A 3D Potree tool for the technological study of sculpture

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Abstract

If the realization of 3D models is now commonplace, the production of professional systems for the digital study of works of art, and sculpture remains a scientific challenge. Within the framework of an ARC project, the PANORAMA platform of the Université libre de Bruxelles has developed a tool for the acquisition and digital study of sculpture. This tool is not only aimed at Heritage documentation: through examples, it is demonstrated that it is an effective support of technological study.

Keywords

Sculpture, Technology, 3D modelling, Digitization, Digital Humanities

Introduction

3D sculpture digitization systems have become commonplace nowadays. With little effort, it is easy to use programs like Sketchfab®, as several Museums do, for 3D model visualization. The acquisition of these models is structured by methodological and solid studies (Alliez et al., 2017; Malik & Guidi, 2018).

However, these uses are most often dedicated to illustrative or informational purposes. There are still many difficulties in producing models for scientific study. For sculpture, particularly bronze, reflection issues are still a challenge for texturing, especially for the details. The production of highly accurate and, therefore, hefty models for online use is another major challenge. Finally, the production of models available for scientific study implies a level of detail and completeness (photogrammetry of the interiors, for hollow bronzes, for example) which, in practice, are complex to achieve.

Trying to address these issues, in the framework of an ARC at the Université libre de Bruxelles, we have developed a 3D tool for the study of sculpture using the open-source WegGL-based point renderer Potree.

The 'USINE' Project

This platform has been developed since 2020 within the 'USINE' project (Uses of Sculpture and Industrialization: New Evolvements) submitted in the framework of the ARC call in the French Community of Belgium. It brings together a large number of partners, the University of Brussels, but also the University of Rouen, the University of Paris-Nanterre, the Rodin Museum, the University of Lyon, and more, and seeks to bring together, over the course

of the project, any partners who wish to join the research actions. USINE will produce academic deliverables (symposia, publications, seminars), but its particularity is also its technological component. A research engineer was hired for a year to develop and set up the 3D study platform for the sculpture. This was launched in October 2021 (https://usine.ulb.be/plateform/) and will be upgraded and developed until 2025. From 2021 onwards, a logistician was hired with the task of expanding the corpus of models and promoting this tool within the scientific community. A corpus of sculptures from the collections of the partner institutions will be uploaded online during the years of the project (2020-2025), but in the long run, the objective is that institutions and museums could appropriate the platform for downloading sculptures from their collections to build up a corpus that is sufficiently developed to be used for a global online technical study of contemporary sculpture.

The industrialization of artistic practices: a turning point in the History of Sculpture?

From the years 1850-1860 onwards, stimulated by the industrial revolutions, sculpture underwent profound changes, both in its processes and in its practices. Practitioners' workshops became specialized, foundries became real industries where mechanization and division of labour were applied, and workshops diversified and welcomed specialized workers.

As a result, historical practices of sculpture have been profoundly modified. From the middle of the century, public statuary provided important commissions for the sculptors (i.e. *La sculpture française au XIX^e siècle*, exh.cat., 1986; Wautelet, Clerbois, 2015, p.40-58). The industrialization of foundries generated significant projects that contributed to the revitalization the market. On the other hand, from 1860 onwards, the rise of "small statuary" contributed to spreading sculpture through reductions, editions, or counter-mouldings in a range of materials, sandstone, painted plaster, and galvanoplasty, which popularized the sculpted image and diversified the sculpture market by introducing it into the sphere of the middle class (Tillier (dir.), 2016).

As a result, the profession of sculptor changed. The artist began to organize the work of practitioners who performed technical tasks. The casting of bronzes was delegated to industrial foundries (Rionnet, 2016). The marble carving was also entrusted to specialized workers, who reproduced the models with the pointing machine technique. The industrialization of the craft also nourished the innovation, invention, and development of "sculpting machines". The pantograph made it possible to reduce or enlarge the sculptures without the sculptor's hand being required. The "pointing technique" made it possible to authentically reproduce the original models with great precision (Dunstan, 2014; Dunstan, 2016).

