CAPuS
Conservation of Art in Public Spaces

WP5

Definition of guidelines for product selection, on-site treatment evaluation, preventive conservation & maintenance

CAPuS project has received funding from the European Commission, Programme Erasmus+ Knowledge Alliances 2017, Project N° 588082-EPP-A-2017-1-IT-EPPKA2-KA.

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WP5 - IMPLEMENTATION OF A CONSERVATION METHODOLOGY

1. definition of a shared condition report,

2. definition of guidelines for product selection,

3. definition of criteria for sustainability choices,

4. definition of guidelines for on site treatment evaluation, for preventive conservation and for maintenance.

WORKFLOW DIAGRAM

Knowledge

1. General approach
2. Constitutive materials / technique of execution
3. Degradation phenomena

Evaluation / Research

4. Degradation causes
5. Tests on mock-ups
6. Tests *in situ*

Practice

7. Intervention
8. Maintenance

1. General approach

- Street art: Should it be conserved? What to conserve?
  Artist's perspectives VS institutional ones
- Who is in charge of street art conservation?
- Criteria at the base of street art conservation
  (sustainability, minimum intervention)
- Time/cost evaluation
- Planning an intervention on site:
  attention to property, commitments, artist involvement (?), public perception
- Main problems faced in CAPuS experience

1. General approach

MATERIALS

Essential bibliography about general approach to street art conservation:

- Santabárbara, C. (2018). *Street art conservation: beyond surfaces' restoration = Conservazione della street art: oltre il restauro delle superfici*, 147-162.
- Sànchez Pons M., Shank W., Fuster Lopez L. (2015), *Conservation Issues in Modern and Contemporary Murals*, Cambridge Scholars Publishing, ISBN (10): 1-4438-7233-4, ISBN (13): 978-1-4438-7233-1
- Rava A. e Collina A. (2019), *Introduzione Ragioni per la conservazione della Street art contemporanea*, in «KERMES- Dossier Street Art», n. 109, anno XXXI, ISBN 9788832029147, pp. 17-20.
- Cagnoni E., *L'arte urbana: fra libertà di distruzione e obblighi giuridici di conservazione*, in «KERMES- Dossier Street Art», n. 109, anno XXXI, ISBN 9788832029147, pp. 26-30.
- Iarzulo P., *Arte urbana e muri dipinti: le questioni irrisolte della definizione, della tutela e della conservazione*, in «KERMES- Dossier Street Art», n. 109, anno XXXI, ISBN 9788832029147, pp. 58-65.

1. General approach

MATERIALS

Essential sitography:

- PUBLIC INVOLVEMENT and BENEFIT

https://artsandculture.google.com/partner/inward-osservatorio-sulla-creativit%C3%A0-urbana

2. Constitutive materials / technique of execution

OBJECTIVE

To investigate the technique of execution, through the comprehension and the analysis of the different steps that led to the creation of the artwork, from the development of the original idea by the artist(s) to its realisation on site. The identification of the constitutive materials, of the technique of execution and their mutual relationships represent an essential component of the analysis.

2. Constitutive materials / technique of execution

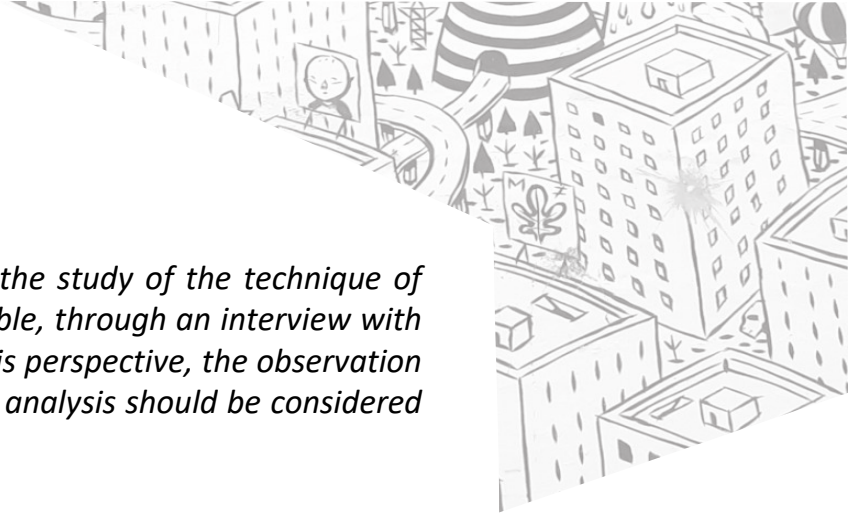
STATE OF THE ART

Within the CAPuS Project, 68 street artworks were selected and analysed in relation to their technique of execution and the constitutive materials used by the artists or previously applied, as part of a preliminary preparation undertaken by the owners or the consumers. The cases studied mainly belong to two classes of materials: painting on murals and metal sculptures.

MURALS: Most of the tested murals were made on old plasters, with or without an undercoat layer. However, contemporary murals may be also be made on different substrates, such as bricks or concrete. Paints with various synthetic binders including mainly acrylic, alkyd and polyester were most often used by artists. Artists often use organic pigments despite their instability. In some cases, the paintings were covered with a protective layer. The technique of execution is strictly related to the research of specific graphic effects that can be created through the use of spray, brushes or rolls, often mixed in a single artwork. Another aspect that affects the selection of the pictorial materials used is the context within which the artwork is made: in case of spontaneous or even illegal murals, cheaper materials are used, while within street art festivals or in case of commissioned artworks greater attention is devoted to the selection of best quality and more durable materials.

METAL SCULPTURES: Metal artworks studied in the CAPuS Project are made in bronze or steel (painted and unpainted) and galvanized steel.

2. Constitutive materials / technique of execution



Considering the experience gained within the CAPuS Project, below is a list of questions that can guide the study of the technique of execution of the urban artworks. The study can be carried out in different ways, including, whenever possible, through an interview with the artist(s) and preliminary research on the materials and the technique mainly used by the artist(s). In this perspective, the observation on site can be enriched with significant data that can guide the interpretation of the visible sign. Scientific analysis should be considered to confirm the hypothesis and characterize the materials.

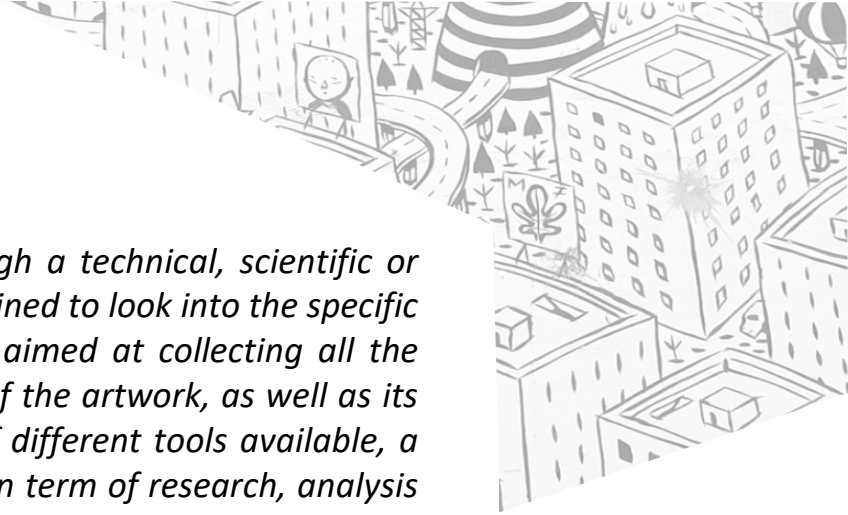
Studying the technique of execution means investigating various topics, such as:

- *Aesthetic value*
- *Artwork style*
- *Constitutive materials*
- *Technique of execution*

QUESTIONS

- What do we know about the artist(s) and his/her(their) general production?
- Has the artwork been created for a specific aim or based on a certain idea? Has it been created for a specific occasion/contest or on commission?
- Considering the aesthetic instance of the object, is it possible to define an artistic style?
- What are the main constitutive materials of the artwork?
- Is it possible to identify a stratigraphy? If so, how many layers can be detected? What is the reciprocal relationship between these layers?
- Looking at the surface, is it possible to glimpse elements related to a specific technique (such as spray paint, dripping paint, stencil, etc.) ?

2. Constitutive materials / technique of execution



Each of previously listed topics should be investigated with a multidisciplinary approach, through a technical, scientific or aesthetic analysis. In order to clarify the technique, all these elements should be merged and combined to look into the specific characteristics of the individual artwork. Such a trans-disciplinary and integrated approach is aimed at collecting all the necessary information through different tools related to the investigation of the aesthetic value of the artwork, as well as its constitutive materials and technique from a scientific point of view. Therefore, in the number of different tools available, a preliminary selection should be made on the basis of the object under study and the possibilities in term of research, analysis and goals of the stakeholders.

A list of useful tools, tested and used within the CAPuS Project, is provided below. As part of a step-by-step study, the analysis should start with non-invasive stages, and gradually proceed toward invasive analysis. In this perspective, in the suggested workflow, priority is given to the collection of preliminary information through the interviews and the close-up observation of the artwork, then followed by a diagnostic campaign. The latter consists in multispectral imaging and non-invasive analyses, then followed, if necessary, by micro-sampling and invasive analyses for further investigation.

The selection of the most helpful and appropriate analytical techniques can vary on a case-by-case basis, depending on the type of artwork (e.g. mural, steel sculpture), the accessibility on site, the availability of equipment and the specific questions. A non-exhaustive list of some of the most common techniques generally used for the study of public art and within the CAPuS project is provided below.

FIND THE ANSWERS

- Artistic studies and artist interviews (focus on original idea and context of the artwork, materials, style, conservation)

- Close-up observation of the whole surface of the artwork
  - autoptic exam
  - portable optical microscopy / video microscopy (observation of the surface morphology; observation of the edges of lacunas or cracks to investigate the stratigraphy; documentation of surfaces in optical microscopy

2. Constitutive materials / technique of execution

FIND THE ANSWERS

> Murals and street artworks

- **Multispectral imaging analyses**

  -IR reflectography

  -False-colour infrared processing

  - UV-induced visible fluorescence photography (only in specific conditions; daylight or direct street lighting should be avoided)

- **Non-invasive analyses**

  - XRF (X-ray fluorescence spectroscopy): elemental analysis of the inorganic components of paints and substrates

  - Portable FT-IR (Fourier-transform infrared spectroscopy): analysis of the organic and inorganic binders, pigments, filler

  - Colorimetry: assessment of chromatic parameters of the surfaces

  (other less common techniques may be used, such as

  - Portable Raman spectroscopy : analysis of the binders, pigments

  - Portable XRD (X-ray diffraction): analysis of the substrate and the inorganic pigments and fillers)

2. Constitutive materials / technique of execution

FIND THE ANSWERS

- **Micro-sampling and invasive analyses on selective samples**
  - FT-IR (Fourier-transform infrared spectroscopy): analysis of the organic and inorganic binders, pigments and fillers
  - GC-MS (Gas chromatography–mass spectrometry): analysis of the organic binders and pigments
    (the sensibility of this analytical technique is higher than FT-IR)*
  - Raman spectroscopy: analysis of the pigments
  - XRD (X-ray diffraction): analysis of the substrate and inorganic pigments and fillers

- **Cross-section preparation and study of the stratigraphy**
  - OM optical microscopy observation under VIS and UV light
  - SEM-EDX (Scanning electron microscopy - energy dispersive X-ray spectroscopy) analysis: visual information related to the elemental composition at the microscopic level (higher magnification than OM)
  - FT-IR (Fourier-transform infrared spectroscopy): analysis of the organic and inorganic binders, pigments, fillers

  (FT-IR analyses on cross-sections may be performed in mapping / imaging mode, adding a spatial distribution to the chemical characterization)*

2. Constitutive materials / technique of execution

FIND THE ANSWERS

> Metal sculptures

- **Multispectral imaging analyses**

  - UV-induced visible fluorescence photography (only in specific conditions; daylight or direct street lighting should be avoided)

- **Non-invasive analyses**

  - XRF (X-ray fluorescence spectroscopy): elemental analysis of metal alloy
  - Portable FT-IR (Fourier-transform infrared spectroscopy): analysis of the organic finish or protective coating

- **Selective micro-sampling and laboratory diagnostic analyses**

  - Metallography (optical metallographic microscope)
  - SEM-EDX (Scanning electron microscopy - energy dispersive X-ray spectroscopy) analysis
  - XRD (X-Ray diffraction)

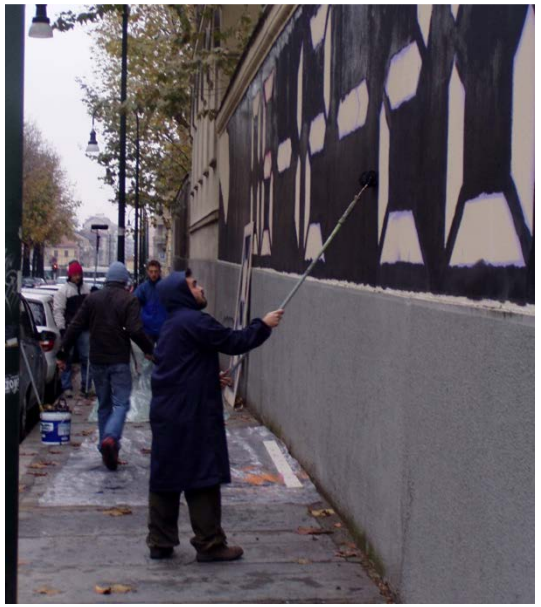
2. Constitutive materials / technique of execution

FOCUS

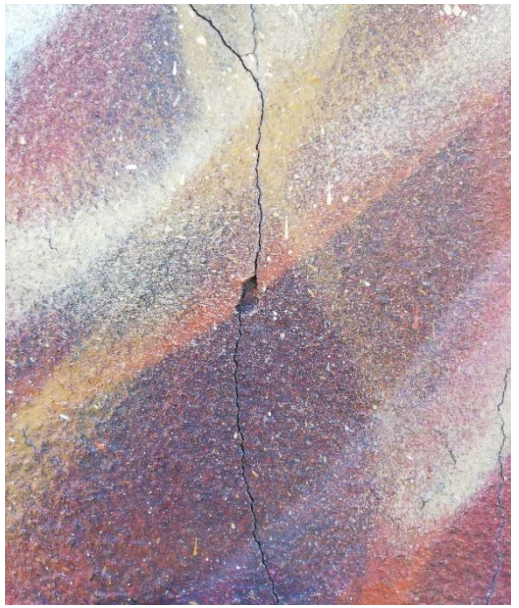
- **Example 1: *Memorial Thyssen victims tragedy,* by various artists (2008), Turin, Italy (1/2)**

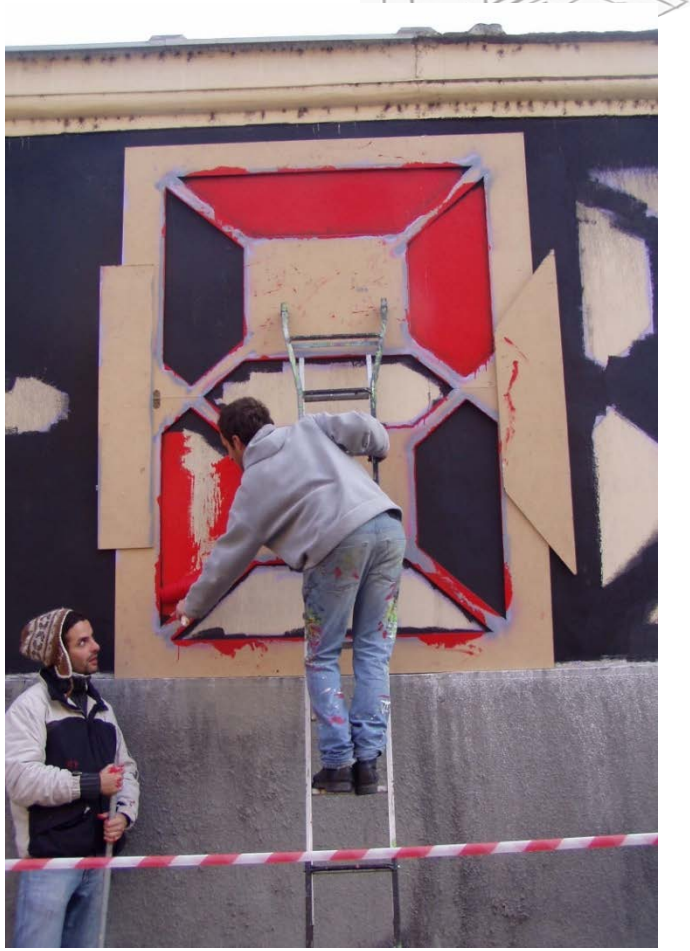
Interview (http://repository.capusproject.eu/artwork/memorial-thyssen-tragedy-victims-turin03) and meeting on site with the artists gave access to significant information about the materials and the technique used to create the mural, as well as the meaning and purpose of the painting.

The use of a self-made stencil has been attested through several images taken by the artists on site during the creation of the artwork; the combination of different pictorial media, such spray paint and brushes/roller has been used to obtain specific aesthetic effects (e.g. the shading flames or the bubbling foam).



Memories of significant events reported by the artists helped in the analysis of the state of conservation of the painting: due to an unexpected snowfall during the execution, some portions of the mural have been repainted by the artists, because the primer literally melted and peeled off during the night, just after the application.





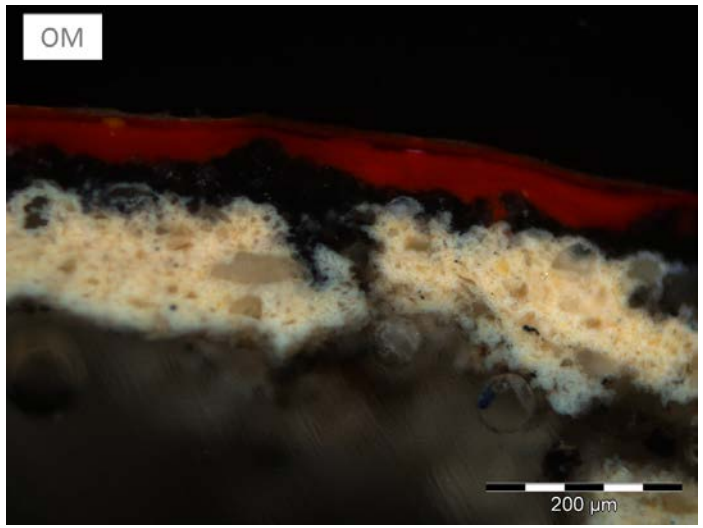
2. Constitutive materials / technique of execution

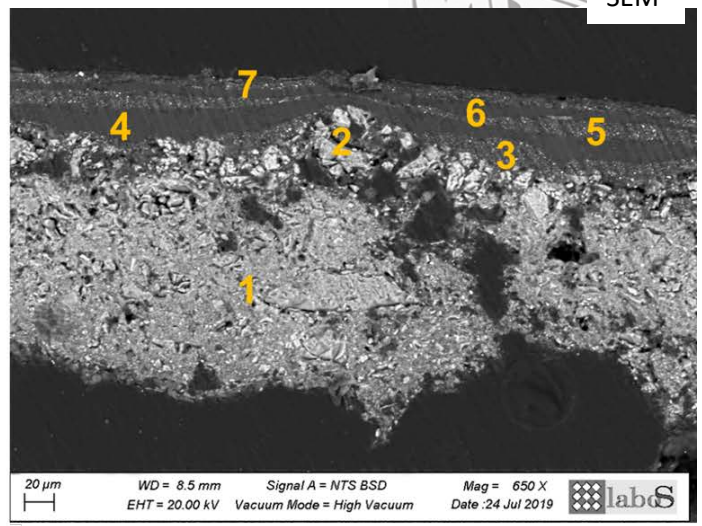
FOCUS

- **Example 1: *Memorial Thyssen victims tragedy,* by various artists (2008), Turin, Italy (2/2)**

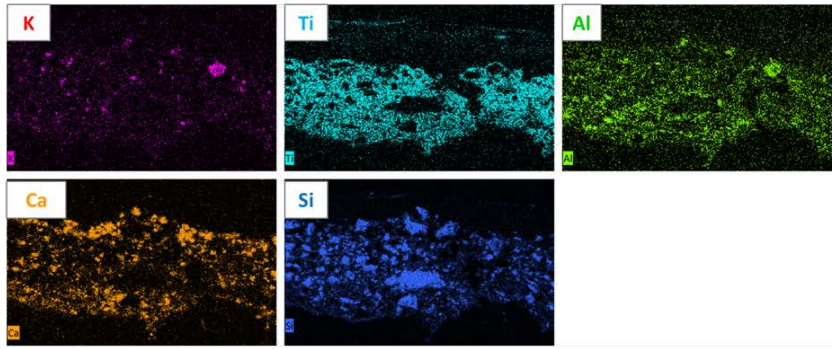
The close-up observation of the surface of the mural highlighted the presence of different techniques, as previously reported by the artists. All the data collected were summarized in graphic maps, useful for describing, graphically, the distribution of the different painting techniques used to create the mural.

Analytical samples were collected from the most representative areas in order to understand the complex stratigraphy of the painting and, possibly, to study the relationship between the use of very sensitive materials (in outdoor conditions) and the decay observed on the painting.





1 – white	**Si**, **Ti**, Ca, Al, (K) -> silicates + Ti white
2 - black	Carbonates + silicate inclusions
3, 5, 7 – red	**Si, Bi,** Cl, Al, Ca, Ti, V
4, 6 – red	**Si, Cl**, Al, Ti



2. Constitutive materials / technique of execution

FOCUS

- **Example 2: *Wall*, by Dora Kovačević (1985), Sisak Steelworks Sculpture Park, Sisak, Croatia (1/2)**

One of the participants of the 1985 Sisak Steelworks Fine Artists' Colony provided conservators/restorers with photographs of the making of the Dora Kovačević sculpture *Wall*. A photograph of the artist at work was published in the Sisak Steelworks newspaper, and another in the catalogue of the final exhibition of the 1985 Colony. These images were shown to Dora Kovačević during an interview, which helped her reconstruct the sculpture's fabrication process in detail.

