SUMUM

ANR 2018-2022

HUBERT JOLY Emilie

Centre Interdisciplinaire de Conservation et Restauration (CICRP)

IT-FR cooperation in heritage science - Vth edition

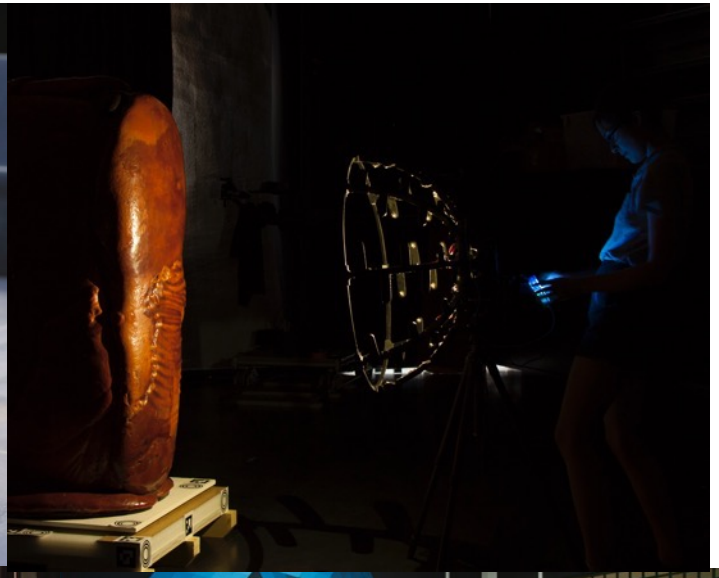
Human-centered approach for cultural heritage in digital transition: disciplines talking to each other

Naples, Suor Orsola Benincasa University

June 28th, 2023

SUMUM

ANR 2018-2022



Zett, Vasarely, fondation Vasarely, Aix en Provence
Expansion Contrôlée, César, MAC, Marseille
Arbre aux serpents, Niki de Saint Phalle, Musée des beaux Arts, Angers

This presentation isn’t going to be exhaustive, but is going to give an overall view of the project

As ANR SUMUM is made up of 4 laboratories

Financed by Agence Nationale de la Recherche (ANR) from 2018 to 2022

Coordinated by Alamin Mansouri (LE2I)

*Laboratoire d'électronique et d'informatique de l'image (ImVIA)

