SHORT COMMUNICATION: SIMPLE AND INVISIBLE SOLUTIONS USING RARE EARTH DISC MAGNETS IN MOUNTMAKING

DEANNA HOVEY

ABSTRACT—Rare earth magnets reduce the need to use visible pins and hardware for some museum mounts. This short article describes four specific applications using rare earth disc magnets: rare earth disc magnets embedded in archival corrugated board to mount clothing, rare earth disc magnets glued into Ethafoam inserts to mount silver objects, rare earth disc magnets countersunk into casework to mount ferrous objects, and rare earth disc magnets used to secure telescoping mount parts. Specific examples of how these applications are used at the Saint Louis Art Museum and general guidelines and precautions for using rare earth magnets are described for each application. Detailed step-by-step instructions, illustrations, and/or photographs demonstrate each magnet application. Material descriptions and supplier information are provided.

TITRE—Des solutions simples et invisibles pour le montage d'objets utilisant des aimants en terres rares RÉSUMÉ—L'utilisation d'aimants en terres rares diminue le besoin d'inclure des épingles et autres quincailleries dans les supports de présentation muséologique. Cet article présente quatre exemples utilisant des aimants en terres rares, soit insérés dans un panneau de qualité archive pour présenter des vêtements, soit collés sur des pièces de mousse de polyéthylène pour présenter des objets en argent, soit insérés dans un boitier pour présenter des objets en fer, et enfin utilisés pour fixer les pièces coulissantes d'un système de montage. Pour chaque exemple, les précautions et les balises d'utilisation pour ces aimants en usage au *Saint Louis Art Museum* sont présentées. Des instructions détaillées, des dessins et des photographies illustrent chaque cas. Une description des matériaux et des informations sur les distributeurs sont également fournies.

TITULO—Soluciones simples e invisibles para la fabricación de soportes usando imanes de tierras raras RESUMEN—Los imanes de tierras raras reducen la necesidad de usar alfileres visibles y cerrajería para algunos soportes de museos. Este artículo corto describe cuatro aplicaciones específicas en las que se usan imanes de tierras raras: imanes de tierras raras incrustados en cartones corrugados de archivo para montar vestimentas, imanes de tierras raras pegados a piezas de Ethafoam para montar objetos de plata, discos de imanes de tierras raras insertados en soportes de exhibición para montar objetos ferrosos, y discos de imanes de tierras raras usados para fijar partes telescópicas de soportes. Se dan ejemplos específicos de cómo se utilizan estas aplicaciones en el *Saint Louis Art Museum* (Museo de Arte de Saint Louis), y se describen guías generales y precauciones para usar imanes de tierras raras en cada una de ellas. Instrucciones detalladas paso por paso, ilustraciones, y/o fotografías, demuestran la aplicación de cada imán. Se proporciona descripciones de materiales e información de proveedores.

TÍTULO—Soluções simples e invisíveis de uso de ímãs permanentes em montagens [de exposição] RESUMO—Ímãs permanentes reduzem a necessidade de uso de pinos e ferragens para algumas montagens em museus. Este breve artigo descreve quatro aplicações específicas de uso de ímãs permanentes: ímãs permanentes embutidos em papelão enrugado de arquivo para montagem de vestuário; ímãs permanentes colados em pedaços de espuma (*Ethafoam*) para montagem de objetos de prata; ímãs de disco permanentes escareados em caixas para montagem de objetos de ferro; e ímãs de disco permanentes usados para segurar partes de montagem telescópica. Exemplos específicos de como essas aplicações são utilizadas no *Saint Louis Art Museum*, diretrizes gerais e precauções no uso de ímãs permanentes são descritos para cada aplicação. Instruções passo-a-passo detalhadas, ilustrações e/ou fotografias demonstram cada aplicação do ímã. São oferecidas descrições de material e informação sobre fornecedores.

