CULTURAL HERITAGE

Vision 2030 & Strategic Research Agenda
Focus Area Cultural Heritage
Public Version #4
February 2009

European Construction Technology Platform (ECTP)

www.ectp.org
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0. Preamble

This single document is the third public version of the Vision 2030 and Strategic Research Area of the Focus Area Cultural Heritage (FACH), which is expected to be integrated in further documents of both the overall 2030 Vision and the Strategic Research Agenda documents of the European Construction Technology Platform (ECTP).

The ECTP initiated in 2004 reflects the response of the Construction Sector to the demands of European society, acting as an umbrella for research initiatives in Europe, and creating a better synergy between European and national industries, between the public and the private efforts involving all relevant stakeholders (industry, SMEs, practitioners and architects, producers and suppliers, scientists, public authorities etc.).

The Focus Area Cultural Heritage (FACH)\(^1\) was initially established in agreement between the Commission Services and the Support Group of the ECTP and has been endorsed by the ECTP High Level Group.

The FACH document, which is presented here, is therefore a third public version based on preparatory elements provided by its Working Groups and Horizontal Issues established in 2005 in the following areas:

- Assessment, Monitoring and Diagnosis
- Materials
- Intervention Techniques
- Environment and Energy
- Management, Exploitation and Maintenance
- City and Territorial Aspects

These Workings Groups are horizontally linked with the following Horizontal Issues:

- Knowledge supporting Education, training and Communication;
- Technical Standards and Specifications;
- Preservation of Art Works;
- Socio-Economic Aspects;
- Disaster Prevention and Risk Management;

This document calls for a periodic consultation and updated versions (every 6 months) including all interested parties but it already shows how it will make a significant contribution to the whole ECTP while also “cross-cutting” some of the tasks implemented by other Focus Areas of this Technology Platform for Cultural Heritage Protection and Adaptive Re-Use of the built environment. Besides, the possible links with the JTI E2B are also considered. E2B JTI will speed up research on key technologies and develop a competitive industry in the fields of energy efficiency and is interested towards Cultural Heritage sector. For both (FACH and JTI E2B) this could be a great opportunity to develop this crucial sector together.

\(^1\) A specific area of the ECTP website [www.ectp.org](http://www.ectp.org) is allocated to the Focus Area on “Cultural Heritage”
1. Executive Summary

A LIVING CULTURAL HERITAGE IN AN ATTRACTIVE EUROPE

A living cultural heritage makes Europe attractive for its inhabitants and visitors, and stimulates economic competitiveness and a better quality of life.

European cultural heritage is the testimony of our shared past and the root of our identity. It enriches the collective memory, which will make the future of Europe more humane and civil for its population, so it needs to be conserved with great care.

The importance of this cultural wealth can be measured in economic and social terms, such as growth in employment, job creation and unified communities, and it has a considerable impact in many areas such as the environment, construction, tourism and regional development to enhance European competitiveness and skills through technical innovation and traditional skills.

The European construction industry will achieve greater competitiveness and the ability to satisfy societal needs through research, development and innovations oriented towards protecting and enhancing cultural heritage, and adaptive re-use of existing buildings. Today, about 40 % of construction activities are devoted to adaptive re-use, repair and maintenance. Beyond that, Cultural Heritage is the key issue to enhance the sustainability of the Construction Sector, ensuring that Cultural Heritage is added to the three basic pillars of sustainability: Environment, Society and Economy.

We are now building for the cultural heritage of future European generations: a strong knowledge-based approach must be used to protect and promote our cultural heritage to keep it alive in an attractive Europe.

The global objective of the FACH is to promote new sustainable and preventive strategies, concepts, methodologies and techniques for conservation and restoration of cultural heritage in order to improve the quality of life of citizens and the attractiveness of Europe, particularly its cities, buildings, monuments and landscapes.

The interventions of the European Construction Sector in cultural heritage must take a knowledge-based and interdisciplinary approach for the sustainable protection of cultural heritage underpinned by the principles of safety, authenticity and compatibility to ensure minimal intervention to avoid damage to cultural heritage and to enable it to be protected from environmental and human causes of destruction. This includes in particular the implementation of ambitious programmes of adaptive re-use and energy-efficient and sustainable retrofits of existing buildings. These imply appropriate use of knowledge-based advanced technologies and the active participation of all stakeholders, practitioners, industry and SMEs.

