

Insights for the endorsement of a holistic approach for public sculpture research: the BIONANOSCULP project

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Abstract

This article reflects on the holistic approach for public sculpture research within the BIONANOSCULP project, focusing on the reasons behind the project development, its objectives, selected achievements and future outcomes. Focusing on one of the seven selected sculptures that were studied within the project, “Afonso de Albuquerque”, the reasons behind the selection of these public art works, their historical study, a critical assessment of their significance and conservation status are discussed. A brief description of the most significant analytical innovations of the project and insight on the future of sustainable conservation is presented.

Introduction

Urban outdoor public sculptures are some of the most vulnerable cultural objects due to their constant exposure to urban pollution and atmospheric conditions. Due to its outdoor nature, classical preventive conservation methodologies such as control of environmental conditions such as temperature, relative humidity and light is completely impossible. Furthermore, the physicochemical changes undergone by these artworks due to these factors and combined with the variety of microorganisms thriving on their surfaces make conservation treatments difficult and put outdoor sculptures at a high risk of deterioration, leading to aesthetic alterations and historical and cultural loss of value. The surface of outdoor sculptures is colonized with a high diversity of organisms, from cyanobacteria, microalgae, bacteria, fungi and symbiotic organisms such as lichens. Each sculpture surface is an environmental niche, combining chemical and physical conditions from the material and structural characteristics of the artwork, the environmental and ecological conditions of implantation

area. The research project BIONANOSCULP proposes the development of innovative and sustainable nanomaterials for applications in the preventive conservation of outdoor sculptures, based on holistic study approach of selected outdoor sculptures from Oporto’s metropolitan area, ranging disciplinary methodologies from areas as different as art history, conservation science, microbiology, chemistry and environmental sciences. An initial survey of the catalogued public outdoor stone and metal sculptures in the Metropolitan Area of Porto was performed. The evaluation of the sculptures to integrate the research work was achieved by observation of the materials present in the sculptures, as well as by visual recognition to the naked eye of the microbial contamination and the sculptures’ general conservation state. The accessibility and surrounding environmental conditions were also evaluated and considered. Seven sculptures were selected to integrate the research project: “Rosalía de Castro” (1951) by Salvador Barata Foyo, pink granite, in Praça da Galiza, Massarelos, Porto; “Sol, Lua e Vento” (1997) by Satoru Sato, grey granite, in Museu Internacional de Escultura Contemporânea de Santo Tirso,

Santo Tirso; “Afonso de Albuquerque” (1930) by Diogo de Macedo, limestone, in Largo de D. João III, Lordelo do Ouro, Porto; “Movimento” (1994) by Jorge Ulisses, marble, in the gardens of Faculdade de Belas Artes – Universidade do Porto, Porto; “Repouso” (1953) by Gustavo Bastos, cement mortar, in the gardens of Faculdade de Belas Artes – Universidade do Porto, Porto; “O guardador do Sol” (1953) by José Rodrigues, bronze, in the gardens of Faculdade de Belas Artes – Universidade do Porto, Porto; and “Eu espero” (1999) by Fernanda Fragateiro, stainless steel, in Museu Internacional de Escultura Contemporânea de Santo Tirso, Santo Tirso. For this article, we will dedicate our attention to the interdisciplinary work performed for “Afonso de Albuquerque” and also partially on “Sol, Lua e Vento”, two stone sculptures with very interesting characteristics (Silva et al, 2018).

Historical and Artistic criteria for Selection

In addition to material and conservation criteria, the selection of the pieces considered historical and artistic standards too, so that the sample could reflect some of the tendencies of modern and contemporary public sculpture in Portugal, both by national and international artists.

Talking about the pieces from the historical-artistic point of view, it is useful to remark that the breadth of the chronological period extends from early 1930s to late 1990s, matching, therefore, a time span of more than half a century.

For this reason, the sample denotes a large representativeness of material, technical, aesthetical and narrative content, joining works from the nationalist statuary period, to the international post-minimalist periods, so expressing the inclusive approach towards public sculpture considered as a specific segment of heritage, so we defend.

