

During the past years an experiment in interdisciplinary research and technology transfer based on the participation of conservation institutions, restoration laboratories, research centres and private companies, has been consolidating in Tuscany. The aims of this network are to promote research, development and the dissemination of advanced technologies and new methodologies in conservation.

The core of the scientific background in this experiment lies in opto-electronic and information technologies, which in Tuscany have a high concentration of activities in public research institutions and in industrial initiatives. The sources of conservation expertise are located in prestigious centres of Tuscany, such as the *Opificio delle Pietre Dure*, the *Centro di Restauro della Soprintendenza archeologica della Toscana*, the *Soprintendenze*, government organizations devoted to the preservation of the artistic, architectural and archaeological heritage, and in organizations linked to the patrimony of cities of art as Florence, Pisa and Siena among many other important historical centres.

The technological innovation policies of the Tuscany Region were put in practice in 2000-2001 with the RIS+ Tuscany pilot project Technologies for cultural heritage. The positive evaluation of the achievements of this pilot experience laid the foundation for organizing these competencies within an association called OPTOCANTIERI, in order to propose advanced technologies to the end-users in this field, at national and international levels.

Proposed technologies are: laser applications for the restoration of stone and metals, reflectographic investigations of paintings, 3D digital documentation using optical and laser scanning, environmental monitoring in museums, investigation of archaeological sites using radar techniques, diagnostics of masonry and wood structures.

In 2002-2003 OPTOCANTIERI will carry out demonstrative and dissemination actions, contribute to projects of advanced research, propose, through associated companies, services for the restoration and conservation of artworks, monuments and historical buildings, organize courses with a high professional profile.

Demonstration yards will be opened in Florence at the Cathedral of Santa Maria del Fiore, in Palazzo Vecchio, and at the *Soprintendenza Archeologica*; in Pisa, in Piazza dei Miracoli and at the Church of San Pietro in Vincolis; in Siena, at the Fonte Gaia site.

At European level the Tuscany network contributes to constitute a cluster of initiatives participating to the Cultural Heritage Special project of CNR, to European Community COST Actions G7 and G8, to the projects of the Fifth Framework Programme (ONSITEFORMASONRY and Light Dosimetry), Information Society Technology and other European schemes for R&D, innovation and technology transfer.

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Cover:

Peter Paul Rubens, *The Battle of Anghiari*, Paris, Louvre

Aristotle da Sangallo (?), copy after *The Battle of Cascina*, Holkam Hall, Lord Leicester collection



ADVANCED TECHNOLOGIES FOR CULTURAL HERITAGE

diagnostics, restoration,
documentation and training



Regione Toscana - Department of Economic Development
Commission of the European Community - General Directorate Regional Policies
Technological Innovation in Tuscany - OPTOCANTIERI Project



1. Lorenzo Ghiberti, *Gate of Paradise*
Florence, Museo dell'Opera del Duomo
2. Donatello, *Prophet Habacuc*
Florence, Museo dell'Opera del Duomo
3. Church of San Frediano, Pisa

4. Jacopo della Quercia, marble head
from Fonte Gaia, Siena
5. Giambologna, *The rape of the Sabine women*
Florence, Loggia dei Lanzi
6. Nanni di Banco, *Porta della Mandorla*
Florence, Cathedral



LASER CLEANING TECHNIQUES FOR RESTORATION



1

Laser cleaning techniques are ideal solutions for several restoration problems in stone and metals, which are encountered during the cleaning phase. Within the framework of the Tuscany network, this technique has been developed by IFAC-CNR in close co-operation with the *Opificio delle Pietre Dure*. A set of laser instruments especially suitable for cleaning the deposited encrustation on stone (sandstone, marble, calcareous stone, red limestone) and metals has been produced.

The ability of the laser cleaning technique to control with great precision the removal of the degraded material, makes it possible to preserve the original patinas or to lighten them and to remove material from the inside of microcavities (pitting).

With the contribution of EL.EN. SpA, these laser instruments have now become products. They have been utilized in the restoration yard of the church of San Frediano in Pisa, to evaluate the feasibility and costs of the technique, and involved the *Soprintendenza di Pisa* and *Restauro Italia Srl*. Important applications of the technique have been carried out on statues by Donatello (the *Prophet Habacuc*, the Pulpit in the Prato Cathedral) and Nanni di Banco's *I Santi Quattro Coronati*, by *Opificio delle Pietre Dure* with *Meridiana Restauri Srl*.

