MODIFYING RIVET FASTENERS IN HISTORIC ARMORS:
SEVERAL OPTIONS
KATHERINE CUFFARI AND DEBRA BRESLIN

A multiyear arms and armor treatment project at the Philadelphia Museum of Art introduced the occasional need to remove and replace the rivet fasteners that join plates and straps in historic armor objects. Several systems were employed to modify fasteners over the course of the project, with multiple aims: retaining the required strength of the fastener system; harmonizing the aesthetic of the armor object with minimal visible alteration; and minimizing the risk of mechanical damage during the course of treatment and in the future. The presented solutions were not devised solely by the authors; one was generously shared with the authors by an armor conservator and several were developed in concert with mount makers. Together, this collection of approaches to problems posed by armor fasteners was shared in the 2017 AIC Objects Specialty Group “tips” session.

KEYWORDS: Armor, Rivet, Reversible fastener

1. INTRODUCTION

The Philadelphia Museum of Art (PMA) is home to a notable collection of over 1,200 European arms and armor objects, the majority of which were bequeathed to the museum in 1977 by collector Carl Otto Kretzschmar von Kienbusch. During a recent multiyear project to prepare collection objects for publication in a pending catalogue, objects conservators encountered a range of challenges posed by fastening systems that joined straps and plate armor components. Like many types of objects seen as both utilitarian and highly collectible, armor objects have a history of significant mechanical and structural repair. Though earlier restorations often employed blacksmithing techniques, in recent decades there has been a strong engagement of modern conservation ethics in the treatment of these collections within museum contexts.

European plate armors are generally constructed of individual steel or ferrous metal plates, or lames, joined by leather straps, rivet fasteners, and occasional hinges. Components to protect different parts of the body are connected to one another with straps and buckles; the leather does the work of supporting and articulating the steel. Metal rivets are used to affix leather straps to the undersides of the plates—the straps often link multiple plates in series to create articulating components that bend along with the body in motion. Rivets also attach hinges, buckles, and linings to armors. Often, a domed rivet head is visible on the exterior of the armor plate, and the narrow solid post of the rivet passes through holes in the plate and leather. The bottom end of the post is peened with a hammer during fabrication, spreading the metal to fully cover the hole and create pressure on the join. “Blind” rivets, flat or peened on both top and underside surfaces, are used when successive plates are layered and must lie flush against one another. Sliding rivets pass through an oblong slot in the steel instead of a round hole, allowing for additional movement along the plane of the armor plate.

Given its strength and flexibility, leather is perfectly suited for joining steel plates during an armor’s use life. Unfortunately, the nature of leather deterioration proves deeply problematic to the objects over time. Deteriorated straps can prevent the proper closure or assembly of armor components. In the worst cases, depending on the nature of the armor’s structure, leather failure can lead to the complete detachment and disassociation of individual plates from a single component. Consequently, armors almost universally have been structurally repaired and leather straps replaced multiple times with the aim of keeping (or making) plate armor components intact and strong enough to be assembled. The removal and replacement of damaged leather necessitates the destruction of the rivets. Examining the interiors of armor objects is particularly revealing, as they usually bear several generations of leather and widely varied rivets and washer types (fig. 1).
While the presence of original leathers is unusual, it is obviously cause for extreme care. We only modified or removed straps that we and the curator were confident were 19th or 20th century restorations. In the interest of minimal intervention, we repaired and reinforced existing leather straps without removing fasteners whenever possible.

The use of traditional hammer-peened rivets involves risks that conservators prefer to avoid on historic objects, including drilling or grinding to remove fasteners and hammering in immediate proximity to historic surfaces to secure replacement rivets. As an additional challenge, the proportions of commercially available solid rivets are incompatible with historic armor. As a result, we employed alternative solutions to peened rivets when possible. In some instances, existing fasteners were structurally sound and serving their intended function but were aesthetically disharmonious with the rest of the object. Surface treatments were devised that allowed for retention of these fasteners.

Structural problems in armor objects can be addressed in multiple ways, some of which do not require physical intervention. Custom mounting structures can be fabricated to support component parts of an armor without altering the object, for example. This short presentation focused solely on instances in which modification and replacement of mechanical fastening systems was necessary to accommodate anticipated handling, photography, storage, interpretation, and display.

2. AESTHETIC ALTERATION OF EXISTING FASTENERS

One breastplate in the collection presented two examples of problematic fasteners from previous restoration efforts (fig. 2).
Several modern screws had been employed in a prior restoration. The screw-and-nut assemblies were a conservative choice—they were reversible, performed the necessary joining function to protect the object, and had been safer to install than peened rivets. The appearance of slotted heads on the exterior of the armor, however, was aesthetically problematic (fig. 3).

We also encountered rivets that were mismatched in size and metal surface when compared to surrounding fasteners (e.g., one steel rivet head surrounded by brass rivet heads). The heads of these rivets were often undersized in comparison to the other rivets on the armor, likely due to the aforementioned problem of the proportions of modern solid rivets (fig. 4).

To address the aesthetic problems posed by otherwise effective fasteners, we created sheet-metal caps that were adhered to the existing fastener heads. After unsatisfactory initial experiments with the heads of upholstery tacks and with the assistance of a mount-making colleague, we turned to custom hemispheres fabricated of sheet brass. Circles were cut from sheet stock with a jeweler’s saw and shaped with a dapping die and punches (fig. 5).