Image source: Catalogue of the exhibition of the 1985 Sisak Steelworks Fine Artists' Colony. Scanned catalogue courtesy of Vlatko Čakširan (Sisak Municipal Museum).

2. Constitutive materials / technique of execution

FOCUS

- **Example 2: *Wall*, by Dora Kovačević (1985), Sisak Steelworks Sculpture Park, Sisak, Croatia (2/2)**

The sculpture is based on a small papier-mâché maquette with a wire or mesh armature. Several steelworkers assisted the artist in making the sculpture. The elements that make up the sculpture were cut from thick steel plates using the oxyacetylene torch method. The central component is made of two pieces of steel which were welded together and bent by hammering. All the other elements were then assembled by welding. Weld splatter was removed, and the welds were smoothed. The artist drew the positions of the perforations with white chalk. The steel was cut using the oxyacetylene torch method. Dora Kovačević wanted a non-glossy coating to be applied on the sculpture, as a form of protection from corrosion. After she left the Colony, the steelworkers painted the sculpture black.

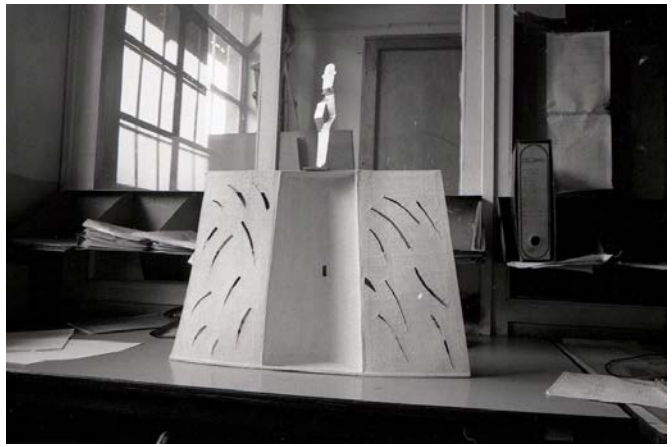


Image source: Personal archive of the artist Branimir Karanović. Courtesy of the artist.

2. Constitutive materials / technique of execution

FOCUS

- **Example 3: Pecado Original, by SOKRAM (2012), Ordes, Spain (1/3)**

This work is located in an urban environment but with a low incidence of vehicles and urban pollution. The work was painted on the facade of an abandoned house, on the bank of the river that runs through the town. The environment is very humid. The facade, a brick wall rendered with cement-based mortar and painted with white acrylic paint, was—initially—very deteriorated.

Wrought iron balustrade, wood and aluminium are the other substrates.

The artist used brush paint of different colours, all of the acrylic type (according to Fourier transform infrared spectrometry).

The work represents a snake that curls around itself taking advantage of the gaps in the façade (openings and doors). The presence of an apple—whose leaf is a banknote—suggests capitalism is one of the original sins.

2. Constitutive materials / technique of execution

FOCUS

- **Example 3: Pecado Original, by SOKRAM (2012), Ordes, Spain (2/3)**

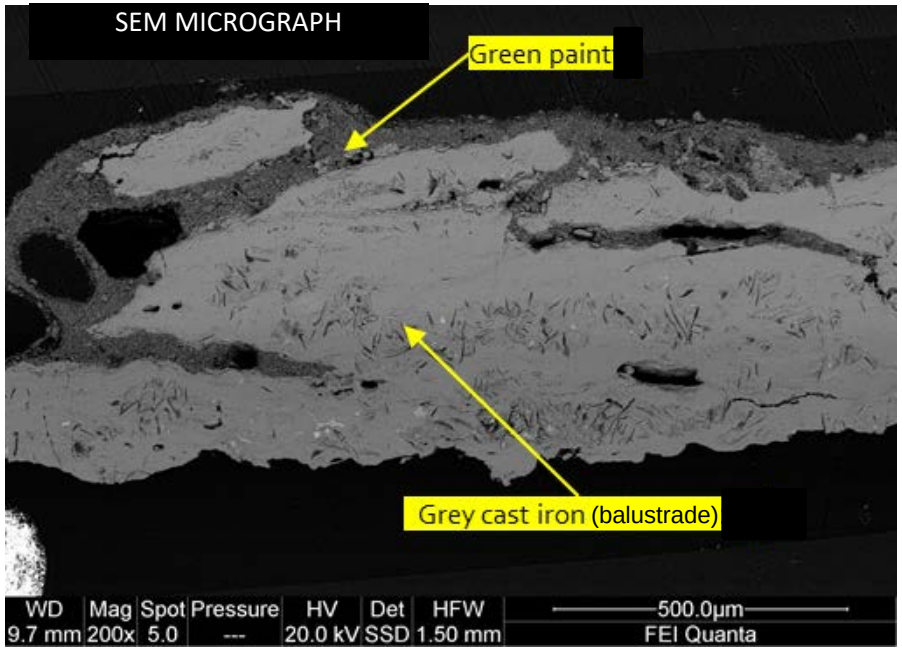
	CHARACTERIZATION OF THE SUBSTRATE	CHARACTERIZATION OF PAINT MATERIALS
DESCRIPTION	1. Reinforced concrete (channel of the river) 2. Brick wall rendered with cement based mortar and painted with white acrylic paint 3. Wrought iron balustrade 4. Wood 5. Aluminium	Several Green-blue colours, red, yellow, black and white. All acrylic paints
ANALYSIS	X-ray diffraction	X-ray diffraction/ scanning electron microscopy (SEM) with EDS
RESULTS	• Concrete: silicate aggregate and Portland cement. • Brick wall: several cement based renders with different kinds of aggregate (silicate, beach sand, etc.). • Balustrade: grey cast iron	Calcium carbonate, talc and rutile as extenders and fillers Several paint layers both by the artist and predating the artwork

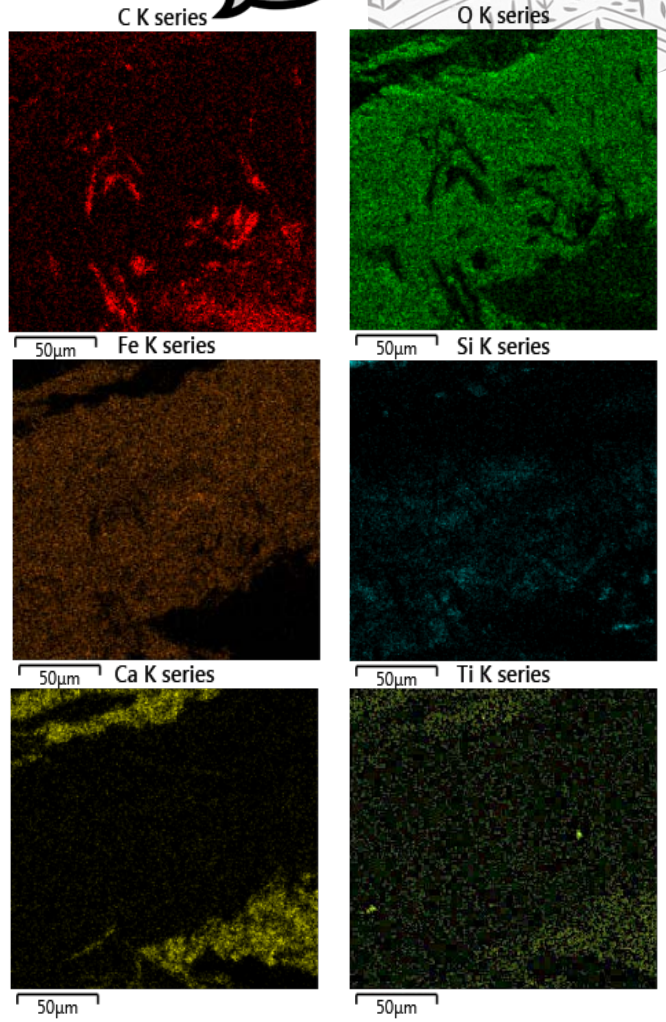
2. Constitutive materials / technique of execution

FOCUS

- **Example 3: Pecado Original, by SOKRAM (2012), Ordes, Spain (3/3)**

SEM analyses of green paint samples from the balustrade confirm that the substrate is a *grey iron cast*; It has a ferritic matrix and carbon in the form of graphite, with a typical laminar and rosette texture. EDS chemical element maps reflect the ferritic nature of the matrix (high Fe content) and the rosette-shaped graphite growths. The paint that remains on the grey cast iron is rich in calcium and titanium.





2. Constitutive materials / technique of execution

MATERIALS

Within the CAPuS Project, particular attention was paid to creating effective communication with the artists, achieved through in-person interviews, via web or by meeting on site. In order to focus on the most useful information, respecting the secrets that the artist does not want to divulgate, a delicate balance should always be maintained. At first, catching the tips or tricks used by a skilled and experienced artist can be a challenging goal, but planning a logical outline before the interview resulted in an incredibly advantageous tool, helping us to focus on specific topics during the talk. In these perspectives, research, planning and the development of a sort of emotional intelligence constitute essential skills and steps for interviewing artists, as described in one of the workshops carried out within the project, with the aim of training a new generation of conservators on new approaches related to the conservation of public art.

In CAPuS Open Access digital repository, a collection of interviews by the partners of the project with various European street and “public” artists are available to students, professionals and teachers to focus on the importance of including this tool among the ones generally used in the preliminary studies.

- On the basis of the experience gained, a general outline and some guidelines for interviews with contemporary artists were listed (>> *Document reporting a general outline for interviews*)
- (CAPuS folder – WP2): photos of interviews, audio recordings, videos)
- (CAPuS folder – WP3): tables with analytical results summarized

3. Degradation phenomena

OBJECTIVE

As a fundamental step of the conservation project, the assessment of the state of conservation of the object is mainly aimed at observing and identifying the different degradation phenomena, recognizing their hazard for the future conservation of the artwork by using established criteria such as the progression of the damage, the location within the stratigraphy of the object and the extent. On the basis of these criteria, the study should investigate the presence, if any, of correlations between those degradation phenomena and classes of constitutive materials of the object specific to contemporary art. Thus, in the aim of better understanding the decay processes through the characterization of the degradation, analytic protocols can be set up.

3. Degradation phenomena

STATE OF THE ART

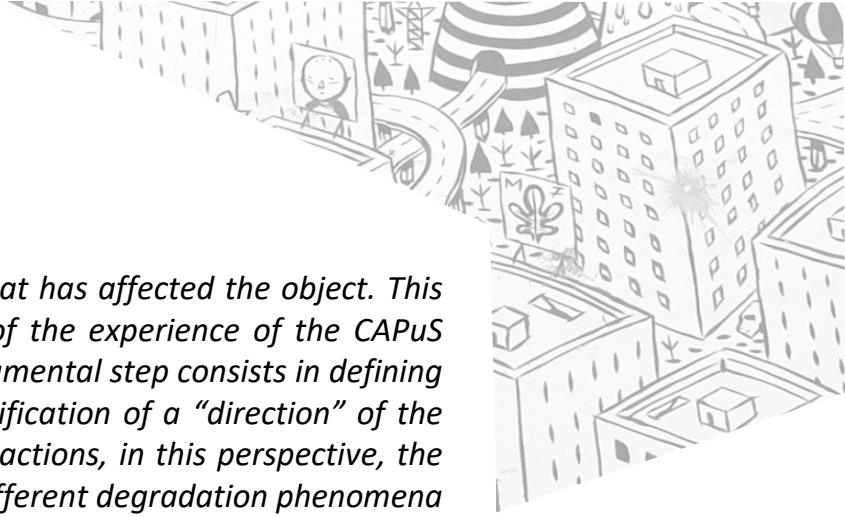
The assessment of the state of conservation of selected artworks in public spaces, within the CAPuS project activities, was summarized in a report of the most common degradation phenomena observed on outdoor murals and metal sculptures.

Generally, decay related to loss of cohesion and loss of material was the most frequent on every kind of substrate: among them, lacunas and abrasion were the most common, involving the painting layers, the background layers or both. Phenomena occurring in the superficial layers, such cracking and flaking, were seen as well, especially in painted artworks. Major losses were equally observed both on murals, often associated with efflorescence, and in metal sculptures, in this case mainly related to other human-caused decay phenomena, such as incisions or scratches.

Corrosion was the most harmful type of decay for outdoor metal sculptures, found, with different extent and progression, in almost all the metal objects analysed.

Considering the overlayed materials, biological colonization was widely documented, especially in objects where the upper layers showed abrasion, erosion or lacunas.

No matter the substrate, widespread decay resulting from human action were found: so-called “unwanted graffiti”, tags, stickers, incisions and scratches, afflicted both murals and metal artworks, especially when other types of decay were already visible.



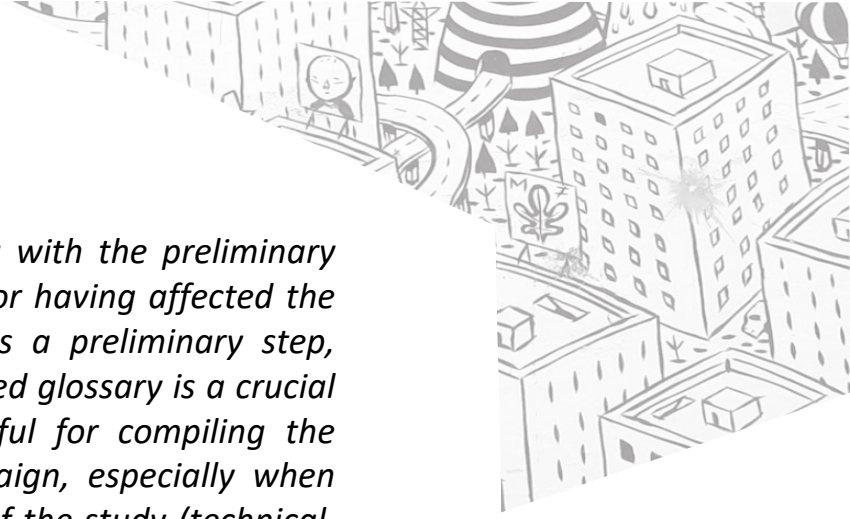
3. Degradation phenomena

The survey of the state of conservation must focus on the identification of the degradation phenomena that has affected the object. This analysis often results in a complex study of the materials and their possible interactions. On the basis of the experience of the CAPuS Project, some questions that might guide this analysis are listed. Considering the preliminary survey, a fundamental step consists in defining useful criteria aimed at orienting the observation and organising the data collected: first of all, the identification of a "direction" of the study might be a valuable tool for separately checking every layer and then considering the possible interactions, in this perspective, the suggestion is to start with the background layers to gradually investigating the superficial ones. Then, the different degradation phenomena may be grouped into clusters on the basis of their specific effects on the objects (such as: loss of material, addition of substances, chemical alteration, etc.). Finally, a gradual approach, from non-invasive observation to micro-invasive analysis, should be taken into account to better orientate any sampling and any specific point of analysis.

QUESTIONS

- Considering the stratigraphy, does the whole object seems to have the same layers, characterized by analogous thickness and similar distribution on the surface?
- Are the constitutive materials in the same chemical-physical status all over the object? Are there visible losses or lacunas?
- Considering the morphology, is the object surface homogeneous?
- In relation to the general chromatic fields or the colour of the substrate, does the upper surface appear homogeneous?
- Are additional substances, applied during previous interventions or because of vandalism, visible on the artwork?
- On the surface or under the upper layers, near lacunas or losses, is it possible to distinguish materials not belonging to the execution technique or to previous intervention, that can be recognized as products of degradation?

3. Degradation phenomena



The condition of conservation of the object can be analysed following a workflow that, starting with the preliminary optical observation, leads to a detailed comprehension of the degradation phenomena affecting or having affected the object, in relation to their extent, location and interaction with the constitutive materials. As a preliminary step, considering the differences in the use of specific terms and definitions, the establishment of a shared glossary is a crucial activity. Once the appropriate terminology has been defined, designing graphic maps is useful for compiling the information collected during both the preliminary survey and the subsequent analytical campaign, especially when integrated with the comprehensive condition report aimed at merging the different perspectives of the study (technical, scientific, historical, aesthetic, etc.). Within the CAPuS project, some tools have been developed with the aim of guiding the analysis of the degradation phenomena and have led to a deeper knowledge of the object and its history, enhancing the sharing of common terms and definitions for the description of the various topics.

FIND THE ANSWERS

- Graphic thematic maps, prepared with various software programmes (even open source), represent an effective tool for summarizing all the data collected during the study. Moreover, by analysing the location of the different degradation phenomena, any correlations may become visible and lead to further study.
- Photographic documentation, especially in close-up mode, helps to evaluate changes in the physical properties and the morphology of the object.
- Optical video microscopy
- Microscopy and analysis of cross-sections may be used to obtain information about the continuity of the layers and the presence of interactions between the constitutive and the non-original materials (OM, SEM-EDX).

3. Degradation phenomena

FIND THE ANSWERS

For a better assessment of the condition of the artwork and to characterize, if any, the degradation, further diagnostic analyses are often needed. The most appropriate analytical technique may be selected depending on the specific type of artwork, the degradation phenomena encountered and their location. Both non-invasive techniques and analyses on micro-samples may be performed. The condition report may highlight the major degradation phenomena that require further investigation.

Generally, analysis on micro samples is preferred and more common. Some examples are listed below:

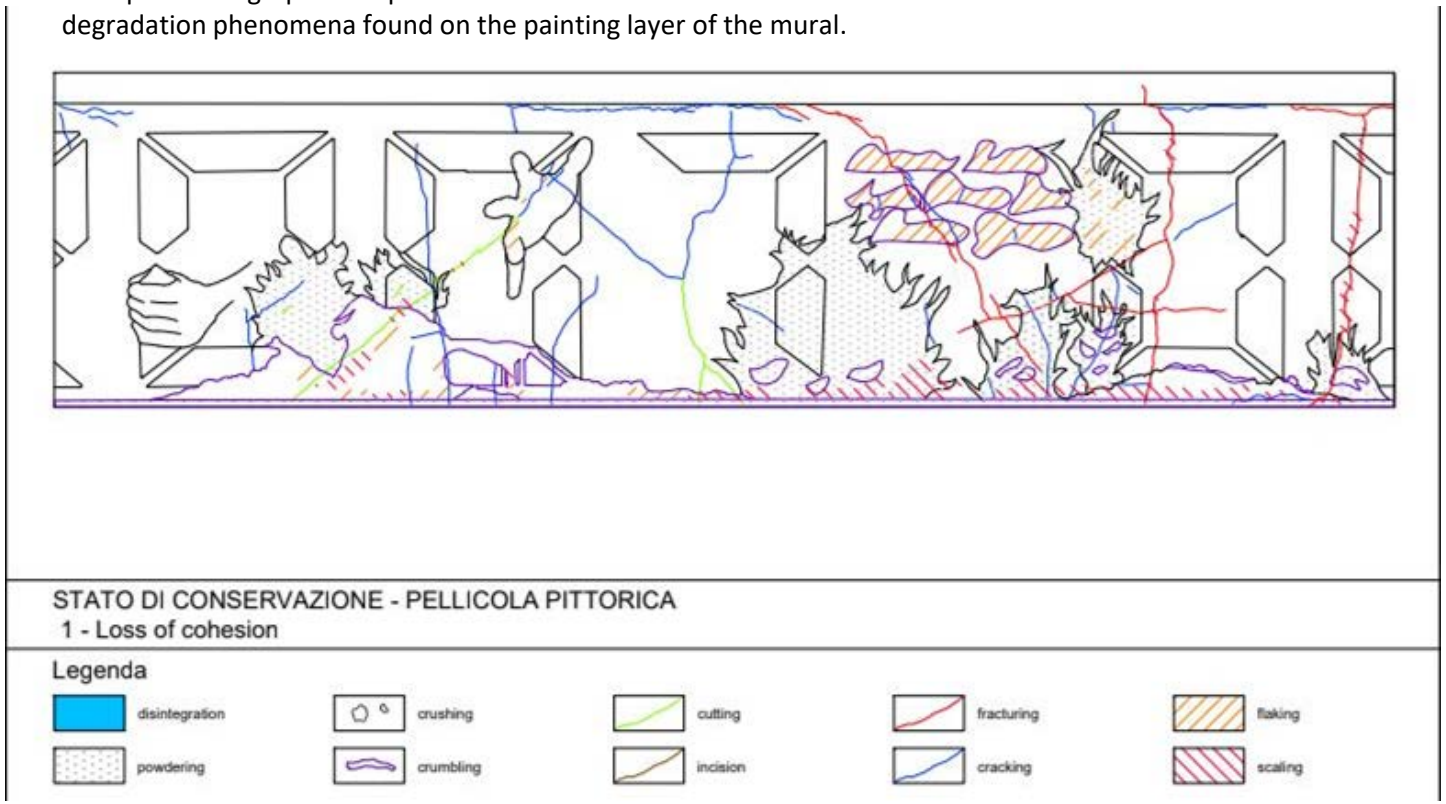
- Analysis of the degradation of the constitutive materials, patina, deposits, corrosion products, salt efflorescence, alteration of surface coatings by:
  - FT-IR (Fourier-transform infrared spectroscopy)
  - SEM-EDX (Scanning electron microscopy–energy dispersive X-ray spectroscopy) analysis
  - XRD (X-ray diffraction)
  - IC (Ion chromatography)
  - GC-MS (Gas chromatography–mass spectrometry)
  - Raman spectroscopy
- Identification of the bio-deterioration agents
  - Microbiological culture
  - Optical analysis/optical microscopy observation of sampling biological materials (such as fungi, plants, shrubs, etc.)
- Study of optical alteration:
  - Colorimetry: assessment of alteration of the surfaces after a period of outdoor exposure

3. Degradation phenomena

FOCUS

- **Example 1: *Memorial Thyssen victims tragedy,* by various artists (2008), Turin, Italy (1/2)**

Example of a graphic map aimed to summarize the distribution and the location of the most relevant degradation phenomena found on the painting layer of the mural.



