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An Attractive Alternative:
The Use of Magnets to Conserve *Homer* by John Chamberlain

Due to copyright restrictions, it is not possible to include images of the artwork in this publication. However, a version of this paper was published, with images of *Homer,* in the May 2011 WAAC Newsletter (Vol. 33, No.2). That article can be accessed at:

http://cool.conservation-us.org/waac/wn/wn33/wn33-2/wn33-204.pdf

1. Introduction

In practice broken metals are often re-adhered with epoxy or acrylic resin adhesives, or by employing methods used in metals fabrication such as soldering, welding or brazing. Though these techniques can be either ineffective or damaging to the original artistry, methods for joining metal pieces are not often debated in conservation literature. On the other hand, numerous publications in the past 10 years have discussed the use of magnets in conservation. Authors report of magnets being painted, or wrapped in paper or textile, and used to mount or secure textiles, works on paper, and objects for both exhibition and travel. Magnets have also been used as a treatment tool, most commonly as a clamp for repairing tears in both paintings and objects. This paper explores the use of magnets as a long-term treatment for rejoining the metal components of *Homer*, a small assemblage created by John Chamberlain in 1960. Driven by the specific challenges of the artwork, magnets had the potential to reconcile the need for an effective join with contemporary conservation ethics.

2. *Homer* in Context

American artist John Chamberlain (b. April 16, 1927) is best known for creating large-scale, three dimensional assemblage sculptures from discarded parts of automobile bodies. In 1960, Chamberlain's first solo exhibition was mounted at the Martha Jackson Gallery in New York, and international success followed almost immediately. Constructed in 1960, *Homer* dates from this turning point in his career. To create the work, Chamberlain found eleven industrially fabricated, polychromed metal parts, which he cut, shaped and attached to a prefabricated wooden base in three places. The work is unusual for Chamberlain, in that it is composed not of car parts but of household metals such as canisters and food tins. *Homer* is also small in scale, rising just 15 ¾ inches off the table. The metal pieces are also visually distinct, varying in their color, texture and sheen, and featuring decorative designs and text. As part of the collection of the Robert Rauschenberg Revocable Trust, the work is also a testament to the relationship between Chamberlain and Rauschenberg, to whom the piece was given.

2.1 Materials, Construction and History

The food tins and canisters that serve as source material for Homer were most likely manufactured during the 1950s. Until the introduction of the aluminum can in 1957, metal food containers were made from tin-plated steel, hence the term "tin cans". All evidence, including XRF spectra of the exposed metal surfaces (see Figure 1), point to this as the composition of the metals used to form *Homer.*[i]

The coatings on *Homer* are most likely oleoresinous lacquers, which would have been applied by spraying or, for the decorative prints, by roller coating. In contrast, XRF spectra taken from the unjoined surfaces of the matte light green diagonal piece show the strongest peaks for zinc (see Figure 2). This is consistent with zinc chromate metal primers, which are available in a wide range of green hues.

Figure 1. XRF spectrum, in keV, of the exposed metal substrate, TV's coffee tin, Side C. Photo

