

# THE ROLE OF INDUSTRIAL RESEARCH IN THE FIELD OF CULTURAL HERITAGE

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*Keywords:* industrial research, protection, conservation, cultural heritage

## 1. Introduction

Chemical science can be found in all the operational phases needed to carry out the restoration and preservation of works of art, architectural heritage or ancient artifacts. It is present from the initial stages, starting from the diagnostics and stabilization and consolidation efforts necessary to avoid further damage, the cleaning of the degraded and / or contaminated parts, to the restoration of its original beauty and functionality [1-7].

What is the specific relationship between the chemical industry and the technologies used in the restoration of a nation's cultural heritage? Four situations can be identified in which the chemical industry is directly involved.

The first, and the most natural, is that of the development of new products and technologies used in the different phases of restoration.

The second is the opportunity a company has, when sponsoring the restoration of a work of art, to demonstrate its commitment to social issues and its ability in knowing how to create close ties with the territory.

The third is the possibility for a company to talk about the restoration work it carries out, thus presenting itself with the chance to clearly explain a chemistry whose utility is easily understood by everyone.

The fourth aspect relates to what was attained at one of the first conferences on sustainable development organized by the European Chemical Industries Association (CIA), held in Paris some years ago. At the conference, while representatives of various chemical industries presented their companies' success in securing safe, clean processes and products whose use did not cause harm to living things and the environment, the Rhône-Poulenc president chose to speak only of the activities of his group in the restoration and conservation of cultural heritage in the world [8-9].

In addition to several interventions carried out in Italy, the French company was involved in the restoration of a wooden building in the imperial citadel of Hue in Vietnam, the Taj Mahal in India, the Burgos cathedral and several old manuscripts in France and Mauritania. More specifically, Rhone Poulenc developed a special silicone adhesive employed in the restoration of the Taj Mahal and an insecticide (fibronil) for wood in the restoration of the Hue citadel in Vietnam and the preservation of the manuscripts

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in Mauritania. The initiative of Rhône-Poulenc's President to speak only of his company's activities in saving European and world cultural heritage at a conference on sustainable chemistry must be interpreted as a very precise strategic choice in wishing to present a positive chemistry. A chemistry that is no longer on the defensive but is eager to explain that chemical production does not alter the ecosystem and is useful to humanity to preserve its existing heritage for future generations.

## 2. Restoration interventions in Italy

In recent years, several industries in Italy have used their products and / or made their skills available to sponsor restoration works. I have selected a number of these industries to highlight this aspect: Eni, Syremont, Rhone Poulenc, Mapei and CIR.

### A. ENI

Eni's role was fundamental in the restoration of the façade of St. Peter's Basilica in Rome, which started in March 1997 and concluded in September 1999 [1,10-11]. It was quite a unique experience, as a large industrial group actually participated in the initiative, and not as usually happens, only acted as a sponsor on the project. For this purpose, Eni made its own resources and expertise available, delegating, at the operational level, EniTecnologie, their division of research and technological innovation. A range of competences was thus made available, related to the field of physical chemistry, materials science, non-destructive testing and environmental monitoring.

These are competences that have been consolidated through years of long-standing research activities, in particular diagnostic investigations, characterized by the intensive use of non-invasive techniques. The project was conceived with a wide-ranging perspective for future development and with the aim of: acquiring the most extensive and detailed documentation on the monument; diagnosing the degradation of the materials and the stone in particular; selecting the most effective intervention technologies with regard to the real problems encountered; analyzing the impact of the environment on the monument.

EniTecnologie's scientific and technological expertise greatly benefitted the entire project, a situation which, due to its special planning and content, is not easily found in other cases of restoration work, even when the monuments are of great historical and artistic significance. Technical-scientific technologies and skills were optimally integrated with artistic and historical knowledge and the high-quality artisan tradition found in the '*Fabbrica*' (Fabric) of St. Peter's.