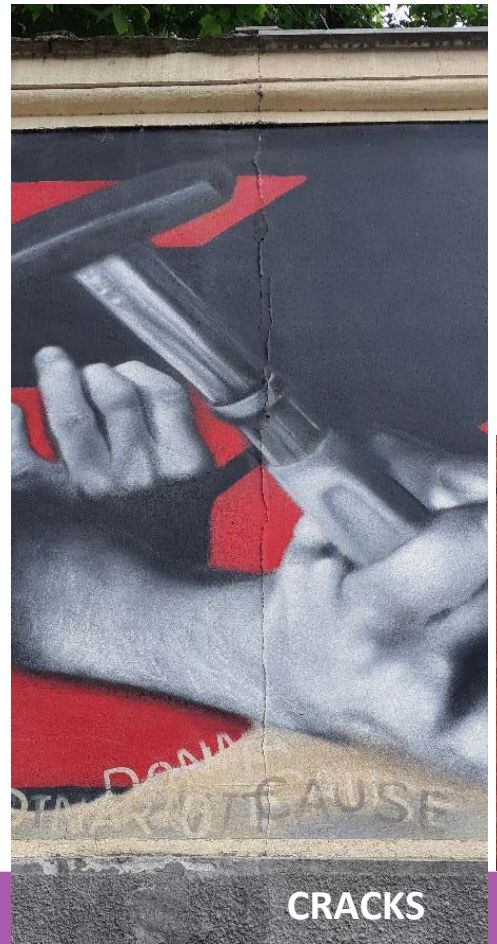
Before the pilot intervention on the "memorial Thyssen" mural, an assessment of the state of conservation of both the painted layers and the substrate was made through the CAPuS condition report form and through graphic mapping of the different degradation phenomena observed on the surface and in the substrate. The results showed widespread degradation phenomena of the paint, including cracking, flaking and lacuna; minor decay related to the substrate, mainly consisting of fractures and lacuna, were also found. The location of these phenomena on the mural surface and the assessment of their diffusion, within the attached condition report, represented a significant step for the analysis and the study of their development and a preliminary step in the identification of the threats and the causes for degradation, as further explained.

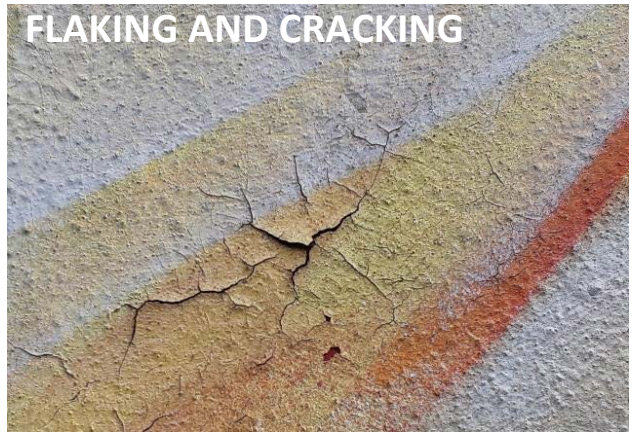
resources/UNITO_CCR/Memorial Thyssen tragedy victims Turin03/Condition Report Turin 03.pdf

3. Degradation phenomena

FOCUS

- **Example 1: *Memorial Thyssen victims tragedy,* by various artists (2008), Turin, Italy (1/2)**


CRACKS


FLAKING AND CRACKING


BIOLOGICAL COLONISATION

LACUNA


FLAKING


GRAFFITI


FADING

Close-up photos of the main degradation phenomena found on the mural.

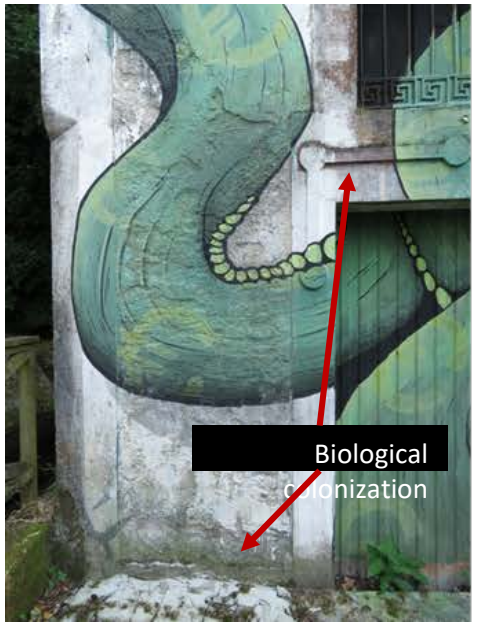
(Photo Credits: Centro Conservazione e Restauro “La Venaria Reale”)

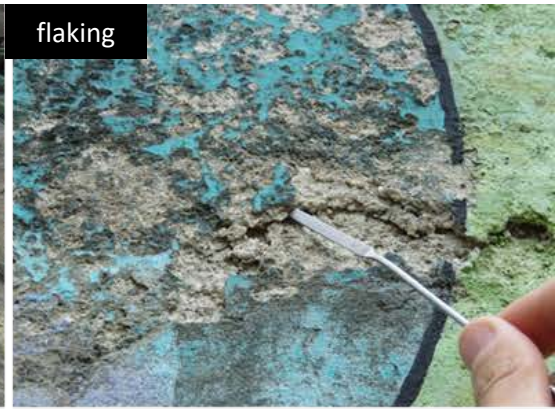
3. Degradation phenomena

FOCUS

- **Example 2: *Pecado Original*, by SOKRAM (2012), Ordes, Spain**

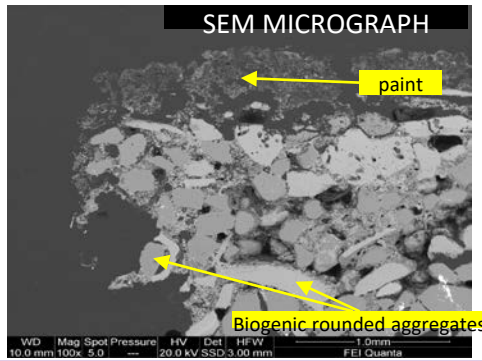
Lacuna (due to a flaking process) and corrosion (of the grey cast iron of the balustrade) are the main forms of deterioration. Due to the humid climate and the highly porous substrate materials, biological colonization is very intense, especially in areas close to the ground and in areas subject to water runoff. The presence on painted layers of gypsum as efflorescences and subefflorescences was confirmed by x-ray diffraction and by means a soluble salt extraction.





The PRINCIPAL DETERIORATION FACTORS are:

- the nearby river: high relative humidity, risk of rise of capillary water, sulphate source?) and climate (high rainfall), which favours biologic colonization and the corrosion of the balustrade
- Cements with high gypsum content



- Structural problems of the walls: many sub-vertical fractures affect the renders and the brick wall
- Use on mortars of aggregates of marine or river origin (using scanning electron microscopy, shells of bivalves and gastropods were found (source of sulphates?)

3. Degradation phenomena

FOCUS

- **Example 3: *Door*, by Branko Ružić (1984), Sisak Steelworks Sculpture Park, Sisak, Croatia (1/2)**

Branko Ružić's *Door* consists of eight relief panels made of steel sheeting and painted in black. The supporting construction consists of scaffolding tubes and clamps partially coated with a red anti-corrosive paint. Severe corrosion and loss of material can be observed in the lower parts of the protruding elements of the relief panels. In the bottom part of the supporting construction, tube clamps are falling apart from corrosion.

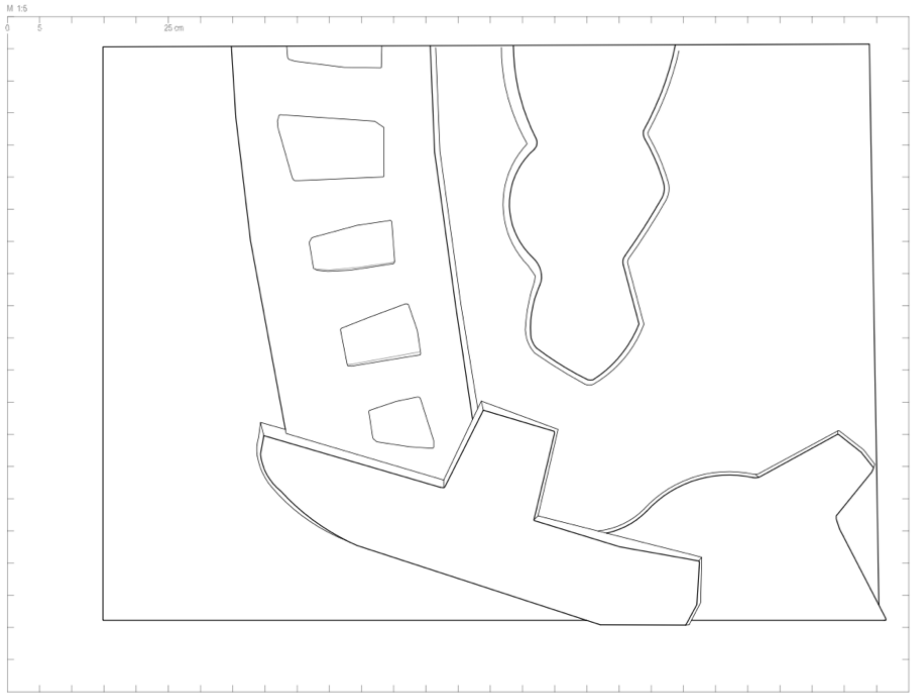
3. Degradation phenomena

FOCUS

- **Example 3: *Door*, by Branko Ružić (1984), Sisak Steelworks Sculpture Park, Sisak, Croatia (2/2)**

On the relief panels, chromatic alteration is evident in the topcoat, while the base coat is exposed in localized areas. The sculpture has been vandalized (spray-painted and scratched). Its backside has been used as a bulletin board; there are residues of adhesive tape and paper announcements and advertisements that were glued to the relief panels. A green biofilm covers large areas of the surface, especially on the backside of the relief panels.

Information about the physical condition of the artwork was collected through visual inspection. A condition report was produced, as well as extensive photographic documentation. A 3D laser scan of the entire relief was obtained. From this, 2D documentation was created in AutoCAD (drawings of the front, back and side views of each relief panel). The drawings were used for mapping the observed degradation phenomena.



Architectural drawing:
Ankica Sučić Marić
(EVEN d.o.o.)

3. Degradation phenomena

Materials

CONDITION REPORT: within the CAPuS project, a condition report has been defined, with the aim of summarizing all results of the preliminary studies related not only to the assessment of the state of conservation, but also to the enhancement of the technique of execution, the previous intervention on the object, the artistic, social and aesthetic value and the data collected through the analytical campaign. To reflect the multidisciplinary and gradual approach to the knowledge of the object, the condition report was divided into four sections focused on the different topics of the study.

1- GENERAL DATA	2- LOCATION	3 – TECHNIQUE OF EXECUTION	4 - DEGRADATION
• Specific information about the artworks, the artist, any social commitment	• Environmental data, information about location inside the city	• Specific “artistic” definitions • Materials	• Degradation description and location

Further information can be found in CAPuS digital repository, at the site: http://repository.capusproject.eu/

3. Degradation phenomena

Materials

CAPuS PROJECT - CONDITION REPORT (WALL PAINTINGS)			
1 - GENERAL DATA			
Artist ()	VARIOUS		
Title of the work	Memorial Thyssen victims tragedies		
Type of work	Mural		
Materials	Paint, plaster		
Year of execution	2008		
Owner / custodian	Turin Municipality		
Legal protection	Italian Ministry of Cultural Heritage		
Dimensions (cm)			
Height	**Width**	**Depth**	
300	1000		
Country	Italy		
City	Turin		
Address	Corso Valdocco - corner Via Santa Chiara		
GPS coordinates			
Latitutde	45°04'38.7"N		
Longitude	7°40'30.7"E		

1 GENERAL DATA

In this section, data related to the title, the attribution, the property, the custody, the dimensions and the geographical location of the object are reported.

3. Degradation phenomena

Materials

2 - LOCATION				
ENVIRONMENT				
Description				
Adjacent to:	X Sidewalk			X Lane: Pedestrian/Vehicles
	□ Vacant Lot			X Parking: Pavement/Gravel/soil
	□ Road: Pavement/Dirt/Gravel			□ Building /Porch
	□ Vegetation/Landscaping			Sidewalk for pedestrian, on the side of a vehicles road, with place for parking at the two sides
		□ Paving Stones		
		□ Garden		
		□ Grass		
		□Trees		
Orientation - Facing towards:	□Nord	□South	□East	X West
Lighting:	street lamp on the side of the vehicles road			
Other Security Measures:				
X exposed	X direct sunlight			□ skaters/bikers riding on artwork
□ semiconfinate	□ gutter			X person living in or around artwork
□ confinate	□ trash around artwork			□ not easily accessible/obstructed
□ isolated	X poor drainage/traps water			□ food vendor/picnic area nearby
□ poor lighting	□ weeds are high/overgrown			external wall of the national archive
X public access	□ people sitting or playing on artwork			
□ contryside	□ artwork is hard to find			

SOCIAL CONTEXT: The mural was made by a group of local street artists as a memorial to the victims of the ThyssenKrupp factory tragedy. Families of the victims, together with the public institutions, promoted the murals, which soon became a fundamental part of the collective memory of the city. This is why citizens are very familiar with the painting and are really interested in its conservation and maintenance. Artists as well consider this artwork a public denouncement and, consequently, a cause for reflection on present-day working conditions and safety measures for factory

2
LOCATION

The second section collects detailed information about the surrounding environment, as well as a short description of the social context and the accessibility for the general public.

3. Degradation phenomena

Materials

3 - EXECUTION TECHNIQUE					
GROUNDING LAYERS					
X ND	□ 1	□ 2	□ 3	□ 4	□ 5
□ TECHINCAL DATA	□ HYPOTESYS	□ SCIENTIFIC ANALYSIS	□ ARTIST INTERVIEW		
PRIME COATING					
	X YES	□ NO	□ NA		
	□ TECHINCAL DATA □ HYPOTESYS □ SCIENTIFIC ANALYSIS **X ARTIST INTERVIEW**	□ TECHINCAL DATA □ HYPOTESYS □ SCIENTIFIC ANALYSIS □ ARTIST INTERVIEW	NOTES		
PAINTING TECHNIQUE					
□ 3D Style □ Abstract style □ Anti-Style/Ugly style □ Backjump □ Blockbuster Style □ Bombing □ Bubble style □ Cartoon/Character □ Challenge (Insides) X **Complex style** □ Dubs (UK)/Plata (ES) □ Free style	□ Full Monty □ Mop X **Mural** □ Old School □ Own style □ Piece (free-hand) □ Punition □ Roller Graffiti □ Semi-wildstyle Sharp □ Tag □ Throw-up □ Wildstyle	□ Domming □ Dripping □ Calligraffiti □ Etching □ Extinguisher bombing/ soaker Tags □ Fading	□ Fill-ins □ Installation □ Outlining □ Poster □ Scriber □ Scribing / Scratching	□ Stencil graffiti □ Sticker □ Yarn bombing □ OTHER	
□ TECHINCAL DATA	□ HYPOTESYS	□ SCIENTIFIC ANALYSIS	**X ARTIST INTERVIEW**		

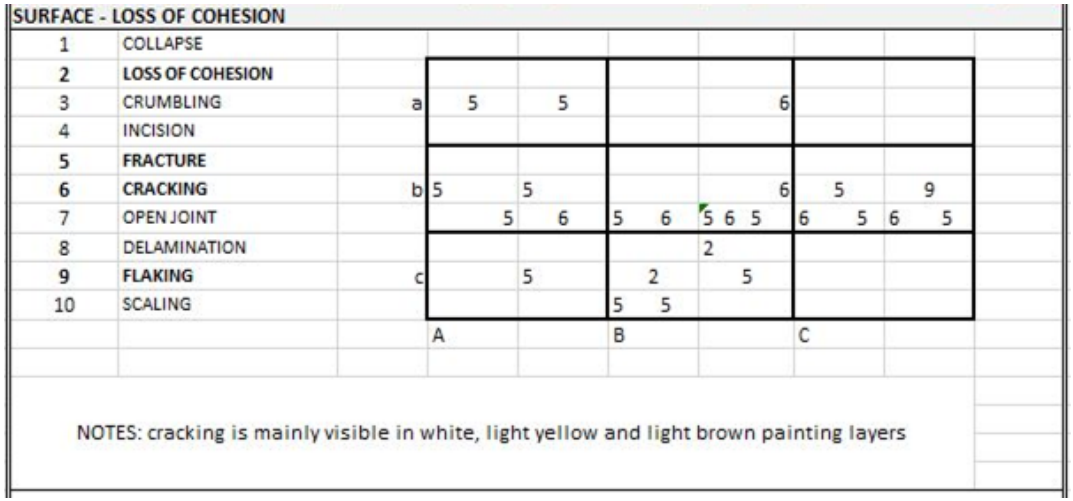
3
TECHNIQUE
OF
EXECUTION

According to the definitions of style and technique terms, provided in the first section of the CAPuS Glossary, in this part of the condition report, data about the execution technique are reported.

3. Degradation phenomena

Materials

4 - DEGRADATION		
General condition classification		
CC0	No symptoms	No measure
CC1	Minor symptoms	Ordinary maintenance
X CC2	X Moderate strong symptoms	X Moderate repair and/or diagnc
CC3	Major symptoms	Major repair based on diagnosis



4
DEGRADATION

The section related to the identification of the degradation phenomena is subdivided into 6 parts, plus a preliminary outline of the general conservation assessment (based on …); the 6 sections reflect the division of the CAPuS glossary, categorizing the decay on the basis of its effects on the objects in:

-LOSS OF COHESION

-LOSS OF MATERIAL

-DEFORMATION

-OPTICAL ALTERATION

-CHEMICAL ALTERATION

-BIOLOGICAL ALTERATION

-ADDITION OF SUBSTANCES

For each section, a list of the terms defined in the glossary is reported, as well as a simple grid used to localize the observed phenomena on the surface of the object.

Further information can be found in the CAPuS digital repository, at the site: http://repository.capusproject.eu/

3. Degradation phenomena

Materials

GLOSSARY: considering the need for a shared definition of degradation phenomena and terms related to the other topics studied, such as the technique of execution and the previous intervention on the artworks, within the CAPuS project a glossary of terms related to street art conservation was created. This challenging creation started from the analysis of the already existing glossaries that, when possible, have been taken as reference. In order the make this tool as simple as possible, the document was subdivided into different sections related to generic terms for street art and specific words useful in the survey on site. To reflect the various kinds of the degradation phenomena observed, after a preliminary introduction of the general terms, the second section consists of categorizing phenomena with similar effects on the object (loss of materials, addition of substances, etc.).

The glossary is divided into two sections, Street Art & Graffiti and Conservation, each supplied with a list of pictures and credits, bibliographic references and an index.
Overall, the glossary includes 141 definitions. The Street Art & Graffiti sections contains General (3), Cultural (38), Style (26) and Technique (15) terms; while the Conservation section is classified into 9 families: General terms (5), Addition of substances (7), Biological alteration (2), Chemical alteration (7), Deformation (5), Loss of cohesion (10), Loss of material (11), Optical alteration (6) and Previous intervention (6).

Further information may be found in the CAPuS digital repository, at the site: http://repository.capusproject.eu/

4. Degradation causes

OBJECTIVE

To understand the origin of the different degradation phenomena previously identified, considering the relationship between the object and the outdoor environment, as well as the impact of the urban context. The analysis of the causes for degradation represents a fundamental step for the definition of effective conservation treatments and interventions.

4. Degradation causes

STATE OF THE ART

According to the results of the study completed within the CAPuS project on 86 objects with different outdoor exposure, the study on the causes of degradation represents a crucial point for understanding decay phenomena and, therefore, for the subsequent planning of effective intervention strategies. Even though such research often require in-depth multi-analytical campaigns, some preliminary results might be obtained by simpler analysis of the context, from both a technical and a scientific perspective.

The results showed that the causes of the observed degradation phenomena can be ascribed to two main areas, related to so-called “endogenous” and “exogenous” factors.

The first is related to the choices of products, techniques and preliminary preparations of the substrates during the execution of the artworks. In fact, the use of paints with low colour durability or generally low resistance to outdoor exposure may be consider one of the main co-causes for fading and colour alteration. On the other hand, the application of film coating on the surface of very porous and moisture-rich (often including salt) substrates leads inevitably to the appearance of cracking, flaking, blistering or even lacunas and losses.

Among the exogenous factors, outdoor exposure groups a number of chemical-physical factors that represent a strong hazard for the murals, wood benches and metal sculptures analysed. The action of the weather, combined with a generally consistent level of air pollution, increases chemical reactions with constitutive materials, which often lose their original chemical and physical characteristics. Another relevant issue, related with exogenous degradation factors, is public access: whilst public art is usually born for specific social and public purpose, unregulated access often turns into an inappropriate use of the nearby areas or of the artwork itself and, sometimes even vandalism.

4. Degradation causes

STATE OF THE ART

CHEMICAL-PHYSICAL PROPERTIES OF CONSTITUTIVE MATERIALS:

- Constitutive painting materials (filming paints, water sensitive materials, UV-sensitive pigments);
- Constitutive materials of the support (cement, salt-rich mortars,..)
- Absence of protective coatings

ENDOGENOUS CAUSES OF DEGRADATION

CRITICAL TECHNICAL AREAS

- Problems related to the technique of execution or the creation of the artworks
- Static issues related with the pre-existing substrate
- Direct exposure to weather due to the absence of pre-existing physical barriers, protective plates, canopy or projecting roof

4. Degradation causes

STATE OF THE ART

EXOGENOUS CAUSES OF DEGRADATION (RELATED TO OUTDOOR ENVIRONMENTAL CONDITION)

Physical factors:

- Light radiation (induces and promotes oxidation, polymerisation reactions, interacts with chemical bonds inside atoms and molecules, enhances biological growth)
- Temperature (day, night or seasonal thermal cycles, thermal expansions, water content variation, chemical reaction kinetics)
- Water (liquid or vapour)

Mechanical factors:

- Wind
- Natural disasters (earthquakes, etc.)