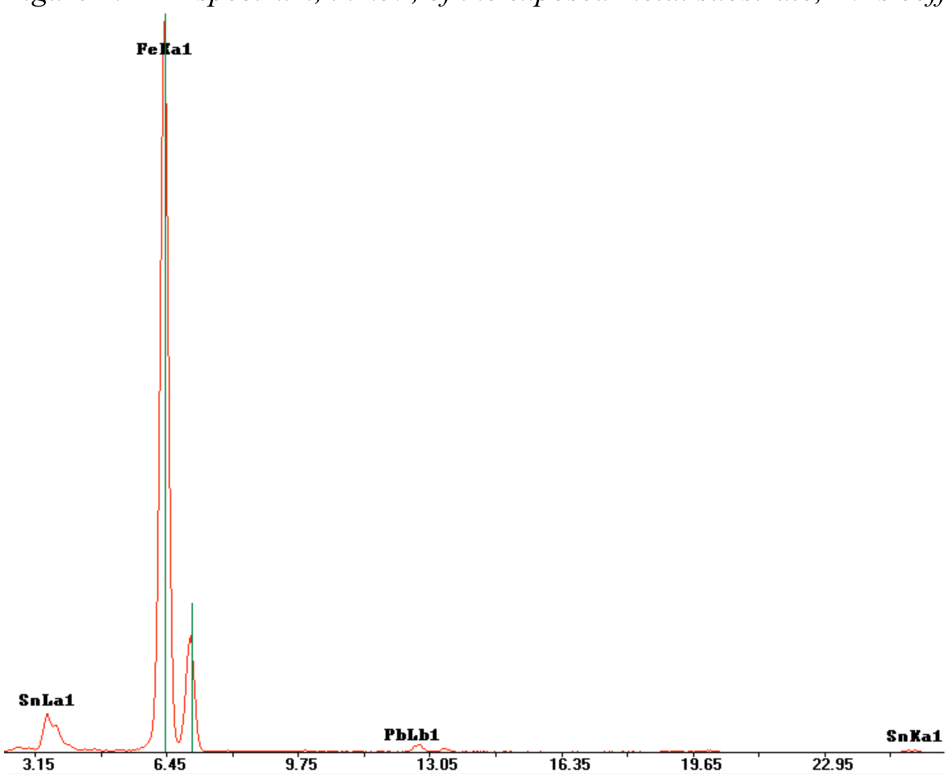


Figure 2. XRF spectrum, in keV, of the light green coated metal, Side A. Photo

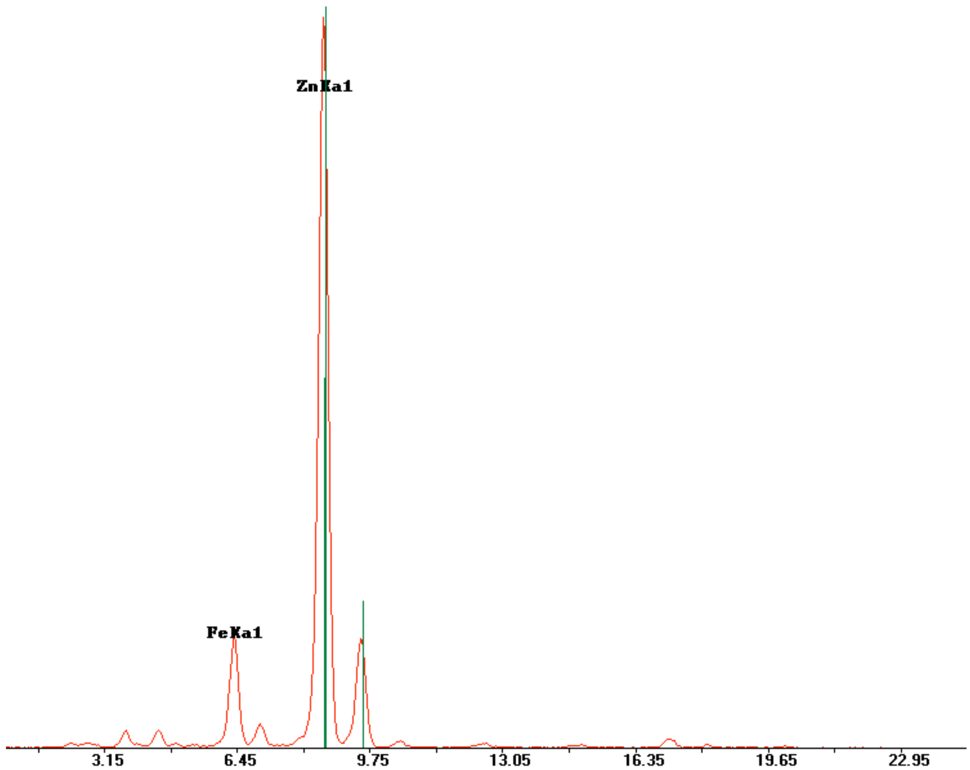
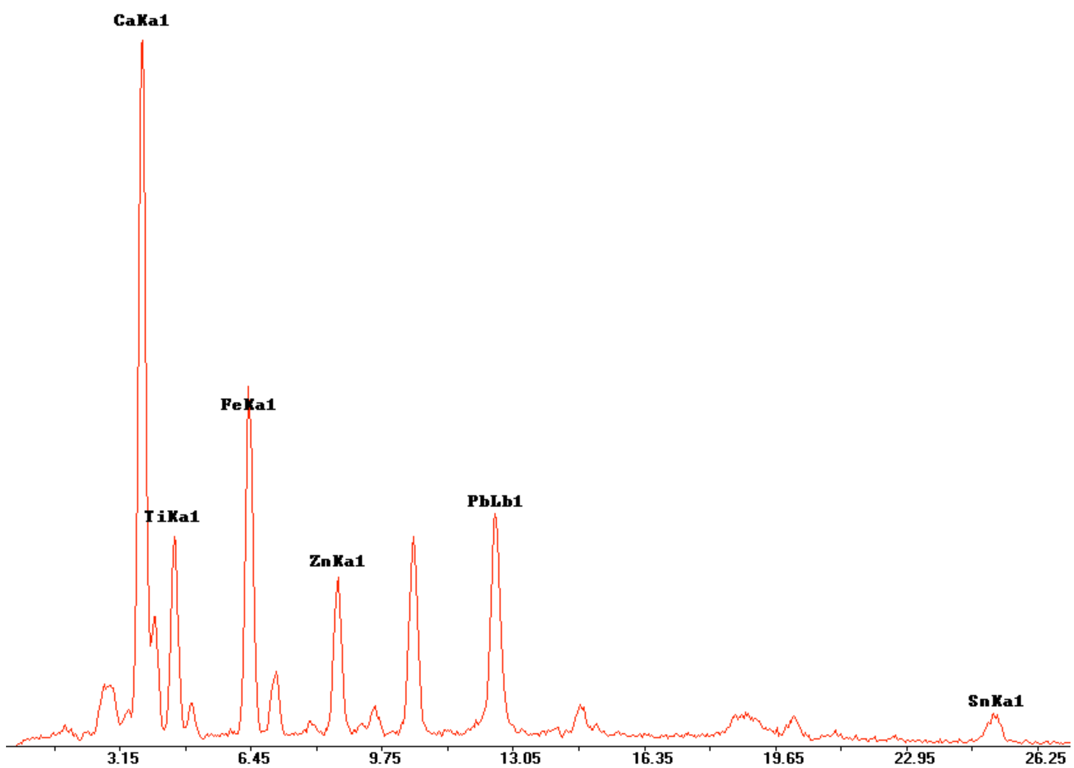