These profound changes have left their mark on the material. Through the traces of tools, fingers, *hands*, or the "new machines", sculpture shows, on its skin, the palimpsest of a technical discourse that the history of art seeks to document and study. Correctly interpreted,

these technical traces document the evolution of sculpture practices during the industrial age, while at the same time, they provided art historians with objective keys to identification and interpretation.

About epistemology

Obviously, the creation of a 3D platform for the study of sculpture does not arise in *terra incognita*. From a historiographical point of view, the study of sculpture technology has long had reference works. In the French area, the book *Sculpture. Méthode et vocabulaire*, by Marie-Thérèse Baudry (2000) is almost a bible on the subject. On the Anglo-Saxon side, there is no synthesis of this magnitude, but the books by Nicholas Penny, *The materials of Sculpture* (1993), or *The making of sculpture* (2007), edited by Marjorie Trusted, among others, provide a solid basis for understanding materials and techniques. Of course, these books sometimes require adjustments or clarifications that the platform could provide, particularly on the most technical issues, which are not covered by the generalist approach of these publications.

In the field of material studies developed over the last two decades, technological or material problems are more and more regularly put into perspective within art history. Martina Droth, the author of *Revival and Invention, Sculpture through its Material Histories* (2011) brought some of the most innovative studies at the time, throughout the historical periods, and try to draw some methodological perspectives on the topic.

In any case, it seems that there is a lack of an intermediate level between technology and art historical studies encompassing material issues. Figure 1, a sculpted portrait of the French painter Jean-Charles Cazin made by his wife, Marie Cazin, shows a rusty element on the top of the head which corresponds to the anchoring point of a pointing machine, which shows that the work was made by a craftsman based on an original model in plaster. Figure 2 shows the bust portrait of the Belgian King Léopold II, by Thomas Vinçotte. The work is carved on ivory plates. The choice of material here is mainly symbolic and efficient. In economic terms, despite its prestige, ivory was accessible since, to stimulate a "revival" of ivory sculpture, Leopold II offered elephant tusks from the Congo colony to Belgian artists. But above all, this kind of sculpture was used in International Exhibitions to legitimize the colonial discourse. And it worked. Brussels was seen as a "New Athens", where the chryselephantine sculpture was a kind of new “Pallas Athena”, and where Belgium is seen bringing "civilization" to the Congo. Here, the material and its *mise en oeuvre* play a significant part in the meaning process (Clerbois 2011, p.231-256).

These two plans resemble what is commonly found in scientific literature: detailed studies dealing with a technological problem or, more generally, classical art history studies incorporating material issues. But, between these two plans, our platform aims to provide a

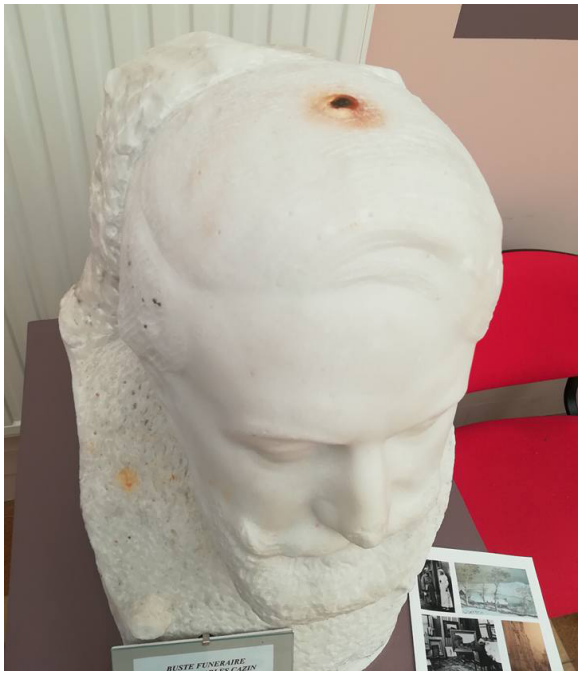

Figure 1 - Marie Cazin (1844-1924), *Portrait of Jean-Charles Cazin*. Date unknown (around 1901). Marble. Samer, Cazin Museum. Photo by Alexandre Buchet, Académie royale de Médecine de Belgique.