The challenge of the application of special techniques, materials and processes to maintain Europe's rich cultural heritage is of great importance for all players involved in these vital activities for the maintenance and preservation of European cultural identity in today's globalised processes. In addition, new strategies for management are needed to reinforce and recognise the added value Cultural Heritage gives to cities and landscapes.
There are six main topics of interest for the Focus Area Cultural Heritage, selected to address the challenges facing the preservation and sustainability of Cultural Heritage: Assessment, Monitoring & Diagnosis, Materials, Intervention Techniques, Environment & Energy, Management, Exploitation & Maintenance and City & Territorial Aspects. They are horizontally linked by the permanent need for development of knowledge and its transfer through education and training to all educational levels; constant attention to socio-economic strategies for interaction with interventions for cultural heritage; promoting the development of relevant European directives, codes and standards; response preparedness against natural hazards such as earthquakes, strong winds, fire and floods and the use of ICT for communication and dissemination. Furthermore moveable works of art are an integral part of the immovable heritage and as such must be preserved as a valuable part of cultural heritage. Finally, strong dissemination and communication methodologies, activities and tools are needed to transmit information on the activities being carried out within the FACH group and ECTP and beyond to ensure their adequate implementation within Construction Sector.

The Vision 2030 of Focus Area Cultural Heritage may be summarized as:

*Holistic protection of living Cultural Heritage and its territorial setting by appropriate understanding; planning and management; monitoring, conservation and restoration, maintenance; encouragement of its sustainability and added value for Society and the Construction Sector; recognition of integration and diversity of cultural assets in relation to all citizens.*

If the input of cultural heritage activities is significant and brings more social and cultural acceptance for the whole ECTP, it can also be expected that the initiatives taken by the ECTP and the other Focus Areas will take into account cultural heritage when implementing various initiatives and projects resulting from the ECTP Strategic Research Agenda.

However, the specificity of the Cultural Heritage Sector and therefore of this Focus Area must also be recognized, as it is quite different from the other Focus Areas. In particular it must be emphasized that some standards, codes and principles used in construction may not apply directly to cultural heritage (otherwise, for example, demolition might become a serious consideration for whole or parts of ancient buildings; or generic building systems appropriate to domestic, commercial and industrial buildings might risk being applied to Cultural Heritage).

Therefore, there is a need for this sector to coordinate its activities with and by these to contribute to the ongoing development of standards for conservation of cultural property, CEN/TC 346, which takes place within the framework of the European Committee for Standardization. In addition, to benefit from and contribute to the already established expertise and knowledge, education and training courses should be developed in collaboration with the European university level conservation-restoration courses.

Moreover, conservation principles, whether of Cultural Heritage, the Environment or Energy can differ in their application. However, more focused management can create synergies that can achieve all three: saving energy, improving the environment and indoor air quality, and safeguarding human health and Cultural Heritage. This Sector needs to develop appropriate guidelines that consider other aspects such as security.

In addition, even if public funding progressively decreases in the tangible cultural heritage research field in many European countries, it still depends largely on the public sector as the private sector in this field is still characterized by a large number of small companies.
2. Introduction

2.1 – The importance of Cultural Heritage

Societal impact

"Each community, by means of its collective memory and consciousness of its past, is responsible for the identification as well as the management of its heritage. Individual elements of this heritage are bearers of many values, which may change in time. The various specific values in the elements characterize the specificity of each heritage. From this process of change, each community develops an awareness and consciousness of a need to look after their own common heritage values."

The Conservation of the existing Cultural Heritage is a strong societal need, as we have to maintain the Architectural Heritage, as well as the Mobile Heritage and Intangible Heritage, for future generations. Besides, Tourism, closely related to Cultural Heritage, is, nowadays, the main industry in the world, with an increasing ratio of 12% of the P.I.B. This sector employs 8 million people in Europe and account for nearly 5.5% of European GDP.

The diversity of Cultural Heritage in Europe is one of the most valuable assets. It forms a major part of the continent’s identity. As yet, however, the full potential of this asset remains under exploited, as do opportunities for further innovation. Culture is one sector of future employment.

The growing importance of culture is closely linked to recent economic development trends. Firstly, the expansion of culture is related to the evolution of societies away from traditional industries towards the service sector. Secondly, changes in lifestyle and growing leisure time create more demand for leisure activities, including culture. Both trends tend to encourage economically viable aspects of culture.