Figure 3. XRF spectrum, in keV, of join, diagonal off-white metal on base, Side C. Lead-tin solder, zinc chloride flux and putty with titanium white and calcium-based filler.



Chamberlain's artistic process is based in material exploration. He starts his works without a fixed idea, and describes the artistic intention as unfolding according to intuition and sexual impulse, incorporating randomness and chance. Chamberlain bends and folds the metals to wrap through and around each other in what he describes as a “sexual fit.” Only after the work is composed does he concern himself with securing it together.

In Homer, undisguised soldered joins hold the different metal sheets to each other and to the wooden base. Corrosion near the joins points to the application and incomplete removal of an acidic flux during soldering. XRF spectra of joins show strong peaks for lead, a primary component of soft-solders, as well as peaks for zinc, which may indicate the use of a zinc chloride flux (see Figure 3).

Archival photographs held by the Rauschenberg Trust demonstrate that the grimy surface patina and visible wear to the coatings and base are likely part of the original aesthetic.[ii] The placement of some of this scratching also appears to have been added intentionally, as in the heavy vertical scratches that underline “Made in U.S.A.”.

Two joining campaigns are apparent on the piece. Of the twenty-three joins on the work, solder is visible on nineteen and likely present in all. As a result of insufficient structural support, excessive stress had been placed on these joins.[iii] Fifteen were previously repaired with one or both of two materials: 1. A white-colored substrate which has been made gray by means of a surface coating and 2. a loop of thin metal wire that pierces the metal sheets.[iv] This thesis is supported both by the registration files of the Robert Rauschenberg Revocable Trust, which notes a repair undertaken in May 1990, as well as by Lawrence Voytek, Rauschenberg’s fabricator, who completed the repair.

2.2 Condition

In September 2009, when the piece was examined, the metal construction remained secured to the wooden base, and the base was structurally sound. The individual steel sheets were also intact, however four more soldered joins and one repaired join had failed. As a result, *Homer* slumped dramatically. Due to the flexibility of the restored joins, the elements of the work moved readily.

The surfaces of *Homer* also showed signs of age-related deterioration, including areas of corrosion, as well as flaking and fading of the coatings.[v] Such deterioration does not yet adversely impact the aesthetic or stability of the work, and was not addressed by this treatment.

3. Treatment Goals

As might be expected for an artist who has sculpted polyurethane foam, Chamberlain accepts that some materials are transient, but may choose to use them for the sake of achieving a desired effect. In his words, "It is not as necessary for the item to last forever as much as it is for you to get something that you are not used to getting."[vi] Furthermore, his practices caring for his own work can prove problematic for collectors who give weight to historical value. In one interview, he describes repainting a paper collage he had made 45 years prior.[vii] Chamberlain also restored his galvanized steel sculpture *Norma Jean Rising* by painting and re-titling the work *Norma Jean Risen.*[viii] The piece now has two dates—1967 and 1981—associated with its manufacture.

Drawing on many published interviews, at no point during treatment did it become necessary to involve Chamberlain in the treatment. In light of these examples, my intervention is not designed to imitate the artist's personal methods of caring for aged works. However, in consultation with the curators of the collection, ethically-acceptable goals for treatment were established that placed priority on the historical value of *Homer* by preserving signs of wear. The primary concern of this conservation intervention was to realign the component pieces and stabilize them in their original position.[ix] For practical reasons as well as out of informed respect for the unique history of the work, the conservation treatment also preserved the materials from the 1990 repair.[x]

4. Traditional Conservation Methods for Joining Metals

As the simplest method of joining metals in terms of application and reversibility, adhesive options were investigated first.[xi] Based on preliminary sampling, three adhesives were tested on a mock-up of the artwork, which had been soldered and puttied together from pieces of ferrous metal cans. The test adhesives were allowed to dry either horizontally or vertically in order to evaluate flow, strength and gap-filling properties.[xii] The conditions of the mockup likely vary significantly from those of the artwork; nonetheless, testing revealed significant information. Each of the adhesives demonstrated problems adhering to the metal, and only half of the bonds remained intact after the application of gentle pressure.[xiii] Though good in theory, adhesives would likely present significant problems in practice.