This synergic union undoubtedly constituted one of the keys to the success of the project, in addition to the many innovative aspects that emerged within it, inspired by the predisposition of the researchers for innovation. This is especially evident in those activities of a diagnostic nature, where spectroscopic techniques and microbiological investigations stand out. Rapid analytical procedures were developed, based on the use of X-ray diffraction, optical microscopy, electronic microscopy coupled with X-ray spectroscopy in energy dispersion and thermogravimetry. These analyses, conducted in part on resin-embedded fragments and partly on the powders mechanically removed from their surface, allowed a detailed description of the chemical composition, crystallographic structure and morphological structure of the most superficial layer of the

stone to be obtained. Microbiological investigations also enabled identification of the species of microorganisms that colonized the facade stone (fungal and algal species, typically present in soil). The collected data clearly showed that the most superficial part of the stone was made up of a layer of variable thickness, well distinguishable from the underlying travertine. This layer was composed of calcium salts, predominantly sulphate (plaster) and to a lesser extent oxalate and inorganic (typically soil dusts) and organic (produced by combustion processes) particulate matter, of atmospheric origin. In conclusion, activities carried out in the research for the restoration of St. Peter's façade were: the photogrammetric relief of the façade; the diagnosis on the state of preservation of the monument, geo-radar reliefs and technical reliefs; stone cleaning; biocide treatment and treatment of metal parts; environmental monitoring; the setting up a database.

## **B. SYREMONT S.P.A.**

Syremont s.p.a. was opened in 1987 by the Montedison Group and in a matter of years achieved a position of excellence in the field of conservation and enhancement of the historical-artistic and environmental heritage [8], focusing all the know-how acquired by the Group on studies and products for cultural heritage. The company specialized in a large range of services covering the entire cycle of heritage interventions: from microclimate determination to diagnostics on the state of conservation of materials, from the development of new restoration methods to treatments with preservative products.

Syremont was involved in the restoration of Masaccio and Masolino's frescoes in the Brancacci Chapel in Florence, and those of Giotto in the Scrovegni Chapel in Padua by formulating ion-exchange resins for desulfating and for removing mortar/plaster and limestone incrustations. The chapel underwent an excellent work of restoration that has removed the black soot layer of the candles and the protective 'eggshell' film used in the 18th century to revitalize the colors of the frescoes, which by that time, had darkened. The frescoes have an exceptional brilliance and vivacity that make it possible to clearly identify the differences between Masolino and Masaccio's work (compare Masolino's serenity and composure in *Adam's and Eve's Temptation* with the transfiguring agony in Masaccio's *Terrestrial Paradise*).

Syremont has also followed the restoration of archaeological sites and several monumental buildings using aggregates, binders and protective agents, generally based on fluorinated compounds. Finally, as regards the development of innovative conservation methodologies, it was Syremont that oversaw the project and realized the particularly sophisticated system of conservation and museum exhibition of the Similaun mummy (commonly called Ötzi), housed in the archaeological museum of Bolzano (South Tyrol, Italy).

In 2002, Thesauron s.p.a, which was already operating at a national level in the field of use and management of cultural and environmental assets, acquired a major share in Syremont [13]. Today, the activities of the two groups, involve scientific and technological research applied to systems and products for conservation and restoration processes; diagnostics and environmental monitoring; planning and execution of interventions of restoration and maintenance; design services relating to architecture and engineering, the design and construction of museum and exhibition installations, including the use of multimedia technologies.

### C. RHÔNE-POULENC

Rhône-Poulenc (now Rhodia for the chemical industry and Aventis for the pharmaceutical industry) has restored the façade of the Senate Palace in Rome and the Vittorio Emanuele gallery in Milan [14], using, inter alia, ethyl silicate for works of consolidation, biocides for cleaning operations and silicone-based resins for the final treatment of all surfaces. Rhone-Poulenc research has been applied in the restoration of several important art works in Italy since 1991. The products of the French group have been employed, for example, in Milan, in the restoration of the Roman Columns that stand in front of the Basilica of San Lorenzo, the Basilica of Santa Maria delle Grazie, Palazzo Belgioioso and Palazzo Marino. Rhone-Poulenc also intervened in the restoration of the Duomo in Como and the Colleoni Chapel in Bergamo.

