**Technical Note**

**The Use of X-Ray Fluorescence Spectroscopy (XRF) in the Technical Study of Gilt Bronze Mounts in This Catalogue**

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Throughout this catalogue, there are numerous mentions of the analysis of gilt bronzes using energy dispersive X-ray fluorescence spectroscopy (XRF). This analytical technique can be used to characterize the elemental composition of the copper alloy casting metal from which these objects are made. Results from this analysis are used to draw conclusions about the authenticity of mounts, as well as likely dates and regions of manufacture.

Gilt bronze furniture mounts are referred to in this catalogue as “bronzes” since this is common parlance, although they are technically brasses, composed primarily of copper and zinc. They have been reproduced, rechased, and regilded for centuries, making attribution and authentication based on style and workmanship problematic.[[1]](#endnote-1) Already by the fourth quarter of the eighteenth century Parisian cabinetmakers were replicating and reusing gilt bronze mounts and other elements of Baroque furniture from the early part of the century. Such revivals in the popularity of earlier styles have followed each other in a complex and never-ending cycle. Leaving aside what might be called “legitimate” reproductions, produced with no intent to deceive, it is clear that deceptive reproduction has occurred for centuries and continues to this day.[[2]](#endnote-2)

Further complicating matters of attribution and authentication, the traditions of material use and methods of fabrication have been passed down through the generations with remarkable consistency. A young artisan in Paris in the nineteenth century, or even today, might receive training as a founder, chaser, or gilder and learn to use tools and techniques that would be entirely familiar to his eighteenth-century counterpart.

While studying the gilt bronzes applied to the furniture in this catalogue, we have employed a number of different methods of technical examination, all of which are important in evaluating their authenticity and quality. These methods include careful examination of chasing techniques (the tooling and finishing of the display surface), inspection of unfinished surfaces (typically on the reverse side of the mounts), X-radiography, and elemental analysis using XRF. While all of these methods are important for evaluating gilt bronzes, XRF has proven to be of particular utility.

Elemental analysis of gilt bronze objects using XRF has been a subject of systematic study at the Getty Museum for over fifteen years. XRF is a very attractive analytical choice for studying artworks as it is a nondestructive method that can provide rapid, multi-element, quantitative analysis with high sensitivity. The analytical program at the Getty has focused primarily on the composition of the base metal used for French castings; data have also been regularly collected on the composition of soldering metal,[[3]](#endnote-3) sheet brass (such as that used for boulle marquetry, hinges, and locks), and gilt bronzes from other regions, particularly England and German-speaking states.

In practice, XRF is a very difficult technique to use well, particularly for quantitative analysis. The spectra generated by XRF instruments can vary considerably from instrument to instrument, and, because of the complex interactions between X-ray photons and heterogeneous materials like historical brasses, the process of converting spectral data to accurate, precise, and reproducible quantitative measurements of composition is extremely challenging. Considerable effort has been made to ensure that the data used here (collected using five different instruments) have been collected and processed in a reliable and comparable manner.[[4]](#endnote-4)

The XRF studies at the Getty have focused on the period from 1675 to the present, and thus far, the data gathered include the results of approximately 1,300 XRF analyses of discrete components belonging to approximately 250 different objects. We have attempted to study as many securely provenanced and dated objects as possible from throughout the period. To this end, over 500 of these compositional analyses (representing individual components of approximately 120 objects) of Parisian casting metal can be considered “reference material,” that is, material whose date of production in Paris is known within a period of twenty years to a high level of confidence. This relatively large data set of reference analyses has become extremely valuable as a point of reference when evaluating gilt bronzes of uncertain provenance.

The collection of the J. Paul Getty Museum contains many examples of securely authenticated French gilt bronzes of the late seventeenth and eighteenth century but many fewer objects from later periods. The author has thus depended on, and benefited greatly from, the generosity of many other institutions and private individuals who have granted access to objects, particularly of the nineteenth and twentieth centuries, for analysis by XRF. These are Adrian Alan, Atelier Michel Jamet, Yannick Chastang, Doheney Mansion, the Fine Arts Museums of San Francisco, Institut national du Patrimoine, Kunstgewerbemuseum (Dresden), musée Carnavalet, musée des Arts décoratifs (Paris), Christopher Payne, the Preservation Society of Newport County, the (British) Royal Collection, the Foundation of Prussian Palaces and Gardens, the Victoria and Albert Museum, and the Wallace Collection, among others.