Figure 2 - Thomas Vinçotte (1850-1925), *Portrait of Léopold II, King of Belgium*. Around 1897. Wood and ivory. Brussels, Royal Museum for Central Africa. Photo by Alexandre Buchet, Académie royale de Médecine de Belgique.

specific tool capable of better linking technical and technological findings to art historical issues to strengthen the integration of material issues when *making sense* in art history.

For example, is it possible to understand *processes* by documenting both technical points of interest also by linking these points to a framework of analysis that describes the phenomenon of which it is only the expression, the consequence?

On the issue of industrialization — the key issue of the USINE project — which had a significant impact on sculpture, particularly in the 19th century, one wonders whether all the conclusions that could be drawn from the study of phenomena could not be better linked to the thousands of technical observations which are the consequences of these phenomena, and of which, sometimes, we understand little, too little. At that time, for example, the commission of public sculpture considerably increased. For technical reasons, especially for large sculptures, sand casting was preferred to lost-wax casting (Lebon, 2012). Can we study this phenomenon through technical markers? What impact did it have on techniques, but more importantly, on sculpture practices? And can we see this in the material?

The web platform

The platform uses the open-source WebGL-based point renderer Potree as a support for the 3D visualization and the study of sculpture. Its conception is based on three key ideas:

- Digitalization. The sculptures in the corpus do not correspond to the notion of the *masterpiece* that often determines their presence in museums. The sculptures we have chosen to study are often kept in storerooms, in public collections that are not easily accessible or in private collections. To reach these works and to be able to handle them for the study is a *mission: impossible*. Knowing the technical possibilities that we have today, dematerialization is needed, even if studying the material on a computer screen can be problematic and does not replace, of course, natural vision.
- Three dimensions. The study of sculpture must necessarily be done in 3D. Here, the technological contribution is an asset since it is difficult to handle and study in good lighting conditions works that are sometimes very heavy and often stored in poorly lit spaces.
- Cooperation. The technical study of such complex phenomena can hardly be done through classical academic formats, such as conferences or seminars. It requires the close collaboration of many scientists, over time, across geographical, cultural or linguistic boundaries. The creation of an online collaborative tool allows for a permanent and, above all, long-term global exchange. To facilitate these exchanges, we have chosen a bilingual tool, English-French. French because it is the language of the most voluminous book on sculpture's materials and techniques (Baudry, 2000), and English because it allows communication on a global scale.

Within the framework of the project, about fifty models of sculptures will be uploaded, but, as said before, we have published on the platform a user guide to help professionals to generate and upload their models.

For technical reasons of model weight but also to avoid the possibility of forgery, the model is presented as a high-resolution mesh of points (Figure 3). The color is not identical to human vision because the model was digitized by photogrammetry in cross-polarization to avoid the reflections one can usually see on bronzes (Hallot, Gil, 2019). This technique helps to reveal the technical markers. However, a Sketchfab® model is available for each sculpture. It allows access to a photorealistic 3D model.

When possible, the model shows the outside and the inside of the sculpture. The acquisition of the inside is made by photogrammetry with an endoscope. Around the model, a set of high-definition photographs show each part of the sculpture. Each photo is associated with a red layer on the model, which precisely locates the photograph in space.

Then, a delimitation tool allows the point of a technical marker; this is done with a classic segmentation tool by surrounding the point or area of interest. From there, it is possible to access the annotation section. Each specialist who identifies a marker can then propose a description of his observation. A definition can be generated from the description. The issue is obviously how to validate these definitions. Who decides? Who moderates? What if there is a debate or discussion? The option chosen was to produce a transparent system based on voting. Indeed, each participant can vote on a definition. At any given time, each definition is associated with a percentage of votes. It is possible to see whether the definition is supported by the scientific community or, on the contrary, whether it is rejected. In the event of rejection, it is, therefore, possible to propose a new definition, which will be put to the vote, etc.

