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title: Case Study 1

subtitle: Reconsideration of a Monumental Roman Relief: The Dolphins of Vienne, France

contributor:

* first\_name: Benoît

last\_name: Mille

bio: Benoît Mille (Archaeometallurgist, Centre de Recherche et de Restauration des Musées de France [C2RMF], Paris, and Laboratory TEMPS-CNRS-Nanterre University) received his PhD in 2017 on the earliest history of lost-wax casting from the Universities of Nanterre and Fribourg. Since 1993 he has been a researcher at the C2RMF, mostly investigating the beginnings of metallurgy (south of France, Pakistan, Chile) and the evolution of large bronze casting techniques (Egypt, South Arabia, Greece, Rome). He coedited *“Bronzes grecs et romains, recherches récentes”* – *Hommage à Claude Rolley* (2012), *Bronzes grecs et romains: études récentes sur la statuaire antique* (2017), *Launac et le launacien* (2017), and *Nouveaux regards sur le trésor des bronzes de Bavay* (2019).

* first\_name: David

last\_name: Bourgarit

bio: David Bourgarit (Archaeometallurgist, Centre de Recherche et de Restauration des Musées de France [C2RMF], Paris, and Laboratory TEMPS-CNRS-Nanterre University) has a background in physics, with a PhD on the physical metallurgy of a specific titanium alloy. Since 1996 he has been a researcher at the C2RMF, where he has been investigating metallic artifacts from almost all periods and regions. His primary research interests are in the technological approach to copper metallurgy, with a focus on the provenance of copper and fabrication techniques. He coedited *French Bronze Sculpture: Materials and Techniques 16th–18th Century* (2014).

abstract: Fragments of a unique, large-scale, gilded Gallo-Roman relief unearthed in the early nineteenth century in Vienne, France, were the subject of an extensive conservation campaign that included a multidisciplinary technological investigation. The results not only shed new light on the skillful methods of production that went into the object, but also led to a reinterpretation of the group’s composition and resulted in the fragments’ rearrangement for display.

short\_title: Case Study 1

## Slide 1: Introduction

Fragments of a unique, large-scale, %%gilded%% Gallo-Roman relief unearthed in the early nineteenth century in Vienne, France, were the subject of an extensive conservation campaign that included a multidisciplinary technological investigation. The results not only shed new light on the skillful methods of production that went into the object, but also led to a reinterpretation of the group’s composition and resulted in the fragments’ rearrangement for display.

**Figs. 440, 441, 442, 443, 444, 445, 446**

## Slide 2: Context: The discovery of the dolphins in Vienne, France

In 1839, during excavations for a new quay on the riverbanks of the Rhône in Vienne, engineers using a pile driver unearthed what were described as a group of “imposing metallic fragments.” These were a rare discovery: the remains of a monumental gilded %%bronze%% relief representing swimming dolphins consisting of two heads, a body in two fragments, and three tails. This sculptural group, now known as the Great Dolphins of Vienne,is a rare surviving example of such reliefs from the Roman world.

**Fig. 447**

## Slide 3: Context: Occasions for technical studies

The bronze fragments had been studied in the 1960s. Based on the surviving tails, the proposed reconstruction of the relief’s original composition was a five-meter-long frieze ofthree dolphins swimming in a row. The visual examination already made clear that joins were present, and that the relief surface was extensively repaired. In 2006, the Vienne museum decided to renovate the presentation of the dolphins. Given the fragmentary nature and the complicated reading of the find, the museum requested a thorough technological probing as part of the conservation process, which addressed a series of questions about the sculptural group.

**Fig. 448**

## Slide 4: The main questions

• How was it made?

• How do the surviving fragments fit together?

• Why was it so heavily repaired?

• What may have been the original iconography and composition of the full relief?

**Figs. 449, 450, 451, 452, 453, 454, 455**

## Slide 5: Visual examination: Some important new findings

By puzzling through the physical evidence on the fragments, the scientist-conservator team discovered a previously undetected connection between the two dolphin heads. Closer study of the fragments proved that the dolphins were originally side by side, hitched together, thereby fundamentally modifying our understanding of the relief’s composition. At the same time, they noticed a neatly cut-out area at the top of the dolphin in the foreground: this is possibly where a rider may have been posed. It also became clear that the deformation and fragmentation in one area of the relief was largely the result of violent and high-speed impacts of a 13 × 13 cm implement—very probably the pile driver used in 1839.

**Figs. 456, 457, 458**

## Slide 6: Interpretation 1: Reconsidering the original composition

The new understanding of the arrangement resolves some iconographic inconsistencies. The dolphin in the foreground turns its head toward the viewer while the one in the background is presented in profile, reinforcing the perspective. In the same way, the wave rising behind the head of the foremost dolphin and descending over its body and tail should be read as passing between the two dolphins. The cutout at the top of the foreground dolphin could correspond to the inset of a rider such as Eros. The existence of three dolphin tail ends still raises questions. Were more than two dolphins hitched together? The newly determined perspective, the structure of the waves, and the presence of the upper edge preserved in most places make this an unlikely scenario. Instead, the tail could belong to one of a second pair of dolphins, or—given how widely it is splayed—to an unhitched, frolicking dolphin diving into the waves.