The oldest work – produced during the military dictatorship that had deposed the previous republican regime – is a remarkable example of the nationalist statuary which programmatically was meant to launch the cult of the brave and victorious figures of Portuguese History, under the national-historicist concept (Portela, 1997), as it was the case of the intrepid *viceroi* of India “Afonso de Albuquerque”.

In the opposed field, the most recent works – produced in the late 90s – link to sculpture produced under a conceptual frame, in which form and materials metaphorically allude to an idea, concept and/or image, thus embodying a com-

plex, wide and open range of meanings. Such is the case of the sculptural park bench “Eu Espero” (I Wait? I Hope?), as well as the case of monumental (for its scale) and cosmic (for its spatiality) sculpture “Sol, Lua e Vento” (Sun, Moon and Wind).

Between these extremes, there are figurative works displaying a decorative accent, such as the reclined figure “Repouso” (Relaxation). There are figurative works denoting a clear evocative character, such as the seated-reclined statue “Rosalía de Castro”. There are figurative works of allegorical character, such as the pedestrian statue “O Guardador do Sol” (The Guardian of the Sun). There are also abstract sculptures suggesting rhythm and music by form, such as the sculpture “Movimento” (Movement).

Besides the diverse artistic conceptions, the seven sculptures that make up the sample equally echo very different plastic languages, which extend from the realistic or idealized portrait, here represented by the statuary that accurately reproduces the figure’s known iconography, including not only anatomy (stature and physiognomy) but also costume (clothing and/or weapons), – as it is the case of the statues of “Afonso de Albuquerque” and “Rosalía de Castro” – up to minimalism – as the case of both sculptures “Movimento” and “Sol, Lua e Vento” – while passing through postwar new figuration – as the case of both sculptures “Repouso”, and “O Guardador do Sol”.

It should also be noted that the sample includes not only varied and discrepant artistic conceptions and plastic languages, but displays also notable examples of the production of their respective authors, some of them top names in the history of modern sculpture in Portugal, such as Diogo de Macedo, who belongs to the 1st Modernist Generation, Barata Feyer, who belongs to the 2nd Modernist Generation, Gustavo Bastos who belongs to the 3rd Modernist Generation, while the remaining cases denote contemporary art leanings, such as José Rodrigues, Jorge Ulisses and Fernanda Fragateiro, whose sculptural production is driven by a most personal and experimental research, thus following distinct concepts and expressions, which in different degrees escape the strictly sculptural model, in order to integrate multidisciplinary approaches, as it is the case of Fernanda Fragateiro, whose production denotes architectural and spatial connotations, coming from constructivism and minimalism, as well as Japanese sculptor Satoru Sato.

