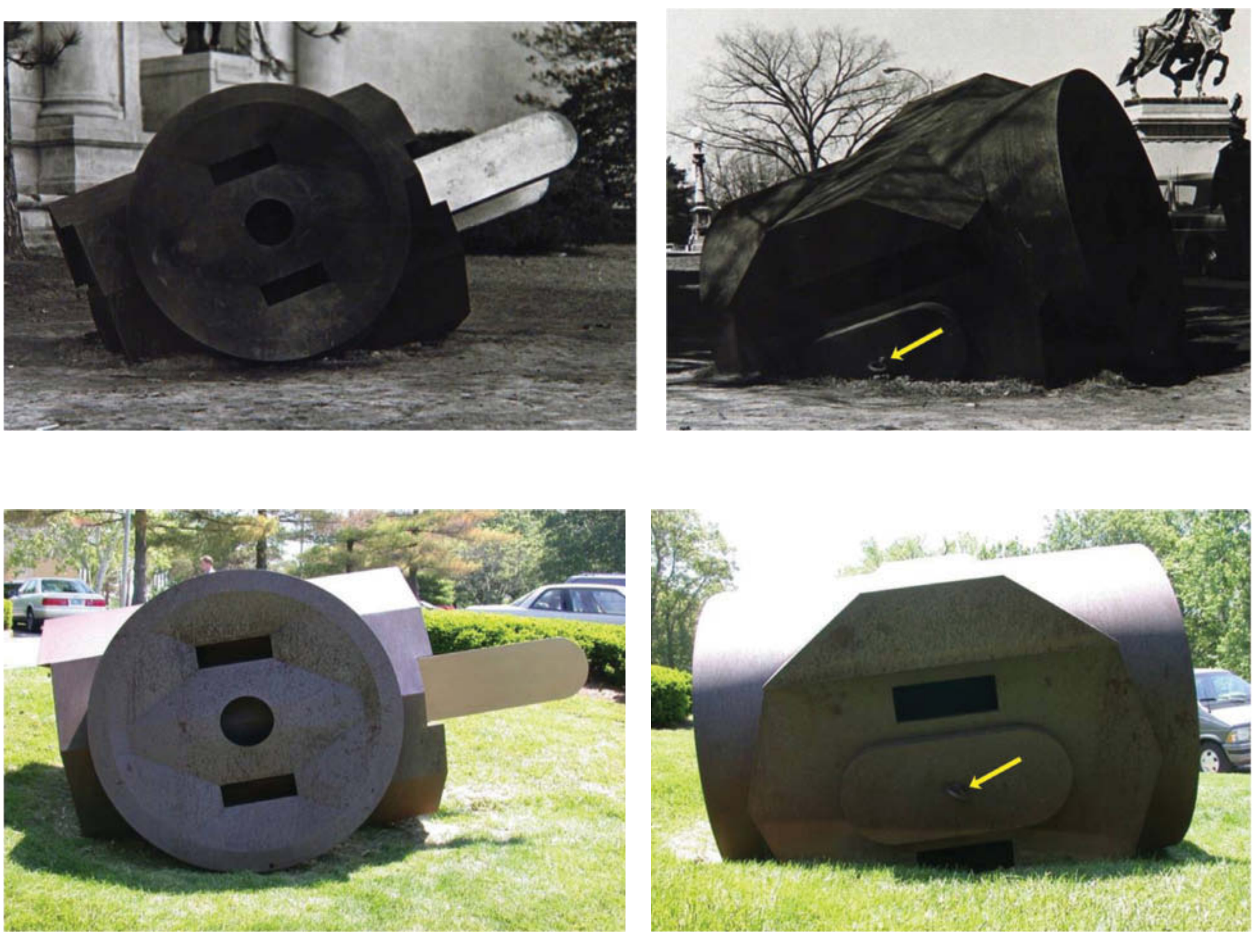
Fig. 29. Natural patina development on the new section of COR-TEN B on the Philadelphia Plug (Courtesy of Materials Conservation, Philadelphia, PA)

Fig. 30. Reinstallation of the Oberlin Plug at the Allen Memorial Art Museum (Courtesy of John T. Seyfried, ICA)

6.9.2 Saint Louis

As noted above, the Saint Louis Plug has not yet been reinstalled because the Saint Louis Art Museum has been undergoing a major expansion for the past several years, with extensive construction projects on the grounds. Plans for reinstallation are currently under discussion with the museum's conservation staff.