Biological factors:

- Trees and superior plants (roots, leaves, pollen, seeds)
- Microbiological colonisation
- Lichens, algae and fungi
- Biofilm
- Animal presence (manure, nesting, burrowing, etc.)

Chemical factors:

- Gas: Acidic and basic substances (CO_2; SOx; NOx; HCl; HF), organic acids, NH_3, oxidising molecules (O_2; O_3), hydrocarbons, metals and ions
- Aerosols (salts, acid compounds, metals, hydrocarbons,..)
- Particulates (residues from combustion, dust, soot, tarry materials, salts and compounds of heavy metals)

4. Degradation causes

STATE OF THE ART

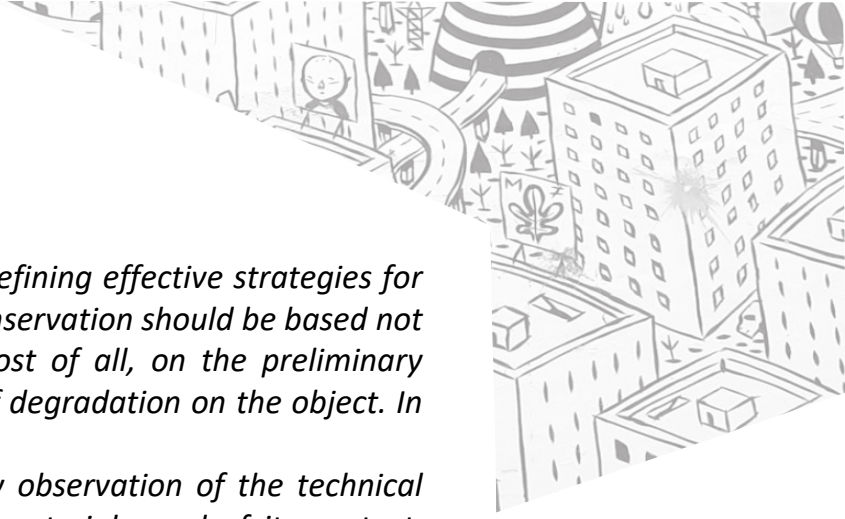
Anthropic factors (…):

- Improper conservation/restoration
- Overlaying of unwanted materials
- Lack of maintenance
- Wear due to the proper or improper use of the objects
- Massive or inappropriate use of the nearby areas

EXOGENOUS CAUSES OF DEGRADATION (HUMAN-RELATED)

Human factors (unforeseen events):

- Vandalism
- Accidental impacts
- Accidental damage and mechanical harm related to intervention/maintenance in the nearby areas (on the structures, grass, streets, water supply system, sewer pipes, etc.)



4. Degradation causes

The identification of the causes at the basis of the observed degradation phenomena is a crucial step for defining effective strategies for both the conservation intervention and the subsequent maintenance of the artworks. In fact, an effective conservation should be based not only on the practical intervention on the decay that has somehow already affected the object, but, most of all, on the preliminary resolution, when possible, of the origin of the decay, meaning to stop or reduce the impact of the causes of degradation on the object. In this perspective, the preventive conservation represents an essential step for urban artwork preservation.

The analysis of the causes of degradation results in a multi-step study that started from the preliminary observation of the technical properties of the object, including highlighting any hazard related to the use of unsuitable constitutive materials, and of its context, meaning the specific wall/building used as substrate zooming out to the exposure of the artwork and the nearby urban landscape made of streets, walkways, gardens, skyscrapers,..

Considering the impact of the weather, parameters like the annual amount of rainfall or air pollution level should be considered in order to highlight any correlation with the degradation phenomena observed on the object.

Finally, a focused multi-analytical protocol might be set up to further analyse the "work of art-environment system", with the aim of proving the direct correlation between the observed potential degradation factors and the attested decay.

QUESTIONS

1- The **ARTWORK**:

- Considering the constitutive materials identified within the study of the execution technique, is it possible to highlight any heightened sensitivity to solar radiation or contact with water?
- Are the chemical-physical properties of the constitutive materials very different?
- Is there visible previous intervention/modification of the artwork or the substrate? Are there unsuitably applied elements?

4. Degradation causes

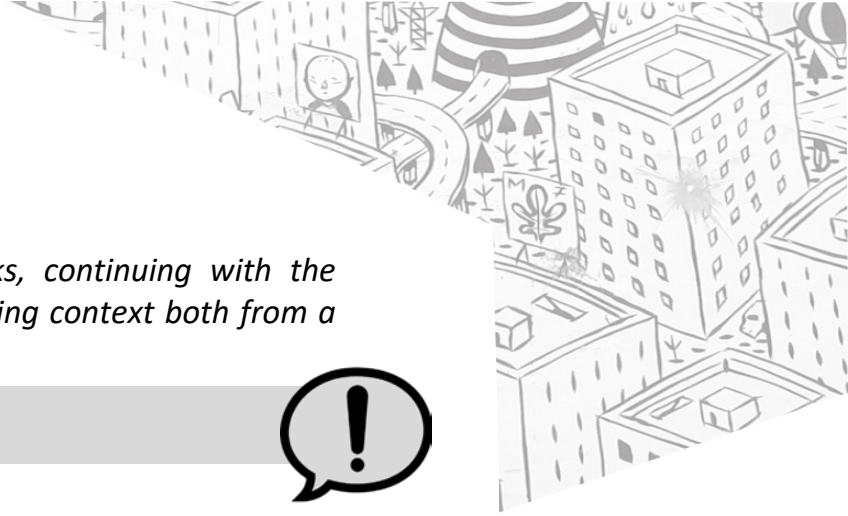
QUESTIONS

2- **EXPOSURE**:

- Is the object directly exposed to sunlight?
- Is it susceptible to rain/snow run-off?
- Is it exposed to strong winds or air currents?
- Are there trees or bushes that protect/interact with the object?

3- **CONTEXT**:

- Where are the artworks located? In a garden? Along a boulevard? On the street? In a parking lot?
- Is the artwork freely accessible to the public? Is the object surrounded by fences or other barriers?
- What are the weather conditions of the region? Is it a rainy climate or a sunny one?
- How is the neighbourhood? Is the area near the artwork well lit? Are there visible traces of glass, cigarettes or other trash?
- Do the local citizens know, appreciate and care personally about the artwork?
- Is there a maintenance programme in the nearby areas? Is it respected? Who is in charged for the maintenance?



4. Degradation causes

Considering the "three focuses" of analysis of the causes of degradation, starting from the artworks, continuing with the observation of the exposure and finally investigating the interaction between the object and the surrounding context both from a scientific and social perspective, some useful tools are listed below.

FIND THE ANSWERS

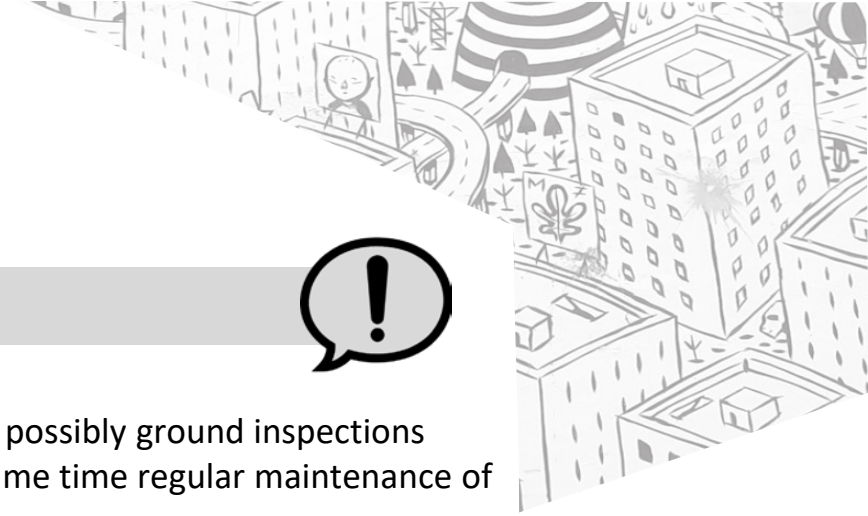
1- **ENDOGENOUS CAUSES (related to the ARTWORK)** :

- The constitutive materials (such as paints or substrates) can be characterised with FT-IR, SEM-EDX or GS-MC analysis and other diagnostic analysis.
- The chemical-physical properties of the constitutive materials can be assessed through on-site evaluation of the hue saturation or the water absorption capacity using colorimetric analysis and sponge tests, or porosimeter measurement.
- Research in archive documents, in local newspaper and on the web may be useful for finding information about works on the structures or the nearby architectures/urban elements.
- A thermal camera might highlight reconstructions or changes to the original architectural substrate (for murals), even when optically no modification could be detected.

2- **EXOGENOUS CAUSES (related to the OUTDOOR EXPOSURE)**:

- The preliminary assessment of the local weather conditions might be carried out by consulting data from a scientific institution/university specialised in climate control and forecasting; then a more specific survey of the surface temperature and of the levels of relative humidity on and, when possible, inside the surface, should be undertaken with temperature and humidity data loggers or weather control units left on site.
- A detailed study of the data related to air pollution can be useful to highlight the presence of a specific deposit (encapsulating particle matter or specific compounds from urban or industrial areas) or specific degradation products (arising from the interaction of constituent materials with atmospheric gases or aerosols) on the surfaces of the object.

4. Degradation causes



FIND THE ANSWERS

- The presence of trees represents both a positive and a negative issue: botanical research and possibly ground inspections should be conducted to determine if the roots might result in a hazard to the object, at the same time regular maintenance of the branches should be carried out.

3- **EXOGENOUS CAUSES (related to the HUMAN CONTEXT)**:

- Relevant elements about the context might be deduced by an accurate observation of the surrounding area, focusing on the presence of cars, public transport, pedestrians, animals. More detailed information may be acquired by consulting the city plan or a detailed map.
- The analysis of the social context may be structured with multi-step workflow, starting with interviews with local institutions, local boards, then citizen associations and finally arriving at the perception of the artist or the purpose at the base of the creation of the artwork (if socially related).

4. Degradation causes

FOCUS

- **Example 1: *Memorial Thyssen victims tragedy,* by various artists (2008), Turin, Italy (1/2)**

As explained previously, the investigation of the causes for degradation phenomena is usually related to a multi-step diagnostic campaign. Nevertheless, an accurate observation of the surrounding area might be useful for highlighting macroscopic correlations and for recognising causes related to the structures or the environment.

In the “Thyssen mural” case study, the presence of a protrusion, in the upper edge of the socle, led to the development of multiple degradation phenomena related to the stagnation of rainwater/moisture/snow: this firstly resulted in increased biological growth and then in visible lacunas, because of the fall of detached scales of both the paints and the concrete substrate.

Close-up images of the protrusion localized along the edge between the mural and the lower concrete socle.

4. Degradation causes

FOCUS

- **Example 1: *Memorial Thyssen victims tragedy,* by various artists (2008), Turin, Italy (1/2)**

Similarly, observing the direction of the main longitudinal fractures, a sort of regular path arose, suggesting the presence of discontinuities in the structure of the wall: delving into the history of the architecture, some changes in the structure of the wall were confirmed. In particular, the central area of the mural, where the main vertical fractures are located, was ascribed to the recent decision of moving the main entrance gate to the other side of the inner courtyard, edged by the wall under investigation. The presence of heterogeneous materials and their different settlement were the cause of the discontinuity observed along the edges of the modern cladding (painted in light yellow in the images below).

Photo of the back side of the wall showing the ancient brick-and-stone structure and the modern light yellow painted cladding.

4. Degradation causes

FOCUS

- **Example 2: *Niguarda antifascista,* by VolksWriterz (2014), Milan, Italy (1/3)**

Author: VOLKSWRITERZ

Dimensions: 30 x 6 m

Technique: Acrylic house paint and spray paint on wall
Date: 2014

Commissioned by: Anpi.
Location: Via Ettore Majorana/Via Graziano Imperatore, Milan, Italy.

Niguarda Antifascista wall, (Ph. Credits: CESMAR7, May 2018)

4. Degradation causes

FOCUS

- **Example 2: *Niguarda antifascista,* by VolksWriterz (2014), Milan, Italy (2/3)**

The mural Niguarda Antifascista was completed between September 2014 and October 2014 for an overall working time of five days.

The work reiterates the bond between the neighbourhood and its unbending resistance to Nazi Fascists during WWII. Over the years, the mural has undergone several recoatings as a result of nine acts of Neo-Nazi vandalism (between November 2014 and April 2017). Local residents have promptly and spontaneously repaired the damage.

In April 2019 it was completely repainted by the artists themselves.

Repainting of the artwork by VolksWriterz in April 2019 (Ph. Credits: CESMAR7)

4. Degradation causes

FOCUS

- **Example 2: *Niguarda antifascista,* by VolksWriterz (2014), Milan, Italy (1/3)**

Degradation	Cause	Analysis carried out for cause identification
Fading of red and orange areas 	Location of the artworks: south All day light exposure Exposure to weather (no protection)	Recurring observation of the artwork and analysis of past image documentation.
Losses and scaling 	Unsuitably reinforced concrete brick inserts (metal and glass pieces)	µ-Raman spectroscopy and Fourier transform infrared spectroscopy-attenuated total reflectance (FTIR-ATR)
Flaking 	Loss of adhesion between the repainting and the original painted substrate.	µ-Raman spectroscopy and Fourier transform infrared spectroscopy-attenuated total reflectance (FTIR-ATR)

5. Tests on mock-ups

OBJECTIVE

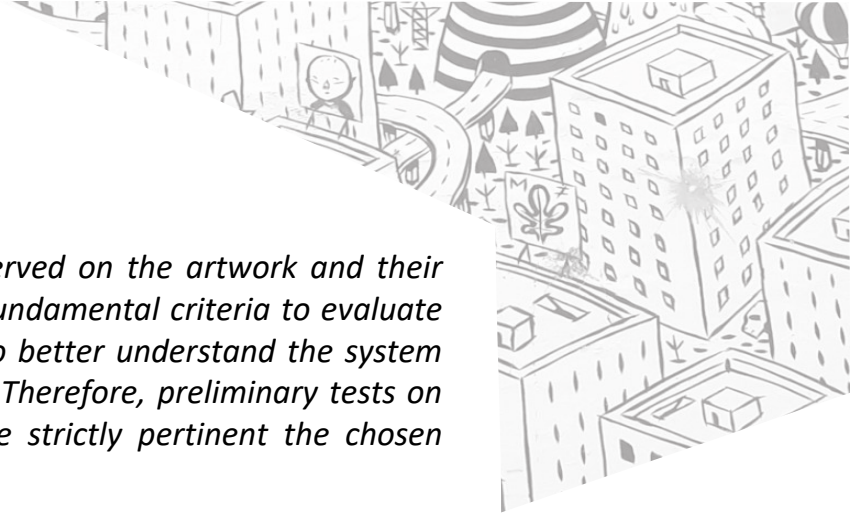
To define the most suitable and effective approach to the conservation intervention through the selection of compatible, reversible and effective materials and the design of respectful and controllable methodologies. This step is aimed at investigating disadvantages and advantages of treatments comparing different products and methodologies by means of laboratory experimental tests, on the basis of pre-selected criteria and taking into account significant parameters.

5. Tests on mock-ups

STATE OF THE ART

Within the CAPuS Project a number of mock-ups were made to investigate and define the most suitable methodologies for cleaning, consolidating and protecting the selected artworks in public spaces. Considering the great variety of objects under study, belonging mainly to the categories of contemporary murals and metal sculptures, one of the most significant outcomes consists in the assessment of the crucial role played by mock-ups, specifically prepared on the basis of the specific technical characteristics and the degradation phenomena directly observed on the artworks. This provided a variety of data and results that perfectly reflects the impossibility of defining an always suitable single operative strategy, highlighting the necessity of targeting each intervention as a unique and specific case study.

5. Tests on mock-ups



On the basis of the preliminary study of the technique of execution, the degradation phenomena observed on the artwork and their causes, the definition of the most suitable operative approach requires first of all the establishment of fundamental criteria to evaluate the performance each operation. Within this framework, making mock-ups represents a valuable tool to better understand the system under study, even though significant limitations related to the representativeness of the real case exist. Therefore, preliminary tests on mock-ups become more valuable the more similar the system is to the original object and the more strictly pertinent the chosen evaluation criteria would be.

The following question gives some hints for planning representative mock-ups, stressing the importance of the identification of effective evaluation criteria.

GENERAL QUESTIONS

- What conservation actions should be analysed through specific tests on mock-ups?
- Considering the single conservation actions, how does one define the proper approach? Are there common criteria?
- What are the aims of the control tests?
- What properties of the object should be taken into account to make representative mock-ups in relation to the execution technique and, most of all, the degradation phenomena observed on the object?
- Can these criteria be associated with quantifiable parameters?
- How could these quantifiable parameters influence the technical characteristics of the mock-ups?
- How are meaningful mock-ups prepared?
- What are the most suitable tests/analyses to evaluate these chosen parameters?

5. Tests on mock-ups

Making representative mock-ups is often challenging. In fact, artificially reproducing degradation phenomena that have different causes and usually arise from the interaction of different factors in the complex "artwork-environment system" is quite hard. The following workflow is aimed at highlighting the crucial steps for making effective mock-ups, focusing on the importance of the preliminary planning phase.

FIND THE ANSWERS

- Definition of the artwork characteristics that must be taken into account in making representative mock-ups (e.g. chemical composition, presence of fillers, grain size, distribution of aggregates, stratigraphic sequence, etc.)
- Definition of deterioration patterns that must be taken into account in making representative mock-ups (e.g. flaking, presence of soluble salts, bio-films, etc.)
- Identification of ageing or other methodologies to be adopted in order to simulate the actual conservation state of the artwork
- Definition of conservation actions to test (e.g. cleaning, consolidation, protection, etc.)
- Definition of criteria to evaluate the effectiveness or harmfulness of conservation products and methodologies on the substrates. It is necessary to define the approach of every single action for example for reversibility of the intervention, materials compatibility, gradual and controllable methods for cleaning (Caution! reversibility should be a crucial point for protection but is quite inapplicable in cleaning)

5. Tests on mock-ups

FIND THE ANSWERS

- Definition of an appropriate analytical protocol for assessing the methodologies tested, allowing the modification of the chosen parameters for the conservation action to be evaluated (characterization of mock-up properties before and after treatments)
- Construction of a set of mock-ups, taking care they are prepared systematically and are comparable to each other
  (The size of the mock-ups should be a compromise between the need for areas large enough for testing the conservation action and the limitation of the ageing /analytical equipment used)*
- Ageing / application of the conservation action / tests /data analysis/ interpretation of result
- It is preferable and strongly suggested to adopt specific international or national standard methodologies to perform the scientific assessment of conservation treatments (see European Standard-CEN/TC346 Conservation of Cultural Heritage) in order to obtain results that are comparable to each other
  https://standards.cen.eu/dyn/www/f?p=204:32:0::::FSP_ORG_ID,FSP_LANG_ID:411453,25&cs=17D2D76D6596BE0CAD81B69108A090D68

5. Tests on mock-ups

FIND THE ANSWERS

MOCK-UP PREPARATION

- In relation to durability/stability criteria, the following examples of parameters to take into account for the accelerated aging test:
    a. UV radiation exposure
    b. Temperature cycles
    c. Humidity cycles
    d. pH variation
    e. Bio-deterioration agents (quantification of presence e.g. by colony counts)
    f. Presence of soluble salts and of degradation products (qualitative and quantitative analysis)

Each of these parameters requires specific evaluation protocols for preliminary testing on mock-ups, usually including accelerated ageing with induced thermal stress paired with swift variations of the humidity level. Tests for the evaluation of the influences of pH variation can be performed with the use of acids or bases only in the preliminary tests on mock-ups. Possible biodeterioration induction should then be investigated, for instance, through microbiological culture tests. In any case, for the assessment of the intervention methodology, the results obtained from the preliminary tests must be considered in relation to the environmental context, focusing on the exposure to direct solar radiation, to rainfall, the presence of high levels of humidity, etc.

5. Tests on mock-ups

CONSOLIDATION/ADHESION

OBJECTIVE

Consolidation and adhesion aim to restore the original continuity of detached components belonging to a single layer (usually following decohesion or, rarely, de-adhesion) or between different layers (as a consequence of de-adhesion).

QUESTIONS

- What are the main guiding criteria for consolidation?
- How can quantifiable parameters be stated?
- What are the most used classes of adhesive/consolidants?
- What are the most common methodologies?
- What are the possible interactions with the environment and the context?

5. Tests on mock-ups

CONSOLIDATION / ADHESION

FIND THE ANSWERS

- Stating that every intervention requires specific reflections for the definition of guiding criteria according to the specific decay and the values assessed, some topics related to the new restoration product to be undertaken should be widely considered as a starting point for the consolidation approach, among them: its adhesive/cohesive capacity, its compatibility with constitutive materials and future conservation products, the modifications induced on the chemical-physical properties of the object, durability and stability towards chemical-physical agents.
- Each of the listed criteria should be analysed in order to identify the quantifiable parameters and the suitable diagnostic tools for their evaluation;
  - ➢ In relation to the assessment of the adhesive/cohesive capacity, examples of parameters that can be measured are:
    a. Hardness: tested with drilling force measurement system (DFMS) tests, a destructive method that can detect the increment of hardness in a layer for a certain depth from the surface measuring the resistance to perforation
    b. Surface cohesion: evaluated with a tape test that measures the resistance of the surface layer to tear (destructive method to evaluate the surface cohesion)
  - ➢ Possible chemical interactions with the constitutive materials and future conservation products should be evaluated with preliminary tests in mock-ups and through the technical information reported in the product data sheets.