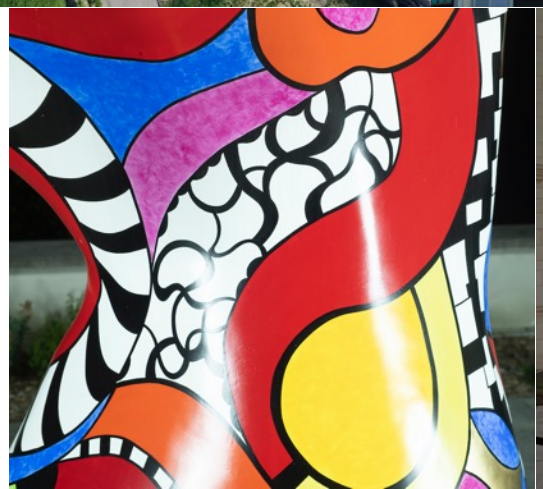
*LABCOM

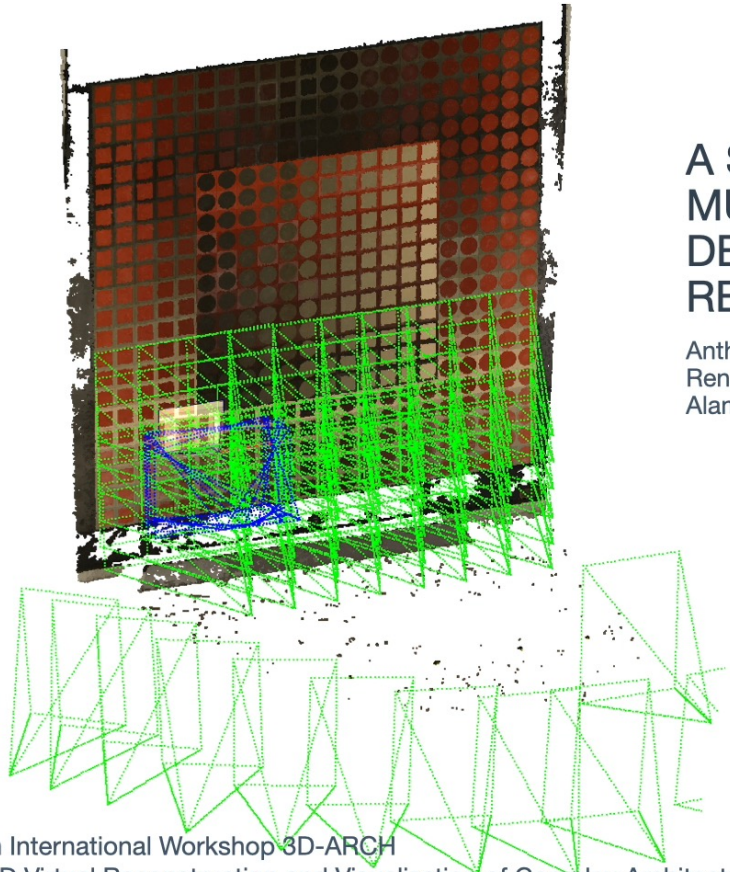
- laboratoire Modèles et simulations pour l’Architecture et le Patrimoine (UMR MAP 3495)
- Centre Interdisciplinaire de Conservation et Restauration du Patrimoine (CICRP)

*Groupe de Recherche en Informatique, Image, et Instrumentation de Caen (GREYC)

*Laboratoire Modélisation, Information & Systèmes (MIS)

- SUMUM = Survey, analyze and share semantically enriched digital replicas
- Selection of works of art presenting technical problems = format, accessibility of the exhibition space, natural light management, surface appearance.
- Photogrammetric-based registration method (TACO) has been developed/to exploit a 2D/3D semantic annotation process implemented into a CH oriented collaborative web platform (AIOLI)
- Can multimodal capture systems overcome these obstacles during capture?





A SEMANTICALLY ENRICHED MULTIMODAL IMAGING APPROACH DEDICATED TO CONSERVATION AND RESTORATION STUDIES

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9th International Workshop 3D-ARCH
« 3D Virtual Reconstruction and Visualization of Complex Architectures »,
2-4 March 2022, Mantova, Italy

- Research into historical and technical data = annotations work is based on condition reports provided by conservation and restoration experts.
- All documentation can be directly merged when saving the image
- Complementary analysis or data can be spatially anchored to annotations as linked resources.

Condition report provided by a conservator on the artwork “Expansion contrôlée” by César

RAPPORT DE RESTAURATION
César, *Expansion contrôlée*, 1967

Institution propriétaire : [MAC] Musée d'art contemporain de Marseille
N° d'inventaire : C.68.05.01
Materiaux traites : Mousse polyurethane et vernis polyester
Intervenants : François Dubosset et Marjorie Nastro, Restaurateur du patrimoine, diplômé de l'Institut national du patrimoine et de l'école des Beaux-Arts d'Avignon
Intervention principale : nettoyage, consolidation, retouche et soclage.
Dates d'intervention : du 18 septembre au 2 octobre 2017

IDENTIFICATION DE L'OBJET

N° d'inventaire : C.68.05.01
Artiste : César Baldaccini, dit César
Désignation : Expansion Contrôlée
Institution / propriétaire : MAC
Année ou période : 1967
Techniques et dimensions : Mousse de polyuréthane autour d'un bloc de polystyrène, vernis épais en polyester.
153x116x80cm. Poids : Au alentour de 40 kg

ÉTAT GÉNÉRAL AVANT INTERVENTIONS

Appréciation générale :
— Neuf
— Satisfaisant
X Peu satisfaisant
— Très mauvais
Manipulation possible :
X Oui : | | Non :

État sanitaire de l'objet : L'œuvre ne présente pas de produit, d'émanation chimique dangereuse. Aucune contamination biologique n'a été observée.