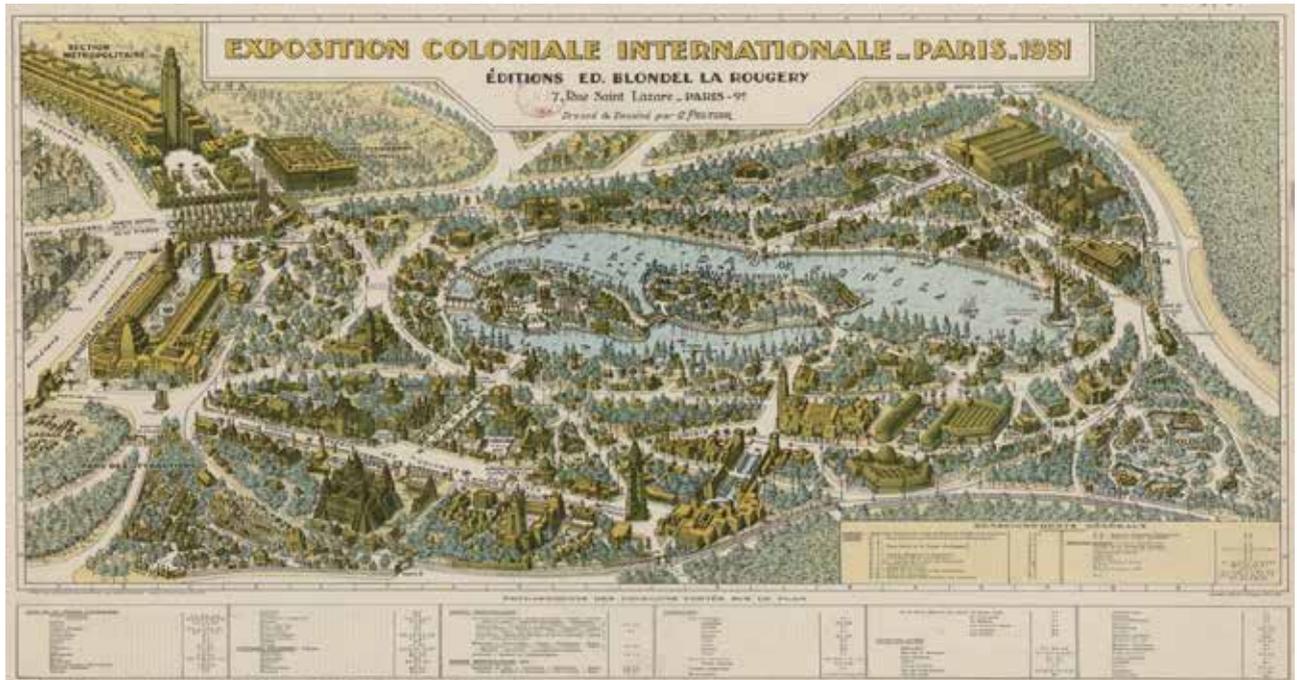


Fig. 1- Georges Peltier, *Plan de l'Exposition International Coloniale de Paris*, Bois de Vincennes, 6/5/1931 to 15/11/1931. Portuguese section inside a red ellipse. Source: <https://gallica.bnf.fr/ark:/12148/btv1b530666671>

Historical study

Focusing a single work, Afonso de Albuquerque statue was commissioned to Diogo de Macedo, after his model had won a competition whose jury was composed by José de Figueiredo, José Pessanha, José Simões d'Almeida sobrinho, António Saúde, Adriano de Sousa Lopes and Raul Lino (Neto, 2016).

The competition's program was to expose two statues in *Exposition Coloniale Internationale de Paris*, which took place in Bois de Vincennes, between 6 May and 15 November 1931. One of Henry the Navigator and the other of viceroy Afonso de Albuquerque, both to be implanted at the entrance of the Portuguese historic Pavilions, whose revivalist project had been assigned, also by competition, to architect Raúl Lino.

The competition for the statues was opened between 9 October 1930 and 31 January 1931. The works were delivered to *Sociedade de Geografia*, in Lisbon, in order to be evaluated by the jury and then exposed to the public. The jury's choices fell on the scale models of Henrique the Navigator, by Francisco Franco, and Afonso de Albuquerque, by Diogo de Macedo, each one intended to be placed at the entrance of the two historic pavilions (Neto, 2016).

In the French press, the Portuguese Pavilions and their statues were described in different newspapers and reviews. On 21st April 1931, *Les Annales Coloniales* referred to the Portuguese Section of Paris International Colonial Exhibition, as follows:

The opening ceremony of the Portuguese Section will take place on 26th May, at 4 o'clock p.m. with the presence of Mr. Branco, Portuguese Foreign Affairs Minister (L.A.C., 1931).

On 13th May 1931, *La Liberté* referred to the Portuguese section, as follows:

Facing the statue of Infante D. Henrique (Henry the Navigator) and beyond the Padrão – small monument signaling the nationality represented there – we find another statue under another porch belonging to the second historic pavilion. It is the effigy of great Afonso de Albuquerque (1452-1515), that terrible conquest warrior who had fortified Goa, Ormuz and Malacca, and with a greatest insight was able to build a large Portuguese empire in the Far East. (Denis, 1931)

On 28th May 1931, *La Croix* referred to the Portuguese section, as follows:



Fig. 2- Portuguese Section of Paris' Colonial Exhibition, Bois de Vincennes, 6/5/1931 to 15/11/1931. View from Lake Daumesnil. Source: <http://expocolo.paris.1931.pagesperso-orange.fr/Portugal.56.html>



Fig. 3- Portuguese Pavilion in Paris' Colonial Exhibition, Bois de Vincennes.