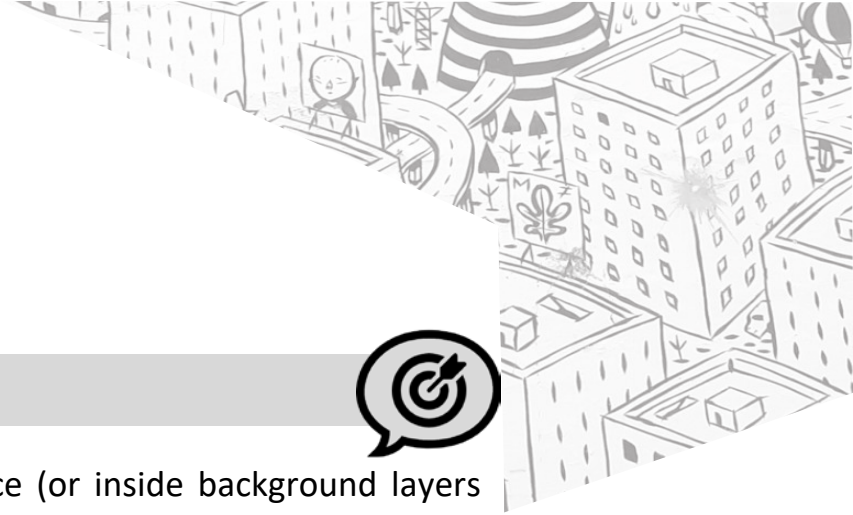
5. Tests on mock-ups

CONSOLIDATION / ADHESION

FIND THE ANSWERS

- in relation to modification of the chemical-physical property, examples of parameters that can be measured, before and after the treatments, are:
    a. Superficial optical properties, such as colour and gloss, that can be evaluated by means of a reflectance spectrophotometer (colorimeter) or glossmeter in a non-invasive manner
    b. Water absorption by capillarity
    c. Water absorption by immersion and drying properties
    d. Water vapour permeability of surfaces
    e. Contact angle measurements to evaluate the changes in hydrophobicity of surfaces
    f. Porosity accessible to water (with a hydrostatic balance)
    g. Total porosity, open porosity
    h. Distribution of the applied products on the surface and inside the substrates by means of microscopic analysis (spot test in optical microscopy, scanning electron microscopy (SEM-EDX) observations on surfaces and on cross-sections)

5. Tests on mock-ups



CLEANING

OBJECTIVE

Cleaning aims to selectively remove the heterogeneous substances layered on the object surface (or inside background layers exposed due to lacunas, missing parts, flaking, etc.) without interfering with the original materials. If the original stratigraphy was partially altered due to yellowing or whitening of coatings (or other chemical-physical degradations), cleaning operations might be intended to selectively remove the altered products, even if originally applied by the artists or in the interest of conservation. Cleaning has resulted in a great variety of methodology and products due to the heterogeneous chemical-physical nature of the substances to be removed; in this perspective, considering that usually incoherent to strongly adhered deposits are visible on an outdoor object, cleaning can be structured as a multi-step operation, starting with gentle mechanical actions and continuing to chemical-physical actions based on solvents or laser tools.

QUESTIONS

- What are the main guiding criteria for cleaning?
- How can measurable parameters be assessed?
- What are the classes of products most used for cleaning?
- What are the methodologies most used for the application?
- What are the possible interactions with the environment and the context?

5. Tests on mock-ups

CLEANING

FIND THE ANSWERS

- Stating that every intervention requires specific reflections for defining guiding criteria according to the specific decay and the values assessed, some topics should be widely considered as a starting point for the cleaning approach, among them: how selective the action is, whether the cleaning action can be controlled (and stopped), effectiveness on the materials to be removed, evaluation of the modification of the chemical-physical properties of the underlying constitutive materials.
- Each of the listed criteria should be analysed in order to identify the relative quantifiable parameters and the suitable analytical/optical tools for their evaluation;
  - The ability to select and check the cleaning action, the efficacy or the harmfulness of the cleaning method, any modification of the chemical-physical property of the constitutive materials or permanence of cleaning agent residues on the surfaces can be assessed through

  a. surface observation by means of microscopic techniques (optical microscopy under visible and UV light and scanning electron microscopy)

  b. Superficial optical property measurements (before and after cleaning), such as colour and gloss, that can be evaluated by means of a reflectance spectrophotometer (colorimeter) or glossmeter in a non-invasive manner

  c. Change in water absorption properties of surfaces (see consolidation section)

  d. Micro-sampling from the surfaces and chemical analysis (by SEM-EDX, FT-IR, GC-MS or other techniques) to detect any residues of materials to be removed or cleaning product used in the conservation action

5. Tests on mock-ups

PROTECTION

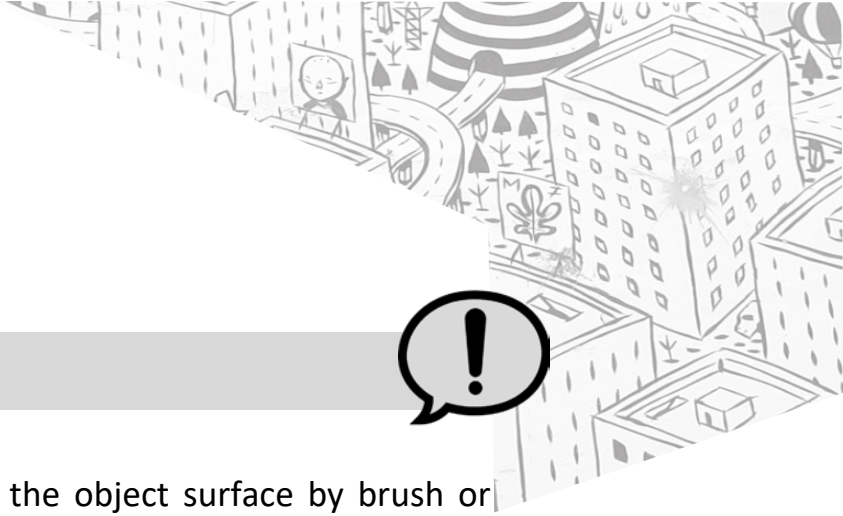
OBJECTIVE

Protection aims to slow down the rate of the deterioration phenomena occurring on the object by means of chemical barriers applied on the surface to stop the action of hazardous agents such as solar radiation, rainfall, soil/dust deposit on the external interfaces.

QUESTIONS

- What are the main guiding criteria for protection?
- How can quantifiable parameters be stated?
- What are the classes of products most used for protection?
- What are the methodologies most used for the application?
- What are the possible interactions with the environment and the context?

5. Tests on mock-ups

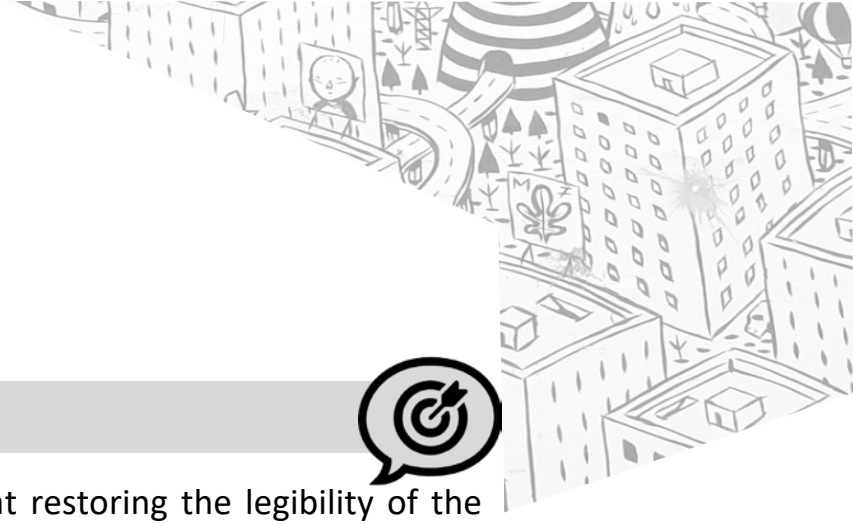


PROTECTION

FIND THE ANSWERS

- Usually protective coatings consist in specific products, permanently or temporary applied to the object surface by brush or spray, but also include indirect intervention, such as the construction of physical protections for a mural or knocking down trees with long roots can be considered interventions aimed to protect the object from the assessed hazard.
- Stating that every intervention requires specific reflections for defining the guiding criteria, according to the specific decay and the values assessed, some topics should be widely considered as a starting point for the protective approach, among them: control of the modification of the superficial chemical-physical properties of the object, product durability/stability, product compatibility with the constitutive materials and the outdoor environment, reversibility.
  - ➢ The modification of the chemical-physical property of the constitutive materials can be assessed through:
  - a. Superficial optical property measurements (before and after protection), such as colour and gloss, that can be evaluated by means of a reflectance spectrophotometer (colorimeter) or glossmeter in a non-invasive manner
  - b. surface observation by means of microscopic techniques (optical microscopy under visible and UV light and scanning electron microscopy)
  - c. Change in water absorption properties of surfaces (see consolidation section)
  - d. Distribution of the products applied on the surfaces and insides the substrates by means of microscopic analysis (spot test in optical microscopy, scanning electron microscopy (SEM-EDX) observations on surfaces and on cross-section)

5. Tests on mock-ups



AESTHETIC PRESENTATION (FILLINGS/RETOUCHES)

OBJECTIVE

The different conservation actions include the so-called aesthetic presentation aimed not only at restoring the legibility of the object surface but also at preventing future degradation phenomena by reducing the “unprotected” surfaced exposed to the elements, such as the areas of lacuna and fractures. Considering the filling of lacunas in a mural, for instance, the application of suitable mortars reduces the water penetration in the background layers, lowering the risks of degradation phenomena related to salt solubilisation. In this case, the preliminary definition of approach and methodologies should be based on reflections about the guiding criteria related to the aesthetic, artistic and technical value of the object in addition to the quantifiable parameters stated for the other operation considered.

QUESTIONS

- What are the main guiding criteria for aesthetic presentation?
- What are the most used classes of products for filling / retouching?
- What are the most used methodologies for the application?
- What are the possible interactions with the environment and the context?

5. Tests on mock-ups

AESTHETIC PRESENTATION (FILLINGS/RETOUCHES)

FIND THE ANSWERS

- The modification of the chemical-physical properties of the constitutive materials can be assessed through:

a. superficial optical property measurements (before and after protection), such as colour and gloss, that can be evaluated by means of a reflectance spectrophotometer (colorimeter) or glossmeter in a non-invasive manner

b. for filling mortars: evaluation of water absorption capacity, assessment of the mechanical properties

5. Tests on mock-ups

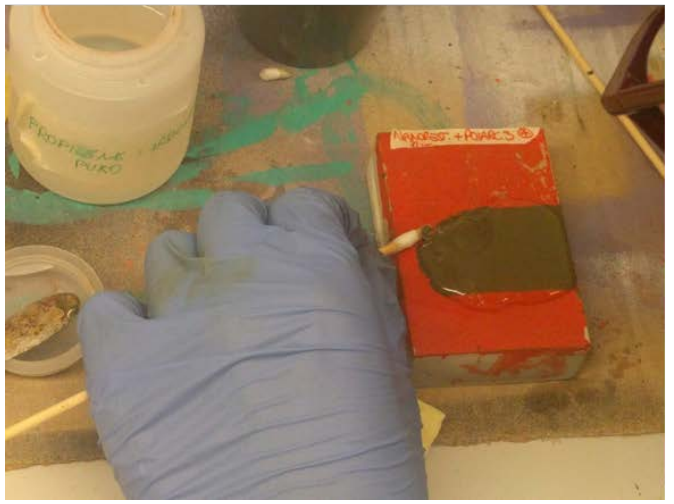
FOCUS

- CAPuS Project – UNITO & CCR team

Tests on mock-ups for cleaning methodology assessment (1/2)

Four different stratigraphies were prepared on concrete specimens

- The mock-ups were prepared with *i.work TECNOCEM 32,5 R* by ITALCEMENTI, a Portland concrete with limestone type II, characterized by a strong resistance in the drying phase. The product, according to the UNI EN 197-1 standard, contains 80% to 94% clinker, while the remaining fraction consists of limestone (TOC 0.20%, in mass (LL)) and other minor constituents. In order to make the mock-ups, the Portland concrete was added to local river sand in the ratio 1:3 and then mixed manually, adding water to facilitate the processing of the mortar.
- In order to obtain similar dimensions and shapes, silicone moulds were used. As a result, all the mock-ups measure 5.5 cm, with a thickness of 2 cm. In order to be sure that the mortar was completely dry, the mock-ups were left to air-dry for two months.
- Two replicas for each stratigraphy were prepared and used to test chemical and laser cleaning methods, respectively



5. Tests on mock-ups

- CAPuS Project – UNITO & CCR team

Tests on mock-ups for cleaning methodology assessment (2/2)

Table 1. Specimens stratigraphy.

Mock-up Name	Stratigraphy	
	Top Layer	Bottom Layer
A	Red styrene-acrylic paint	Green styrene-acrylic paint
B	Red alkyd spray paint	Green alkyd spray paint
C	Red styrene-acrylic paint	Green alkyd spray paint
D	Green alkyd spray paint	Red styrene-acrylic paint

Table 2. List of the cleaning systems used.

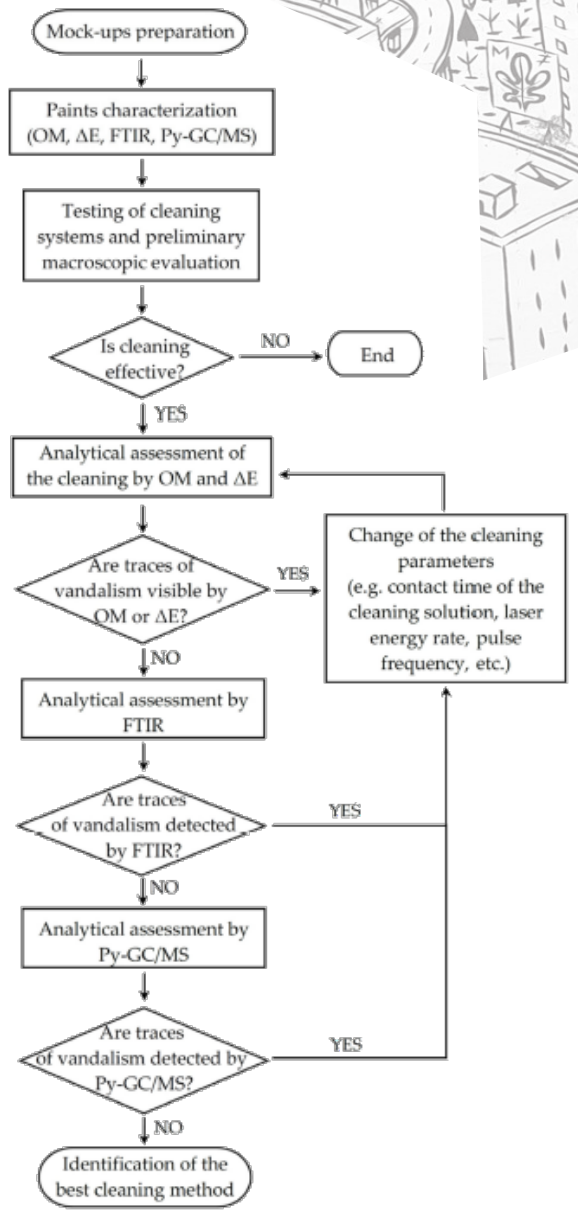
Cleaning Code	Cleaning System	Supplier
I	Propylene carbonate, anhydrous	Sigma Aldrich
II	2 g/L agar in water gel + 10 mL of 30% ethanol in water solution	CTS S.r.l., Italy Sigma Aldrich
III	*Extra Dry* Nanorestore Gel® + Polar Coating S + 9% ethyl acetate	CSGI, University of Florence CSGI, University of Florence
IV	EOS 1000 Long-Q-Switch mode (LQS) Nd:YAG laser	El.En. Group, Florence, Italy

The results of the cleaning tests performed are reported in this paper (open access):

Bertasa, M., Ricci, C., Scarcella, A., Zenucchini, F., Pellis, G., Croveri, P., & Scalarone, D. (2020). Overcoming Challenges in Street Art Murals Conservation: A Comparative Study on Cleaning Approach and Methodology. Coatings, 10(11), 1019.

FLOW CHART OF THE EXPERIMENTAL PLAN

OM: optical microscopy; ΔE: colorimetric measurements



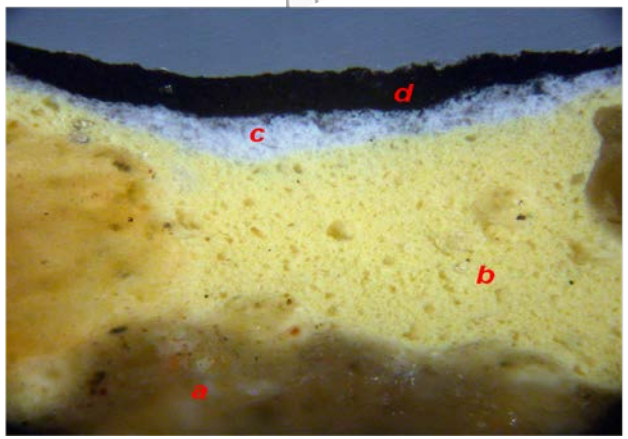
5. Tests on mock-ups

FOCUS

- **Example 1: *Niguarda antifascista,* by VolksWriterz (2014), Milan, Italy (1/4)**

Mock-ups were prepared according to results from microscopic observation, details deriving from artists' interviews and dialogues on the social context, photographic archive documents, cross-section structure and analysis materials (samples and in situ e.g. portable Raman) of Via Selo, Reggio Emilia and Milan murals.

Layer	*Composition*	*Products tests/methods*
SUPPORT	Concrete (pre-formed concrete blocks)	
PRIMER	Sikkens® Quartz Full farbe	
PAINTING LAYER	MNT 94 Bright Red (RV3001) Sikkens ® Alpha Acrylmat Light Blue	
STANDARD DIRT	• Carbon black • Iron oxide-ochre • Micronized Silica • Kaolin • Gelatin Powder • Soluble starch • Cement • Olive oil • Mineral oil • White spirit D40	➢ dry cleaning ➢ aqueous buffer solutions pH and conductivity ➢ adjusted, semi humid methods, ➢ Agar gels
OVERPAINTINGS	Nero d'inferno dye (Fabbrica Chimica Unione srl) Signal Black marker (Molotow CoversAll™) Bitumen Black Matt (Molotow CoversAll™) Revered Violet RV-27416 (Montana Colors MTN 94) Chrome (Molotow-Burner400)	➢ Solubility test blends ➢ Solubility test blends on Evolon™ ➢ Solvent surfactant gels ➢ Ligroin-Propylene carbonate blends ➢ Benzyl Alcohol in Velvesil Plus™

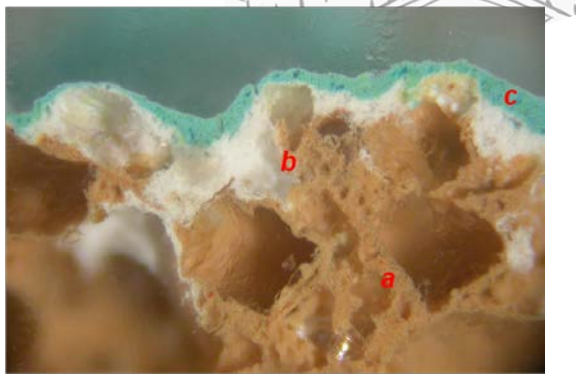


5. Tests on mock-ups

FOCUS

- **Example 1: *Niguarda antifascista,* by VolksWriterz (2014), Milan, Italy (2/4)**

Layer	*Composition*	*Products tests/methods*
SUPPORT and FINISHING	Bacchi - Prontomalt- on bricks (hydraulic mortar) +Saint Gobain - Webercem	
GROUND LAYER	Rival - Stella Oro	
(PRIMER)	LECHLER - Chrèon - Framaton Riveste Prof, white	
PAINTING LAYER:	Montana Colors Light Yellow (MTN 94) Montana Gold Pure Orange G2080 (Montana Cans)	
OVERPAINTINGS	Montana Colors MTN 94 Matt Black Montana Cans Montana Gold Silverchrome Pentel Pen - Permanent Marker N60 Grog - Squeezer Mini 10 FMP- Diving Blue	**Organic solvents and blends in liquid form** Solubility test blends Solvent blends (dibasic esters, Propylene carbonate blends, Loxanol, DMSO blends + Ethyl acetate, butyl acetate, Ethyl Lactate and Dowanol PM, Solvenon,)etc **Water-in-oil micro-emulsions in liquid form:** Nanorestore: Cleaning Coating (Polar Coating B, G, S and Apolar Coating) **The most efficient organic blends and water-in-oil micro-emulsions applied in gels, thickeners and supporting agents:** Evolon™ , Agar gels, Velvesil Plus, PVA-Borax, nanorestore gels (hwr), solvent surfactant gels



SELECTION OF CLEANING PRODUCTS PARAMETERS:

- pH, conductivity, solubility parameters (fd fp fh),
- Safety/environmental impact
- Ease of use
- Availability
- For overpaintings: representativeness (chemical nature, method of application)

EVALUATION CRITERIA

T preservation of the topographical integrity
Cr presence and clearance of the residues
G preservation of the surface gloss
Cp cleaning efficiency and evenness
Am method feasibility
(Pp pigment pick up)