1. INTRODUCTION

Rare earth magnets are available in many shapes. The following mount examples use only rare earth disc magnets with diameters ranging from 0.6 to 2.5 cm and with a thickness of 0.3 cm. The thin disc magnet has a large magnetic surface area that

can be easily set into various materials for a discreet and secure mount solution. Exhibition casework can be designed and built with steel panels specifically for the use of magnets (Potje 2008) or altered with the addition of a steel plate or ferromagnetic cups. Ferromagnetic cups are machined to the exact dimensions of the disc magnet; the tight-fitting cups focus the magnet force in one direction and increase the strength of the magnet by a factor of four (Moriarity et al. 1999). They also provide a means to securely bolt the magnet to the casework to prevent the magnet from migrating toward another magnet or magnetic object. Rare earth magnets lose magnetism at a low temperature (310°C to 400°C) (Spicer 2010); ferromagnetic cups can be hot glued into place to protect the rare earth disc from exposure to the heat of hot glue.

2. USE OF RARE EARTH MAGNETS IN MOUNTS

Rare earth magnets have been used at the Saint Louis Art Museum to mount clothing, silver objects, and magnetic objects and as a means of securing telescoping mount parts. Detailed descriptions of these applications are given below.

2.1 RARE EARTH MAGNETS EMBEDDED IN ARCHIVAL CORRUGATED BOARD USED AS INSERTS IN CLOTHING

Rare earth magnets embedded in archival corrugated board inserts have been used for mounting clothing onto magnetic slanted case decks. For example, as shown in figure 1, the pair of Nimíipuu men's leggings (ca. 1880), primarily made of native tanned hide, was mounted on case furniture with two sections: a magnetic display panel (Ellis 2008) (fig. 2a) that cleated onto an angled back support (fig. 2b).

Both the angled back support and the display panel were built from 1.9 cm (¾ in.) birch plywood; the display panel attached to the angled back support with two plywood cleats. Both sections were completely wrapped in Marvel seal as a barrier to isolate the wood from the case environment. A sheet of 16-gauge (1.5 mm thick) steel was nailed to the front surface of the display panel. The steel was cut to the same dimensions as the display panel. The edges were sanded smooth; holes for nails were drilled on each side of the steel and down the center. The steel was cleaned with acetone, sealed with Krylon crystal clear acrylic coating, and allowed to give off gas for 2 weeks. Then 18-gauge (1.2 mm diameter) wire nails were used to attach the steel sheet; after being hammered into the plywood, the wide, thin head of the nail was set flush with the surface of the steel. After the steel sheet was in place, both sides of the panel were covered with the display fabric; the cleats were not covered. The visible surfaces of the angled back support were also covered with the display fabric.

For the leggings each insert with embedded rare earth magnets was made with .32 cm (⅛ in.) thick archival corrugated board and two 1.9 × 0.32 cm (¾ × ⅛ in.) rare earth disc magnets. Eight inserts were needed to secure the leggings in figure 1. The archival corrugated board was cut into 15 × 5 cm (6 × 2 in.) rectangles with rounded corners. The corrugation of the board ran lengthwise; widthwise corrugation allowed the board to buckle between the two magnets. Two holes, slightly smaller than the magnets, were cut into each insert. The holes were centered on the insert and spaced 5 cm (2 in.) apart (fig. 3a). The magnets were pressure fit into each hole (fig. 3b) and sealed in place with gummed linen tape on both sides (fig. 3c).

For installation, the case furniture was positioned in the display case, the angled back support was screwed to the case deck, and the magnetic display panel was removed. The magnetic display panel was placed flat on a table, and the leggings were moved onto the panel. The leggings were set into position with the archival corrugated board inserts. Two archival corrugated board inserts were placed inside at the top of each legging and two placed inside at the bottom (fig. 4). The archival corrugated board inserts held the leggings against the display panel and helped to define their edges.

An Ethafoam form was placed inside each legging to add some volume to the display. A piece of 2.5 cm (1 in.) thick, 2 lb. density Ethafoam was shaped to loosely fit inside each legging. The Ethafoam forms were smoothed and wrapped with acid-free, unbuffered tissue. Display fabric was stitched around the top and the bottom of each Ethafoam form, and the forms were slid into the leggings from the top down. The extreme taper of the leggings held the Ethafoam forms in position. The fringe was arranged and

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Fig. 1. Completed mounting of men's leggings. Courtesy of Nimíipuu (Nez Percé); men's leggings, ca. 1880; native tanned hide, glass seed beads, red and navy blue wool cloth, and dyed red horsehair; 62.2 × 81.3 cm; Saint Louis Art Museum, The Donald Danforth Jr. Collection, Gift of Mrs. Donald Danforth Jr., 98:2010a,b.

loosely stitched to the display fabric before the display panel was placed onto the angled back support.