The caps were mechanically distressed; toned as needed with cold chemical patinas, toned waxes, or lacquers; and adhered to the fastener head with a viscous solution of Paraloid B-48N in acetone bulked with glass microballoons. The resultant caps balanced the appearance of the existing fasteners with the surrounding rivet heads without requiring removal and replacement (fig. 6).
3. RIVET REPLACEMENT

Some condition problems necessitated the removal and replacement of fasteners, particularly when the replacement of straps was required and when fasteners were missing entirely. In these instances, we used grinding and cutting bits on variable-speed rotary tools on the interior of the object to remove the peened edges from the rivet post and free the underlying washer. Protective barriers were used to
guard against damage of the surrounding surfaces. Several replacement fastener types were then employed in reassembly depending on the configuration of the object and the work required of the fastener.

Fig. 5. Dapping die and punches with new covering caps made from cut sheet brass (Courtesy of Philadelphia Museum of Art)

Fig. 6. After treatment images of brass caps adhered over the existing fastener heads shown in figures 3 and 4 (Courtesy of Philadelphia Museum of Art)
3.1 Threaded Fastener
Whenever the configuration of armor plates provided sufficient space for use of a nut on the interior surface, we used reversible threaded fasteners to minimize risk in assembly and ease retreatment. During a consultation about armor treatment questions, armor conservator Ian Ashdown generously gave us a threaded fastener assembly that he fabricated, which served as our prototype (fig. 7).

We began with two options for rivet heads. Using a jeweler’s saw, we either removed the heads from the restoration rivets that we had removed from the armor or we removed the heads from new commercial solid rivets. These heads were soldered onto a threaded rod of appropriate gauge (generally 4-40 or 6-32) and the rod was cut to length after a test assembly. Nuts with integrally attached smooth washers (nonmarring locknuts with spring-lock washers, also called Keps nuts or “K-nuts” without external teeth) were purchased to match the threaded rod. The locknuts with washers were dipped in a nitric acid solution to remove their bright galvanized surface and patinated with Birchwood Casey Presto-Black to minimize the industrial appearance of the fastener on the interior of the object. Figure 8 illustrates the fabrication steps for fastener and washer assembly.

Rivet heads were toned with patinating solutions, toned lacquers, and/or toned waxes. Threaded fasteners used to attach waist straps to a backplate are illustrated in figure 9.

3.2 Split-Tube Fastener
In concert with mount-making colleagues, we devised another option that was useful when a nut used to anchor a threaded fastener would have damaged an underlying plate and when no individual fastener was bearing a lot of weight. For this split-tube fastener, we soldered an annealed brass tube to the rivet head. This “rivet” was held in a jig and a jeweler’s saw used to bisect most of the length of the tube (fig. 10).
When inserted through a strap, steel plate, and washer, this annealed tube was pliable enough to be spread apart with a steel awl. When fully opened, the splayed brass fastener effectively compressed the sandwiched layers, lay flat against the interior surface, and could easily be removed without the use of grinding tools (fig. 11).

3.3 Peened Rivets
In a few instances, neither of the previous solutions were viable options. Solid peened rivets were employed when an underlying armor plate prohibited the use of a threaded fastener and nut assembly and individual fasteners and straps needed to bear significant weight. Peened rivets were also employed to
attach buckles onto straps since a smooth underside surface was required. For the breastplate, backplate, and gorget seen in figure 9, the curator requested wholesale replacement of straps because the prior restoration straps were too short for the components to be assembled with appropriate proportions. As the weight of the breastplate and backplate is borne by the buckled shoulder straps, which anchor at only one point each, split-tube fasteners were not a good choice. These plates also lie directly on the gorget when assembled, leaving no room for the interior nut that would be required to affix a threaded fastener.

The proportions of commercial solid rivets do not match those of historic armor objects; the heads of large rivets tend to match the most recent rivets on the objects, but the posts are too large to fit through the holes in the plates. Conversely, the rivets that fit through the holes have heads that are too small (fig. 12).

We used a belt sander or lathe to reduce the diameters of the posts of large rivets and cut the posts to appropriate length after a test assembly. We created a small rivet set in a solid 2-in.-diameter brass rod using a burr grinder in a rotary tool to create a small semicircular recess that could accommodate and
protect the rivet head during peening. The small size of the rivet set allowed for flexibility in placement, which is helpful when one needs to safely support the entire armor object in a configuration that allows for hammering of one rivet post. During attachment of the new leather straps, the rivet posts were peened over washers, using a ball peen hammer and the rivet set (fig. 13). Steel rivets were used on this armor to match the surrounding hardware on the object (fig. 14). We used brass rivets when brass-capped...
rivets already existed on the object. Brass posts were immediately discernable as replacement fasteners from the interior of the plate, and the greater malleability of the metal facilitated the hammering process.

4. CONCLUSION

When modification or replacement of rivets and other fasteners in historic armor objects is required, a range of techniques can be employed to produce well-matched, sufficiently strong fasteners that minimize alteration of and risk to original components.

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SOURCES OF MATERIALS

Solid Rivets, Threaded Rod, Locknuts with Washers, Brass Hollow Tubing, and Brass Sheet
McMaster-Carr
200 New Canton Way
Robbinsville, NJ 08691
609-689-3000
http://www.mcmaster.com

Jeweler’s Saw, Dapping Die and Punches, and Silver Soldering Supplies
Rio Grande
7500 Bluewater Road
Albuquerque, NM 87121
800-545-6566
http://www.riogrande.com

Birchwood Technologies Presto Black BST4 for iron/steel, and Antique Black M20 for copper alloys
Birchwood Laboratories, LLC
7900 Fuller Road
Eden Prairie, MN 55344
800-328-6156
http://www.birchwoodtechnologies.com

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

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