**Fig. 459**

## Slide 7: Evidence of fabrication: How was the wax model made? (1 of 2)

Examination of the rear surfaces of the fragments revealed evidence that the sculptor worked in wax and had access to what would have been formed as a wax shell in a %%mold%%—in other words, an indirect %%lost-wax casting%% process. One finds, for instance, a series of marks made by dragging a tool through a malleable material that were ultimately translated into bronze.

**Fig. 84**

## Slide 8: Evidence of fabrication: How was the wax model made? (2 of 2)

The presence of numerous %%sprues%% on the reverse also proves that the wax %%model%% was worked from the back surface, and therefore not built up directly on a %%core%%. The wax heads were made of separate parts that were joined in the wax. This can be seen in the lips, for instance, which appear to have been made up of several discrete sections, which would further confirm the use of an indirect process. The overall even thickness of the bronze walls, which was confirmed by radiography (see slide 11 below) points to the probable use of a wax slab process, as that would offer greater control than other processes such as slush molding.

**Figs. 86, 441**

## Slide 9: Evidence of fabrication: How were the segments of the relief assembled? (1 of 2)

Once all the separate parts were %%cast%%, the vast puzzle of primary castings had to be assembled. To achieve this, the Roman %%founders%% responsible for the relief used flow-fusion %%welding%%, a technique learned from ancient Greece, where it had been practiced since the fifth century BCE. Recent scientific studies and characterizations of ancient welds, with experimental simulations in the laboratory, have shed more light on the long-forgotten process (see **video 12**; [I.5](#I.5)). With its three-plus linear meters of weld joins, the Vienne dolphin relief bears testimony of the extensive application of this complicated method of assembly. And while the remains of the relief represent only a small part of the original sculpture, they provide a window into the exceptional scale and ambition of this work.

**Fig. 460, video 12**

## Slide 10: Evidence of fabrication: How were the segments of the relief assembled? (2 of 2)

Some welds measure more than a staggering 70 cm in length. The fact that these joins were achieved in a single %%pour%% bears witness to the great mastery of the founder. The welds were very wide and the flow of metal must have been contained, probably by channeling the welding metal with a %%refractory mold%% that covered the whole weld path. Despite the channeling, some leakage did occur (see also slide 14 below). Bulk alloy analyses by inductively coupled plasma with atomic emission spectroscopy (ICP-AES) on drillings indicated a difference in the alloy used for the different sections and welds. The alloy of all of the primary castings is in the range of 3–4% tin, 5% lead, and the welds are 1–2% tin, 5% lead.

**Figs. 461, 462, 463**

## Slide 11: Evidence of fabrication: Structure of the assemblage using X-radiography

X-radiography confirmed that the metal walls of the separately cast sections are relatively thin and even across the board (measured at 4–6 mm), including the mouth area, even though it is in high relief. It also helped to clearly map out the extent of the assemblage: the welds show up as irregularly shaped, lighter swaths that correspond to the thicker—and therefore denser—metal joins. The vast amount of repair work that the relief necessitated, especially in the central area, is visible as well. The edges of the many polygonal %%patches%% that were inset into the outer surface to repair the innumerable small flaws are recognizable, as are the copper rivets, which will be further discussed below.

**Fig. 367**

## Slide 12: Interpretation 2: Proposing a casting plan

Roman founders did not have the technological know-how to cast complex pieces such as the dolphin relief in a single large pour, so they cast larger sculptures in smaller sections (primary castings) and then joined the metal parts by flow fusion welding (see [I.5§1.1](#I.5§1.1)). Careful examination of the fragments and the corresponding radiographs, which helped locate the joins, led to the proposal of a %%casting plan%%for the eleven extant pieces of the large relief. It provides some idea of how the original model was divided up to facilitate casting.

**Fig. 367**

## Slide 13: Evidence of fabrication: How was the cast repaired?

All large ancient bronzes, even exceptional commissions, will inevitably have some %%casting defects%%, as is reflected by the large number of repairs. The Vienne dolphins are no exception: if the extant portions are anything to go by, the relief was heavily flawed. Repairs cover 25 percent of the exterior surface. But once they were covered by gilding, they would have been nearly invisible. Close examination of the surfaces, aided by cleaning during conservation, showed that the external bronze skin is riddled with endemic %%porosity%% (fine holes that formed in the metal during casting) and repairs. These are even more clearly visible in the radiographs (see **fig. 367** on slide 11). It was possible to tally no less than 265 patches made of bronze. Many of the largest ones (a total of 178) were fastened to the primary %%cast%% from the back with copper rivets.