OTOCANTIERI contributes to the activities of the Action G7 of the European Community, which is devoted to laser applications in art conservation.



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courtesy of Soprintendenza Speciale per il Polo Museale Fiorentino



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7. Bronzino, *Saint John*
Rome, Galleria Borghese

8. Matteo di Giovanni, head from *Madonna and Child with four Saints*, Pienza, Cathedral

9. Filippino Lippi and Perugino, *Deposition*
Florence, Galleria dell'Accademia

10. Florence, Galleria degli Uffizi

REFLECTOGRAPHIC INVESTIGATION OF PAINTINGS



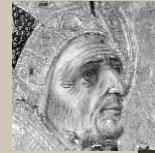
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Infrared and visible reflectography is a technique that is widely employed by restorers and art historians for diagnostics of paintings. In fact it makes it possible to see hidden details behind the pictorial layers, due to the partial transparency of the components to IR radiation.

Since 1990 INOA has been studying high resolution reflectography, by means of a scanning device, capable of acquiring perfectly superimposed infrared and visible images of about 1 m², with 4.4 points/mm². Shifting the scanning area makes possible an integration of the images acquired in large paintings. In the RIS+ Tuscany pilot project, this apparatus was tested at the *Opificio delle Pietre Dure*, in cooperation with Falcon Instruments Srl an enterprise skilled in artificial vision, that then produced this device.

Masterpieces such as *Madonna del Cardellino* and *San Giovanni Battista* by Bronzino, among many others, were investigated using this diagnostic method. On the occasion of Masaccio's birth centenary, thanks to the systematic campaign carried out in European and American museums, the reflectograms of the complete works of Masaccio and Masolino are now available. The comparison between the infrared and visible images made evident the different moments in the painting realization, the author possible second thoughts, and corrections between the preliminary drawing and the resulting painting.

Moreover, the set of digital images represents a high-quality historical memory of the artwork.



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ENVIRONMENTAL MONITORING IN MUSEUMS AND GALLERIES

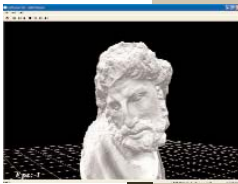
Light, polluting gases, sudden changes in temperature and humidity due to an excessive and uncontrolled number of visitors: this is the dangerous cocktail that could put the conservation status of the pictorial patrimony housed in museums and galleries at risk. Hence to prevent such a situation (generally with reference to the exceeding of a recommended level of illumination, set at 600 klux·hour/year) it is essential to control the colour variation induced in pigments by the overall effect of environmental conditions. Using this approach in the RIS+Tuscany project IFAC-CNR has developed an automatic device capable of recording the colour variation induced on pigments samples with great precision. This apparatus has been tested in the geographic maps room at the *Galleria degli Uffizi* by recording the colour parameters in different positions with respect to the vicinity of windows, seasonal changes in ambient lighting etc.). At present the above instrumentation has been modified and improved so as to comply with the requirements of LiDo (Light Dosimeter) a EC project for short and medium term measurements in museums and galleries.

11. Nicola e Giovanni Pisano, *Saint John*
3D image in virtual reality

13. *Salone dei Cinquecento*, Palazzo Vecchio, Florence

12. Ellenistic art, *Minerva of Arezzo*, Florence
Soprintendenza Archeologica della Toscana

3D SCANNING AND VIRTUAL REALITY



11

Technologies devoted to the high precision 3D digital reconstruction of volumetric objects (statues, ceramics, art objects) are assuming rising importance and diffusion for restoration and conservation procedures. The Visual Computing Group at ISTI-CNR in Pisa and INOA in Florence have designed and built 3D scanning systems characterized by low cost and easy handling and use. The working principle is based on the measurement of the distortions experienced by the light line generated on the object by a scanning beam from a laser or a lamp, at the intersection zone. A full set of software programs has been developed, to manage all the elaboration and rendering phases, in order to permit interactivity and easy use. The main experimentation took place at the *Centro di Restauro della Soprintendenza Archeologica della Toscana*, within the framework of the restoration of the *Minerva di Arezzo*, one of the classical style large bronzes in the Medici collection. The 3D model achieved as a final result documents the level of accuracy achieved by the system by means of 26 million triangular facets. Current activities are involving the collection of the medieval masterpieces of the Pisano's sculptures of the Piazza dei Miracoli monuments in Pisa, as well as the Danti's *Globe* in Palazzo Vecchio in Florence. The laboratory PERCRO of the Scuola Superiore Sant'Anna in Pisa is developing the *Museo delle Pure Forme*, an immersive system of Virtual Reality, where the user may "touch" 3D digital models of artworks.