Other common options for joining metals proved no more promising (see Table 1). Soldering, brazing or welding could be very effective if skillfully done, however these methods would damage the well-preserved coatings and repair materials on the work. Mechanical joins would stabilize the piece, however the metal sheets would have to be punctured with new holes in order to apply bolts or another type of fastener. This could negate Chamberlain's “sexual fit” of the metals, as well as impact *Homer*'s appearance.

5. Magnetism and Magnets

At this point, magnets that had been placed on the work for temporary stabilization had been holding it together for approximately three months. They were still effective, and easy to reverse as well as apply. Though the magnets had shifted slightly, transportation and gentle handling had not further damaged *Homer*. As the most promising option, further testing and research was undertaken into the use of magnets as a long-term joining method for metals.

Permanent magnets are classified as materials that continuously generate their own magnetic field. Substances which can form permanent magnets are described as ferromagnetic, and include iron, cobalt, nickel and some rare earth elements. The atoms of ferromagnetic materials have several unpaired electrons in their outermost orbital. In these atoms, an orbital magnetic

Table 1. Methods for Joining Metals

Considerations	Adhesives	Soldering, Welding or Brazing	Mechanical Fasteners	Magnets
Application	Easy to apply	Requires specialized equipment and knowledge	Must create holes in metal, if none exist	Easy to apply
Reversibility	Reversible mechanically or with solvents	Not reversible; re-treatable	Fully and easily reversible	Fully and easily reversible
Changes to Artwork	Requires clean join surfaces, i.e. removal of patina in areas	Application is damaging to surface coatings, metal sheets and repair putty	Must create holes in metal, if none exist	No immediate change; slight magnetization of metal over time
Join Strength	Variable strength, depends on adhesive used and surfaces to be joined	Strong join	Strong join	Variable strength, can be customized to specific join
Character of Join	Rigid to somewhat flexible	Rigid join	Rigid to somewhat flexible	Somewhat flexible; accommodates small shifts in alignment
Other Considerations	Further complicates mixture of materials and chemistry of joins	Only joins metal to metal; cannot be applied over other materials	Usually create a strong visual impact	Unknown effects of magnetization of metal

moment is generated when the unpaired electrons have the same spin and orbit. This orbital magnetic moment is characterized by both a magnitude and a direction. When the orbital magnetic moments of groups of atoms align in parallel within a crystalline structure, a magnetic domain is formed. An object is magnetically-charged when its magnetic domains are aligned in the same direction, creating one large magnetic field.

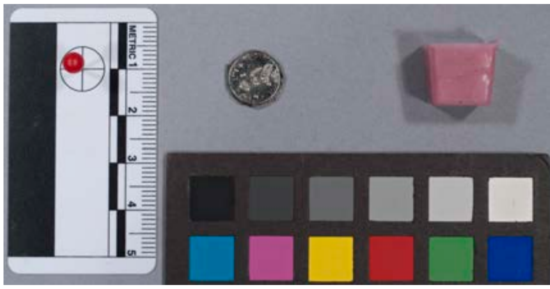
There are four types of commonly available permanent magnets. For this experiment, different shapes and sizes of neodymium-iron-boron rare earth magnets were tested. The strongest and most permanent magnets in existence, they are over 10 times stronger than ceramic magnets. Susceptible to corrosion, rare earth magnets are always coated, usually with zinc or nickel. Their maximum operating temperature, above which demagnetization occurs, is 176° F, well above the temperatures at which *Homer* would be stored or displayed.

In order to protect both the surface of *Homer* from abrasion and the nickel coating on the magnet from chipping, polymer coatings for the magnets were investigated.[xiv] Through the addition of a magnetic powder, this coating could itself be made into another type of magnet, known as a bonded magnet.[xv] This bonded magnetic coating would be strengthened as a result of curing under the influence of the magnet inside. The coating could be molded or shaped to fill the negative space around the broken joins, strengthening the bond with the artwork, and promoting invisibility of the repair.