ETUDE TECHNIQUE

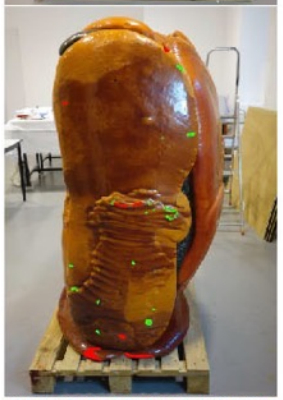
L'œuvre est constituée d'un bloc rectangulaire de polystyrène expansé autour duquel, l'artiste a déposé des mélanges de polyuréthane donnant de la mousse expansée d'une densité d'environ 40 kg/m3. Plusieurs coulées sont visibles, une pour chaque face, soit 6, plus une de couleur verte de petite dimension. La couleur finale n'est pas particulièrement donnée par le vernis, mais pas la couleur de la mousse sous-jacente. Le vernis est légèrement teinté en orange, mais il n'a pas été possible de définir s'il s'agissait d'une teinte du produit, ou si César la volontairement teinté.
Il en est de même pour les mousses où il n'est pas possible de définir précisément l'origine volontaire, ou résultant uniquement de la teinte des produits de fabrication de l'œuvre.

La mousse est de nature polyuréthane éther. C'est une mousse qui devient rigide directement avec une teinte naturelle légèrement orangée dès la fin de la réaction chimique. Le vernis utilisé est du type polyester. C'est un thermodurcissable qui peut être très résistant dans le temps, s'il a été mis en œuvre et polymérisé correctement respectée. La résine a été posée une fois toutes les mousses expansées réalisées. Il est a été coulé en plusieurs fois, probablement deux, afin de bien répartir la résine et en prenant en compte le volume et le relief de l'œuvre. L'épaisseur du vernis varie de moins 0,5 mm à plus de 5 mm dans les creux des mousses. Plus le vernis est épais, plus la couleur de l'œuvre est foncée. L'aspect final est lisse, légèrement brossé et brillant. La légère trame se trouve sur la mousse, sous le vernis.

CONSTAT D'ÉTAT ET DIAGNOSTIC

ÉTAT DE CONSERVATION

Empoussièrement / Encrassement : Les surfaces présentent une couche de poussière fine, noir et légèrement grasse.



Manques de mousse et de vernis en Rouge et entoilement en vert
De face (en haut à gauche), côté gauche (en bas à gauche)

Manques de mousse et de vernis en Rouge et entoilement en vert
Côté arrière (en bas à droite), côté droit (en haut à droite)

Technical Difficulties $\Longrightarrow$ multi-modal acquisition strategies

« Zett » by Victor Vasarely / multi-scale approach

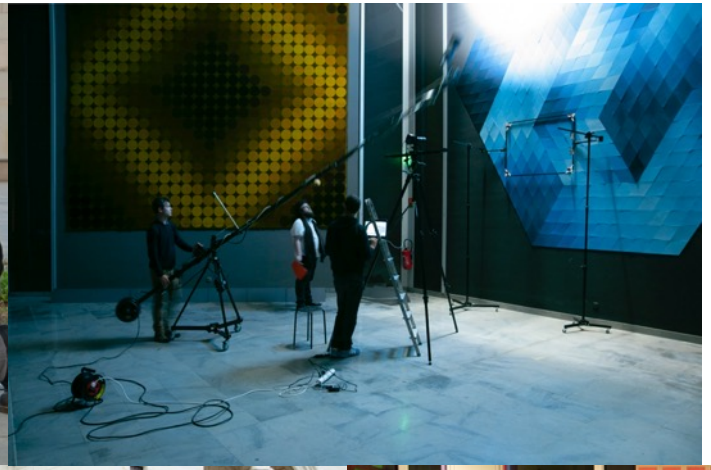
« L'Arbre aux Serpents » by Niki de Saint-Phalle / multi-temporal data

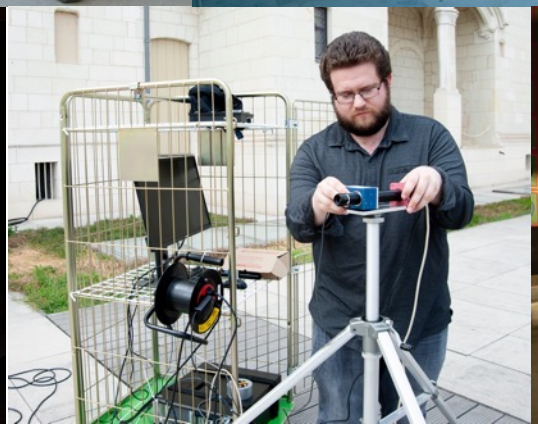
« Expansion controlée » by César / multi-spectral methodology.

Indoor or outdoor environments

Several acquisitions before, during and after restoration

Examine and follow-up a wide range of alterations and decays documented and analyzed by conservation scientists.