Fig. 4- D. Macedo, Afonso de Albuquerque- Statue implacement inside a red ellipse. Source: *Ilustração*, nº 131, 1931, p. 9. *que*. Source: *Ilustração*, nº 136, p. 20.

From the other side of the *Padrão*, that small palace topped with pinnacles is inspired by an old, quite old monastery. No monk at the door, however filling with his high stature the outer cloister (the clearest you would ever see), Afonso de Albuquerque. This terrible warrior whose beard tapered hangs up to the waist, holds in his right hand the cities of Goa, Malacca and Hormuz, that he was able to powerfully fortify. Symbol of his glory remains behind him the cannon he took from the king of Malacca. (Baron, 1931)

These quotes show the expressive qualities of Afonso de Albuquerque's statue, for it was able to evoke one of the most powerful, although brief, periods of the Portuguese primacy in the East.

Paris' International Colonial Exhibition was not the unique implantation of Afonso de Albuquerque's statue in a Colonial Exhibition. In fact, while the Parisian Exhibition was still ongoing, an article published in "Portugal Colonial" – whose text, echoing Nazi's connotations, was intitled "Towards the 3rd Empire" – announced:

The Colonial Exhibition which is being prepared in Oporto will undoubtedly take this idea a big step. Within a few years, therefore, the Portuguese, [...] will be convinced that Portugal is still a great Empire and that all its politics, both internal and external, must be oriented in an imperial sense. It is

necessary, however, that the Government clearly enter this path (Costa, 1931).

The exhibition that the article referred to, was *Exposição Colonial Portuguesa*, whose Technical Director was Lieutenant Henrique Galvão, who curiously was also the Director of *Portugal Colonial* review.

In the Exhibition's Album-Catalogue, talking about the Portuguese Colonial Empire, Francisco Vieira Machado, Secretary of the Minister for the Colonies, asserted:

Outlined and vague in Infante's [Henry the Navigator] organization, more precise under the ambitious will of D. João II, it gains the first real and perfectly shaped expression with Afonso de Albuquerque. And the first imperial effort on the part of Portugal is spent in the dream of forming a great Asian Empire with vigilant guards in Aden, Hormuz and Malacca (Machado, 1934).

Afonso de Albuquerque was the historical figure who could better embody the muscled Imperial rhetoric that the just founded *Estado Novo* was about to promote, in order to increase the campaign for Portugal's *Engrandecimento* (Grandeur).

In *Exposição Colonial Portuguesa*, the statue of Afonso de Albuquerque was placed outdoors, as it is described in the exhibition's *Album-Catalogue*:

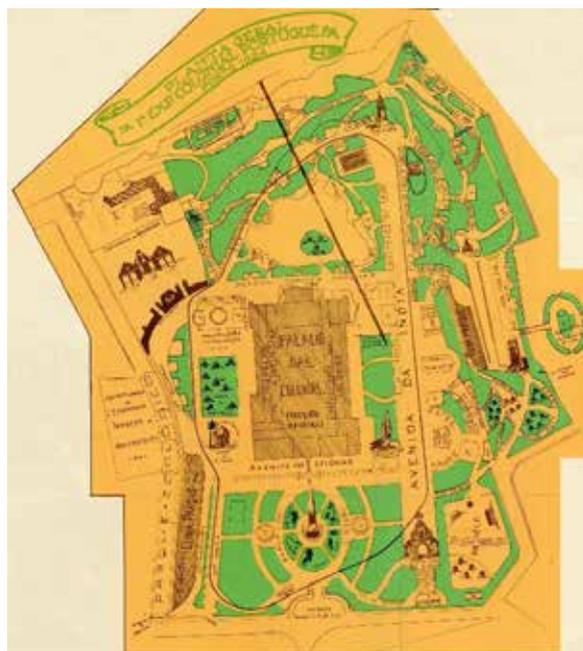


Fig. 5- *Exposição Colonial Portuguesa – Planta Geral.* Location of Afonso de Albuquerque's statue in a red circle. Source: Album of *Exposição Colonial Portuguesa*



Fig. 6- Afonso de Albuquerque's statue in *Exposição Colonial Portuguesa*, 1934, Palácio de Cristal. Source: Álbum de Alvão.