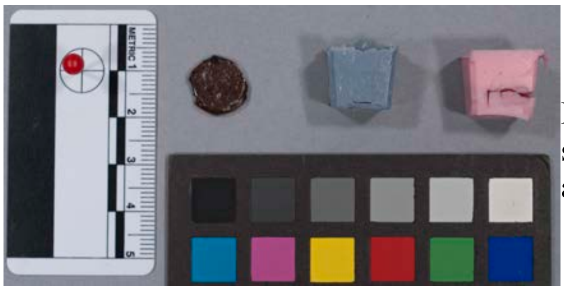
5.1 Polymer Coatings for Rare Earth Magnets

Experiments were conducted on two classes of coating polymers, and three formulations of silicone rubber. Using materials found in the lab, initial testing was performed with Paraloid B-48N and Elite Double 8 silicone rubber.[xvi] Paraloid B-48N adhered well to the magnet's surface, however, the film formed was brittle and hard—not unlike the nickel plating already on the magnet. Because silicone rubber will not bond with a metal surface, a coating was formed by submerging the magnet in a mold. This coating broke easily when the magnet inside was attracted to a nearby object, however the softness and flexibility of the rubber made it an appealing prospect.

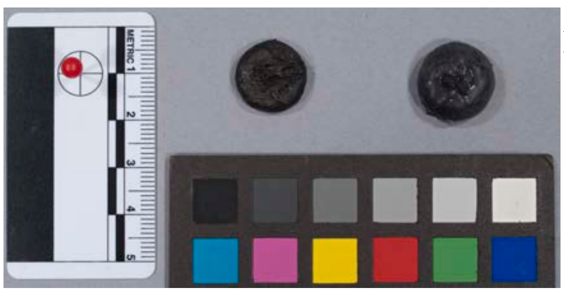
Figure 4. Coating Tests with Additives



Paraloid B-48N (left) and
Elite Double 8 silicone rubber (right)



B-48N with burnt umber (left) and
silicone rubber with viridian and titanium white (middle)
and chalk white (right)



B-48N (left) and silicone rubber (right) with strontium ferrite powder

5.2 Additives for Coatings

In an attempt to improve the aesthetic properties of these coatings, pigments were added to both the B-48N and the Elite Double 8 silicone rubber (see Figure 4). This effectively changed the color of the coatings, including the pink silicone rubber, but showed no other beneficial effects.

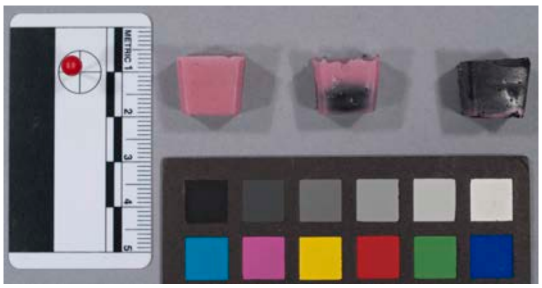
To create the bonded magnets, strontium ferrite powder was added to both coatings. When added to uncured silicone rubber, these particles secured the coating to the magnet's surface, effectively strengthening the coating. The powder also served as a bulking agent, increasing the thickness of the coating layer and enabling one-step dip-coating. With the B-48N, however, the powder also made it difficult to achieve a smooth surface, creating a hard pointed coating. Because of its rigidity, B-48N was eliminated from further study and consideration.

Varying the amount of strontium ferrite in the mixture changed the appearance of the final coating. Mixtures that were not saturated showed marked separation, with the black particles clustering closest to the magnet, leaving an outer surface of pink silicone rubber (see Figure 5).

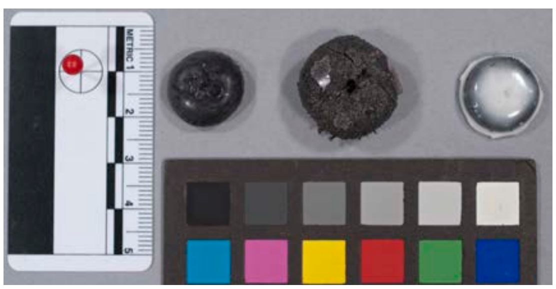
Iron filings were also tested. Though they effectively adhered the rubber to the magnet, the large size of the filings proved problematic to achieving a smooth, regular coating.[xvii]

Chalk white and the black strontium ferrite powder were mixed together and added to silicone rubber in the hope that they resulting polymer would be grey, like *Homer*'s existing joins. Instead, the strontium ferrite powder formed an interior layer close to the magnet, while the white pigment remained suspended in an uneven outer layer.