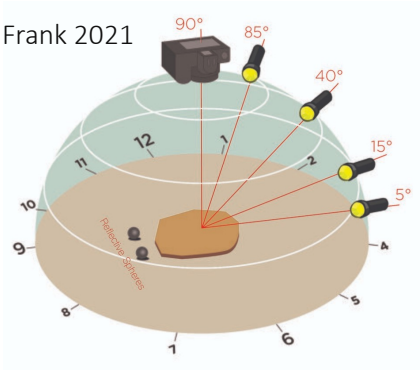




The 2D/3D imaging and analytical techniques performed are :

- Terrestrial Laser Scanning (TLS)
- Terrestrial Close-Range photogrammetry (T-CRP)
- Aerial (UAV-based) Close-Range photogrammetry (A-CRP)
- Multi Light Imaging Collection (MLIC) such as Multispectral RTI (MS-RTI) or Photometric Stereo (PS)
- Technical Photography (TP) in visible (VIS), raking light (RaK), infrared (IR), ultraviolet (UV) or cross-polarization (CP) setups.
- Documentary Photography (DOC), single or isolated pictures from archive or for documentation purposes
- Analytical techniques = Spectrocolorimeter (SC)/ sampling analysis with FTIR (SP)

Technique	Lasergrammetry	Photogrammetry		MLIC			Technical Photography					Photography	Analytical		
Case Study \ Modality	**TLS**	**T-CRP**	**A-CRP**	**RTI**	**MS-RTI**	**PS**	**VIS**	**RaK**	**IR**	**UV**	**CP**	**DOC**	**SC**	**SP**	**Total**
Zett by V. Vasarely	X	X	X	X	X	X		X	X				X	X	10
Expansion Controlée by César	X	X		X			X		X	X	X		X		8
Arbre aux serpents by Niki de Saint-Phalle	X		X				X					X	X		5



3 key areas have been the focus of extensive research at sumum: <u>the RTI, TACO and AIOLI techniques</u>.

RTI (Reflectance Transformation Imaging):
Based on the principle of varying lighting directions
Enables to better represent the appearance
Discriminates and characterizes surfaces more accurately.

Displays significant benefits when acquiring uniform, flat, shiny surfaces such as our corpus.

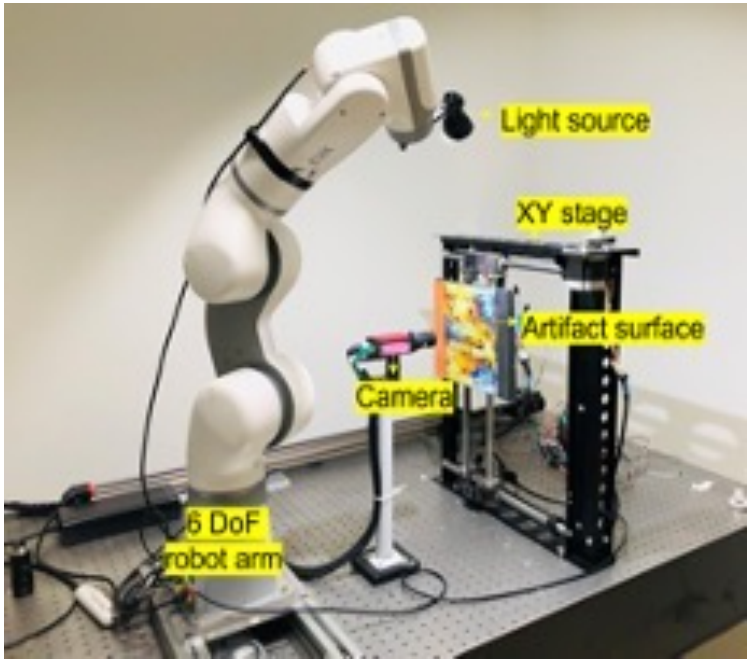
RTI imaging technique is not widely used for complex and/or large-scale objects, which means that appropriate modeling and processing are required.