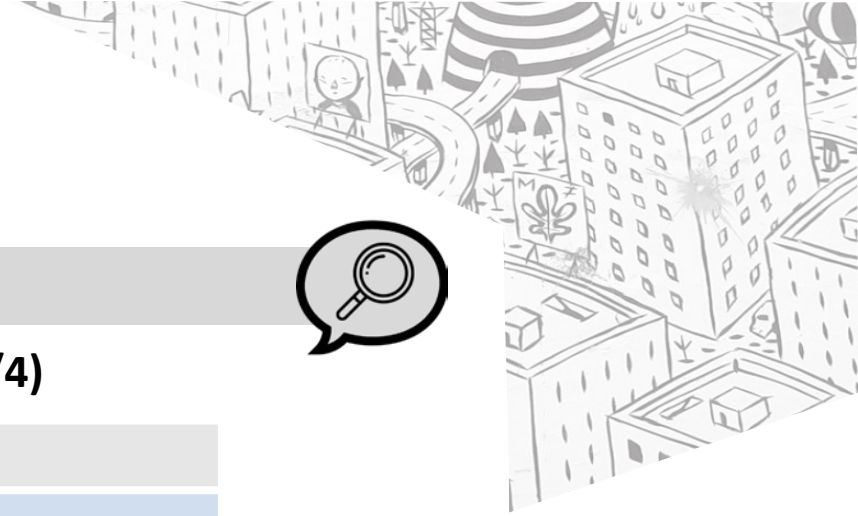
5. Tests on mock-ups

FOCUS

- **Example 1: *Niguarda antifascista,* by VolksWriterz (2014), Milan, Italy (3/4)**

Layer	*Composition*	*Analysis and product tests*
SUPPORT and FINISHING	Bacchi - Prontomalt- on bricks (hydraulic mortar) +Saint Gobain - Webercem	
GROUND LAYER	Rival - Stella Oro	
PRIMER	LECHLER - Chrèon - Framaton Riveste Prof, white	
PAINTING LAYER:	Montana Colors Light Yellow (MTN 94) Montana Gold Pure Orange G2080 (Montana Cans)	
VARNISHES	Montana Cans Acrylic Varnish Gloss, Montana Colors MTN PRO Synthetic Varnish Gloss	
COATINGS	An.t.a.res s.r.l. Anti-Stain Maflon s.p.a. Hexafor SA-6320 Pelicoat Italia s.r.l Pro-Stone Colorificio San Marco s.p.a Isograff Guard Industrie s.a.s. Protect Guard TC matt	
OVERPAINTINGS	Montana Colors MTN 94 Matt Black Montana Cans Montana Gold Silverchrome Pentel Pen - Permanent Marker N60 Grog - Squeezer Mini 10 FMP- Diving Blue	➢ **Cleaning methods recommended by each coating manufacturer (**Wall Guard, Graffi-Guard, Steam) ➢ **Organic solvents: Ligroin and Ethanol** ➢ **Organic blends and water-in-oil micro-emulsions applied in gels, thickeners and supporting agents:** Velvesil Plus with 20% of Ethanol Evolon soaked with Ethanol Evolon soaked with solvent blend (DBE, Loxanol and Propylene Carbonate) PVA/Borax hydrogel 6% with 20% of solvent blend Nanorestore gel HWR loaded with Nanorestore coatings B, G and S

5. Tests on mock-ups



FOCUS

- **Example 1: *Niguarda antifascista,* by VolksWriterz (2014), Milan, Italy (4/4)**

Layer	*Composition*	*Analysis and product tests*
SUPPORT and FINISHING	Bacchi - Prontomalt- on bricks (hydraulic mortar) +Saint Gobain - Webercem	
GROUND LAYER	Rival - Stella Oro	
PRIMER	LECHLER - Chrèon - Framaton Riveste Prof, white	
PAINTING LAYER	Montana Colors MTN 94 FLUOR / Orange Montana Colors MTN 94 Frame Gold Montana Colors MTN 94 RV Magenta LECHLER Chrèon - Framaton Riveste PROF Red	**Characterization:** FT-IR (ATR)+ Raman spectroscopy **NATURAL/ACCELERATED AGEING:** FT-IR Colorimentric measurements
VARNISHES	Montana Cans Acrylic Varnish Gloss, Montana Colors MTN PRO Synthetic Varnish Gloss	**Characterization:** FT-IR (ATR)+ Raman spectroscopy
COATINGS	An.t.a.res s.r.l. Anti-Stain Maflon s.p.a. Hexafor SA-6320 Pelicoat Italia s.r.l Pro-Stone Guard Industrie s.a.s. Protect Guard TC matt Colorificio San Marco s.p.a Isograff	**Characterization:** FT-IR (ATR)+ Raman spectroscopy **BEFORE AND AFTER AGEING:** Optical observation Contact angle measurement (wettability) Colorimetric measurements Performance evaluation

SELECTION OF COATING PRODUCTS PARAMETERS:

- Water-based
- Safety/environmental impact
- Ease of use
- Availability
- Sacrificial and permanent

PERFORMANCE EVALUATION:

1. ease of application
2. film homogeneity
3. morphological changes
4. colorimetric variation
5. contact angle variation
6. cleaning efficacy

5. Tests on mock-ups

Materials

- Report CAPuS WP4 – tests on products
- Report CAPuS WP5 – criteria for selecting products

6. Tests *in situ*

OBJECTIVE

After the preliminary selection of products and methodologies, made by means of specific tests on mock-ups, the most promising systems could be tested on site with the aim of evaluating if the results obtained in the laboratory are reproducible on the artwork and how close or far from the "real" situation the experimental test performed is. The result obtained from these tests, carried out in small but very representative areas, constitutes a fundamental basis for the definition of procedures and practices for the intervention on the whole artwork.

6. Tests *in situ*

STATE OF THE ART

Generally there were very few opportunities to perform the test directly on site, on real artworks.
This is quite common, due to several reasons, such as the lack of time and funding other than for the intervention stage itself, or difficulties in returning to the site several times for repeated measurements and for periodic monitoring of the tested products and the observation of possible degradation phenomena.

Nevertheless, when applicable, the tests *in situ* can be truly helpful, providing an additional and more realistic assessment of the effectiveness of the products/methodologies considered, if compared to the tests on mock-ups. This is particularly true for those artworks whose original condition in known and documented, allowing an effective and long-lasting monitoring of the quantifiable parameters associated to the stated criteria.

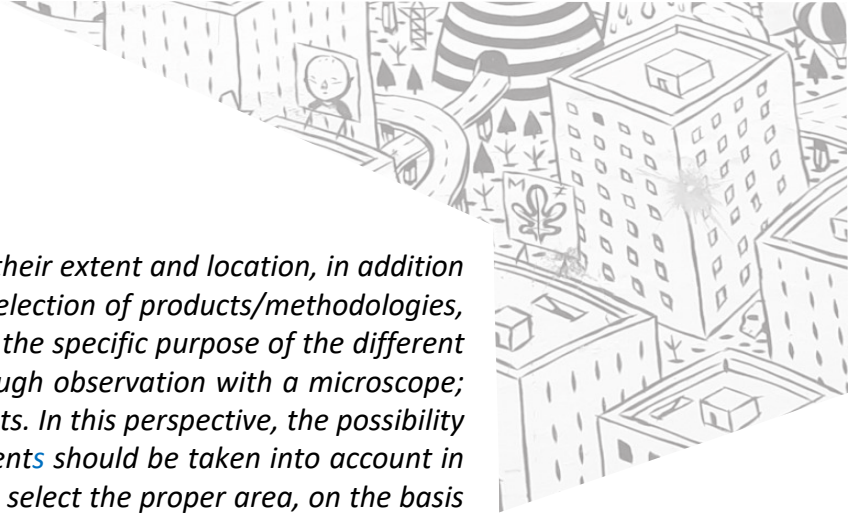
Within the CAPuS Project in situ testing was performed on the case of the mural “A Guarda Escrita Nas Estrelas”, created in 2018 by Nuvi&Éxfico and located in the harbour of the city of A Guarda, Spain. Two different protective coatings were tested and applied in some delimited areas of the mural. It was monitored periodically for one year through colour measurements.

6. Tests *in situ*

In situ *testing should be carefully planned as part of a wider protocol aimed at controlling the effects and possible interaction of the intervention products with the constitutive materials. As for the tests on mock-ups, each test is strictly related to a single operation or phase (sub-operation); usually a set of trials is necessary for better defining, and thus evaluating, both the results obtained and the methodology.*

QUESTIONS

- What is the purpose of the selected operation?
- What are the guiding criteria?
- Is it possible to attribute an evaluation to these criteria? Is it necessary to define measurable related parameters?
- On the basis of the selected criteria or the new defined parameters, what methodologies should be used to measure/evaluate them?
- How does one choose the proper analytical instrument?
- How can the significant area for *in situ* tests be identified?
- What could be the influence of the context on the tests and the expected results?
- How are significant tests performed?



6. Tests *in situ*

The setting of in situ *tests require a previous detailed analysis of the most representative degradation phenomena, their extent and location, in addition to an analytical characterisation of any products of degradation. After having defined the guiding criteria for the selection of products/methodologies, as for the preliminary tests on mock-ups, a selection of the measurable parameters should be made on the basis of the specific purpose of the different operations: e.g. for a cleaning test, the presence of residues of the substance to be removed may be verified through observation with a microscope; while, for consolidation, the variation of the water absorption properties might be attested with portable sponge tests. In this perspective, the possibility of evaluating the results with simple but scientific methodologies and portable, and possibly non-invasive, instruments should be taken into account in order to minimise the impact of the test on the object. On the other hand, to obtain significant results it is crucial to select the proper area, on the basis of the location of the specific degradation phenomena analysed. The following are some reflections that might be helpful in setting up tests on site.*

FIND THE ANSWERS

- Preliminary results of tests carried out on mock-ups allow one to evaluate the product/application methodology behaviour in a system that simulates the object and therefore to highlight eventual critical points and disadvantages;
- Graphic documentation, preliminary survey and results of the diagnostic campaign must guide the selection of the proper area for the test on site;
- Before starting the test, a preliminary assessment of the best environmental condition for the operation should be done: in this perspective, some products might not be recommended for use in specific weather conditions, or in a public space because of their hazard for humans or the environment;
- The definition of scientific instruments or methodologies to be used is subject to availability and economic sustainability; non-invasive techniques and simple experimental tests are preferable, but if a parameter to be tested is considered fundamental, micro-invasive techniques could also be taken into account
- The scientific assessment of a specific treatment protocol should take into account and put in relation all the results collected, the interpretation of analytical data has to be done in consideration of the intrinsic heterogeneity of real cases. For this reason, the tested areas must be the most similar and most homogeneous as possible

6. Tests *in situ*

FIND THE ANSWERS

- From a general point of view for the in-situ assessment of the efficacy of treatments, the same properties tested in the laboratory were considered, but the analytical methods that must be used must take into account that we are working directly on the work of art and a number of limitations arise.
    a. Test areas must be as homogeneous and uniform as possible and wide enough to perform several measurements
    b. Non-invasive testing must be preferred, possibly combined with micro-invasive sampling
    c. Testing areas are “non-movable” and may have a specific space orientation that can influence the testing method (e.g. vertical, horizontal or sloped surface)
    d. Some test methods were adapted to be transferred from the laboratory to *in situ* analysis (e.g. Water absorption by contact sponge test that define procedures depending on in situ conditions and instrument availability*)
    e. Environmental conditions could influence the efficacy of the products and/or the results of tests and must be considered in data evaluation; regarding the use of conservation products, technical data sheets usually provide all the necessary information about the suitable environmental conditions.
    f. Only portable instruments can be used directly on site (portable video-microscope, portable XRF, portable spectrophotometer/colorimeter, etc.)

* *See Italian standard UNI 11432:2011 «Beni culturali - Materiali lapidei naturali ed artificiali - Misura della capacità di assorbimento di acqua mediante spugna di contatto»*

6. Tests *in situ*

FOCUS

- **Example 1: *Memorial Thyssen victims tragedy,* by various artists (2008), Turin, Italy**

On the basis of the results of preliminary tests on mock-ups for the assessment of the most suitable product and methodology for scale consolidation, the two most promising products were tested on site. Thus, two acrylic emulsions ®Primal B60A and ®E411 were applied by micro-injections under the detached scales of painting with a dilution in water of 40% and 25% respectively. In both cases, the choice was based on the lowest dilution showing effective adhesion in the preliminary tests on mock-ups.
Any measurement specifically aimed at assessing the adhesive property (intended as traction resistance properties) of the methodology was taken on site, because of the intrusiveness of tests such as the tape test. Considering that the variation of the water absorption capacity was already studied in the preliminary test in vitro and that the flaking areas showed significant difference in their morphology, no sponge test was performed *in situ*.
Nevertheless, chromatic and glossy variation were taken into account in the evaluation of the optical properties of the treated areas: considering that an increase in the superficial gloss was clearly visible to the naked eye after application of Primal B60A on the black paints, no further measurement was taken.

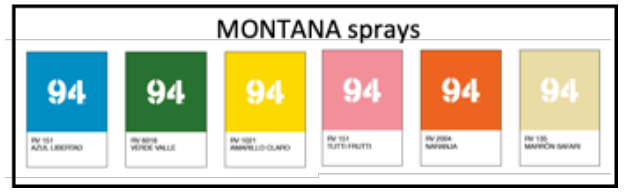
On the left, flaking area treated with Primal b60A, showing a higher hue saturation and a visible glossy aspect in the area surrounding the scales. On the right, a nearby lacune whose edges presented scales treated with E411: in this case, no significant variation of the hue or the gloss were detected.

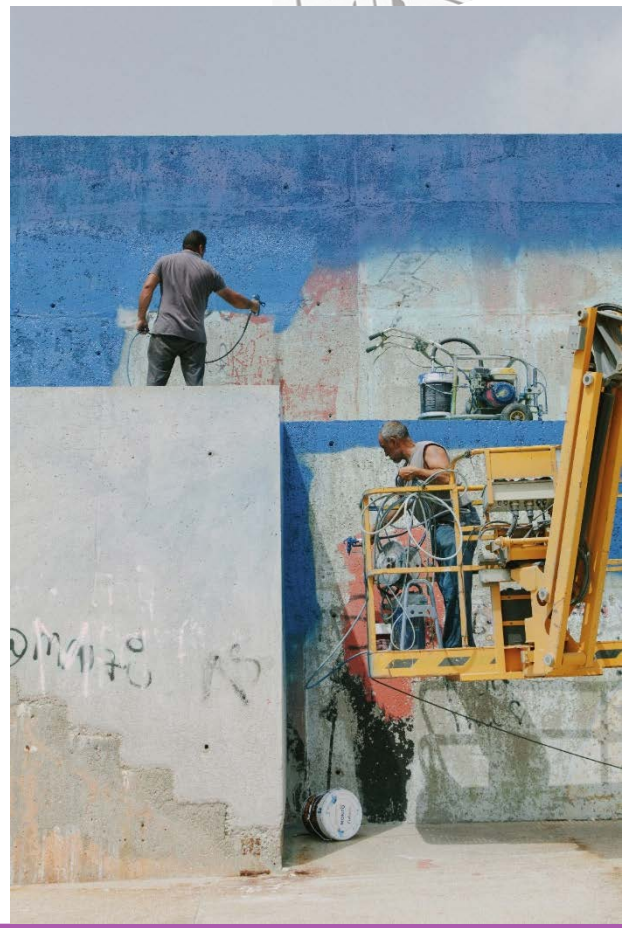
6. Tests *in situ*

FOCUS

- **Example 2: *A Guarda Escrita Nas Estrelas,* by Nuvi&Éxfico (2018), A Guarda, Spain (1/2)**

This artwork was painted in 2018 on the great breakwater of *A Guarda* fishing port. On the reinforced concrete, a blue acrylic paint was applied as the base of the artwork. Then, the artists created their artwork by means of *stencil graffiti,* using six Montana spray paints.





The mural represents iconographic marine activities of the port and the fauna and flora of the area.

6. Tests *in situ*

FOCUS

- **Example 2: *A Guarda Escrita Nas Estrelas,* by Nuvi&Éxfico (2018), A Guarda, Spain (2/2)**

$\triangle E_{ab}$ (before-after application)	Yellow	Brown	Green	Pink	Blue	Orange
With PROA Protector	4,63	1,33	3,01	3,05	5,69	5,25
With EGA Protector	0,58	0,78	0,55	0,30	0,54	0,73

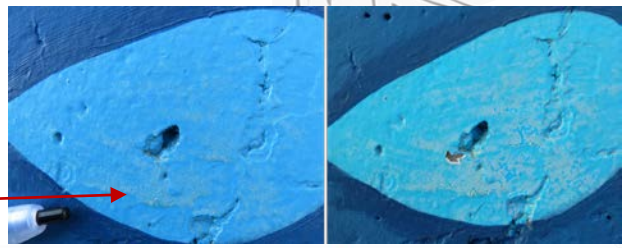
Two colour protectors (from EGA and PROA suppliers) were applied on selected areas on green, yellow, brown, pink and blue paints. Colour changes after application and after one year of natural exposure were evaluated by monitoring $\triangle E_{ab}$ (global colour change on *CIELab colour space*).

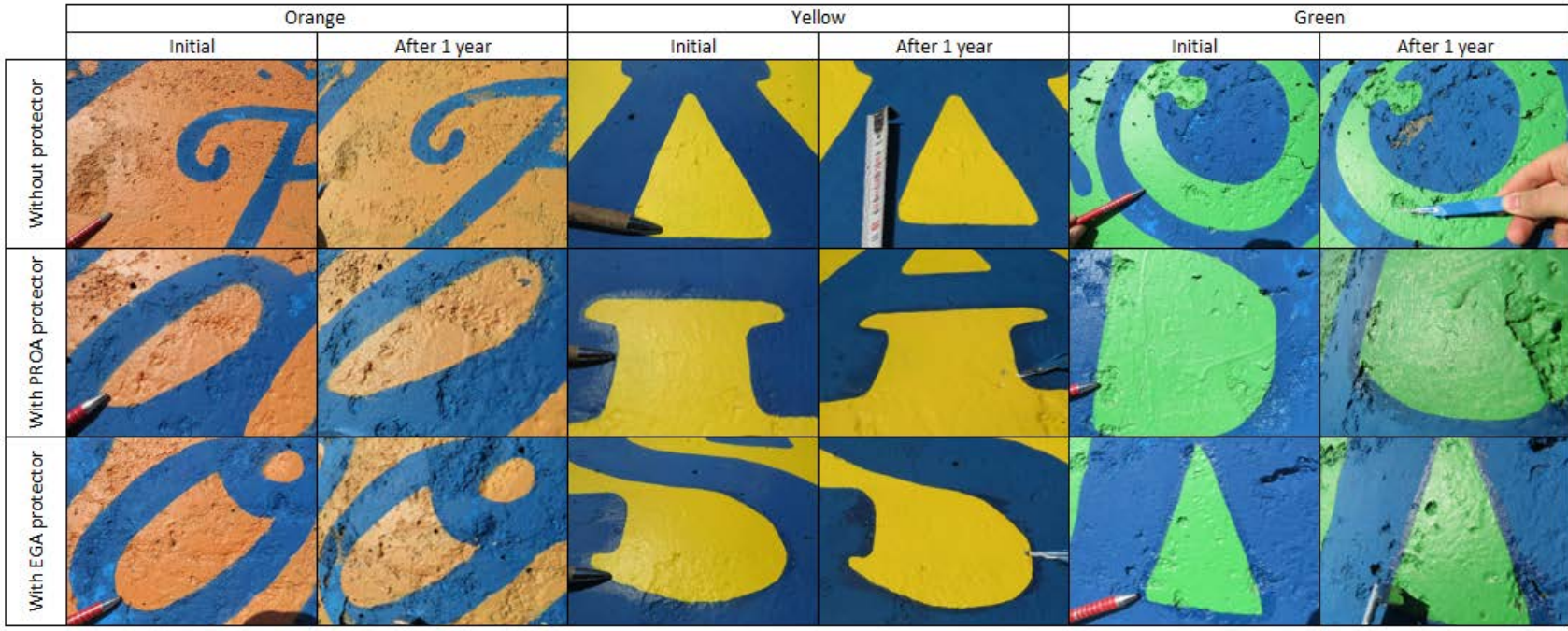
After a year of exposure, a moderate effectiveness of the two protectors, specifically that of EGA was confirmed: $\triangle E_{ab}$ was always less with either of the two products.

This effectiveness was not enough, however, in the case of less resistant paints, such as orange, for which the colour change is very significant, with or without protectors.

PROA protector peeled off the surface over time; it is the least durable.

Two colour protectors modify the colour of the paintings; PROA protector does it to a greater extent, the change being visible to an expert eye ($\triangle E_{ab} > 3.5$); also, PROA, on the blue and brown paintings, leaves residues.





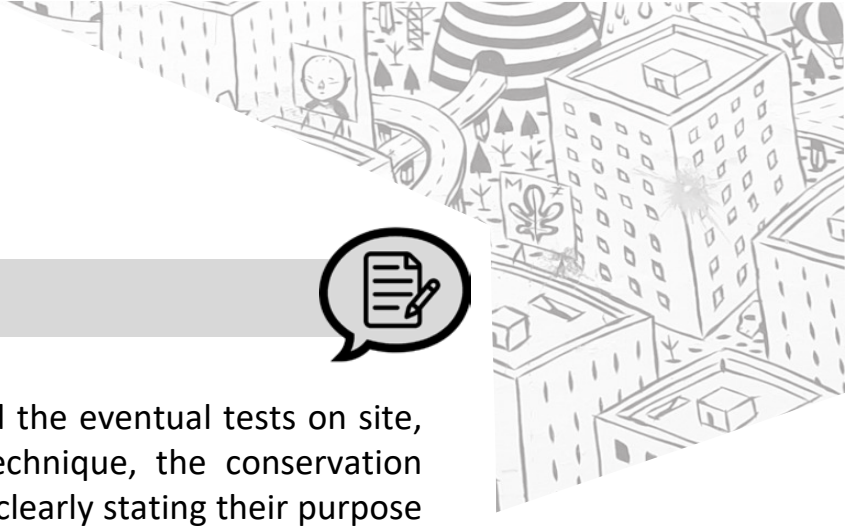
7. Intervention

OBJECTIVE

The conservation intervention aims to preserve the material, historical and aesthetical instances of the artwork itself, by slowing down the active degradation phenomena, by reducing the risk factors and by remedying the effects of previous decay on the object. At the same time, specific operations such as filling or retouching are intended to conserve the aesthetical value and the message carried by the artwork by maintaining or re-establishing (possibly with recognisable systems) the legibility of the surface. Moreover, the conservation intervention on an urban artwork represents an important occasion to enhance the knowledge about this kind of artistic expression, in relation to the execution technique, the materials used by the artists and their behaviour in the outdoor context. In this perspective, when the intervention is also paired with effective dissemination activities, it becomes a vector for increasing awareness and interest in the local social community toward the artwork itself, generating a larger public involvement in future conservation.