Figure 5. Silicone Rubber Coatings with Magnetic Additives



Elite Double 8 silicone rubber (left) mixed 2:1 (middle) and 1:1 (right) with strontium ferrite powder



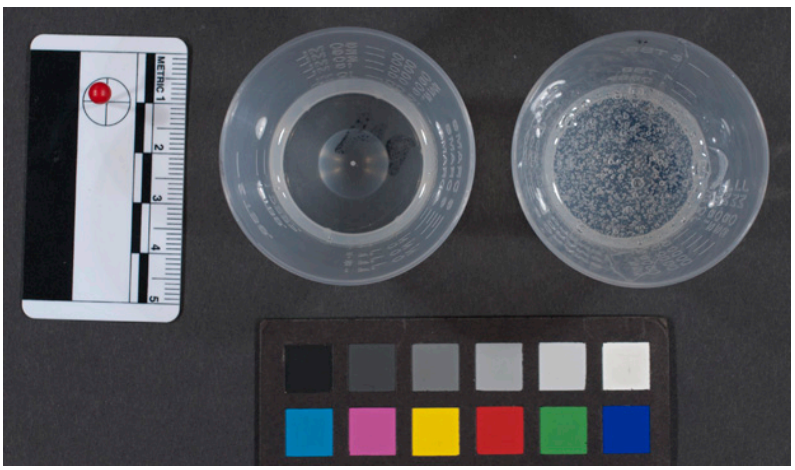
Elite Double 8 silicone rubber mixed with strontium ferrite powder (left) and iron filings (middle).
Silicones Inc. P-4 silicone rubber mixed with equal parts strontium ferrite powder and chalk white (right).

5.3 Silicone Rubber Formulations

Research was also conducted to select an appropriate silicone rubber formulation for the final treatment. In general, cured silicone rubbers consist of a silicone polymer, traces of catalyst, cross-linking agents, filler materials, softeners and stabilizers. Clear products were selected, both for aesthetic reasons and because of the implied lack of pigmented additives. In order to form a coating of sufficient softness and strength, formulations with a Shore Hardness A value of approximately 40 were considered. For ease of application, the rubber should vulcanize at room temperature. Two-part silicones that cross-link via an addition mechanism generally have the fewest additives of the room-temperature vulcanizing rubbers. To reduce the likelihood of the treatment aging poorly, the search was restricted to these products.

Based on these requirements, two products were tested: Smooth-On SORTA-Clear® 40 and Silicones Inc. P-4. SORTA-Clear® 40 is much thicker than P-4 when in the liquid phase, which could present a problem for casting the rubber into a mold. In addition, air bubbles which formed while during mixing remained in the SORTA-Clear® 40 after curing (see Figure 6). Oddy testing was conducted to indicate whether the chosen formulations would release harmful volatiles upon aging. Samples of the cured products with and without added strontium ferrite powder were aged, as well as a control setup and a B-48N reference. Overall, the products tested performed well and no coupon displayed a significant percentage weight change. Because it exhibited superior working properties, Silicones Inc. P-4 was chosen as the coating material for the magnets used in this treatment.

Figure 6. Silicone Rubber Formulations



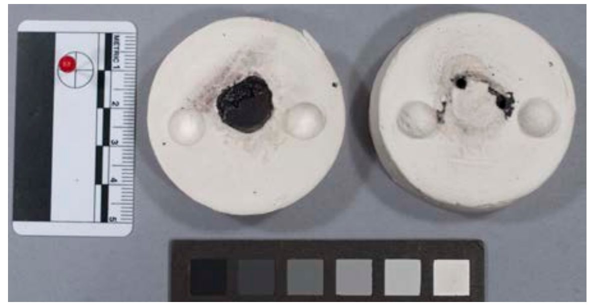
Cured product samples:
Silicones Inc. P-4 (left) and
Smooth-On Sorta Clear® 40 (right)

5.4 Shaping the Coating

Two methods of forming a coating were employed in the treatment (see Figure 7). In order to create the custom-shaped coating for the magnets, impressions were taken from the negative space surrounding broken joins using a two-part silicone rubber mold-making compound. Two-part plaster molds were fabricated from these impressions. A magnet of appropriate size was placed inside the mold before the uncured silicone-rubber mixture was poured in. As an alternative, some magnets were dip-coated with silicone rubber, with or without strontium ferrite added.

Figure 7. Casting the Coatings

Kerr Extrude XP Xtra Putty Impressions



Plaster mold with bonded magnetic coating

The coating and magnet used to repair a specific join varied depending on the aesthetic and strength needs of the location. Cast bonded magnetic coatings were employed behind the broken joins on the TV's can and the light green zinc-chromate primed piece. As strontium ferrite powder makes the cured rubber black, it was not added to the most visible repair joins. For the diagonal white metal piece attached to the base, the magnet used was painted with pigments in B-48N prior to dip-coating.

6. Additional Stabilization

In addition to repairing exiting joins, further options for stabilization were pursued. A coated magnet was added to serve as a spacer, holding the white tin in alignment above the light green piece. This cast coating contains a small amount of strontium ferrite in order to keep the silicone attached to the magnet but allow the spacer to remain translucent.