The cultural sector is characterized by growing close and varied interrelations between cultural life and the cultural economy. In this context, culture can contribute significantly to employment. Cultural products and industries offer opportunities for job creation, adding significantly top the effects of more “classical” measures such as the preservation or development of cultural heritage. Culture is not merely a public occupation creating extra costs but also an increasingly important part of the private economy with considerable growth potential, fostering creative, innovative and productive effects for regional economies.

As reflected in the texts of Council of Europe, high social dimension of Cultural Heritage is clear, and, for this reason, EU Policies consider Culture as a key factor of EU development. This is due mainly to its potential impact in economy and employment; quality of life; reinforcement of European identity and contribution to tolerance.

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Impact for the Construction sector

XXIst century, European Society is facing an overwhelming number of challenges: demography changes, climate change, globalisation, and the gloomy perspectives of declining natural resources. And yet, European Society is still relying on the Construction Sector to obtain better living and working conditions from its built environment. For the Construction Sector, this represents a dramatic upturn: to convert a technology-push industry into a demand-driving sector. The new key for development is sustainability, and Cultural Heritage is now an essential topic to reach a new dimension (Culture), added the three basic pillars of sustainability: Environmental, Societal and Economic aspects.

The city and village sprawl is probably one of the most important working places for the Construction Industry and an addressable market. Their urgent need for restructuring and re-qualification has already been observed everywhere in Europe. Knowing that these "territories" contain significant remaining parts of past structures (natural (relief, green and water structures), and human (communication networks, past activity remains and housing kernels)) it could be useful to reuse them systematically as a basic support for restructuring the place.

As above-mentioned, conservation of our Cultural Heritage is a major aim that should be afforded by the Construction sector, as, if no action is taken, a further 10% of our tangible cultural heritage may have been lost by 2030. Therefore, Construction sector through the conservation of Cultural heritage, could strongly contribute to improve the societal needs of European citizens. Project results will contribute to a more sustainable cultural heritage, through better and more effective interventions and maintenance. European building (building materials) industry will benefit from the results, because product development will be stimulated.

The necessary saving of natural resources lead to a better reuse of existing infrastructures and buildings, as approximately 80% of the buildings and structures of the future city are already constructed. As a consequence of that, it is expected an increase of the activities of refurbishment and rehabilitation, representing, nowadays, about 40% of construction activities, thus being a promising area of activity for the Construction sector. Besides, the historic buildings are very energy effective, especially in cities, and, therefore, it could be considered as an example to be recovered for the design of new cities and buildings.

The active engagement of European construction industry in cultural heritage safeguarding gives the unique opportunity for its transformation into R&D intensive industry. Construction activities and heritage preservation needs will however be in conflict if they are not considered together at the initial planning stage of any development. For this reason, the active engagement of the European construction industry working together in interdisciplinary teams with institutes, universities, stakeholders and restoration professionals, in the preservation of cultural heritage is crucially important for future generations and offers very significant RTD challenges. Knowledge deriving from the fundamental research should be made available to end-users (like industry, heritage authorities and restoration architects) in a direct way.

Change and continuity will be the ‘leitmotiv’ in building and conservation activities related to cultural heritage. Maintenance, re-design, re-use and adaptation of function of historic buildings will be the focus points for architects, authorities and building industry. Ambition for 2030 is to be able to deal in a sound way with the balance between new requirements on one hand and authenticity / compatibility of conservation assets on the other.

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2.2 - The European policies

Main European policies concerning Cultural heritage preservation and enhancement of its added value for European Society are:

- **Cultural heritage policies**\(^7\) \(^8\) \(^9\): Cultural heritage is a precious asset in terms of economy and as a vehicle of cultural identity. For both reasons, preserving and enhancing Europe’s cultural heritage is one of the objectives of the European Union. Although cultural aspects were taken into account in previous EU actions, there was no specific cultural policy until the entry into force of Maastricht Treaty, in 1993. Article 151 of this Treaty stipulates the preservation and enhancement of cultural heritage of European significance. The underlying idea of investment in research to safeguard Cultural Heritage is considered in Article 17 of “The Convention for the protection of Architectural Heritage of Europe”.