Then we will find, on the extreme south of the Avenue, the exact reproduction of Macao's Farol da Guia.

Contouring this by the left, we descend to Tête Street and find in a belvedere over Douro river the statue of Afonso de Albuquerque. (Leitão, 1934)

With this description, it is possible to identify the place where the statue was implanted, in the Album's Map.

On the Album-Catalogue a photograph shows its implantation, among some natives from Cabo Verde Colony, under the concerned presence of Henrique Galvão, Technical Director of the Exhibition.

After its exhibition during *Exposição Colonial Portuguesa*, Afonso de Albuquerque's statue remained in the gardens of Palácio de Cristal facing "public offenses", as it was deplored in an article published in newspaper *República* in 28th December 1967.

In February 1968, a recommendation by *Comissão Municipal de Arte e Arqueologia* (Parecer nº 7/68) declared that the statue should remain in Palácio de Cristal's gardens, however in an adequate place, adding that "in the project of reform of Palácio de Cristal should be included a study for a new emplacement of the statue" (Abreu, 2012).

Two years later, another recommendation by *Comissão Municipal de Arte e Arqueologia* (Parecer nº 82/70) shows that the statue was still in the same place, as Abreu asserts:

We conclude then that the reimplantation of the statue in Praça de D. João III cannot be before 1970, should the same have occur in that year, or on the next one. (Abreu, 2012).

The soft stone of Afonso de Albuquerque's statue suffered much harm, during its exposure both to climate and public aggressions. In fact, as we have seen, the statue was not conceived to be exposed to such inclement conditions.

Critical analysis

Beginning by the analysis of the creative and technical process, it is important to remark that in order to carve Afonso de Albuquerque's statue, Diogo de Macedo developed a iconographic research, which we can reconstitute by the remaining images, based on a series of copies of the portrait of the second Viceroy of Portuguese India, belonging to the Gallery of Governors and Viceroys, this portrait being kept, since 1960, in *Museu Nacional de Arte Antiga*, Lisbon.

This well-known collection was recently studied, in detail, by Teresa Reis in her master art thesis (Reis, 2014), and from the images she gathered, we think we can reconstitute the evolution of Macedo's iconographic research.

In fact, we found three models for the statue: two models in clay and one in plaster. The iconographic source for the first clay model was most probably the copy of Afonso de Albuquerque's portrait presented in the book *Galleria dos Vice-Reis e Governadores da India Portuguesa*, by José Maria Delorme Colaço, published, in Lisbon, in 1841, which was "the exact and thorough copy of the large portraits that exist in the rooms of Palace of the Govern in Pangim", so the author said (Colaço, 1841).

The second clay model, however, moves apart from the first source, discarding the *gorra* (cap), and covering the figure's head with an oriental *coifa* (coif), which is visible under the cap of an older image, presented in a new edition of the

book *Lendas da India*, by Gaspar Corrêa (1492-1561), published by Real Academia das Ciências, Lisbon, in 1860.

Finally, a third model, in plaster, which seems to be the same presented in Vincennes, smooths the aggressive expression of the second model, enhances the coif, and introduces the symbol of Santiago's Cross, on the cloak, beside his left shoulder, as it is represented in *Livro do Estado da India Oriental*, by Pedro Barretto de Resende, 1646.

Besides the iconographic research, Macedo developed a cautious formal and expressive study, merging the required official hieratic and honorable presence with a most expressive *verismo*, rare in this "canonic statuary".

In its figuration, Macedo's Albuquerque appears dressed in hauberk, tunic, cloak, long boots and coif, holding in the right hand a model of the three fortresses of Goa, Hormuz, and Malacca, he took and rebuilt, while the left hand rests on the sword.

It is relevant to observe that the transfer from the plaster model to the soft stone statue that was shown in *Exposição Colonial Portuguesa*, is not an exact copy. Even in that final stage Diogo de Macedo introduced some little differences, such as the hauberk sleeve that covers the left arm, instead of the nude arm of the plaster's model.

This detail, as other minor ones, shows that the sculptor's creative process was in fact a permanent one, and in each new stage something new was always about to appear.