During treatment, stacks of magnets had been used as spacers to keep the central metal piece at an appropriate distance from the metals joined to the base. Though effective, the shiny silver color would disturb both the appearance and concept of the piece. For the final repair, a spacer was fabricated out of cast plexiglass rod. Magnets were attached to both ends with adhesive and an aluminum rod sheath. These magnets were then coated with silicone rubber at one end, and a bonded magnetic coating at the other. This spacer is necessary to the integrity of the work, and less obvious from the few angles at which it can be seen.

Finally, a "stopper" was made to fit around the checked floral metal where it rests on the wooden base. While the spacers prevent the central metal mass from leaning to the left or right, the stopper should prevent it from sliding out of alignment on the wooden base. This stopper was cast around two small disc-shaped magnets using silicone rubber mixed with strontium ferrite.

7. Conclusion and Recommendation for Future Research

Though established conservation methods of repairing metals were not viable for *Homer*, treatment was absolutely necessary in order to extend the life of the work. Through experimentation with coating and additives, magnets have proven to be an effective alternative, and a promising non-invasive option for joining certain types of metal.

As there are no published precedents for the use of magnets as an adhesive on metal artwork, it is difficult to predict the long-term effects of this treatment. Over time, magnets are known to slightly magnetize the metal surface to which they are attached. It is unclear, however, how strong such effects would be, their duration and whether this would alter the ability to conduct instrumental analysis of the work. Accelerated aging experiments are difficult to design for magnets, as they are uniquely altered by substantial elevations in heat. Therefore, it would be ideal to monitor and report the effects of this treatment over time, and independently verify that magnets remain strong and do not migrate.

The lifespan of silicone rubbers is supposed to be greater than 30 years in an outdoor environment. Nonetheless, the coatings should also be periodically monitored for migration of silicone oil to the surface and deterioration or cross-linking of the polymer matrix. The frog-grip quality of the surface that makes silicone rubber a desirable coating is also likely to cause the repairs to collect dust and dirt preferentially. As silicones are sensitive to solvents, cleaning would need to be approached carefully.

Though further investigation is warranted into the long-term effects of the treatment, through the application of custom-coated magnets, *Homer* has regained structural strength and stability. The piece now stands upright of its own accord, and can be moved and handled without falling out of alignment. Furthermore, all signs indicate that the treatment should age well, and last for decades to come. According to the manufacturer, "If they are not overheated or physically damaged, neodymium magnets will lose less than 1% of their strength over 10 years – not enough for you to notice unless you have very sensitive measuring equipment. They won't even lose their strength if they are held in repelling or attracting positions with other magnets over long periods of time."[xviii] In light of the time spanning the previous interventions on *Homer*, this treatment should aim to last for at least 20-30 years. However given their durability and strength, magnets may prove reliable for many decades more.

Acknowledgements

This project began as part of the course *Conservation of Modern Sculpture*, coordinated by Lynda Zycherman in Fall 2009 at the Conservation Center of the Institute of Fine Arts, New York University. Research was conducted as part of an independent study supervised by Christine Frohnert from 2010-2011. I am indebted to David White and Thomas Buehler of the Robert Rauschenberg Revocable Trust for their support of this project. I am most grateful to Christine Frohnert, Conservator for Contemporary Art, Cranmer Group; and Chair, Electronic Media Group of the American Institute for Conservation for her vision and guidance. In addition, Simone Miller, Paintings Conservator and Research Assistant, Technische Universität, Munich, Germany, Department of Conservation, Art Technology and Conservation Science, and Astrid Schubert, Paintings Conservator, Museum Ludwig, Cologne, Germany, have generously shared their work on silicone rubber and magnets respectively, which served as direct predecessors to this study.

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i The magnetic susceptibility of the pieces indicates that they are formed from an iron-rich alloy like steel. Further analysis of the metals and coatings was conducted using a Brucker Tracer III-V handheld XRF. All spectra collected from the work showed K-alpha 1 peaks for iron. Nine of the thirteen spectra collected also showed small but distinct peaks for tin (K-alpha-1 and L-alpha-1).

ii The presence of dirt and accretions is consistent with his body of work and points to the use of found materials. "I really wasn't interested in car crashes; I was interested in the material that came from cars, because it was free. Nobody really wanted it. I mean, in the 1950's, it wasn't yet to the point where they turned them in and made 20 dollars or so." In John Chamberlain and Hans Ulrich Obrist. *John Chamberlain*. Köln: Verlag der Buchhandlung Walther König, 2006. p. 102. Furthermore, after forcibly bending and crushing his materials, Chamberlain's objects often leave his studio with surfaces that are scratched, chipped or otherwise worn.

iii The floral checkered piece, which is the central, weight-bearing element of the metal construction, was never directly secured to the base. As the metal shifted freely with handling and movement, this weight would have placed great stress on the joins of the work. Two of the original joins which are now broken had attached this piece to those metals which were fixed in position on the base.