- **Tourism**\(^10\): Tourism is an activity that affects our society in many different ways. For this reason, Article 3(1)u of the Treaty of Maastricht includes “measures in the sphere of tourism” in the list of Community activities foreseen in the support of overall EC objectives. Cultural tourism makes the optimum contribution to fundamental EC goals as a major opportunity for job creation, improvement of the quality of life of EU citizens and as a tool to enhance the less developed and peripheral regions. Culture can contribute to alternative, more disperse and out seasonal peaks of tourism with a positive influence in employment.

- **Sustainable development and urban environment**\(^11\) \(^12\): Since the Treaty of Amsterdam (1997) until the Brussels European Council (2003), the sustainable development, considered as “the development that meets the needs of the present without compromising the ability of future generations to meet their own needs”, has been adopted as one of the European Union’s priorities. In this context, the urban environment, where some 80 % of European live, is a matter of concern with implications at the local, European and global levels, as cities are centres of economic growth, but also face concentrations of social, environmental and economic problems. The implementation of good practices to promote sustainable and homogeneous conservation of cities is considered within this global framework.

- **Regional Policies**\(^13\): Culture and heritage play an important role in support of regional policies, as is a key element of the identity of European regions and a source of economic activity and new jobs. It also helps reduce the isolation of certain areas and promote their development. Cultural provision is one of the factors in the choice of locations for investment projects, because it contributes to the image and attractiveness of a region, regenerating declining urban and depopulated rural areas. Lately, culture and cultural heritage makes a positive contribution towards social stimulation and integration, and helps to achieve social cohesion between the Union.

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\(^12\) SCADPlus: Integrating the environmental dimension into the urban environment. [http://europa.eu.int/scadplus/leg/en/lvb/128106.htm](http://europa.eu.int/scadplus/leg/en/lvb/128106.htm)

Employment\textsuperscript{14}: The Commission’s White Paper on “Growth, Competitiveness and Employment” identifies Culture as one sector for future employment. The expansion of culture leads to the evolution of societies away from traditional industries towards the service sector. Besides, changes in lifestyle create more demand for leisure activities, including culture. Culture products offer opportunities for new jobs and long-term employment, especially through SME’s.

A summary of these policies and legal references is following in the next table.

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<td>Article 151 – EC Treaty (Maastricht (1993))</td>
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<td>Investment in Research in Cultural Heritage</td>
<td>Article 17 of The Convention for Protection of Cultural Heritage in Europe</td>
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<td>An initiative to protect and safeguard European Cultural heritage through scientific and technological research</td>
<td>London Declaration for Improving CH Research (2004)</td>
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<td>Technological requirements for solutions in the conservation and protection of historical monuments and archaeological remains</td>
<td>Working Paper – STOA Unit (2001)</td>
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<td>The horizontal aspects of culture</td>
<td>Council Resolution, OJ C 136, 2003, 26/05/2003</td>
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</table>

| TOURISM |
| Measures in the sphere of tourism | Article 3(1)u of the Treaty of Maastricht |

| SUSTAINABILITY AND ENVIRONMENTAL POLICIES |
| Assessment of the environmental effects of those public and private projects which are likely to have significant effects on the environment | EIA Directive (97/11/EC) amending (85/337/EEC) |
| The effects of air pollution on cultural heritage. Protect and improve the built environment and cultural heritage, and promote biodiversity and green space within urban areas. | EC CAFE initiative (Clean Air for Europe) - Thematic Strategy on air pollution (COM(2005) 446 final, Brussels, 21.9.2005) |
| Sustainable development, considered as “the development that meets the needs of the present without compromising the ability of future generations to meet their own needs” | Treaty of Amsterdam (1997) |
| Brussels European Council (2003) |

| REGIONAL POLICIES |
| Cultural heritage as a key element of the identity of European regions and a source of economic activity and new jobs | Regional Policy Inforegio |

| EMPLOYMENT AND COMPETITIVENESS |
| The Union must become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion | Lisbon goals, European Council, Lisbon (March 2000) |
| Culture as one sector for future employment | Commission’s White Paper on “Growth, Competitiveness and Employment” |

\textsuperscript{14} Cohesion policy and culture: A contribution to employment. Commission of the European Communities. (1996), Brussels
2.3 - The needs and goals