### D. MAPEI

Mapei, founded in Milan in 1937 [15-18], is today the world's largest manufacturer of adhesives and complementary products for the installation of floor and wall coverings of all kinds. It is also specialized in related fields of chemical industry, such as waterproofing, mortars, concrete additives and other specialty products for the recovery of historic buildings.

By using the results of its research and employing its skills and technologies to improve interiors, such as inside a large museum or a medieval basilica, they are made safer and more secure. In fact, Mapei has contributed to making some of the most important art sites and cultural complexes viable and durable, both in Italy and in other countries. The renovation and restoration of the *Teatro alla Scala*, Milan's famous opera house, is the prestigious context in which Mapei's expertise, technology and research, combined with its great love for art, was taken advantage of to the fullest [19]. Mapei's contribution to the restoration of the Scala included: an analysis of the stratification of the flooring in the stage area, which allowed the correct materials and technologies to be defined for the recovery of the original tiled flooring, one of the last points that represent an example of the choices made by the Scala's architect, Giuseppe Piermarini; the cognitive investigation of the finishes and plaster of the walls of the foyers that have enabled the nature of the more recent coatings of low quality to be identified and so determine the most suitable removal techniques to bring to light the precious antique stuccoes in *marmorino*; the analysis of the existing gilding on the decorative elements of the boxes that allowed it to be dated and therefore, permitted the oldest gilding to be distinguished from the more recent. In this case too, it ensured that suitable conservation techniques were subsequently used.

Mapei has also contributed, with its technologies and products, to the restoration of Giorgio De Chirico's *Mysterious Baths* in Milan, an important and significant work of art in the Triennale Gardens. The *Mysterious Baths* are a sculptural polychrome complex made in 1973 by Giorgio De Chirico in Milan's Sempione Park.

Acrylic products were used to stand up to outdoor weathering, restoring all the sculptures in the fountain to their originally painted bright colors, according to the artist's project, which was mapped by Mapei's Color Laboratory using instrumental spectrophotometry. Michelangelo Buonarroti's last work, the Rondanini Pietà, found a new location in the Museum of Rondanini Pietà, set up in the Spanish Hospital of the Sforza Castle in Milan. The transfer, which was part of the large-scale restoration project of the Spanish

Hospital was designed by Michele De Lucchi. The final project comes from the profound reflections on the need to find a museum space that would enhance the evocative power of Michelangelo's sculpture, making it accessible to a wide audience. Placed in the center of the new exhibition hall, the Pieta rests on a cylindrical base which is built into a platform made of bevelled sessile oak, which has systems of anti-vibration (to protect the sculpture from any risk arising from the passing of underground trains) and seismic isolation. The project saw Mapei's participation, which involved providing flooring materials and technologies, starting from the regularization of the substrate with Ultraplan Maxi, a product used for its rapid setting self-leveling smoothness and low emission of volatile organic substances (Emicode EC1 R Plus). The parquet was later laid with the aid of Ultrabond ECO S968 1K, a single-component adhesive based on silylated polymers, completely solvent-free and without plasticizers, it has a very low emission of volatile organic substances.

In 2010, Mapei participated in the FAI project (Italian Environment Fund) for the restoration of the *Fontana delle 99 cannelle* (a historic fountain with 99 pipe-shaped spouts) an important symbol for the town of L'Aquila (Italy), damaged by the 2009 earthquake. It also provided technical consultancy and specific products for the consolidation and reinforcement of many buildings.

In addition to Mapei's restoration work, it carried out the waterproofing and protection of the building elements, the cortical consolidation of different types of mechanically weakened and flaking (porous stone, bricks, tuff stone, mortar beds, plasters, etc.), by means of impregnation; consolidation of masonry and plasters; dehumidification of walls using binders and mortars for plasters; protection and decoration of traditional plasters that have a lime-cement and /or concrete base; protection and decoration of breathable, dehumidifying and structural plasters.