7. Intervention

THE CAPUS PROJECT STATE OF THE ART



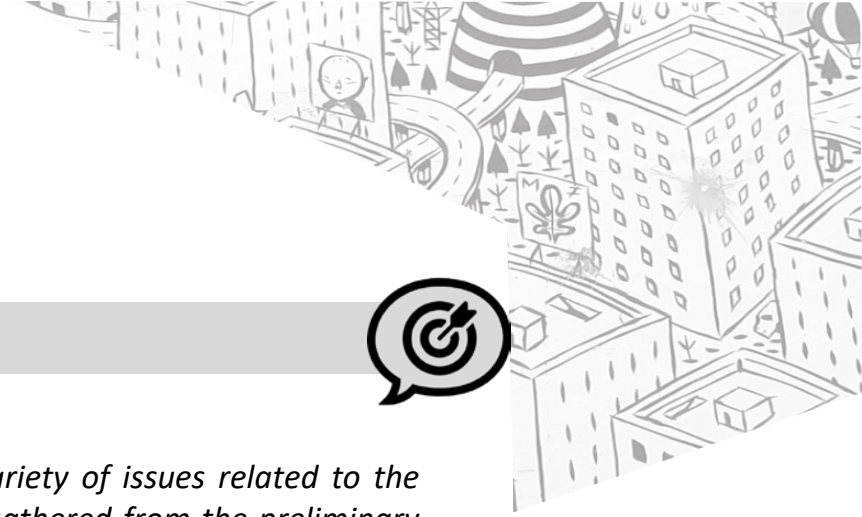
Any conservation intervention on the artwork, as well as the preliminary diagnostic campaign and the eventual tests on site, must be planned in advance within a detailed project, aimed at describing the execution technique, the conservation conditions, any preliminary intervention and all the required investigation or conservation actions, clearly stating their purpose and the products/methodology to be used. If this step is quite common for the intervention on other kinds of artworks, usually subjected to specific provisions of national laws, in the field of urban and street art conservation, this *modus operandi* is not so prevalent.

The design of an effective and comprehensive conservation project is not limited to listing decay and related conservation actions but rather must take into account a wider reflection on the values recognized in the artworks (previously analysed in the study and research activities). For instance, the relation with the environment, meaning the social and urban context, strongly influences the choice of removing unwanted graffiti from the surface, since the partial modification of the aspect of the artwork may lead to possible adverse “reactions”.

This acknowledgment is fundamental for the subsequent definition of the guiding criteria, tailored to the purpose of every single action. On the basis of these criteria, as described in the previous sections of these guidelines, preliminary tests on mock-ups and on site should be defined, along with the measurable parameters for the evaluation of the efficacy of treatments. Then, the selection of the most suitable approach for every single conservation action should take into account the sustainability of the intervention, analysing the topic under an economic, environmental, timing and human-safety perspective.

Furthermore, a comprehensive documentation of the whole intervention must be produced, with specific explanations of the results of the preliminary study and the detailed descriptions of each operation, including details on products and methodology, in order to enhance future surveys of the conservation condition and facilitate further maintenance of the object.

7. Intervention



QUESTIONS

The definition of a conservation project requires a series of steps aimed at defining and planning a variety of issues related to the technical approach and to the operative setting up of the work on site. In this perspective, the results gathered from the preliminary study and the tests for defining the methodologies/products should be read in the view of a large-scale intervention, evaluating in detail issues such as the sustainability and feasibility of the different treatments. This requires specific investigation of the time/cost evaluation for each conservation action planned, in relation with the specific methodology selected from the preliminary tests on mock-ups and on site.

Another issue to focus on is related to the definition of the sequence for the conservation treatments, on the basis of the specific needs of the artwork: for example, in relation to the specific degradation phenomena assessed, a preliminary consolidation is necessary to secure the surface before starting any cleaning action. When possible, this issue should drive the selection of products also in the preliminary test phase, in relation to any known interactions between different classes of products.

Moreover, in a large-scale perspective, any (localized) differences in the results of the different treatments, related to the irregular distribution of the degradation phenomena, should be taken into account for the definition of the proper methodology for each area of the object.

Given the intervention in the urban context, measures to consider are those related to the safety of the work site and the surrounding context: in particular, in addition to the usual attention paid to the safety of operators, in the case of intervention in public spaces, any possible impact of the conservation products on the public or the environment must be analysed carefully. The study of this complex issue must follow the regulation of the local law in the field of safety and work sites.

7. Intervention

QUESTIONS

For each of the highlighted issues, a list of questions is reported below with the aim of guiding the analysis of these topics.

For the scalability assessment:

- Is the time/cost evaluation compatible with the budget and the deadlines of the conservation intervention?
- Are there areas of the object affected by several degradation phenomena? If so, do these require specific treatments or preliminary securing that might influence the further operations?
- Might the climate or the weather conditions influence the results of any of the treatments? Are there specific precautions to be considered in relation to possible negative side effects of the selected treatments?

For the definition of the most proper sequence of operations:

- Bearing in mind the observed degradation phenomena, what are the ones intended to ensure the stability/adhesion/cohesion of the object as a whole or of a specific area?
- Considering the cleaning as a multi-step operation, is it possible to proceed step by step in relation to the specific overlayed material to be removed?
- Are there any possible interferences between the different products/methodologies selected on the basis of the preliminary tests on mock-ups and on-site?

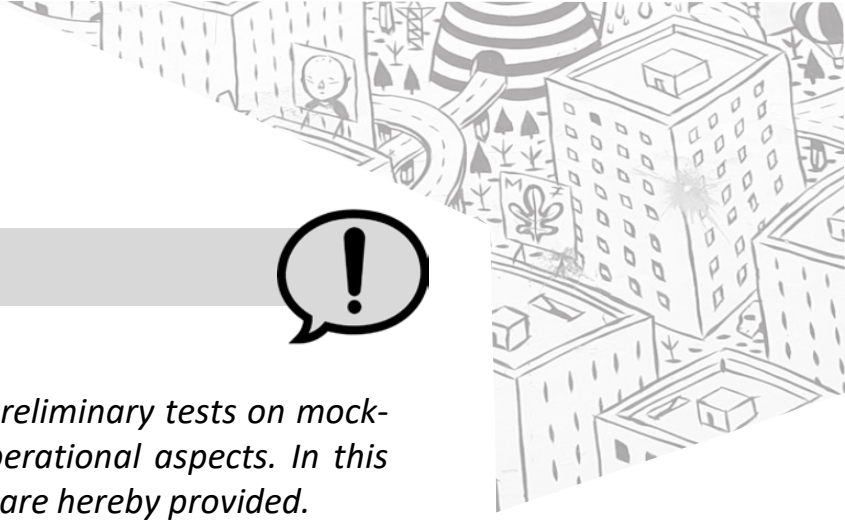
7. Intervention

QUESTIONS

For the analysis of safety measures:

- What are the local legal requirements for safety on the work site?
- Are specific elevators or scaffoldings needed for the intervention on the object?
- Can the artwork be temporarily enclosed (for the duration of the intervention)?
- According to the local regulation, what limitation to the access/specific permissions should be provided?
- Do any of the planned treatments require specific safety setups?
- Might other professionals or consultants be involved in the work?

7. Intervention



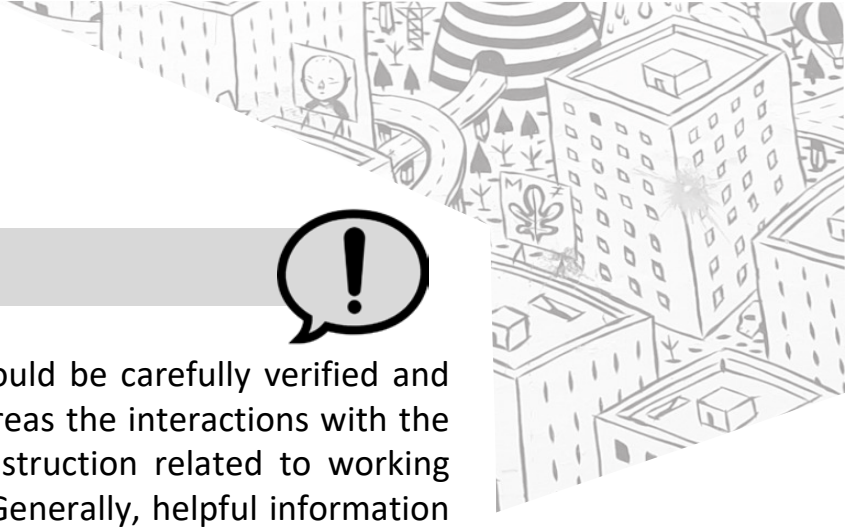
FIND THE ANSWERS

Considering that the definition of products and methodologies has been carried out through the preliminary tests on mock-ups and on site, the process of "scalability" requires further analysis of safety, logistical and operational aspects. In this perspective, on the basis of the shortlisted questions, some suggestions for developing these issues are hereby provided.

For the scalability assessment:

- The time/cost evaluation requires an analysis of the costs of each operation, including the cost of the products, of the labour and of any ancillary costs. This step requires also an examination of the expected duration for each operation and, consequently, for the whole intervention. Useful tools for this analysis are conservation price lists, usually established by the local association of conservators or by the national institutions.
- Even if the preliminary tests on site are effective in selected small areas, different results might be obtained when the treatment is extended to the whole surface, due to possible heterogeneities in the stratigraphy or in the conservation condition of specific areas. When this can be clearly observed, it is fundamental to make some preliminary tests, applying on different areas of the artwork the treatments which showed better results during the on-site tests, with the aim of evaluating their efficacy on the whole surface or area to be treated. This requires careful review of the graphic documentation on the conservation condition, as well as possibly performing on-site measurements of those parameters used for evaluation, already considered previously in the "on-site testing" stage.

7. Intervention



FIND THE ANSWERS

- Moreover, information about the suitable “operative” climate condition for each product should be carefully verified and followed so to not affect its performance, as observed with the preliminary tests: if in small areas the interactions with the outdoor conditions are usually minimal, when considering a large-scale intervention any instruction related to working temperature or possible interaction with dry/wet weather must be taken into consideration. Generally, helpful information about usage can be found in the technical data sheet of the products, together with specific notices regarding unsuitable use conditions.

For the definition of the most proper sequence of operations:

- The definition of the most proper sequence of operations needed for the intervention is very case-dependent, due to the specific degradation phenomena observed and their interactions with the constitutive materials. But first, the need of a preliminary securing of some critical areas should be evaluated, in order to reduce any risk to the artwork during the intervention. Then, the sequential order for all remaining operations should be decided on the basis of the specific purpose and the possible interaction with the others: for example, when possible, a preliminary removal of the superficial dust should be completed before a consolidation treatment, in order to avoid fixing the incoherent deposit to the surface. This kind of evaluation might be based even on interactions among the different products used for the treatments: e.g., when a surface is cleaned with solvents, possible interactions with the adhesive used for preliminary consolidation of scales can be observed, resulting in a weakening of the adhesive power. In this perspective, a careful analysis of the technical data sheet of the selected products might highlight possible interferences with other materials or products.

7. Intervention

FIND THE ANSWERS

For the analysis of safety measures:

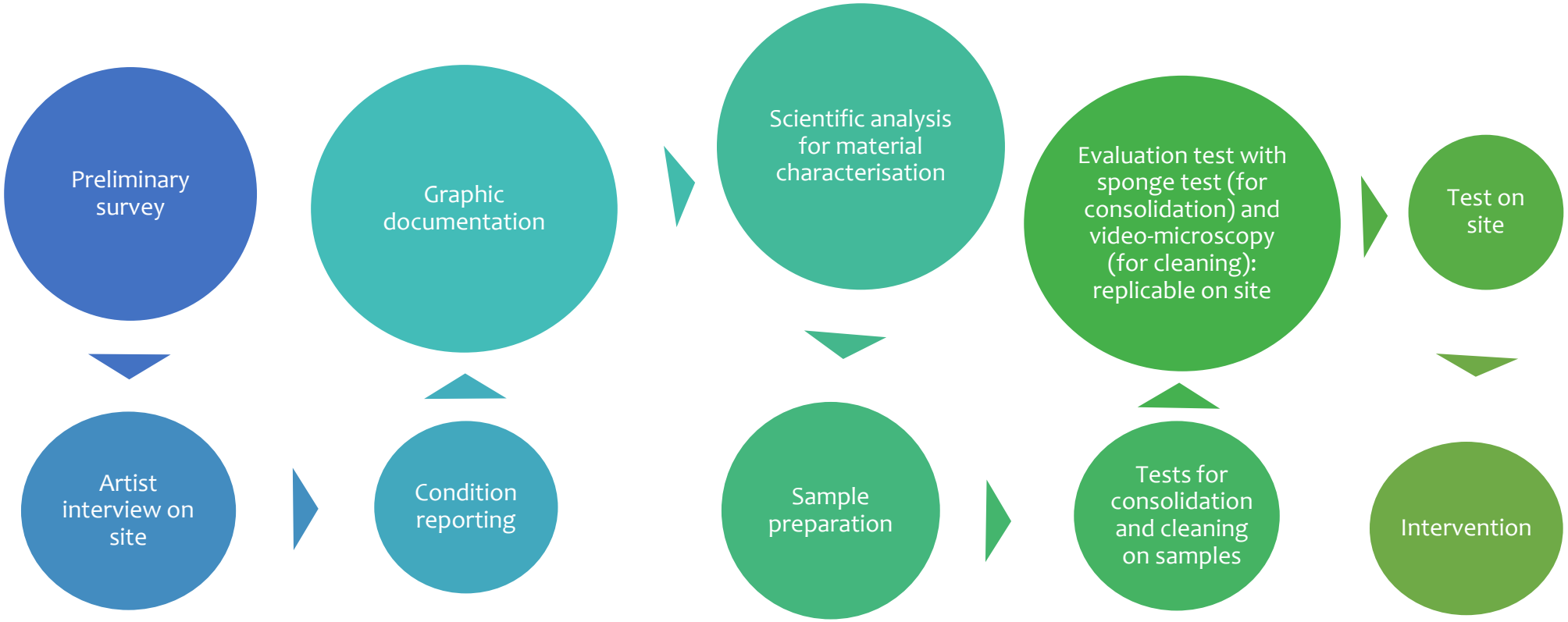
- Usually, the national legislation about safety on a work site state all necessary measures to ensure the safety of operators within conservation work in an outdoor location, also defining the professionals to be involved in establishing a safety operative plan.
- Considering that urban artworks are usually located in areas of free public access, a further necessary step is to determine the other “legal” actors involved, meaning the owners, the clients, the local institution respectively responsible for the use of the site and the conservation of the artwork, the artist(s), the citizens or inhabitants living in the surroundings.
- Given the restricted access, a preliminary evaluation of the professional or consultants to involve in the intervention should be made to provide necessary permissions and personal protective equipment (PPE).
- On the basis of the national law and upon agreement with the local institutions, specific safety measures should be considered to enable the access of the public to the work site (free or possibly regulated through dedicated tours), with the aim of enhancing the awareness of the artwork under study among the local community.
- On the basis of the selected operations, further safety setups may be considered to protect the surrounding environment: in this perspective, the use of polluting products should be avoided in preference to green formulations; moreover, when specific equipment is used, such as a laser system for a cleaning operation, appropriate shields should be placed around the site to block any dangerous radiation.
- Depending on the dimensions and the accessibility of the artwork, specific scaffolding or an elevator might be necessary to reach the different areas: in this case, national legislation and local regulations must be consulted for further measures in terms of safety and permissions.

7. Intervention

FOCUS

- **Example 1: *Memorial Thyssen victims tragedy,* by various artists (2008), Turin, Italy (1/5)**

In the summer 2019, within the CAPuS activities, a university internship was offered by the University of Torino and the Centro Conservazione e Restauro "La Venaria Reale" with the aim of designing a pilot conservation intervention on the Thyssen Mural. Starting with a preliminary study, the approach was aimed at focusing the students' attention on the importance of an effective and respectful planning of the different steps of the conservation process. Below, a flow chart summarizes the fundamental activities and their correct sequence.



7. Intervention

FOCUS

- **Example 1: *Memorial Thyssen victims tragedy,* by various artists (2008), Turin, Italy (2/5)**

Within every step, different activities were carried out, with the aim of enhancing the knowledge of the artwork both from a technical and a conservation perspective. At the same time, a close dialogue with the institutions and the artists was set up with the purpose of understanding the different instances related to the conservation of the mural and defining the conservation strategies.

Main activities/steps:

- Identification of the main degradation phenomena;
- Contact with Institutions and owners;
- Analysis of the environment (survey on the other side of the wall)

Preliminary survey

Artists interview on site

CAPuS PROJECT - CONDITION REPORT (WALL PAINTINGS)

1 - GENERAL DATA

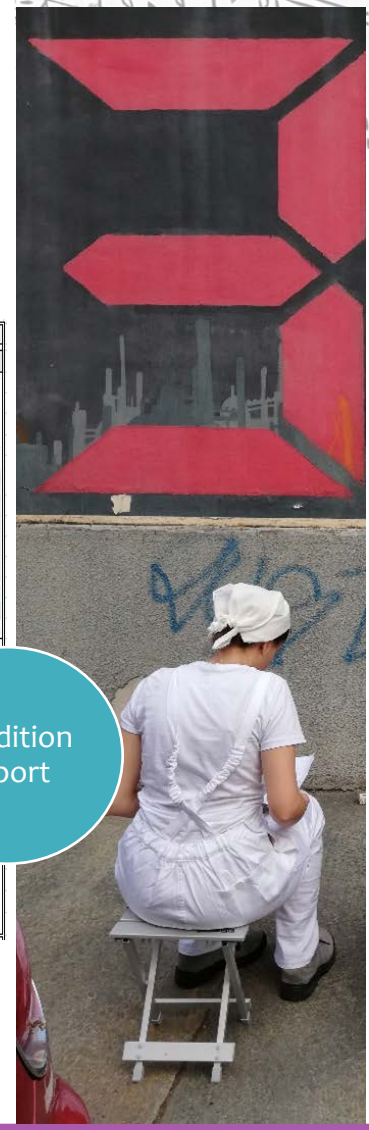
Artist ()	VARIOUS
Title of the work	Memorial Thyssen victims tragedies
Type of work	Mural
Materials	Paint, plaster
Year of execution	2008
Owner / custodian	Turin Municipality
Legal protection	Italian Ministry of Cultural Heritage

Dimensions (cm)		
Height	Width	Depth
300	1000	

Country	Italy
City	Turin
Address	Corso Valdocco - corner Via Santa Chiara
GPS coordinates	
Latitutde	45°04'38.7"N
Longitude	7°40'30.7"E

Condition report

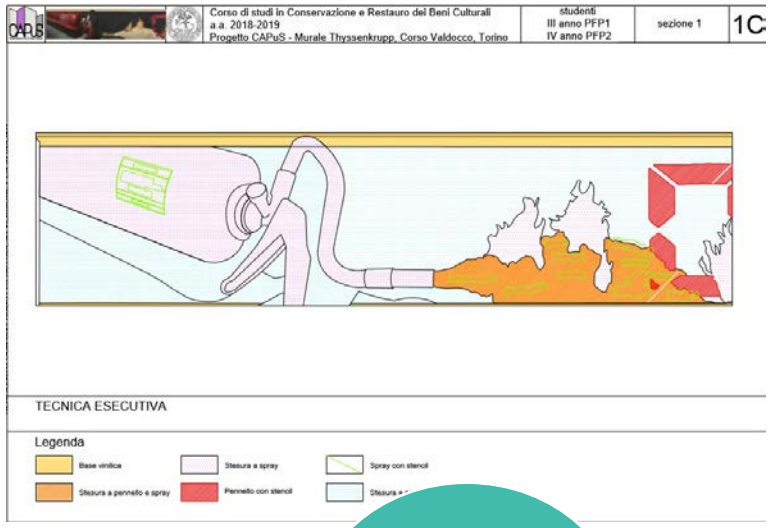
- Fracturing
- Cracking
- Scaling
- Lacunas
- Fading
- Efflorescence
- Biological growth, etc.



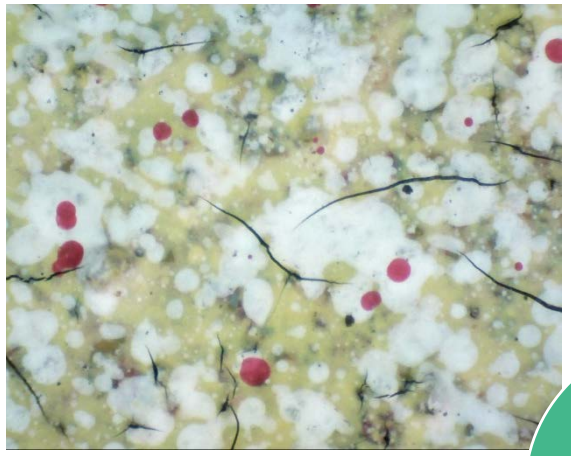
7. Intervention

FOCUS

- **Example 1: *Memorial Thyssen victims tragedy* by various artists (2008), Turin, Italy (3/5)**



Graphic documentation



Scientific analysis for material characterisation

Diagnostic plan for constitutive material characterisation:

- Background layer of vinylic paint
- Acrylic paint for bigger fields, applied by brush
- Alkyd paint for shades, applied by spray

Mock-up preparation

GOALS:

- Replicate a complex stratigraphy (interactions between different classes of materials);
- Replicate degradation phenomena (scaling and cracking);

7. Intervention

FOCUS

- **Example 1: *Memorial Thyssen victims tragedy,* by various artists (2008), Turin, Italy (4/5)**

Main selection criteria (consolidation):

- Compatibility with constitutive materials;
- Reversibility;
- Stability;
- Re-adhesion power;
- Sustainability.

