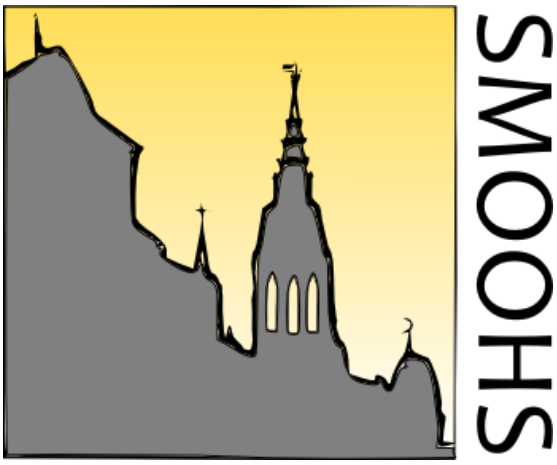

SMooHS

THE CHALLENGE

HISTORIC STRUCTURES CONSTITUTE AN IMPORTANT PART OF OUR CULTURAL HERITAGE WHICH WE IN TURN HAVE A DUTY TO PASS TO FUTURE GENERATIONS IN THE FULL RICHNESS OF THEIR AUTHENTIC ARCHITECTURE AND MATERIALS. THE CONSERVATION OF THESE STRUCTURES PRESENTS A FASCINATING AND DIVERSE RANGE OF SCIENTIFIC CHALLENGES; IN PARTICULAR THE NEED TO PROTECT THEM EFFECTIVELY FROM ENVIRONMENTAL DEGRADATION IS WIDELY RECOGNISED. DIAGNOSTIC MONITORING THUS FAR HAS BEEN LARGELY LIMITED TO ACQUISITION OF CLIMATE PARAMETERS AND AIR POLLUTION LEVELS USED AS INPUT INTO FUNCTIONS OR MODELS PREDICTING DAMAGE. THE LIMITATIONS OF THE APPROACH IN ASSESSING PRECISELY THE RISK OF DAMAGE TO A CONCRETE HISTORIC STRUCTURE IN ITS SPECIFIC ENVIRONMENT LEAD INEVITABLY TO A SEARCH FOR SCIENTIFIC METHODS OF DIRECT TRACING DAMAGE: NON-INVASIVE, CONTINUOUS, SIMPLE, ECONOMIC AND CAPABLE OF OPERATING IN REAL-WORLD CONDITIONS.

PROJECT OBJECTIVES

THE MAIN OBJECTIVES OF SMOOHS ARE:

- DEVELOPMENT OF SMART MONITORING SYSTEMS USING WIRELESS NETWORKS OF MINIATURE, ROBUST SENSORS FOR MINIMALLY INVASIVE INSTALLATION AT HISTORIC STRUCTURES TO MONITOR THE MOST SIGNIFICANT VALUES THAT ARE NEEDED TO BETTER UNDERSTAND

AT A GLANCE

Title: Smart Monitoring of Historic Structures

Instrument: FP7, Collaborative Project

Total Cost: 1,839,951 Euro

EC Contribution: 1,404,993 Euro

Duration: 3 years

Start Date: 1.12.2008

Consortium: 14 partners from 6 countries

Project Coordinator: MPA Universität Stuttgart
Dr. Markus Krüger

Project Web Site: www.smoohs.eu

Key Words: Wireless Monitoring, sensor technologies, smart data processing and analysis, FE modelling, lifetime prognosis, damage assessment

deterioration processes and to help optimize the preservation of cultural heritage.

- Provision of smart data processing based on the built-in material deterioration models which would warn owners and conservation professionals about threats, and the production of recommendations for action.
- Development of user-friendly, modular and open source software which can be continuously updated and broadened to handle specific questions arising at objects, steer various combinations of sensors and be open for extensions in the future.

Methodology

Developments in the proposed project are designed as smart monitoring techniques that employ permanently installed technologies addressing mainly competitiveness, simple application and stable long term behaviour with respect to reliability. For that purpose competitive sensors and sensor technologies (e.g. MEMS – Micro Electro Mechanical Systems) are developed or used, if they are already available on the market.

Up to now there is a lack of sufficient models for material and structural deterioration that take into account the data from continuous monitoring. In order to provide the practitioner in the field of cultural heritage with a tool which goes beyond the mere accumulation of data, but instead provides help in the sense of warnings (e.g. if damaging factor values increase) and recommendations for action (e.g. window opening/closing, ventilation on/off, heating on/off, etc.) data fusion and interpretation is implemented within the monitoring system.

A number of building materials (wood, brick and stone masonry, mortars, plasters, terracotta, pigment layers, etc.) and material assemblies typical for historic structures will be monitored for better investigation of structural damage and environmental pollution effects. With respect to the aspects of smart monitoring techniques defined above, for some applications there are presently no sufficient sensor technologies available. This is especially true for chemical attack due to gases or salts, for the measurement of moisture content inside a material and for the measurement of air flow at low speed inside buildings. For this reason new sensor technologies are investigated and tested with these purposes.

There are three climatic zones (Central European, Northern and Southern Mediterranean) represented in three main and three additional case studies during the project. Those sites offer the possibility of indoor and outdoor testing.

Measures of physical, chemical and mechanical material and environmental parameters during repeated monitoring on samples and specimens in varying but well defined environmental conditions in laboratory are intended to simulate and better understand structural and material deterioration processes due to the environment.

Based on previous experiences of the partners, physical models built in the lab will simulate the form of structural elements made of brick and stone masonry, with the addition of plaster layers; component materials and

masonry layout will be chosen in view to reproduce complex elements typical for historical structures. The laboratory testing conducted is also used to evaluate the capacity of the NDT methods and the developed monitoring systems to detect the beginning of material and structural damage and its evolution over longer periods, by measuring mechanical and physical properties. Based on the testing results it is necessary to determine materials and deterioration models, considering the most important influences of the environment, that could be monitored by sufficient technologies.

Expected Results

At the end of the project small modular wireless sensor networks and autonomous wireless sensors will be available that (i) could be used in combination with any kind of low power sensors, (ii) provide self organizing and reorganizing network functionality, (iii) have very low power consumption with optimized soft- and hardware functionality and (iv) achieve sufficient methodologies for data analysis, data fusion and data reduction.

Additional software will be available which is:

- user friendly, to be used by practitioners in the field,
- modular (modules for specific questions arising at the object to be monitored and sensor combinations),
- open source, for maximum transparency,
- open for extensions and new modules, also from other research groups.

The modularity and open source concepts are most important for providing a dynamic tool, which can and will be updated and broadened continuously with new research results, both from partners within this project team and from other research groups with their special expertise.

Project Partners	
MPA Universität Stuttgart	Germany
AuRA Bärbel Dieruff Karl Fiedler GbR Restorers	Germany
IWB Universität Stuttgart	Germany
Accademia Europea Bolzano	Italy
Alma Mater Studiorum – Universitá di Bologna	Italy
Rathgen Research Laboratory - National Museums Berlin	Germany
Polish Academy of Sciences	Poland
Technisches Büro Käferhaus	Austria
TTI GmbH – TGU Smartmote	Germany
Metalmobile S.R.L.	Italy
Artemis srl	Italy
Consorzio Cetma	Italy
Riwaq - Centre for Architectural Conservation	Palestinian-administered areas
Faculty of Civil Engineering – University of Zagreb	Croatia