## E. CIR

CIR (Chimica Italiana Restauri) [20] is today a well-established company renowned for the hi-tech content of its chemical formulations, specifically developed for use in the field of architectural and monumental heritage. It is highly appreciated by the bodies assigned to protecting and monitoring heritage structures and to the restoration and maintenance of historical and monumental cultural heritage.

CIR began its activity in the early eighties with the aim of offering the building industry flooring and facade treatments with improved performance that were able to guarantee better results, greater durability and interventions of excellent quality. CIR's products include detergents, consolidating and protective agents for stone and absorbent building materials; they also find application in the field of civil construction. CIR has proposed a full range of chemical formulations for the restoration of historical and monumental buildings, as well as for civil construction: the range includes permanent anti-scratch protection, antismog protection, ecological products and detergents for the removal of graffiti and graffiti persistent halos, ecological and super-fast gel paint strippers for removing mural paint, varnishes and enamels. CIR's products include: lithium silicate based consolidators in aqueous solution; high penetration acrylic insulators for non-cohesive mineral surfaces; water-repellent acrylic-siloxane protective consolidation; transpiring water-repellent protectors; protection against the growth and proliferation of biodeteriogenic microorganisms; leaners and detergents for artifacts, delicate stones, plaster and non-delicate limestones; sanitizing detergents

and anti-re-growth treatments; products for protection against molds, algae and musk, efflorescence and infiltration; anti-stain products for glass surfaces and color brighteners; polyurethane-based treatments for surface protection.

It may seem etymologically contradictory to associate art with work, but the ability to combine these apparently distant concepts of art and work is the mission that various Italian and foreign industries have always pursued and that have decreed their success throughout the world.

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### Biographical notes

**Prof. Ferruccio Trifirò** was born in Barce (Libya) on June 17, 1938. He graduated in Chemical Engineering at the Politecnico di Milano in 1963 under the guidance of Prof. Giulio Natta (Nobel Prize in Chemistry in 1963). In 1965 he worked at the Prague Academy of Physical Chemistry at the Academy of Sciences of Czechoslovakia. In 1968 he obtained a scholarship at the Department of Chemistry at the University of Reading (UK); in 1974 he won a scholarship (Alexander von Humboldt) at the Institute of Industrial Chemistry at the University of Erlangen (Germany) In November 1975 he was appointed professor of industrial chemistry at the Faculty of Engineering in Cosenza, Italy; in November 1976 he was called to Bologna University to work at the Faculty of Industrial Chemistry. His main research activity has been in the field of heterogeneous catalysis through oxidation and hydrogenation applied to the synthesis of the main intermediates and to a lesser extent in the field of homogenous catalysis, environmental catalysis and biomass transformation, through gasification chemistry, into raw materials. He is the author of 517 scientific publications, 24 patents, 5 books published abroad in English in the field of oxidation processes; editor of 8 books, 17 teaching reviews and has made 400 presentations in congresses. He is the author of 200 Italian articles in the field of chemistry.

He is a professor emeritus of the University of Bologna; director of the magazine, chemistry and industry since 1996; president of the Academy of Sciences of the Istituto di Bologna; scientific member of the OPCW (Organization for the Prohibition of Chemical Weapons) and Scientific Adviser for Innovative Technologies for Environmental Control and Sustainable Development (TICASS), a consortium in Liguria.

### Summary

This paper reports on several activities carried out in Italy in the restoration of cultural heritage by the following industries: Eni, Rhone Poulenc, Syremont, Mapei and CIR. Their activities, in this particular sector, involve the development of new chemical products for the restoration of architectural and monumental heritage, diagnostic analyses to characterize deterioration and the financing of conservation and restoration work.

### Riassunto

In questa nota state riportate alcune attività nel restauro di beni culturali realizzate in Italia da parte delle seguenti industrie: Eni, RhonePoulenc, Mapei Syremont e CIR. Le attività delle diverse aziende sono state: la messa a punto di nuovi prodotti chimici per le opere di restauro, analisi diagnostiche per caratterizzare il deterioramento ed intervenire anche con finanziamenti per le opere di restauro.