The Nimíipuu leggings were good candidates for a rare earth magnetic mount because the hide was soft, in good condition, and lightweight. To help prevent the leggings from slipping while on display, the case furniture was slanted and covered with a textured fabric. Two smaller rare earth magnets rather than one larger magnet were embedded into the archival blue board insert, which distributed the force of the magnets across a larger surface area. The installation of the magnetic inserts was done in a clean room free of any metal dusts to prevent the magnet from picking up any dusts that might damage or stain the leggings.

2.2 RARE EARTH MAGNETS GLUED INTO ETHAFOAM INSERTS USED TO MOUNT SILVER OBJECTS

Rare earth magnets have been glued into the base of Ethafoam inserts to secure small silver objects to case decks at the Saint Louis Art Museum, for example, the silver English tea canister (ca. 1774–1775) (fig. 5).

To secure the object to the case deck, a magnetic Ethafoam insert was prepared by hot gluing a 0.95 × 0.32 cm (⅜ × ⅛ in.) ferromagnetic cup into the base of the Ethafoam insert. A rare earth disc magnet was installed inside the magnet cup after the hot glue was cooled. The case deck was prepared for the magnetic insert with a 16-gauge (1.5 mm thick) steel plate cut to

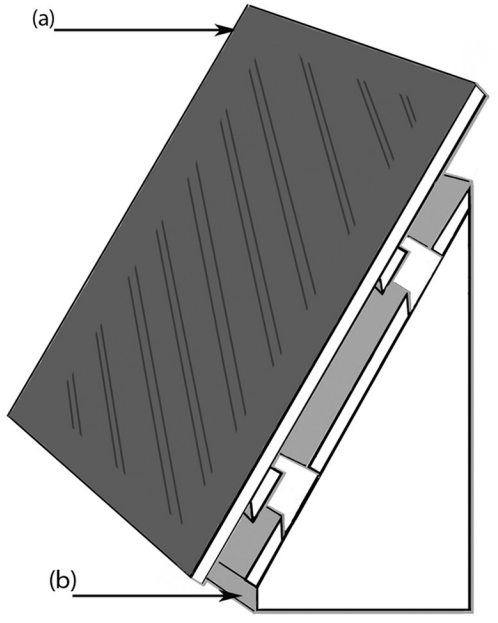

Fig. 2. Two sections of case furniture for leggings: (a) removable magnetic display panel and (b) angled back support.

fit inside the footprint of the tea canister and nailed to the case deck. The object was secured to the case deck by the magnetic force passing through the silver object to the steel plate attached to the casework.

For the Ethafoam insert, the lid of the tea canister was removed (fig. 6a), and the length and width of the rim and the depth of the interior of the canister were measured. A block of 2-lb.-density Ethafoam was cut to loosely fit inside the rim of the canister with approximately 2 mm of space on each side and 5 mm below the top edge. Two sides at the top of the Ethafoam insert were cut away to create a handle for installing the block inside the canister (fig. 6b). The sides of the block were wrapped in soft Tyvek to prevent the Ethafoam from abrading the silver if it were to make contact. A hole was cut at the bottom of the Ethafoam block; the hole was deep enough to accommodate the archival hot glue, a ferromagnetic cup, a rare earth disc magnet, and 2 mm of space between the magnet and the bottom of the Ethafoam (fig. 6c). Archival hot glue was injected into the hole, and the ferromagnetic cup was set into place. Once the glue was cooled, the rare earth disc magnet was set into the ferromagnetic cup.