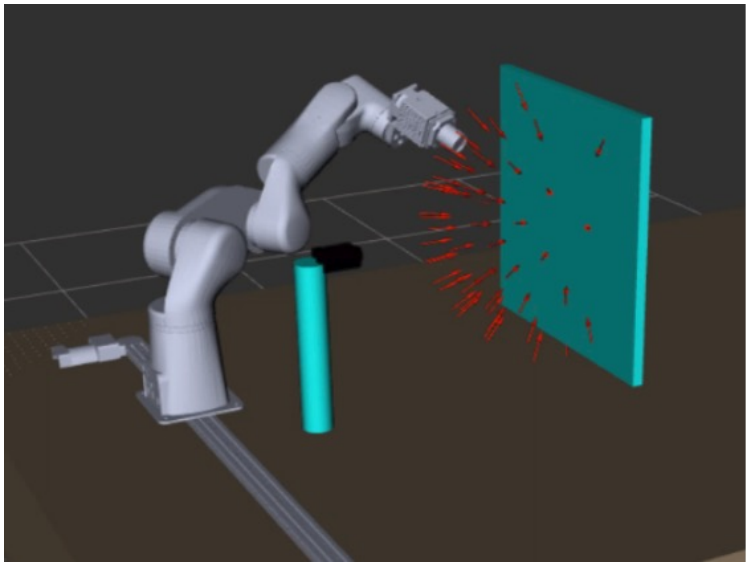
An articulated arm for large-area RTI acquisitions was developed : The prototype "lightbot"

Tests were carried out to study light distribution in the event of overlap during multiple captures.

The thesis of Yuly Castro : *A multi-light approach for documenting and modeling the appearance of large cultural heritage objects* propose an “artifact removal” treatment of light overlapping zones.

Development of LED-based light sources for color and multispectral RTI acquisitions is underway.





TACO « Totally Automated Co-registration and Orientations »

TACO is the photogrammetric engine that processes the acquisition set and produces the 3D image directly in AIOLI, where it can be annotated.

The incremental processing steps:

1/ An initial image set (if possible, a global and optimal acquisition) after-defined as master acquisition

2/A first scene reconstruction is generated (including cameras and geometry)

3/ Other image sets are incrementally co-registered among pre-oriented sets.

4/ The subset of scientific imaging presented for each case studies were automatically registered in order to build, a collaborative annotation framework from multimodal 2D/3D scene.

AIOLI

- a reality-based 2D/3D annotation system allowing to build semantically enriched digitization of heritage assets from a photogrammetric-friendly image set and spatial annotations coupled with additional resources.

- to create an innovative framework for the massive and large-scale collaborative CH documentation by linking features like image-based 3D reconstruction
- 2D-3D spreading
- correlation of semantic annotations, multi-layered analysis.

ZETT by Vasarely

Specifications:

* dimension (528x528cm): multi-scale approach to link the global conservation diagnosis completed with additional resources spatially linked through annotations.