Test for consolidation and cleaning on mock-ups

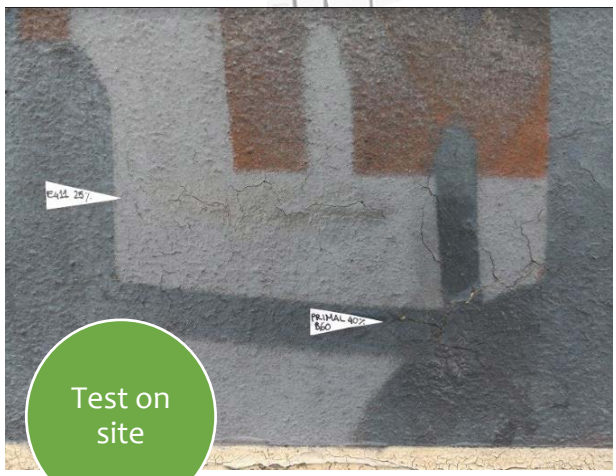
Main selection criteria (cleaning):

- Compatibility with constitutive materials;
- Absence of residues;
- Cleaning power;
- Sustainability.

Test selection:

- Replicability on site
- Non-intrusiveness
- Cleaning effectiveness and absence of residues
- Adhesive power
- Compatibility with the properties of the constitutive materials.

Evaluation test with sponge test (for consolidation) and video microscopy (for cleaning):



Test on site

7. Intervention

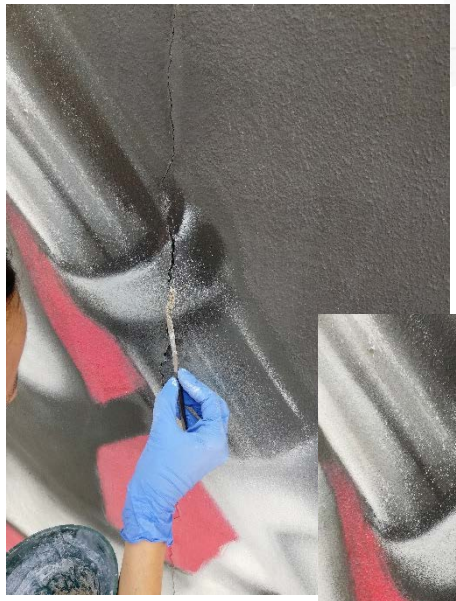
FOCUS

- **Example 1: *Memorial Thyssen victims tragedy,* by various artists (2008), Turin, Italy (5/5)**

Large-scale intervention

- Scaling/flaking consolidation

- Drycleaning



- Filling of the wider fractures and lacunas

7. Intervention

FOCUS

- **Example 2: *Stilt Walkers,* Linas Domarackas (2008), Warsaw, Poland (1/4)**

The first step of the conservation project was the investigation of the social and cultural value of the murals, created in 2008, in memory of the stilt walkers' workshops organized for children from the Prague district of Warsaw and was made with their help.

Observing the photos taken during the "collective painting" of the mural, important details were gathered in relation to the technique of execution and the materials used by the children. In this perspective, the analysis of the pictures showing paints usually used for indoor works allowed the conservator to detect one of the most relevant reasons for the widespread lacunas and lack in adhesion/cohesion and other degradation phenomena visible on the artwork.

7. Intervention

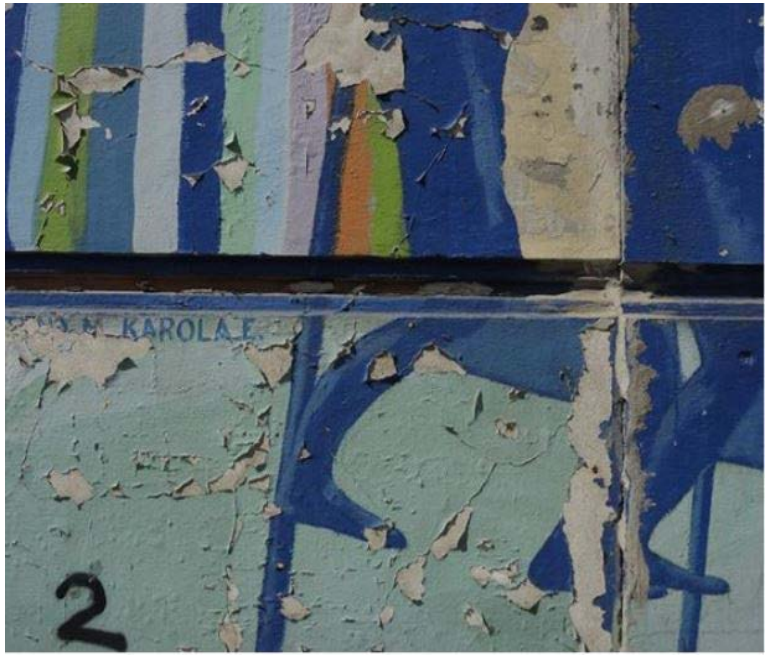
FOCUS

- **Example 2: *Stilt Walkers,* Linas Domarackas (2008), Warsaw, Poland (2/4)**

The deeper investigation of the other causes for degradation revealed the presence of hazards related both to the technique of execution and the outdoor environment, such as the use of improper paints and plasters, weather-related factors, air pollution, vandalism, leaks in the rainwater drainage system, as well as massive intervention on the surrounding building like construction activities, repairs and reconstructions.

Mural condition in 2011.

Domarackas, *Stilt Walkers,* 2018, Photo R. Stasiuk



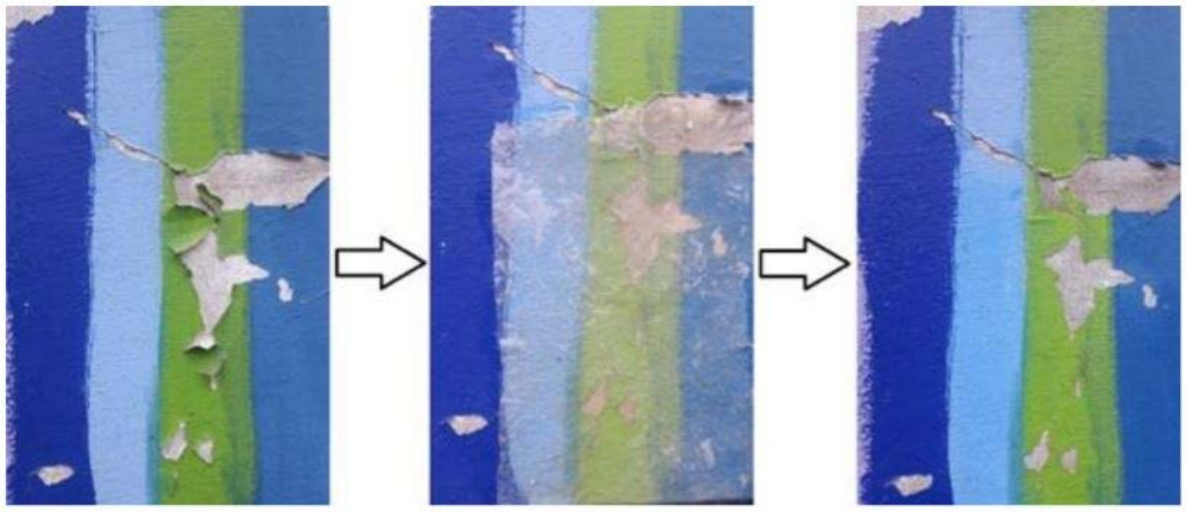
Images 1 and 2 show worsening of the conservation conditions after a leak in the water and sewage system (2010) and after construction works in 2011-12. Image 3 shows that the use of improper materials resulted in lacunas and flaking.

7. Intervention

FOCUS

- **Example 2: *Stilt Walkers*, Linas Domarackas (2008), Warsaw, Poland (3/4)**

The analytical research led to the identification of paint and binders used, consisting of acrylic, alkyd and vinyl resins. Among the pigments, calcium carbonate, titanium white, organic blue, carbon black and phthalocyanine blue were detected.
Conservation treatments on the murals, according to the detected degradation phenomena, consisted in different steps of cleaning and mortars and painting layer consolidation. When needed, preliminary tests were performed to assess the proper methodology of intervention: this was the case of the consolidation of flaking areas, where adhesion and optical properties of two acrylic resins and ammonia casein were preliminarily evaluated.



7. Intervention

FOCUS

- **Example 2: *Stilt Walkers,* Linas Domarackas (2008), Warsaw, Poland (4/4)**

Solvents and surfactants were used to remove effects of acts of vandalism. Most of the inscriptions were removed with acetone and using mechanical methods.

Finally, thanks to the documentation and historical photographs, it was possible to reconstruct fragment of the lower part of the painting with a fragment of a European map and the vertical multi-colour stripes.

Fragment after filling cavities. Photo S. Woropaj

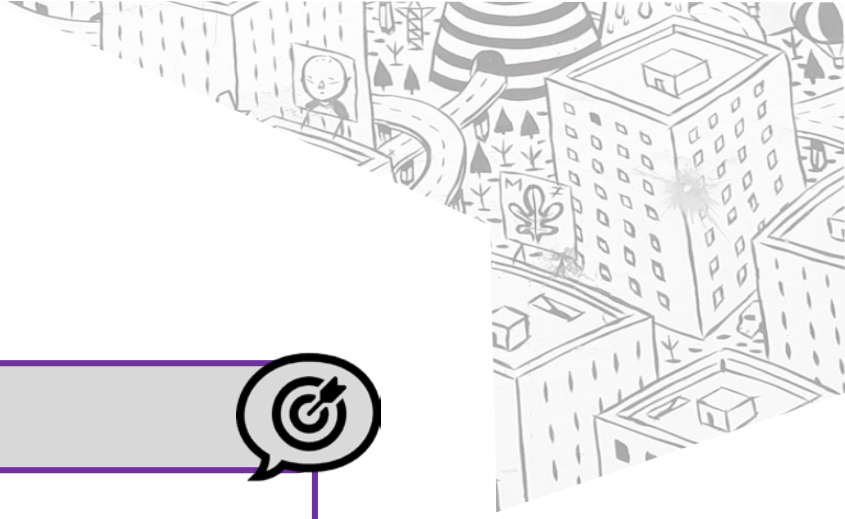
Fragment after reconstrucion. Photo R. Stasiuk

7. Intervention

MATERIALS

The conservation project: a closer look.

8. Maintenance

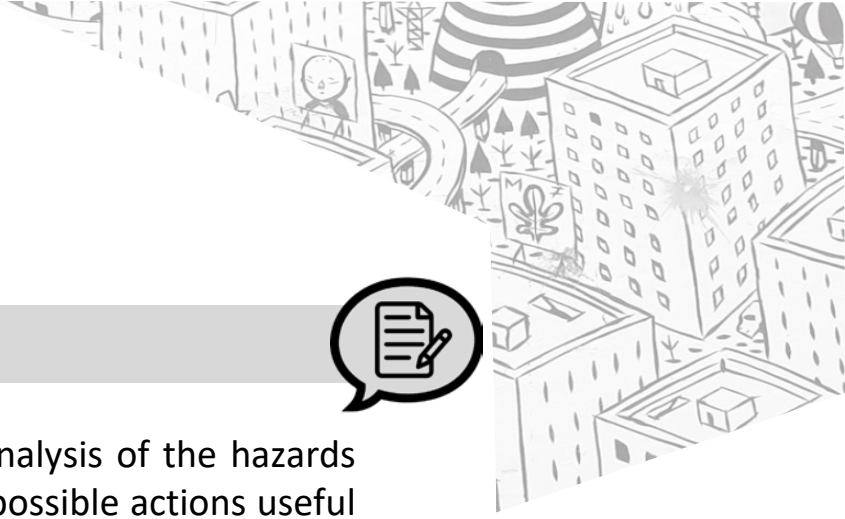


OBJECTIVE

"The maintenance programme is aimed at keeping the cultural resources in a manner that will prevent the loss of any part of them. It concerns all practical and technical measures that should be taken to maintain the site in proper order. It is a continuous process, not a product." [1]

[1] Feilden B.M. and Jokilehto J., *Management guidelines for world cultural heritage sites,* ICCROM 1998, https://www.iccrom.org/it/publication/management-guidelines-world-cultural-heritage-sites

8. Maintenance

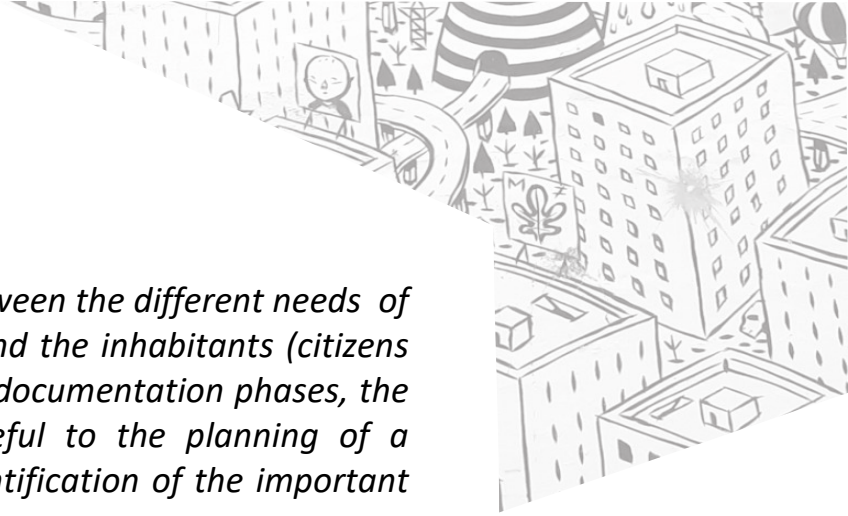


STATE OF THE ART

Within the CAPuS Project no maintenance programme was proposed; nevertheless, the analysis of the hazards and the identification of the main causes of degradation frequently highlights some of the possible actions useful to reduce the risk for the conservation of the objects of study.
According to the ICCROM, UNESCO, ICOMOS definition[1]:
"Maintenance includes all practical and technical measures that are needed to keep the site in condition at a standard that permits enjoyment of the cultural resource without damage. It is a continuous process. Frequencies of action should be defined based upon professional input and special training of crafts persons. Monitoring of the maintenance programme is necessary. Special precautions may be needed against vandalism, theft, fire, floods and earthquakes."
An important issue arose from the preliminary studies: the crucial role played by the social communities in the conservation of the selected street artworks. In this perspective the definition of an effective maintenance programme must aim to find a balance between the conservation needs of the object, the benefit related to the public and unregulated access to the site where the object is located and the interest of the stakeholders, namely the local institution, the consumers of the artwork, the local communities/association/citizens and, in a certain way, the artists themselves.

[1] Feilden B.M. and Jokilehto J., *Management guidelines for world cultural heritage sites,* ICCROM 1998, https://www.iccrom.org/it/publication/management-guidelines-world-cultural-heritage-sites

8. Maintenance

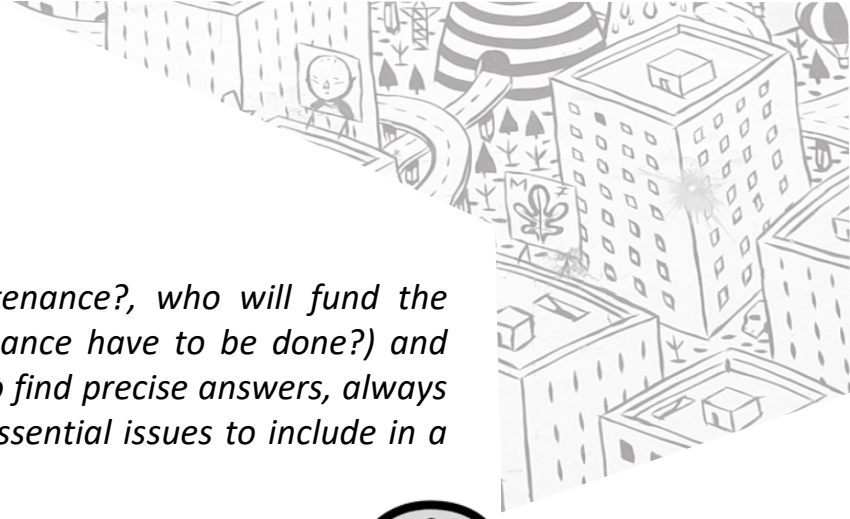


Setting up an effective maintenance programme is based on the research of a compromise between the different needs of conservation, benefit and use coming from the object, the environment, the urban context and the inhabitants (citizens and institutions). Part of these issues have already been studied in the previous research and documentation phases, the main purpose being to select the significant information, highlighting that which is useful to the planning of a maintenance programme. Below are listed some questions that might be helpful for the identification of the important materials.

QUESTIONS

- What are the main hazards for the object?
- How can the risk for the object be mitigated in the medium-long period?
- Who will take care of the object after the intervention?
- Are there some needed maintenance actions of the areas surrounding the object? Are they still planned/completed?
- Who are the main stakeholders? Is it possible to involve the citizens? Does (or will) the local administration participate in the maintenance of the object?
- Are there preventive actions that might be addressed toward exogenous degradation causes related to the context, the location or the accessibility of the object?
- Is the maintenance program economically sustainable?

8. Maintenance

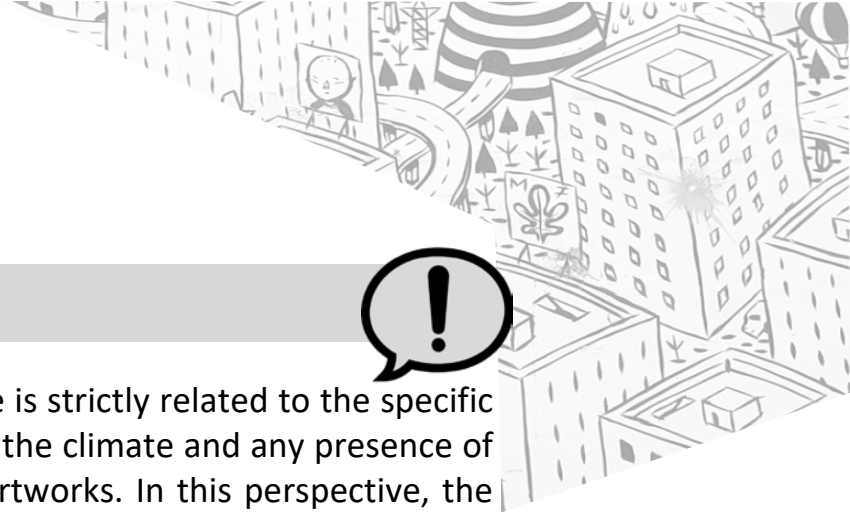


Once the main questions are highlighted about WHO? (who will be in charge for the maintenance?, who will fund the programme?), HOW? (how will the programme be achieved?), WHEN? (when does the maintenance have to be done?) and WHAT? (what are the necessary operations/surveys?), the set up of the programme requires one to find precise answers, always specifically related to every single object and the specific context of reference. Below is a list of essential issues to include in a maintenance programme.

FIND THE ANSWERS

- WHO One of the main issues relating to a maintenance programme is the economic sustainability of the activities: in this perspective, a crucial step is the research of stakeholders; on the basis of this information, different strategies can be designed, involving local associations or citizens in crowd-funding activities or, when possible, in the ordinary activities mainly addressed to the surrounding environment. In the maintenance plan, special care should be given to the identification of the professionals in charge of the different tasks: conservators/conservation scientists must be responsible for all the activities related to specific operations on the artworks or to the periodic survey of the conservation conditions; on the other hand, maintenance of the surrounding areas should be assigned to artisans, specifically trained in the possible interactions of their activities with the object.
- HOW Including the maintenance programme indicating any personal protective equipment needed is crucial for the time/cost evaluation, especially when funding opportunities have to be researched or created. The starting step is the design of multi-year plans including all the activities required for the maintenance and their scheduling. These plans must be built by means of a synergistic effort of the main stakeholders, the professionals involved in the conservation of the object, the artist (when possible) and any sponsor; and then shared with the local association and community to enhance their awareness and commitment in the conservation of the object.

8. Maintenance



FIND THE ANSWERS

- WHAT The definition of the necessary operations to include in the maintenance programme is strictly related to the specific case study, depending on the conservation condition of the object, on the assessed hazard, on the climate and any presence of vegetation in the surrounding areas and on the possibility for people to directly access the artworks. In this perspective, the definition of the operative working condition on site, including safety measures and any scaffolding or elevators, is required.
- WHEN Considering the specific needs of the objects, defined on the assessed hazard coming from the outdoor context, and the feasibility of the different actions included in the maintenance programme in relation to the outdoor conditions, a specific schedule for the different actions must be clearly defined.

According to the ICCROM guidelines, maintenance should consist in cyclic tasks, *integrated into* **a scheduled routine** that covers:
- monthly tasks, e.g., control of plant growth on buildings and sites
- seasonal tasks, e.g., spring and autumn
- annual tasks, e.g. cleaning and polishing
- 5-year tasks

"The scheduled routine should also have flexibility, in order to allow emergency **tasks** to be tackled promptly, such as
- after heavy rain
- after high winds
- after a fire, earthquake, flood or other natural disaster [1]"

[1] Feilden B.M. and Jokilehto J., *Management guidelines for world cultural heritage sites,* ICCROM 1998, https://www.iccrom.org/it/publication/management-guidelines-world-cultural-heritage-sites

Knowledge

Evaluation/Research

Practice

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