At present, the protection of cultural heritage has taken on substantial importance. Cultural heritage is no longer about the preservation of symbolic heritage or the importance of a single profession; it is an essential part of the living environment and the fulfillment of societal needs. Considering cultural heritage as an essential part of life, new approaches and definitions are needed: definition of cultural heritage in contemporary global environment with special attention to space planning, re-evaluation of current values of cultural heritage, implementation of heritage understanding into practice and holistic approach to heritage protection that takes into account the interaction of immovable and movable heritage with the intangible heritage. This new understanding of cultural heritage has to be incorporated into the political, public and professional milieu. Besides, it is necessary to develop appropriate strategies to create a Cultural Heritage that is accessible physically, and in order to protect and conserve the material Cultural Heritage, develops also intellectual and remote sensory access. This has both societal and environmental benefits by contributing to a knowledge-based economy and the environmental protection from a reduction in pollution, CO2 production and increased energy saving. These benefits will also reverberate in an economy saving, paving the way also towards economic sustainability.

Conservation of Cultural heritage is necessary in order to avoid its irreversible lost, as, unfortunately, many cultural assets have been seriously damaged or destroyed, due to the use of inappropriate and irreversible materials, inappropriate intervention techniques and poor management of the environment. There is a need to create a system that will integrate learning about harmful impacts on heritage, the development of methods for its preservation and the establishment of long term monitoring to understand the nature of interventions and the role of management in heritage. Construction activities, including the design of active building services and building management systems, and heritage preservation requirements should be harmonized from the very start of interventions by recognizing and then validating design solutions that are applied in domestic, commercial and industrial buildings and those that are appropriate for heritage buildings. The challenge of application of special techniques, materials and processes in order to maintain the rich cultural heritage of the European Union is of the first importance for all players in these extremely important activities oriented to maintenance and preservation of European cultural identity.

Historic towns, villages and buildings, in their territorial setting, represent an essential part of our universal heritage, and should therefore be seen as a whole with the structures, spaces and human factors, normally in the process of continuous evolution and change. This involves all sectors of the population, and requires an integrated planning process, consisting of a wider range of different activities. Conservation in the urban or natural context deals with ensembles of buildings and open spaces, which are part of larger urban areas, including intangible values. In this context, intervention refers to the city and territory in its morphological, functional and structural whole, as part of its territory, its environment and surrounding landscape. The buildings that form historic areas may not have a special architectural value in themselves, but they should be safeguarded because of their organic unity, distinctive dimensions, cultural identity, and their technological, spatial, decorative and chromatic characteristics as connecting elements.

The research challenges should be addressed to the involvement of the construction industry in the preservation of cultural heritage. Socio-economic integration needs to be assessed in order to reach the goals of a consequence based approach to heritage protection. The research partnership of construction industry, institutes and universities, and organizations responsible
for heritage maintenance is of the crucial importance for heritage protection and its integration in contemporary life of cities and their cultural environment as a whole. The need to keep stakeholders, authorities, construction professionals, architects, academics, urban planners, sociologists, economists, environmental professionals, tourism operators, marketing professionals, researchers and training specialists in touch with heritage developments can be thoroughly maintained within the European Construction Technology Platform having in mind the importance of research driven activities. Communication and dissemination need to be essentially strengthened as means to support interdisciplinary dialogue among the scientific, the industrial and the stakeholders communities, as well as to raise awareness among the citizen and the general public. Moreover, there is a great need to develop new ways of communicate and disseminate, as well as to transfer research results into the industry directly involving SMEs in applied research, with the goal to strengthen their potential for innovation and internationalization.

2.4 - The strategy

The main topics, forming the foundations of heritage preservation, and their respective goals are divided into two groups, being the first one devoted to the challenge to preserve Cultural values including setting standards for this in coordination with the CEN/TC 346 activities, and the second one to sustainability and added value of cultural assets:

Preservation of Cultural Heritage:

- **Assessment, Monitoring and Diagnosis:** To integrate technologies for building diagnostics (based on non-destructive techniques), monitoring and research in the safeguarding and long term management process of the heritage buildings to enable sustainable and cost efficient maintenance, including prediction of energy consumption in order to anticipate the possible actions or solutions going over the big barriers present in the historical buildings.

- **Materials:** To understand degradation mechanisms as a basis for the development of more durable and better adapted materials and treatments to be used for conservation interventions. Design development and production of smart, memory-, self-adjusted, self-cleaning energy storage and self-healing materials. Development of strategies for compatible and more durable materials, to infer in structures' durability and to resist to environmental stresses on the basis of energy efficiency.