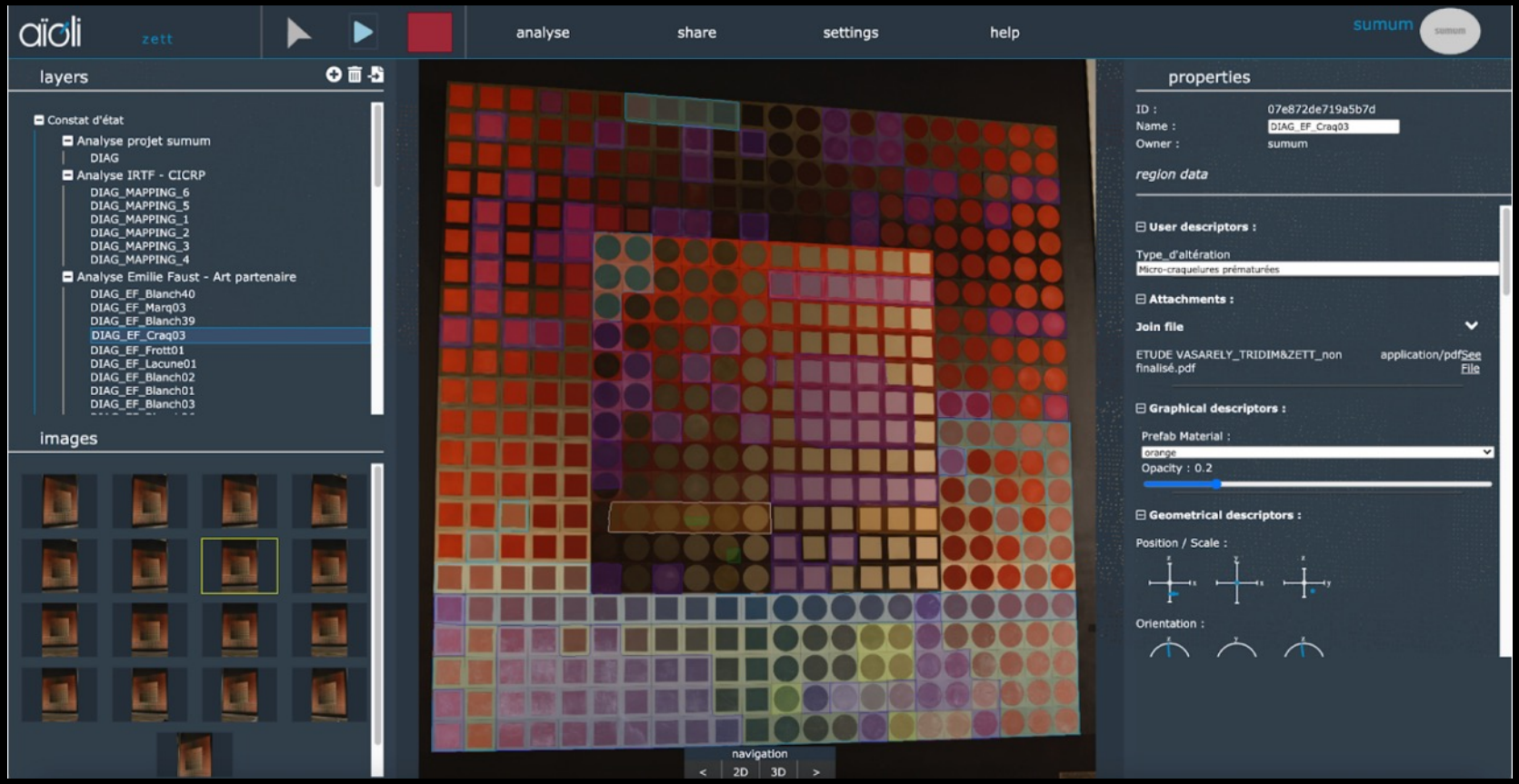
* specific Nextel coating, which raises specific conservation issues

  - interesting to study,

  - surface texture that facilitates photogrammetric acquisition.

In the final project, 227 pictures were registered from 9 iterations :

- A T-CRP handled and convergent global acquisition
- A close-up A-CRP acquisition performed with indoor UAV flight
- A T-CRP macro acquisition performed with visible (VIS) + Infrared (IR) orthomosaic multispectral guiding system
- Semi-Raking light (S-RAK) pictures extracted from the Technical Photography (TP) documentation set
- Multi Light Imaging collection sets, including Multispectral RTI (MS-RTI), dome-based RTI and Photometric Stereo (PS)



The AIOLI annotation structure includes:

- One layer with the complete nomenclature of the painted cardboard elements.
- A group of layers concerns their detachment level and alterations
- A group is used to point out the location of stratigraphic samples analyzed with microscopy and FTIR attached to the annotations.

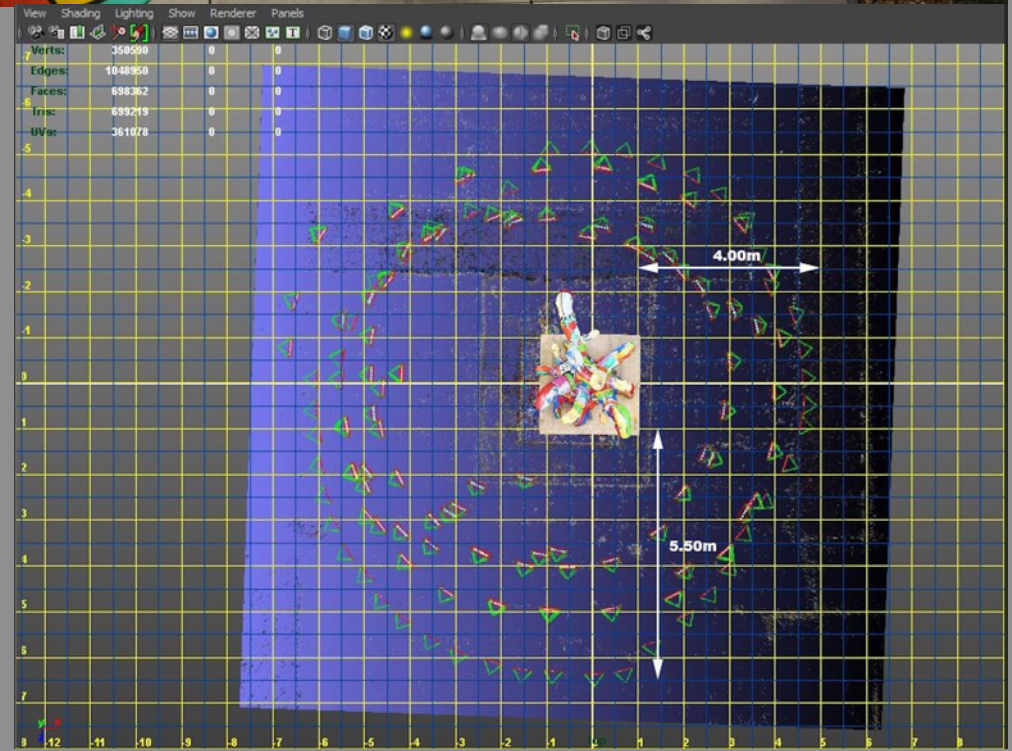
L’arbre aux serpents by Niki de Saint Phalle