Several issues are under consideration regarding the reinstallation. A major concern is the angle of installation. A comparison of photographs from the 1971 and 1982 installations (figs. 31–34) shows that in 1971, the sculpture was angled more sharply upwards and was buried more deeply in the ground. Since the artist was present at the original installation and guided its positioning, there is a strong case to reinstall the sculpture as it originally was. In comparison, the 1982 siting was quite timid—not buried as deeply and at a less dramatic angle—though perhaps better for the sculpture in terms of long-term preservation. Should a more original positioning be chosen, additional work will need to be carried out on the body of the COR-TEN to apply the protective coatings over a greater portion of the metal.



Figs. 31–34. Clockwise, from upper left: Fig. 31. Saint Louis Plug, original 1971 installation, proper right side; Fig. 32. 1971 installation, back and proper right sides; Fig. 33. Saint Louis Plug, 1982 installation, back; Fig. 34. 1982 installation, proper right side. Arrows in figs. 32 and 33 indicate eye bolt in back, as reference for comparing burial depth (Figs. 31 and 32 courtesy of the Saint Louis Art Museum, figs. 33 and 34 courtesy of Russell-Marti Conservation Services, Inc.)

As with the Oberlin Plug, cathodic protection is being explored for the underground portions of the sculpture. When the final site is selected, this subject will be taken up again with a corrosion engineer.

Regardless of positioning or whether the sculpture will receive cathodic protection, the issue of site drainage is of primary importance in the longevity of the treatment. The optimum shape and size of the bedding material is being researched to allow maximum water drainage as well as minimal abrasion to the COR-TEN during the inevitable shifting that will occur in the ground.

6.9.3 Philadelphia

Several options were discussed for the reinstallation of the Philadelphia Plug, ranging from building elaborate mounts to simply reinstalling it in a bed of gravel. The advantages to mounting the object, like proper elevation and attitude being ensured without the inevitable settling into the gravel, that an air space could be created beneath the object, etc., were outweighed by the significant additional cost, possible coating failure and crevice corrosion at contact points, and the genuine uncertainty as to whether anything would be gained by the effort. When the Three-Way Plug was reinstalled in its new location in the Anne d'Harnoncourt Memorial Sculpture Garden, it was placed in a 4-ft.-deep bed of gravel (fig. 35).

The installation angle of the Philadelphia Plug has changed over its three installations. Between its original installation and the first conservation treatment in 1986, the object had settled backward and toward the proper right. Evidence of this was the location of the coatings on the

Fig. 35. Reinstallation of the Philadelphia Plug in the Anne d'Harnoncourt Memorial Sculpture Garden, Philadelphia Museum of Art (Courtesy of Materials Conservation, Philadelphia, PA)

underside and the direction of the streaking in the biological growth on the front face of the sculpture. The position shifted slightly for a second time with the reinstallation in 2010 owing to its new installation location.

7. PROJECTED MAINTENANCE

The ongoing stability of the Three-Way Plugs will depend on consistent programs of vigilant monitoring and maintenance.

7.1 OBERLIN

The biggest issues with maintenance seem to be prevention of vandalism, maintenance of coatings on the prongs, and prevention of buildup of debris inside cavities and against the sides. In light of recent graffiti on the prongs, the Allen Museum has proposed installation of security cameras as a deterrence to vandalism. The site is somewhat hidden from view because the hill slopes downward away from the street, and a large tree obscures the view, so cameras aimed toward the sculpture may help. The prongs take a beating even without vandalism because people touch and climb on them, a reality that most likely will not change since the sculpture is on a college campus. The solution, budget constraints aside, would be to refresh the lacquer coating regularly.

7.2 SAINT LOUIS

A maintenance plan will be developed with the conservation staff at the Saint Louis Art Museum. Maintenance will be similar to that for the Oberlin and Philadelphia Plugs, with regular "housekeeping" being of primary importance: keeping grass and weeds from growing against the sculpture, and keeping the interior chambers free of dirt, debris, and water.