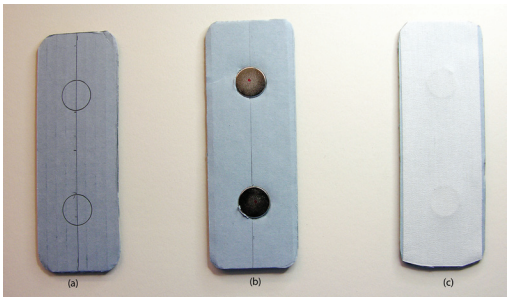

Fig. 3. Magnetic archival blue board inserts for leggings: (a) layout of magnet holes, (b) rare earth disc magnets inserted into holes, and (c) rare earth disc magnets sealed in place with gummed linen tape.

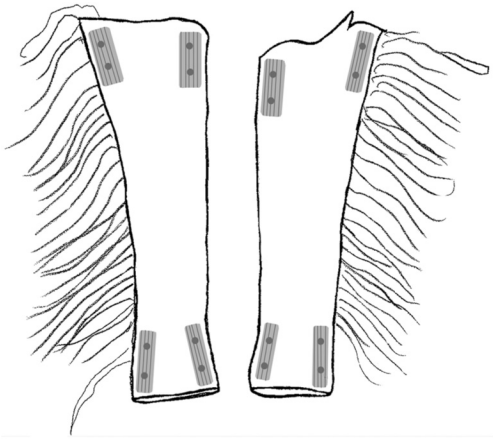

Fig. 4. Positioning of magnetic archival blue board inserts inside the leggings.

To make the steel plate for the case deck (fig. 6d), the footprint of the tea canister was traced and the thickness of the foot was subtracted from the outside dimensions. The steel plate was cut on a band saw, the edges were sanded smooth, and two holes for nails were drilled. Then 18-gauge (1.2 mm diameter) wire nails were used because the 16-gauge (1.5 mm thick) steel was too thin to countersink screws and the thin, wide head of the nail set flush with the steel. The steel plate was cleaned with acetone, sealed with Krylon crystal clear acrylic coating, and allowed to give off gas for 2 weeks before installation.

When the tea canister was installed, the steel plate was nailed to the case deck first, and then the canister was set on top of the steel. The lid for the canister was removed, the magnetic Ethafoam insert was lowered inside the canister, and the lid was replaced.

The 2 mm of Ethafoam beneath the magnet glued into the insert provided a buffer to protect the object from the initial force of contact between the magnet and the steel plate, distributed the force of the magnet over a larger surface area, and provided the installer with a handle to easily access the magnet. Magnetic Ethafoam inserts were used inside small canisters or deep vases that had a low center of gravity and no damage around the base. The material at the base of the objects was thin and stable. Nonferrous metal objects were best suited for this technique; on ferrous objects the magnetic insert was only attracted to the inside of the object not the steel plate attached to the deck (use of rare earth magnets with ferrous objects is covered in section 2.3). For objects with a deep cavity beneath the foot, a steel plate nailed to the case deck was not suitable. Magnetic Ethafoam inserts were used both inside and beneath these objects. When two magnetic Ethafoam inserts were used on an object, it was critical to align the polarity of the magnets to attract, not repel, each other. A tightly fitting insert beneath the object was used to prevent any potential distortion of the object between the two magnets.

2.3 RARE EARTH MAGNETS COUNTERSUNK INTO CASEWORK TO MOUNT FERROUS OBJECTS

Rare earth magnets have been countersunk into exhibition casework to invisibly secure ferrous objects, such as the Charles Parker Company table (ca. 1885) (fig. 7). The table has four iron spherical feet; beneath each foot a ferromagnetic cup was bolted through the exhibition casework, and a rare earth disc magnet was placed inside each ferromagnetic cup. The force of the four magnets on the iron spherical feet held the table in place (fig. 8).