iv The putty is found on 13 joins, applied over the solder and wire, if present. It is difficult to judge how many joins make use of wire loops, though they are visible in 7 locations, 5 of which are in conjunction with putty.

v Red-brown accretions encircling the joins appeared to be iron corrosion products. This is likely generated by residual acidic flux. The silver paint which covers the white putty of the restored joins was cracking, due to movement of the pieces as a result of join failure. Though there are scratches and losses to all the coatings, the light green zinc oxide primer is extensively worn away at the peaks of the folds, and is actively flaking. The checkered floral piece is unevenly faded, with more color preserved in valleys of the folds than on the peaks. Because this fading relates to its current topography, it is likely that it occurred after assembly.

vi At times Chamberlain even seems frustrated by cultural expectations of the permanence of art. Speaking of his polyurethane foam sculptures, he notes in an interview, "I have one or two of them left and they are ready to, well, not fall apart, but parts of them are. But they have lasted forty years. What the hell do you want? How long is it going to take you to get it? It is not as necessary for the item to last forever as much as it is for you to get something that you are not used to getting." Olbrist p. 34

vii "Things are hard enough to keep without using materials that break down easily. I know this for a fact because I have just repainted a forty-five-year-old-piece, a small collage, but there was paper in it and all the paper was very very brittle. The piece has been handled with great care, still, it's almost like you look at it and it flakes." Olbrist p. 18.

viii "First in the series of galvanized pieces, in which boxes were fabricated in dimensions approx. 42 x 28 x 18 in. (106.5 x 71 x 45.5 cm.), handled by the artist in a compactor, and finished in his studio. This one was remade, painted, and retitled in 1981. It was originally titled Norma Jean Rising." Smithsonian Institution Research Information System. *Norma Jean Risen (Sculpture)*, © 2001-2004 Smithsonian Institution. < http://siris-artinventories.si.edu/ipac20/ipac.jsp?uri=full=3100001~!308031!0> (17 October 2009).

ix This would not only prevent further damage caused by movement, but it would also return the piece to its original rigidity and intended formation. Though five joins are broken, only the four which are causing component pieces to be destabilized or misaligned will be repaired.

x As the condition of the surface beneath the putty is not known, removing the restoration materials poses an unnecessary risk. Furthermore, removing the wire loops and putty would likely cause the piece to lose any remaining stability.

xi For preliminary testing, a selection of five epoxy-based adhesives were obtained from conservation suppliers and hardware stores, sampled and applied to a foamcore board in order to evaluate their visual and working properties. Based on this sampling, Araldite 2013, FastSteel, and J-B Weld were chosen for further testing in a mockup due to their medium gray color, matte finish, high viscosity and gap-filling properties. Paraloid B-72 was also used in further tests based on its familiarity to the researcher and popularity in conservation. Paraloid B-48N should also have been tested. Twelve days after curing, five of the joins involving FastSteel had delaminated, demonstrating a lack of adhesion to the mock-up join. As a result, it was eliminated from consideration for use and further testing.

xii Paraloid B-72 was only tested in the vertical position.

xiii Though Araldite 2013 appeared to have the best working properties, the join in which it was applied over solder, without a barrier layer and dried in the horizontal position did not fully harden, demonstrating a sensitivity to contamination during curing. This could be a problem given the complex mixture of compounds likely present on the joins of Homer. In the B-72, small bubbles consistently hardened in the dried film, creating a visual disturbance.

xiv The magnet supplier for this project recommends protecting the surface of neodymium magnets from damage due to impact by applying a rubberized coating K & J Magnetics (link to article on coating magnets)

xv These are comprised of a magnetic powder consolidated in a polymer matrix, similar to the pads proposed by Astrid Schubert. Though magnetically weak, they can be moldable and flexible, as the polymer matrix can be thermoplastic, thermosetting or elastic.

xvi Rohm & Haas Paraloid B-48N (40% mixture in 1:1 Acetone-Ethanol), an acrylic resin designed to bond to bare and primed metals. Zhermack Elite Double 8 was chosen due to its softness, elastic nature, purported unreactivity, and characteristic “frog-grip”.

xvii The filings did not mix well with the silicone rubber. The coating and filing mixture cured in a starburst formation which radiated outwards from the surface of the magnet. This created a much thicker coating layer than the strontium ferrite powder. It also raised concerns not only about the appearance of the filings in the coating, but also of the potential for abrasion of the artwork's surface by the iron filings.

xviii If we look to the artwork itself for precedents, *Homer* was created in 1960 and repaired once in 1990, meaning that the original joins were broken by the time 30 years had passed. When examining the piece in 2009, the materials of all of the 1990 repairs, except one, were still functional.

http://www.kjmagnetics.com/FAQ.asp#lose