- **Intervention Techniques:** To guide all steps of intervention by continual attention to consequences using interdisciplinary competences and aiming at preserving the authenticity of the cultural heritage, be it single buildings or complex city fabrics; to develop appropriate intervention strategies using less invasive and possibly removal techniques in order to improve performances of the existing buildings also in terms of energy saving and CO2 reduction.

Sustainability and added value of Cultural heritage:

- **Environment and Energy:** To integrate new environmental challenges by assessing, predicting and managing the impacts of climate change, energy consumption, CO2 production and pollutant damage to safeguard cultural heritage assets in urban and natural areas. To develop prediction models, environmental impact assessment methodologies and risk assessment and risk preparedness studies. To set up information management systems as well as appropriate preventive measures and suitable
interventions for the improved care of the cultural assets in relation with their environment and contents. To improve the use of traditional materials and skills, the use of new materials also addressed to energy storage, renewable forms of energy, water conservation and the implementation of recycling of materials for sustainable and cost-effective strategies in the adaptive re-use of Cultural Heritage.

- **Management, Exploitation and Maintenance**: To set up sustainable strategies for the preservation of cultural heritage assets by developing new management and predictive maintenance tools to ensure their added value for European cities and the local environment and also to reduce the use of energy and the production of pollution and CO2; this will enhance the European Society’s knowledge, access and understanding, and promote a reliable predictive and cost effective maintenance.

- **City and Territorial Aspects**: To improve and sustain the integration of cultural heritage in the urban and rural settings through remedial territorial planning and rational energy resource management, using historical urban grid systems, while taking into account the characteristics of historic settlements and cultural assets. To develop communication and public participation strategies to set up an European citizen interaction and improve the safeguarding of the most substantial European cultural heritage linked to urban development.

**The horizontal issues:**

The horizontal issues are linked with the topics dealing with the preservation of Cultural Heritage, sustainability and added value in the following way:

- **Education, training and Communication** process is an important, permanent task. It is necessary to form large multidisciplinary networks of experts. Education & training could be organized on the several levels: Formal Education, Training of Educators, Training of Professionals, Upgrading of specialized knowledge and Lifelong education of specialized professionals in SMEs. Particular attention will be given on how to bridge the gap between science and industry, as well as on methods to increase the direct involvement of SMEs in applied research and their way how to cooperate with research institutions thus easing their need to ‘go international’.

- **Technical standards and specifications**: A specific European standardisation activity in the field of conservation of cultural property is essential to acquire a common unified scientific approach to the problems relevant to the preservation/conservation of the cultural property itself. Moreover, this common approach and the use of standardised methodologies and procedures would promote the exchange of information, would avoid the risk of duplication and foster synergy between the European experts and specialists involved in the preservation activity.

- **Preservation of Artworks**: To improve a global and integrated vision of cultural heritage, an intra-European exchange of views between movable and immovable stakeholders, should be promoted with inter-professional seminars for the various parties involved in monumental architecture restoring; periodicals and exhibits; cultural trips involving various partners (architects, curators, restorers, craftsmen), access to continuous formation as a means to heighten specialized craftsmen’s awareness of restoring work and deontology, and development of a data bank centered on research and identification of ancient traditional materials.
Socio-economical aspects. The scope of this issue would be: Compilation of the state-of-the-art of socio economics aspects of immovable CH and of statistical data available (historic rehabilitation direct and indirect jobs, income generated by trade, tourism and services, maintenance investments, etc), Design tools to show the authorities, planners and policy makers the importance of the economy aspects of CH, to prevent and neutralise threats and to develop local competitive advantages: study the economic effects of: current legislation and new legislation criteria; Design strategies to stress the importance of socio economic aspects amongst the different stakeholders

Disaster prevention & risk management: In terms of disaster preparedness and risk management, there is the realisation that disasters may be unavoidable. The increasing influence of climate change means that the likelihood of extreme weather events such as storms, floods, droughts and high winds is increased, along with the already-present threats such as landslides, fire and physical damage. Four key themes to be developed are: - Management systems for disaster prevention - Assessment and management of risk - Software and hardware countermeasures for disaster prevention - Research and investigation on causes of disaster.
3. Background and highlights of cultural heritage protection

As UNESCO expressed, the term “Cultural Heritage” has not always been associated with the same meaning. Recent decades have seen the concept of heritage – much like that of culture - undergoing a profound change. Main principles of cultural heritage safeguarding have been established during years, by means of different charters and other documents reflecting its evolution according to the changes happened in the society, economy and culture.