Fig. 7- AA Colaço's copy, 1841 Fig. 8- Macedo 1st clay model Fig. 9- AA Corrêa's copy, 1860 Fig. 10- 2nd clay model



Fig. 11- AA Resende's copy, 1646



Fig. 12- Macedo, AA, plaster model



Fig. 13- Macedo, Albuquerque, 1934, stone

Abreu enhances this genuine expressionist interpretation of the figure as follows:

Under the cloak, opened in the front, the right leg moves forwards, showing powerful musculature, conceived and carved in a most expressive manner. A nice *chiaroscuro* effect all over cots the statue. (Abreu, 2012)

Afonso de Albuquerque statue may appear as one of the most notable representatives of Estado Novo's canonic statuary, standing without disadvantage before Francisco Franco's statue of João Gonçalves Zarco, from where the canon proceeded.

Evaluation of Conservation State

The seven selected sculptures of BIONANOSCULP project have different locations which can be a relevant topic to understand the action of the deterioration agents. In public sculpture the concept of site specific is generally related with artworks produced in the context of Sculpture Symposia or commissioned orders. Urban environments hold myriad hazards for public art (Macnally & Hsu, 2012) that include meteoric agents, anthropic acts, pollution and contaminants, biodeterioration all with different levels of impact in the sculptures, but none acting alone. The combined action of meteoric agents (water, solarization, erosion, and

biodeterioration) can cause serious aesthetic effect on the sculptures surfaces and promote a relevant agent of deterioration such as dissociation (Waller, 1995) from their belonging community besides the fruition problems, since the reading and interpretation become compromised.

The seven sculptures were made in different materials with singular vulnerabilities to deterioration. Thus, we have *Afonso de Albuquerque* (1), *Movimento* (2) *O Sol, o Vento e a Lua* (3) and *Rosalina de Castro* (4) all stone based but divided in silicate (granites 1,3, 4) and calcareous rocks (Pedra Ançã 2) and other in based cement mortar (*Repouso*). The second group are two metallic sculptures in distinct alloys, namely *O Guardador do Sol* in bronze (copper alloy) and *Eu Espero* in 316- TI stainless steel (ferrous alloy with titanium), both with protection coatings to increase their resistance to the environment. Generally, in the bronze sculpture a patina is given also with the aesthetic purposes, whereas in the park bench *Eu espero* was applied an anti-corrosion product. The based cement mortar artwork of *Repouso* from FBAUP museum collection (as *Movimento* and *Guardador do Sol*) can be highlighted as an example of good integration of art in the garden environment despite the problems due to the interaction between the public and the sculpture. Although the main anomaly was the severe bio coating that covered all surfaces of the sculpture turning its white/grey mortar into