To prepare the case deck for mounting the table, a plastic circle template was used to determine that a 1.9 cm (¾ in.) diameter rare earth disc magnet (fig. 8a) and ferromagnetic cup (fig. 8c) would be least visible. The table was placed on the 1.9 cm (¾ in.) thick birch plywood case furniture; each foot of the table was traced. The circle template was used to find the center of the traced table foot. A spring-loaded center punch was used to mark each center point. The depth of the ferromagnetic cup and magnet assembly (fig. 8a, 8b, 8c) was measured,

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Fig. 5. Tea canister installed. Marked by Eliza Godfrey, English, active from 1741; tea canister, one from a set of three, 1754–1755; silver; 14 × 10.2 × 10.2 cm; made in London, England; Saint Louis Art Museum, funds given by Lewis and Amanda Smith, and gift of John M. Harney in memory of Florence M. Warfield and Charlotte W. Harney, funds given by Joseph Pulitzer in memory of his wife, Elinor Wickham Pulitzer, and funds given in honor of Joseph Pulitzer II, by exchange 4:2010.1a,b.

including the 1 mm where the assembly was countersunk beneath the top surface of the casework. The holes for the magnet cups were drilled out with a 1.9 cm (¾ in.) Forstner drill bit on a drill press. A drill bit of the same diameter as the machine screw was used to drill a hole through the casework. All four of the ferromagnetic cups were bolted to the casework, and the magnets were slipped into the magnet cups (fig. 8a, 8b, 8c). A barrier of adhesive-backed polyethylene suede was attached to the magnet to isolate the table from the magnets and prevent the steel feet from chipping the magnet. After the casework was secured to the exhibition platform, the table was lowered onto the magnetic footing.

This technique can be used for securing magnetic objects to casework (e.g., steel-footed tables and chairs or steel mount stands for small objects). Unlike the magnetic Ethafoam mounts, in which the magnets are pulling directly on the object, only well-constructed and stable ferrous objects have been

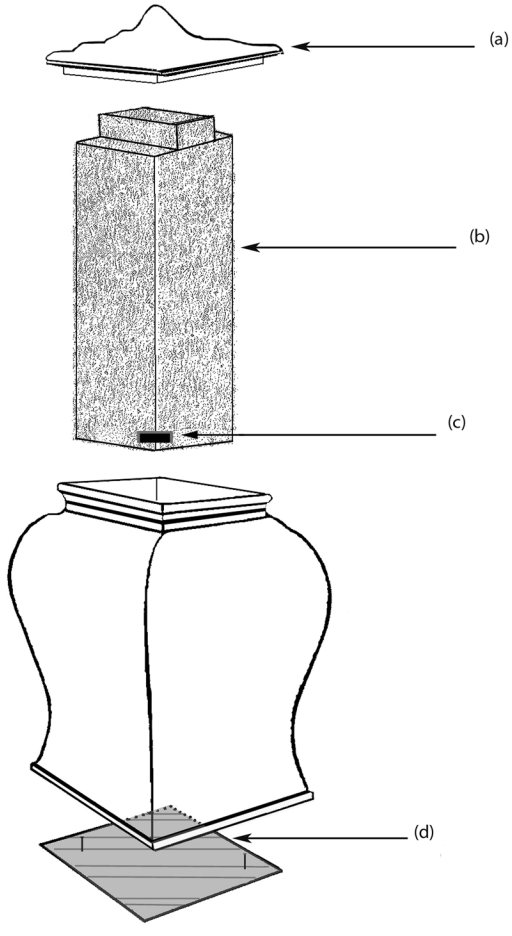

Fig. 6. Diagram of the tea canister mounting system: (a) canister lid, (b) Ethafoam insert, (c) rare earth disc magnet and ferromagnetic cup glued into place, and (d) steel plate nailed to case deck.

mounted this way. The magnet cups were bolted so that they could be removed and reused in the future; if the magnet cups were held in place with wood screws, it would be extremely difficult to remove the magnet cups from the casework.