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THE PILOT YARD IN PALAZZO VECCHIO



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Within the framework of a vast program of museum-related reorganization in Palazzo Vecchio in Florence, a project of diagnostic and historic-artistic investigation is under way in the *Salone dei Cinquecento*. The project is being carried out thanks to an agreement between the Comune di Firenze and Editech Srl, for a study focused on the period (1540-1574) when the old Palazzo dei Priori was substantially modified by Vasari starting with the *Salone dei Cinquecento*. Together with the diagnostic investigation historical research will try to identify the original nucleus of the Great Hall and the surfaces that were covered by the Vasari's frescos where Leonardo da Vinci and Michelangelo painted the *Battle of Anghiari* and the *Battle of Cascina*. The main objective of this program is the digital reconstruction of the body of the building, with the complex of internal spaces, the texture of the masonry, the detection of fillings, the presence of columns or voids. Many different technologies are being used, such as thermographic, radar, ecographic and endoscopic investigations, tridimensional computer modelling, as well as historical and documentary research.

14. *Salone dei Cinquecento*, roof trusses
Florence, Palazzo Vecchio

15. *Hermes Trismegistus*, marble tile of the floor
Siena, Cathedral

Mapping of the deterioration and of the intervention

16. Tests on wooden structures

17. *San Blas Chapel*, Toledo, Cathedral

18. Assisi, ceiling of Basilica Superiore

19. Pisa, Camposanto Monumentale

DIAGNOSTICS FOR MASONRY AND WOOD STRUCTURES



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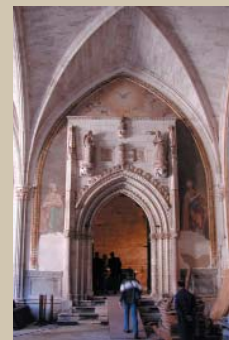


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A set of technologies is currently used for conducting preliminary investigations prior to restoration interventions in architecture, thus providing a reliable intervention strategy. Within the Tuscany network, several professional companies offer specialized answers to a wide range of technology-related questions. Within the OPTOCANTIERI project are involved professional expertises in radar investigation of masonry structures (Irma Diagnosis Srl), architectural photogrammetric documentation, underground detection, digital reconstruction (General Engineering Srl), evaluation of the conservation status of wood structures (LegnoDOC Srl). Some of the most recent interventions have involved a diagnostic campaign at Vilhena Palace in M'dina (Malta); a safeguard project for the Historical Centre of Mostar for UNESCO and a contribution to the reconstruction project of the Old Bridge of Mostar in Bosnia Herzegovina; the tridimensional photogrammetric restitution of monuments (the Colosseum), historical buildings (the Sarajevo Library), churches (Santa Maria Novella in Florence); investigations regarding the roof trusses of the Cesena Cathedral and of the wood structures of the Guariniane Towers of the Castle of Racconigi (Cuneo).



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RADAR TECHNOLOGY FOR NON-INVASIVE INVESTIGATION

Radar technologies are a source of increasing interest as a non-invasive investigative instrument for wall structures or underground structures in archaeological sites.

New radar systems, called RIS-2K, enriched by effective technical solutions for such uses, have been developed by IDS Spa, Pisa. High modularity, reduced weight and power consumption, a set of multi-frequency antennas, and a well developed software are their characteristics. These make it possible to employ the systems on the field in every phase of an investigation, from the acquisition of radar maps, to their direct reading by means of specialized algorithms depending on the aim of the research. The versatility of the instrument makes it useful in various contexts. Recent experiments include an investigation carried out with Irma Diagnosis Srl in the Toledo Cathedral (on the paving to verify unknown burials); in the *San Blas Chapel*, to map humidity extension; on the outside wall of the *Mazarabe Chapel*, to identify the masonry texture); in investigation campaign in the yard of the Camposanto Monumentale in Piazza dei Miracoli in Pisa (to detect archaeological remains of the ancient baptistery).

Within the sphere of OPTOCANTIERI demonstrative investigations are scheduled in Santa Maria del Fiore in Florence.



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