This functionality has not been activated yet, but we are looking into the possibility of a thesaurus, i.e. a constituted scientific committee could definitively validate approved definitions that would not appear in the discussion area but in a kind of online dictionary.

Among other possible extensions to the platform, we have also considered the possibility of implementing artificial intelligence. A marked point of interest would be defined as a model for the automated identification of other identical patterns, as is done today in medical imaging. But this needs much more development, which would require, for example, further European funding to be successful.

A case study: the bronze bust portrait of Jules Bordet

This bust (Figure 4), by the Belgian artist Edmond de Valeriola, is in the Université libre de Bruxelles. Jules Bordet was a famous Belgian immunologist (1870-1961) who won the Nobel Prize in Medicine in 1919 for his research in microbiology. This portrait was commissioned in

February 1927 by the Alumni Union, of which Jules Bordet was president. Around 1928, the Union offered it to the University, which installed it in the *Salle du Conseil d'Administration*.

The bust of Jules Bordet has certainly not changed the course of the history of sculpture. But on the other hand, it is good to support the study carried out within the framework of USINE, since the ambition here is not to produce a classical history of styles but rather to study structural phenomena specific to the history of sculpture through the study of technical markers.

Visually, one can see on the 3D model that the face's surface is smooth, even waxy, while the bust is expressive and modern. Traces of modeling are visible. If we cross-check this observation with a study of the markers outside and inside the work, one can clearly see the trace of an assemblage (the French language uses the term *marcottage*) at the level of the neck, which means that disparate elements were put together in a novel configuration, a head, probably coming from a casting and an original model of the bust.

The Royal Academy of Medicine of Belgium has in its collection a marble copy of this portrait (Figure 5). Interestingly, this work was shown at the Antwerp Salon in 1926. It, therefore, predates the bronze of 1927. The bust is obviously different from the bronze, while the head is identical. On the other hand, the bust has the same modern style, *à la Rodin*, as the bronze, made by a contrast between the polished face and the *non-finito* in the lower part.

Looking at the marble and the bronze, it is reasonable to assume that the bronze was made by over-moulding, or, more precisely, that the face of the bronze was over-moulded on the marble; hence it's smooth, almost waxy skin when the lower parts of the bust are clearly different.

A first hypothesis would be that the model was lost or destroyed, and it was necessary to use the marble as a model. This hypothesis is unlikely since clay models are always cast, so there is almost always a plaster or gelatin mould of the original model, but also a casting on which the marble is made. It is, therefore, unlikely that the original model was not preserved by casting. The second one would be that marble was over-moulded for its intrinsic quality, particularly its texture. The surface of the original model, probably in clay, was not as smooth as the authentic version in marble. As often at the time, de Valeriola probably entrusted the execution in marble to a craftsman. This man was not trained to *create*, but to translate the original work, in a traditional style, made of technical virtuosity, that we would call "academic" today. The marble is carefully cut and, above all, perfectly polished. The hypothesis would be that the sculptor, for the bronze, would have preferred, instead of reusing the mould of the original model, to mould the marble because there was a realistic effect he was looking for.

At the time, the sculpture competes with photography (Leonardi, Natale, 2019), which could make very realistic and cheaper portraits. For that reason, sculpture sought to produce realistic portraits as well with particular techniques as the one presented here.