The most relevant documents that underline the chronological progress are:
- The Athens Charter for the Restoration of Historic Monuments (1931)
- ICOMOS Charters (since 1965)
- European Council Texts (1999)
- Charter of Krakow (2000)
- EC research documents (2002)
- Declaration of London (- 2004)
- UNESCO Texts (- 2005)

Besides, the four basic documents of Council of Europe are to be respected in planning and fulfillment of research targets:
- The European Cultural Convention (1954)
- The Convention for the Protection of the Architectural Heritage of Europe (1985)
- The European Convention on the Protection of the Archaeological Heritage (1992)
- The European Landscape Convention (2000)

All these documents reflect an evolution of disciplines, methodology and associated technologies involved, throughout time, summarized as follows:

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<th>Framework</th>
<th>Disciplines</th>
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<td>Monument restoration and conservation</td>
<td>Monument</td>
<td>Conservation and restoration vanguard scientific knowledge</td>
<td>Previous studies. Urban and rural setting. Communicating science</td>
<td>Conservation and restoration vanguard technologies</td>
</tr>
<tr>
<td>Technical assistance, training, awareness, spreading</td>
<td>Historic centers and rural areas</td>
<td>Architecture, Urban Planning</td>
<td>Integrated conservation, management and promotion. Transfer of knowledge and know-how</td>
<td>Interdisciplinary work, Human-centred ICT tools and methodologies</td>
</tr>
<tr>
<td>Environmental control, maintenance, repair, restoration, renovation, rehabilitation</td>
<td>Cities and towns, Cultural landscapes</td>
<td>Above, plus Sociology, Economy,</td>
<td>Systematic research, inspection, control, monitoring and testing. Preventive measures. Training and education</td>
<td>Materials and ICT's Nanotechnology Intelligent Materials, Human-centred ICT tools and methodologies</td>
</tr>
<tr>
<td>Living Cultural Heritage and Past</td>
<td>Tangible heritage: urban, rural, natural. Intangible heritage: acts of creation, processes of transmission</td>
<td>Every discipline synergies in order to preserve, renewal, create, promote and legislate</td>
<td>Global and holistic approach. Interdisciplinary methodological approach in communication and dissemination.</td>
<td>International best practices involving ethics and techniques. Archives with safeguard new technologies, Human-centred ICT’s tools and methodologies,</td>
</tr>
</tbody>
</table>
As shown in the previous table, Cultural Heritage sector is being addressed to a **holistic management of the monument and its environment**, ensuring its historical and cultural **integrity**, as well as sustainability of interventions and maintenance of Cultural assets. Furthermore, Cultural Heritage should be now consider as a key aspect for **territorial development**, as cultural identity is, at present an element of high added value.

This evolution in present tendencies lead to some changes in the technologies that should be applied to preserve a **conceptually wider** Cultural Heritage where a key element is now its **social and economic value**, together with the development of disciplines to ensure its **adequate conservation and restoration** and preserve its historical and cultural dimension. According to this, an adaptation and integration of sciences, technologies and disciplines should be carried out to develop the required **interdisciplinary understanding**.

On the other hand, the concept of “cultural heritage” become wider, passing from the “monument” and “art works” to a new dimension of “tangible” and “intangible” Cultural Heritage of **rural, urban and natural** environments.

Last, but not least, to ensure the adequate sustainable conservation of cultural heritage, as well as its role as **dynamisator of regional and territorial development**, adequate strategies for **planning, management and dissemination** of cultural heritage and its added value for cities and territories should be considered. Besides, the creation of **comfortable, safe and accessible places** to live will contribute not only to improve the quality of life of citizens living in historic areas also to transform these areas in better places to also work and visit.

Cultural heritage today, as a set of values, can be formally protected by number of international, national and even local conventions, laws and regulations. However, the real protection can be achieved by its integration in everyday life and economy to become a part of contemporary life as an asset having extremely important role in satisfying societal needs and fostering the development of society as whole.