- A multi-temporal approach
- Photogrammetric survey done just before and right after a complete restoration of this severely damaged monumental sculpture exposed outdoors.
- Surface was pickled, rewhitened and repainted by the original craftsman
- Altered and restored states had been captured and combined to create an optimal follow-up documentation set.

Gérard Haligon

Before restoration

After restoration



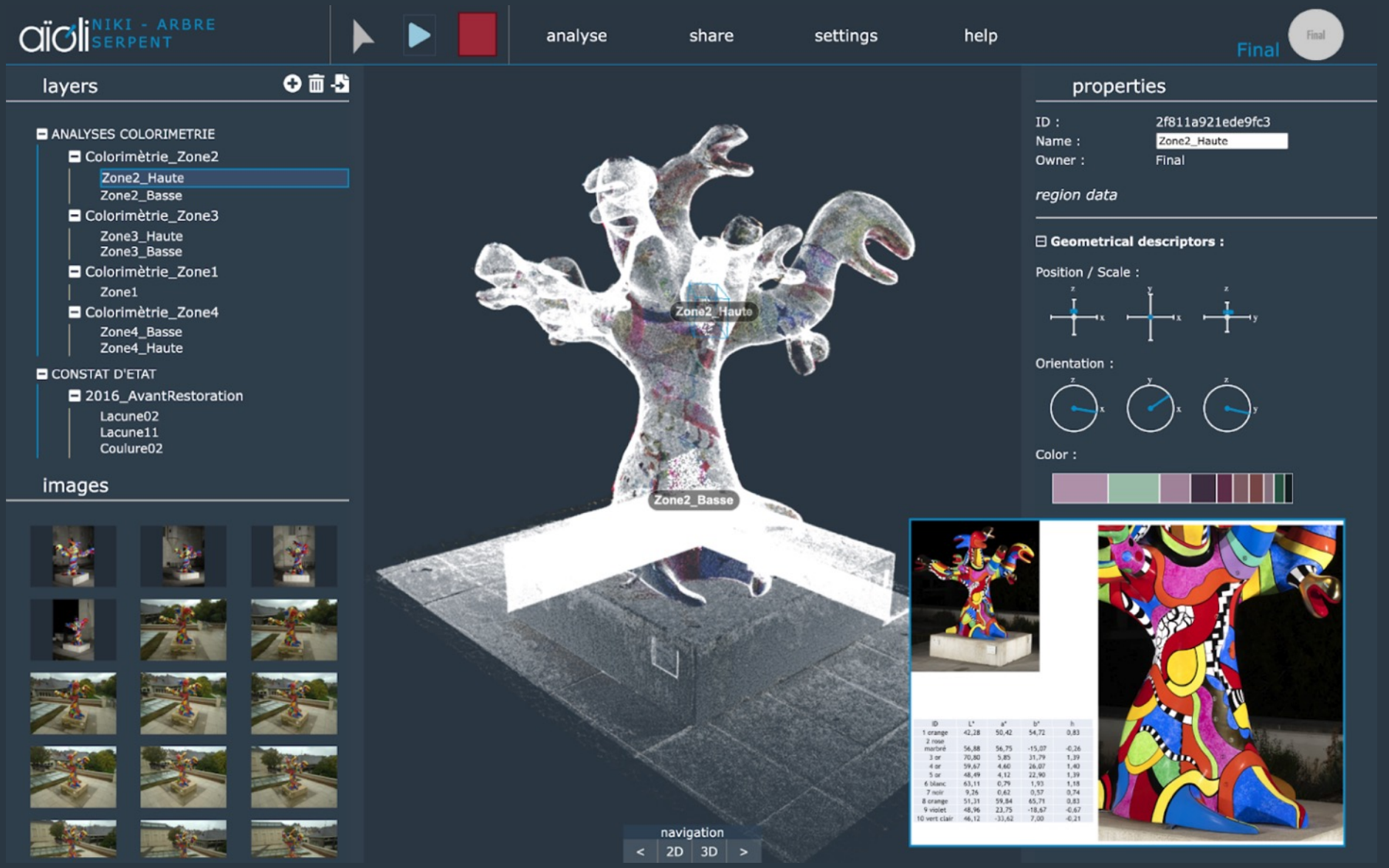
The final dataset is composed of 178 pictures registered in 5 iterations defining 4 modal layers:

- An A-CRP set extracted from a UAV mission in 2016 before restoration
- An A-CRP set extracted from a UAV mission in 2018 after restoration
- Pictures of the visible (VIS) Technical Photography-based (TP) documentation set
- Few isolated documentary photographs (DOC) from 2012 but not taken for photogrammetric purposes

The first photogrammetric survey to define the master acquisition = the alteration of the surface actually improved the quality of recording and reconstruction.

The complex snake shape and the appearance = a noisy and incomplete point-set.

Combined the image-based aerial point-set with the terrestrial laser-based one acquired after restoration to serve as 3D basis for Aioli's annotation process.



* One layer refers to a condition report from photogrammetry and the documentary survey acquisition before the restoration.
* A second layer aims to locate spectrocolorimetric analysis (with CIELAB coordinates joint as linked resources) performed after restoration

Expansion Controlée by César

* Multi-spectral scenario

* Most challenging and complicated object to document, leading to more limited outcomes.

- Composite material (polyurethane foam over polystyrene core structure)
- Moderate dimensions (153x116x80cm)
- Blobby shape compound with pronounced glossiness (variable thickness of polyester varnish)

The final dataset is completed by 116 pictures recorded in 9 iterations defined by the following modalities :

- A T-CRP global capture with cross-polarisation (CP) set-up
- Several albedo viewpoints (14) extracted from automated RTI dome capture set
- An extended Technical Photography set composed of visible (VIS), infrared reflected (IR) and ultraviolet fluorescence (UV)

* Appearance / specular variation issue = a cross-polarized master photogrammetric.
* Necessary to highlight the main elements of the condition report (old restorations visible in the multispectral range).

- A layer recalling intervention areas from a restoration made in 2017
- A group of layers pointing out visual and mechanical alterations, still visible in the actual state.

- Project creation = extended and/or public access granted
- Experts and non-experts to explore the enriched documentation by navigating freely into an interactive 2D/3D environment
- Consulting the groups, layers and related annotations.

Two visualization frameworks are explored:

1/ One tailored for research and CH experts' purpose

Share with peers and observe a centralized, up-to-date project that cannot be modified or deleted.

2/ One for wide public and museographic uses.

Work-in-progress public viewer will allow users to

compose from an Aioli's project a simplified scene:

- To create a sort of a story-telling subset made only of components that ease the interpretation or the understanding for a target audience.

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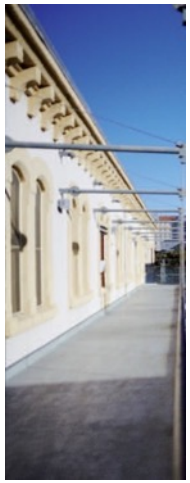
This presentation is based on the article:

A. Pamart, R. Roussel, E. Hubert, A. Colombini, R. Saleri, E. M. Mouaddib, Y. Castro, G. Le Goïc, and A. Mansouri.
2022. A SEMANTICALLY ENRICHED MULTIMODAL IMAGING APPROACH DEDICATED TO CONSERVATION AND RESTORATION STUDIES. Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci. XLVI-2/W1-2022, (February 2022), 415–420.

And on the ANR project end report.

c!crp
Centre Interdisciplinaire de Conservation et de Restauration du Patrimoine



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