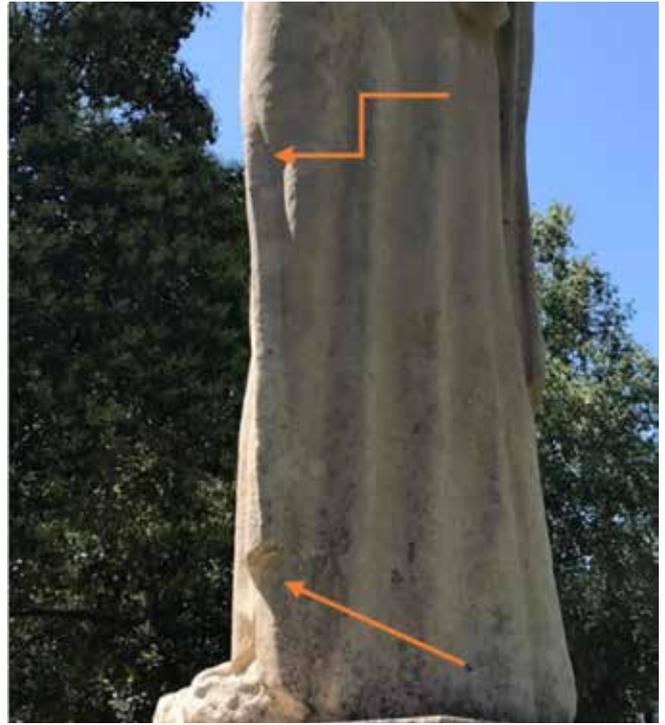
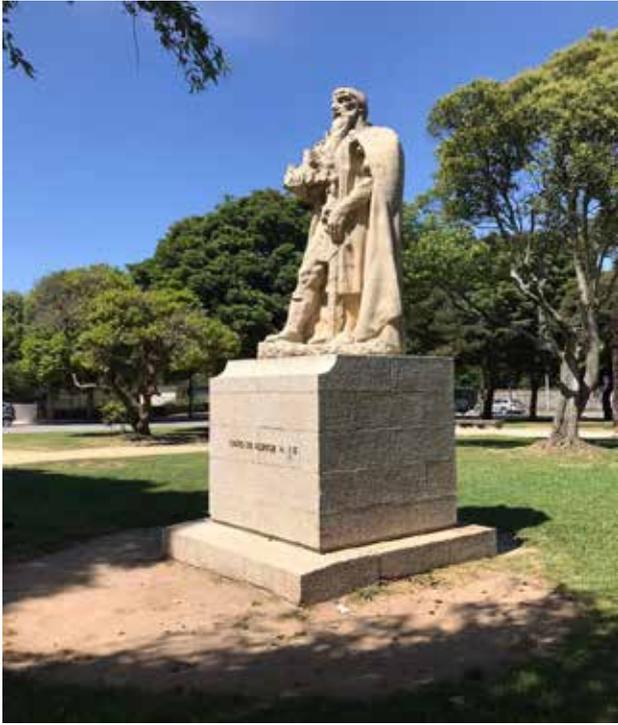


Fig. 14 and Fig. 15- Overview of sculpture after the recent cleaning. besides the too light tone of the limestone the sculpture shows evident losses of chiseled details probably caused by a cleaning with uncontrolled pressure machine.

a giant black spot that everyone faced whenever surpassed the building atrium, the closest coexistence with the sculpture led to the fracture of its left foot during a faculty party. In 2020 an intervention carried out under the master dissertation this artwork was restored towards to assure its physic integrity and the rescue of the symbolic elements for its proper recognize and fruition.

One of the major problems of public sculpture conservation is the lack of maintenance plans, either in artworks under the supervision of public or private entities since there's widespread cultural mindset that considers materials like stone, metal or mortars extremely resilient and not affected by risks caused by weather, pollutants and humans (vandalism).

This framework explains the deep lacks in public sculpture maintenance and delay in prevention public urban policies in this field (Cadeco & Vieira, 2017). In Oporto the municipal heritage department tries to face problems related with vandalism (blue paintings applied periodically by local football fans) and community dissociation due to dirt and bio contamination covers, by cleaning them with a solution of water and bleach agents, or just with tap water applied

by jet cleaning pressure machines, which are harmful to the sculpture conservation considering both the material support and the formal work (eg. 2020 cleaning of Afonso de Albuquerque sculpture).



This cleaning is of common use on stone-based sculptures, despite their chemical group. Other important topic is the relationship between the sculpture location, especially in public parks or gardens and the irrigation systems as the cleaning methods of the grass. It is frequent to have the irrigation water taps to close or even targeted to the sculptures which increases the conservation problems since the during the watering period the material support of the artwork is being soaked, which induces physical and chemical reactions.

Hence the BIONANOSCULP project allowed us to have an overview on the conservation issues of public sculpture in Oporto and S. Tirso International Contemporary Sculpture Open Air Museum and prioritize them for developing a methodology based on a sustainable approach (Carreira-Ramirez, 2018).