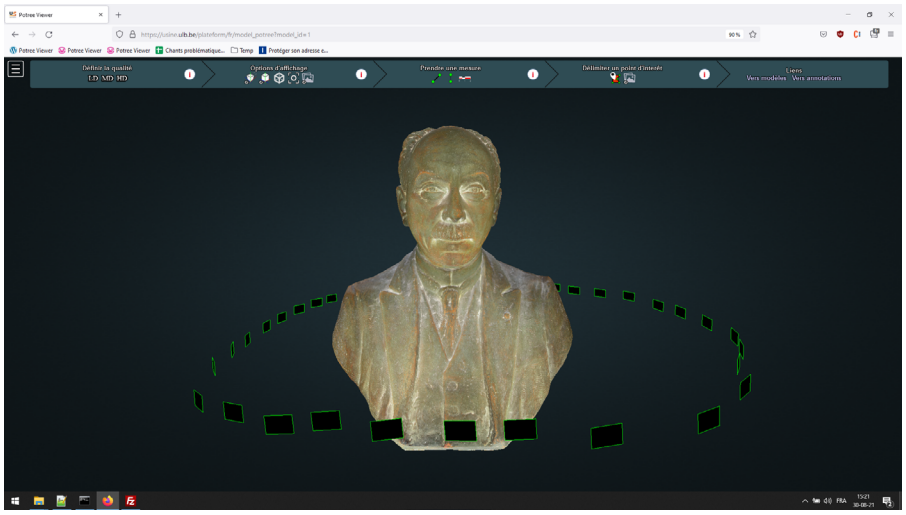

Figure 3 - *3D mesh of a model on the USINE plateforme*. © PANORAMA, ULB. Photo by Alexandre Buchet, Académie royale de Médecine de Belgique.

Figure 4 - Edmond de Valeriola (1877-1956), *Portrait of Jules Bordet*. 1927. Bronze. Brussels, Université libre de Bruxelles. Photo by Alexandre Buchet, Académie royale de Médecine de Belgique.

Figure 5 - Edmond de Valeriola (1877-1956), *Portrait of Jules Bordet*. 1926. Marble. Brussels, Royal Academy of Medicine. Photo by Alexandre Buchet, Académie royale de Médecine de Belgique.

This over-moulding of the head is then assembled into a bust modeled in plaster or clay, and the whole is moulded and cast in bronze. Expressivity is easy to render in bronze, as the alloy keeps the imprint of the modelling used for the casting. By expressively modeling this bust, the sculptor can make a realistic portrait, whereas, in the marble case, the expressivity is made with more incredible difficulty with the tools during the carving process.

Inside the bust, very particular marks were found. These marks are seams, but it is not easy to understand why they are inside the bust and to which process they should be linked. It could be the result of the moulding of the core with a piece mould. The aim would be to make several cores by moulding and then several bronzes without making a new core for each bronze casting. This would mean that several bronze copies of this bust were made or that the sculptor expected several copies to be made. So far, one copy is known at the Athénée Jules Bordet in Brussels, but, indeed, some other copies exist both in public and private collections.

It is not surprising that, at the time, sculptors sought to rationalize the production process, taking advantage of the technical possibilities in an industrial context to allow the production of authentic copies in series. During the 19th century, the dissemination of the sculpted portrait responded to the logic of celebrating "great men" in the public space (Aghulon, 1978; Aghulon, 1998; Aghulon, 2003; Lalouette, 2018). From the end of the *Ancien Régime*, the elites constituted themselves by the strength of their actions and sought to legitimize their position by seeking public honours. The image plays a significant role in this process. The sculpted effigy of an honorific nature casts moral value in bronze and functions as an *exemplum virtutis*. The various copies of Bordet's portrait that we know accompany the progression of his career and public recognition as he climbed the social ladder, entered the Academy of Medicine, became president of the Union des Alumni, etc. Competition with photography may also have played a role. The very nature of the photographic image is to make reproduction possible at a relatively low cost. To survive in the face of photography, the sculpture may also have had to prove that it could offer the possibility of reproduction at relatively affordable prices.

Overmoulding, *marcottage*, moulding of the core for a serial casting, what we see here, in the heart of the material, is an almost banal but fascinating use of the technical possibilities of sculpture in an industrialized context for the benefit of the reproduction and the diffusion of the sculpted portrait. It is the study of these relations between the technical markers and the historical processes or phenomena that this project intends to support and develop.

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Authors' Curriculum Vitae

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Article received on 17-01-2022 and accepted on 27-04-2023