7.3 PHILADELPHIA

In Philadelphia the Plug is examined weekly, cleaned out as necessary, and notes are made regarding any condition issues. Since the object has been resited in a bed of gravel as it was originally, the area is maintained to keep plants from growing next to the object and causing damage as they had previously. There has been ongoing discussion about attaching loosely fitting, dark-colored netting to the interior of the sculpture with magnets. The idea is to catch leaves and organic matter and to discourage animals from making the sculpture their home. Ultimately, there has been disagreement along aesthetic lines and the general opinion is that frequent maintenance will make the netting unnecessary. A brief problem with animals seeking shelter has been resolved with using ultrasonic deterrents. Discreet signage in the sculpture garden to discourage climbing has not proven very effective in practice. Finally, there is a guard presence in the sculpture garden during the day, and 24-hour camera surveillance. While this does not prevent people from climbing on the sculpture, it does permit fairly immediate action.

8. CONCLUSIONS

Oldenburg's desire to have one of the Three-Way Plugs rust completely through at the ground line, as he discussed in his talk at the inauguration ceremony for the Oberlin Plug, is very unlikely to be realized, if for no other reason than these objects retain both inherent and aesthetic value to the individual and institutions caring for them. Deterioration of the pieces has been, repeatedly, slowed by various stakeholders.

The various conservation treatments of the three editions of the Three-Way Plug over the past 40+ years have been undertaken in a similar manner and in response to much of the same condition issues. Some of these issues are the result of well documented problems inherent to COR-TEN steel kept continuously damp, like the aggressive corrosion that has taken place due to organic material and water collecting in the interiors. Other issues are the direct result of the construction of the sculptures, for example, the jacking that has occurred between the prongs and the adjacent COR-TEN.

All three sculptures have had corrosion products and previous coatings removed on the undersides, then were painted with either zinc- or aluminum-filled metal primers to provide galvanic or barrier protection, and coated with high-performance topcoats. Though they differ in details, these three coating systems have proven performance in field service and have been thoroughly tested in industrial applications.

The three sculptures, their various condition issues, and the necessary conservation treatments of the past four decades make a collectively compelling case for active maintenance programs. For instance, if the sculptures had not been permitted to accumulate organic matter, they would not have held as much interior moisture, and corrosion would have been less of an issue. The Plugs may still have needed to be removed from the ground on an approximately 20-year cycle to examine paint coatings, but much of the structural damage could have been avoided, limiting the treatments needed at those times to coating renewal.

Inherent in active maintenance is the need to examine the sculptures frequently, including the use of inspection mirrors and/or borescopes to see behind the faces. This will make more timely intervention possible when inevitable condition issues do arise, and will prevent the need for much more costly and interventive treatments.

Through presenting these treatments we hope to contribute to the body of information available to conservators involved with the problems of COR-TEN steel and encourage further discussion. We will continue to monitor the condition of the three editions of the Three-Way Plug and, most importantly, continue to draw on our collective experiences to guide their future conservation treatments. Ideally, a similar presentation to this will be given at another AIC meeting 20 years from now.

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NOTES

1. Throughout the document, the term COR-TEN refers to COR-TEN B (ASTM A588).

2. The Saint Louis Art Museum houses extensive documentation in the registration and conservation departments about the installation, condition, and treatment of the Three-Way Plug. Documents include photographs, letters (to/from the artist, Don Lippincott, conservation professionals, and coatings, finishing and fabrication industries), in-house memos, proposals, and condition and treatment reports. These materials provided invaluable information about past research and treatments.

3. The Allen Memorial Art Museum has similar archives in the registration office.

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FURTHER READING

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SOURCES OF MATERIALS

Carboline 890 epoxy, Carbomastic 15, Carbothane 133 HB, Carbozinc 11
Carboline
2150 Schuetz Road
Saint Louis, MO 63146
(314) 644-1000
http://www.carboline.com/

Incralac
StanChem, Inc.
401 Berlin Street
East Berlin, CT 06023
(860) 828-0571
http://www.stanchem-inc.com

Permalac, Permalac 2K
Peacock Laboratories
1901 S. 54th Street
Philadelphia, PA 19143
(215) 729-4400
http://www.peacocklabs.com

Ship-2-Shore industrial corrosion inhibitor
Liquid Corrosion Control Systems
Box 48205
Victoria BC Canada V8Z 7H6
(250) 477-7325
http://www.ship-2-shore.com

Silicon carbide abrasive papers
3M Corp.
3M Center
Saint Paul, MN 55144-1000
(866) 279-1235
http://www.3m.com

Series 90-97 Tneme-Zinc, Series 27 F.C. Typoxy, Series 63-1500 filler and surface (this product has been discontinued)
TNEMEC
6800 Corporate Drive
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(800) TNE-MEC1
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Walnut shell blast media, 1092 micron/.0430”
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