2.4 RARE EARTH MAGNETS USED TO SECURE TELESCOPING MOUNT PARTS

The plate mount design shown in figure 9 has been used to mount plates flat against case walls. The magnetic telescoping mount arm replaced set

Fig. 7. Table installed in gallery. Courtesy of The Charles Parker Company, Meriden, Connecticut, 1877–1987. Table, ca. 1885; brass with silver and other metallic plating, iron, wood, and replaced silk velvet; 73.7 × 48.3 × 44.5 cm; Saint Louis Art Museum, Mary Elizabeth Rosborough Decorative Arts Fund, the Anne L. Lehmann Charitable Trust; and the bequest of Anne Lehmann, bequest of Miss Avis H. Blewett, gift of Miss Ruth McCollum in memory of William W. McCollum, and gift of Lindell Gordon Jr., by exchange 2:2006.

screws and eliminated the need to access the side or back of the mount and allowed for a more flexible display. A simple steel channel assembly (fig. 9b, 9c) was fabricated to screw the mount to the case wall and receive the magnetic telescoping mount arm (fig. 9a). Two 6.4 mm (¼ in.) rare earth disc magnets were set into the rectangular, steel telescoping mount arm. The magnetic telescoping mount arm was slid inside the steel channel that was welded to a steel bar. The rare earth magnets secured the magnetic telescoping mount arm inside the steel channel assembly and held the plate in the mount.

The steel stock used to fabricate the telescoping mount assembly included a 1 cm wide by 3 mm

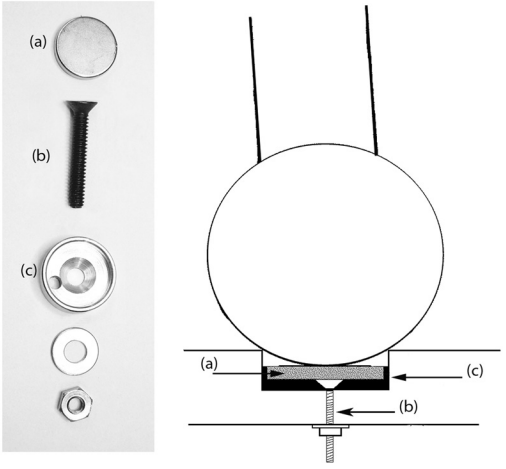

Fig. 8. Hardware for attaching magnetic cup to casework and a cross section of the installation: (a) rare earth disc magnet, (b) machine screw, and (c) ferromagnetic cup.

thick rectangular bar for the telescoping arm (fig. 9a), 1.3 cm square tubing for the channel (fig. 9b), and a 2.5 cm wide by 3 mm thick rectangular bar that the channel and the mount arms were welded to (fig. 9c). The larger steel bar was cut to a length that fit within the footprint of the plate. The steel tubing was cut lengthwise; the inside depth matched the thickness of the telescoping stock. This tube became the channel for the telescoping stock and was cut to the same length as the larger steel bar. The inside of the channel was finished so that the telescoping bar glided smoothly without catching at any point. The channel was then welded to the larger bar stock. The telescoping bar was test fit; the corners were rounded slightly and sanded smooth. The inside of the channel was cleaned and filed smooth. The positions of the two button-head wood screws (fig. 9d) were laid out on the bottom of the channel assembly. Both screw locations were set below the center point of the channel assembly to maximize the amount of space available for the telescoping bar. A pilot bit the same size as the screw shank was used to drill the holes through the flat stock and the channel. A drill bit slightly larger than the head of the screw was used to open up the holes in the larger steel bar (fig. 9c). The bottom two mount arms were bent to fit the contours of the plate, the position of the mount arms was marked on the channel assembly, and they were

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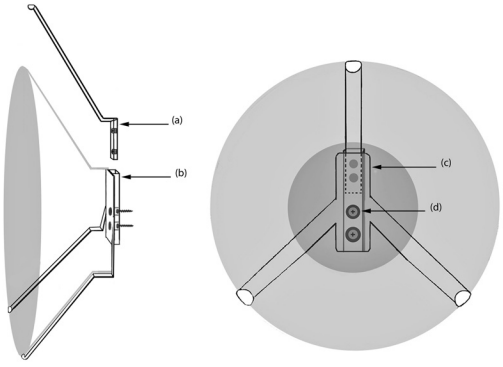

Fig. 9. Front and side views of plate mount with a magnetic telescoping mount arm: (a) telescoping mount arm with rare earth magnets set into place, (b) steel channel assembly that receives the telescoping mount arm and screw to the case wall, (c) rectangular bar that the steel channel is welded to, and (d) two button head wood screws.