Analytical approaches

One of the may novelties in BIONANOSCULP was the comprehensive study of a significative number of public outdoor sculptures, not only using an array of interdisciplinary practices which involved classical methodologies as well as the use of innovative methods that were for the first time applied in the field of conservation and restoration. The search for innovation was not made for itself but in order to get a more complete view of a very complex problem, as these works of art, since they present little to no frequent accompaniment of their state of conservation, or biodeterioration status, as would be expected for a work of art in a museum or cultural institution. Furthermore, these art works were selected to achieve very broad range of material in their constitution, from different stone materials to at least two metals, with the common denominator being, the outdoor exposure to elements, the application of the exact same methodologies and a common region, two cities, closely located on the North region of Portugal, Oporto and Santo Tirso. The presuppose behind this selection was to make sure that, for biodeterioration and bio-colonization description, almost every single possibility and conjugation of parameters was covered by the project and dully studied. Furthermore, since BIONANOSCULP final objective is the creation of an innovative coating directly related to the bio-colonization, in fact with the objective of prevention of the bio-colonization, gathering objective data in the characterization of the surface microbiome is very important for

strategies that make use of bio or nanotechnology innovative coatings.

For this article, we selected to focus on the work performed on two of the sculptures, both stone, to fine tune some differences in relation both to their conceptualization, creation and execution, state of conservation and surface contamination, including study of microbiomes.

When describing the innovative approaches of the bio-colonization study, we first must mention the first time use and evaluation of a green gel for sampling the heterogenous surface of sculptures without residues and without mechanical damage to the surface. Polymeric hydrogels are already used in cultural heritage, usually containing variable concentrations of organic solvents, essentially for cleaning procedures (Baglioli et al, 2013). We compared either swabbing with a sterile cotton swab or pressing a sterile disk of a HEMA/MBAm cryogel onto the sculpture surface as a sampling technique for these objects (Silva et al, 2018). This approach was first tested on “Sol, Lua e Vento”, and accompanied with a set of other methodologies in order to obtain the maximum data from the surface microbiome. Although we further decided to continue the sampling by swabbing in order to avoid comparability issues with other published works and lower values of cells this idea will be further explored in the future with different types of gels, especially those with higher viscosity. The quantification of bio-colonization of the sculpture was done by ATP bioluminescence assays, colorimetry, and SEM observations, implying high levels of total ATP content (Silva et al, 2018). High-throughput sequencing revealed a diverse and rich microbial ecosystem thriving on the sculpture surface, as expected and matching the observations from the other techniques but allowed for greater detail when regarding genera and species taxon level identification. The same methodology approach was performed for Afonso de Albuquerque with similar interesting results that extend from the usual obtained from classical techniques, such as identification of major groups such as microalgae and lichens (Silva et al, 2018) but also allowing to obtain fine details about genera and species present and relate them to particular characteristics of the environmental conditions and human exposure for both sculptures.

Insights into future sustainable methods

Not only the scientific methodologies for bio-colonization were diverse and innovative, but also the fact that besides

this scientific characterization, the project also aimed at the development of bio-based coatings and extension of their properties for high performance as antimicrobial coatings with relevant mechanical, physical and chemical characteristics. The clear advantage over other products is the low level of toxicity in our material, due to the use of biocompatible biomaterials such as chitosan. Chitosan with different molecular weights and concentrations were tested for the development of the coatings, as well as the addition of several concentrations of glycerol and sodium tripolyphosphate as adjuvants and cross-linking agents (Silva et al, 2019). The objective of these several combinations was to create different matrices with high performance, able to support outdoor conditions, for the protection the sculptures. Physic-chemical (such as functional groups and surface analyses), hydrophobicity and permeability assessments, as well as mechanical assays were performed in order to improve the performance and durability of the new protective coatings when applied to outdoor sculptures, without changing the original aesthetics of these artworks (Silva et al, 2019).

Conclusions

BIONANOSCULP project contributed to bring closer the languages of experts from very different areas, from chemistry to art history, from biotechnology to art conservation, all with the same mutual objective to holistically work on the best and more detailed description possible of a set of sculptures, regarding their inception and production, their conservation state and biodeterioration in order to design the appropriate materials to pursue preventive conservation through coatings with anti-microbial activities. Although the project is closed, the work is still ongoing as well as publication of the results obtained and most important, the bridges that were crossed by these experts to meet in middle ground and explore these sculptures will remain and will allow for further collaborative ventures in the near future. One of the challenges for future work is the development of strategies for exploring the integration of very diverse data produced by disciplines from the social sciences, humanities and hard sciences, especially when regarding non-quantitative and quantitative data produced by very dissimilar methodologies.

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