XRF analysis of copper alloys, as currently practiced at the J. Paul Getty Museum, returns compositional data for thirteen elements. For the purposes of discussion, these can be divided into two groups: the so-called major and minor elements. It should be noted that there is no clear consensus in the literature regarding the definition of terms such as “major,” “minor,” and “trace” for analysis of this sort, and the terms as used here are relevant only to the present context. For gilt bronzes, the concentrations of the major elements—copper, zinc, tin, and lead—serve to define the casting alloy, and they are all generally present in the casting metal in amounts of around 1% or greater by weight. They are also all elements that foundrymen, particularly in the eighteenth and nineteenth centuries, would have considered the fundamental components of their alloy. Thus, it is these four elements that the foundry exercised intentional control over to formulate their casting metal alloy. The additional minor elements are generally present in amounts of less than 1% and, importantly, are elements that founders normally would have had little influence over since they are essentially impurities. The relative abundance of these elements reflects the level of smelting and refining technology at the time the metal was produced, as well as the origin and nature of the ore used to produce the metal. The minor elements of interest that are detectable by standard XRF methods include (in order of atomic weight) manganese, iron, cobalt, nickel, arsenic, silver, cadmium, antimony, and bismuth.

The data compiled to date have yielded considerable insight into the working methods and materials of French *bronziers* and have proved to be of considerable utility for the evaluation and authentication of gilt bronzes in the Getty collection. Some forays have been made into sophisticated statistical and machine learning analysis of the data generated, with promising results.[[5]](#endnote-5) Some conclusions based on these methods are presented in this catalogue, and further work in this direction is anticipated. It has also become abundantly clear that meaningful interpretation of the quantitative results depends very strongly on an understanding of the history of both artistic technology and metallurgical technology. That is to say, the numbers and statistics may suggest a conclusion, but confidence in the significance and reliability of the conclusion comes only if it can be supported by other methods of technical examination informed by a familiarity with artistic tradition and technological history.

In addition to quantitative analysis of base alloys, XRF analysis can provide useful information regarding the presence and method of gilding used in the production of gilt bronze objects, though the results may not be conclusive. First of all, the detection of substantial amounts of gold can confirm, naturally, that an object has been gilded. This is not necessarily as trivial a finding as it may seem since it was not uncommon in the eighteenth century to apply durable tinted varnishes to chased and polished castings, creating the appearance of gilding for a fraction of the cost.[[6]](#endnote-6) There are instances where even an experienced eye may have difficulty telling the difference, particularly on dirty and corroded pieces. XRF analysis can also give a reasonably good indication of whether a piece has been gilded by traditional mercury amalgam gilding or by electroplating. Based on XRF analyses from reference objects, amalgam gilding generally results in a considerably thicker layer of gold than electroplating, and spectral peaks for mercury are quite clear in the spectra from amalgam gilt objects. Electroplated bronzes may, however, also show that some mercury is present, either from chemical pretreatment or, in the case of restored bronzes, as residues from an earlier amalgam gilding.

## ***Bibliography***

{{de Bellaigue 1974}}; {{Heginbotham et al. 2011}}; {{Heginbotham et al. 2015}}; {{Heginbotham et al. 2019}}; {{Heginbotham et al. 2020}}; {{Heginbotham, Erdmann, and Hayek 2018}}; {{Jacobsen 2016}}; {{Roubo 1774}}.

1. {{Kisluk-Grosheide 2008}}; {{de Bellaigue 1974}}, vol. 1, 35. [↑](#endnote-ref-1)
2. {{de Bellaigue 1974}}, vol. 1, 36; {{Jacobsen 2016}}. On present-day deceptive reproduction, see, e.g., Vincent Noce, “New Twist in Fake Antique Furniture Scandal Overshadows Opening of Biennale des Antiquaires in Paris,” *Art Newspaper*, September 8, 2016. [↑](#endnote-ref-2)
3. We have chosen to use the terms “solder” and “soldering metal” in this volume because they are familiar and correspond well with the widely used French terms “souder” and “soudure.” In this context, the terms refer to joining pieces of brass by the addition of a lower melting brass alloy that is melted into the joint. This procedure would in fact be more properly referred to in technical English terms as “brazing” and the metal used as “brazing metal.” [↑](#endnote-ref-3)
4. {{Heginbotham et al. 2011}}; {{Heginbotham et al. 2015}}; {{Heginbotham and Solé 2017}}; {{Heginbotham et al. 2019}}. [↑](#endnote-ref-4)
5. {{Heginbotham, Erdmann, and Hayek 2018}}. [↑](#endnote-ref-5)
6. {{Roubo 1774}}, vol. 3, 1031–33. [↑](#endnote-ref-6)