welded in place. The fit of the bottom two mount arms was adjusted until the plate stayed in position without the top telescoping arm in place. The top mount arm was bent to fit the contours of the plate. Two holes to fit the rare earth disc magnets were drilled through the telescoping bar. The top mount arm was welded to the telescoping bar, the plate was installed into the bottom mount arms, and the fit of the top arm was tested. The entire mount was cleaned and painted, and the rare earth disc magnets were pressed into the holes on the telescoping bar. The magnets fit flush on both sides of the telescoping mount arm; the telescoping mount arm was placed on a hard nonmagnetic surface. The rare earth disc magnets were set into the steel of the telescoping mount arm with a spring-loaded center punch. On both sides of the telescoping bar, three to four punches were placed 0.5 mm (.02 in.) away from the edge of the magnets. The punches around the magnets caused the steel to mushroom and prevented the magnets from slipping out. The telescoping mount arm was placed inside the steel channel. The rare earth disc magnets kept the telescoping arm from moving inside the channel.

The mount was easily installed with the two button-head cap screws. The top telescoping mount arm lifted up, and the plate was installed in the bottom two mount arms. The only function of the top mount arm was to keep the plate from bouncing out of the mount.

3. GENERAL GUIDELINES

Rare earth magnets should be used in a clean environment free from iron dusts; once dusts are picked up by a magnet, that magnet should not be used for mounting an artifact. The plated surface of the rare earth magnet should be protected from being chipped or scratched. Once the plating on the magnet starts to bubble or flake off, the magnet should not be used for mounting an artifact. To prevent any damage to the artifact from the use of rare earth magnets, a mockup of materials similar to the artifact and the display should be created and various magnet strengths and combinations, as well as magnetic surface thicknesses, should be tested. Increasing the space between the rare earth magnet and the magnetic surface with archival padding will reduce the force of the magnet on the object. However, the adhesive in polyester suede and felt can leach through the padded surface, so it is not recommended to use this on textiles or where a large surface of the magnet will be touching the artifact.

4. CONCLUSION

The purpose of this short communication is to present the specific applications of rare earth magnets currently in use as mounts at the Saint Louis Art Museum. Each artifact and exhibition display is unique, and adjustments to mounting systems are necessary to protect the artifact. The steps taken for these applications continue to be refined and adjusted as each application is used on different artifacts.

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REFERENCES

Ellis, S. 2008. Conservation DistList, Magnets for Exhibition Mounting. Message ID: cdl–22–26–008.

Moriarity, J., M. O'Malley, and L. Sevack. 1999. Magnets. *Lee Valley Technical Bulletin* 15: 1–4.

Potje, K. 2008. Conservation DistList, Magnets for Exhibition Mounting. Message ID: cdl–22–26–005.

Spicer, G. 2010. Defying gravity with magnetism. *American Institute of Conservation News* 35(6):1–5.

SOURCE OF MATERIALS

Archival corrugated board, archival hot glue, gummed linen tape
Gaylord Brothers
PO Box 4901
Syracuse, NY 13221-4901
www.gaylord.com

Adhesive backed polyethylene suede
Benchmark Exhibit Supplies
PO Box 214
Rosemount, NJ 08556
www.benchmarkcatalog.com

Acid-free, unbuffered tissue
Archivart
40 Eisenhower Dr.
Paramus, NJ 07652
www.archivart.com

Rare earth disc magnets, ferromagnetic cups
Lee Valley Tools
PO Box 1780
Ogdensburg, NY 13669-6780
www.leevalley.com

Marvel seal, Mylar, soft Tyvek, tested fabrics
Talas
330 Morgan Ave.
Brooklyn, NY 11211
www.talasonline.com

Ethafoam
Foam Products Corporation
2525 Adie Rd.
St. Louis, MO 63043
www.fpcfoam.com

Krylon crystal clear
Dick Blick
PO Box 1267
Galesburg, IL 61402
www.dickblick.com

Wire nails, washers, nuts, machine screws, and wood screws
Square steel tubing, steel flat stock, steel sheet
Local hardware and metal suppliers

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