**Figs. 367, 464, 465, 466**

## Slide 14: Interpretation: Summary of main technological features observed at the back of the dolphins

The diagram synthesizes the evidence preserved from the various stages of production of the relief beginning with the creation of the wax model. The discrete, indirectly formed sections were joined in the wax (light blue lines). Sprues and hanging rings (blue) were modeled in wax and joined to the back. The separately cast bronze pieces (fine red lines indicate the edges) still preserve some %%core pins%% (black dots) and %%flashing%% (lilac).The separate bronze pieces were joined by massive flow fusion welds (red to pink). And the many flaws were fixed with %%cast-on repairs%% (brown) and innumerable patches (green), many of which were reinforced with rivets (dark green).

**Fig. 467**

## Slide 15: Conservation treatment and surface coloration (1 of 2)

As conservators prepared the careful mechanical cleaning of the surface, examination of all of the fragments also served to assess their structural and physico-chemical condition and any alterations of the metal. Focus was on the removal of the bronze %%corrosion%% products that masked the entire surface. It was decided early on to clean the reverse as well in order to enhance the readability of technical features and learn as much as possible about the object’s manufacture. There was no question of attempting to address deformations or fill losses.

During the cleaning, which was mostly done mechanically with an ultrasonic scalpel, it became clear that below the outer corrosion crust, the bronze surfaces of the dolphins still preserved much of an original gilding. The geometric pattern of 12 cm wide squares with denser gold at their edges was clear evidence that gold leaf had been used and applied, as is traditionally done in many cultures, overlapping neatly at the edges. The main challenge in laying bare the gilding was to avoid damaging this extremely fine layer, given its fragility and the corroded state of the underlying bronze.

**Figs. 290, 468**

## Slide 16: Conservation treatment and surface coloration (2 of 2)

Also revealed was that the decorative layer was applied selectively: the waves bore no trace of gold. Instead, their surfaces, which were only slightly corroded, were found to have been covered with a very dark (brown to black) homogeneous layer. Whether it was deliberately %%patinated%% black to create a dramatic contrast with the gilded dolphins remains to be determined. A virtual, colorized reconstruction shows what such a dichromatic surface treatment might have looked like.

**Fig. 381**

## Slide 17: Summary of findings

The results of the technological study allowed the fragments to be repositioned, which resulted in a composition that produced an unexpected new sense of perspective, spatial depth, and movement. A new iconographic interpretation was proposed for these rare remains of an important architectural ornament: it was not a five-meter-long frieze of dolphins, but a hitch of two dolphins, probably pulling a marine chariot and most likely with a rider, Eros, atop one of them. The original gilded surfaces that were uncovered during conservation treatment lend more visual power and sophistication to the relief.

Technological examination showed that the preserved fragments were created in a unified manner and the product of one workshop, as evidenced by:

* the unified production of the lost-wax model with similarly thin and even wall thicknesses;
* similarity in the kind and quantity of casting defects (usual in the Roman period) and their repair; same alloy;
* same variant of flow fusion-welding over more than three meters of linear joins.

**Figs. 379, 380**

## Slide 18: Synopsis of technical parameters

The Musée des Beaux Arts et d’Archéologie de Vienne coordinated the entire operation. The C2RMF took charge of developing, setting up, and carrying out all of the examinations and analyses. The restoration project was conducted by the Center for Restoration and Municipal Archaeological Studies (CREAM) in Vienne. The objectives and issues of the restoration project were determined and discussed collegially by the three partners. The study consisted of:

• daylight photography: C2RMF studios using a high-resolution Hasselblad numerical camera;

• X-radiography: C2RMF using an Isovolt 420 kV X-ray tube;

• bulk metal analyses by atomic emission spectrometry (ICP-AES): C2RMF using a Perkin-Elmer Optima 3000 SC atomic emissionspectrometer; a protocol developed specifically for elemental analysis of cultural heritage copper-based artifacts was used ({Bourgarit and Mille 2003});

• 3D scanning and reconstruction: Archeovision using lasergrammetry and 3D modeling.

## Slide 19: Further questions

• What did the full relief look like and represent?

• Were the rivets a distinctive way of securing patches, or commonly used?

• Was the dark patina on the waves deliberate?

• Was the low tin content (1–4%) of the alloy used for the primary casting commonly used for large Roman bronze sculptures? Or was it particular to reliefs?

• Why was the work so heavily repaired?

## Slide 21: Further resources

<https://c2rmf.fr/actualite/les-grands-dauphins-de-vienne>

{Azéma et al. 2011}

{Azéma and Mille 2013b}

{Azéma 2013}

{Boucher 1964}

{Mille and Robcis 2012}

{Mille 2017}