The underlying idea of investment in research to serve safeguarding cultural heritage is the way to implement Cultural Heritage conservation policies, as well expressed in Article 17 of The Convention for the Protection of the Architectural Heritage of Europe (1985):

“The Parties undertake to exchange information on their conservation policies concerning such matters as:

- The methods to be adopted for the survey, protection and conservation of properties having regard to historic developments and to any increase in the number of properties concerned;
- The ways in which the need to protect the architectural heritage can best be reconciled with the needs of contemporary economic, social and cultural activities;
- The possibilities afforded by new technologies for identifying and recording the architectural heritage and combating the deterioration of materials as well as in the fields of scientific research, restoration work and methods of managing and promoting the heritage;
- Ways of promoting architectural creation as our age's contribution to the European heritage.”
4. Vision 2030 as an answer to challenges

“Europe today is characterized by a cultural diversity and thus by the plurality of fundamental values related to the mobile, immobile and intellectual heritage, the different meanings associated with it and consequently also conflicts of interest. This obliges all those responsible for safeguarding cultural heritage to become increasingly attentive to the problems and choices they need to face in pursuing their objectives.”\(^{15}\)

In order to aid the safeguarding cultural heritage, European construction industry, supported by research efforts of own research and development units and efforts of different professional profiles and educational background from universities, institutes, and institutions responsible for heritage protection, brings together the efforts of well-harmonized teams and their efficiency depends on permanent conjunction of theoretical, experimental and in-field activities. The research challenges related to involvement of construction industry in heritage safeguarding encompass the intersection of technology, environment, and societal and economic impacts.

The challenges of Cultural Heritage fulfil an important need for long term prospective on research needs and sets ambitious objectives for Construction sector. As reflected in the document of Strategic Research Agenda of the ECTP\(^{16}\), main targets of the sector are specified as follows:

- Meeting clients requirements
- Becoming sustainable
- Transforming the Construction sector

The following challenges of Cultural heritage have been considered, addressed to the above targets of the Construction Sector:

**Meeting client requirements: Approaching citizens**

*European cultural heritage is the testimony of our common past and the base of our identity, it enriches the collective memory what makes the future of Europe more human and friendly for its population and increases quality of life. Its conservation could contribute to the creation of a new image of cities, where Cultural Heritage is a valuable element that should be comfortable and accessible for all, in terms also of barriers and costs of maintenance.*

**Integration within the urban environment**

- Developed, improved and verified methodologies for research the importance of cultural heritage territories and buildings (CHTB) in development of contemporary towns and territories;
- Historic towns and villages considered in their territorial setting, as a whole with the structures, spaces and human factors, in the process of a continuous evolution;
- Integrate planning processes with cultural heritage management strategies, involving all sectors of the population;
- Reference to the city in its morphological, functional and structural whole, as part of the territory, its environment and surrounding landscape.

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\(^{15}\) Krakow Charter 2000

\(^{16}\) Strategic Research Agenda – for the Construction Sector. ETCP (2005)
Increasing quality of life
- Safety and mitigation of natural and man-made risks;
- Design or adapt buildings or infrastructures in order to obtain accessibility, health, comfort, energy saving and security optimal levels;
- Motivate social capabilities and values enhanced the cultural offer and creating new ones;
- Use cultural heritage values in order to stimulate urban regeneration and regional development projects;

Developing multicultural tolerance
- Strengthen Identity with cultural heritage policies;
- Optimise tolerance through multicultural strategies and projects;
- Stimulate the relationship between citizens and cultural heritage in an active way developing perception and creative tools;
- Develop tangible and intangible cultural heritage strategies avoiding folk styles;
- Stimulate the peace.

Raising awareness
- Promotion of Cultural heritage understanding at the whole intervention process, by improving the relation between professionals, society and citizens
- Improvement of accessibility, visibility and added value of Cultural Heritage for all the citizens;
- Make aware in all citizens and especially in young generations that the right to enjoy Cultural Heritage is complementary to a duty to understand and a duty to transmit;

Transferring knowledge
- Participate actively in EU and JTI networks of Cultural Heritage Benchmarking;
- Stimulate contact between all actors;
- Promote R+D+I structures;
- Improve active participation in national, regional, EU cooperation programmes and JTI initiatives;
- Promote knowledge and technology transference to underdeveloped countries.

Transforming the Construction sector: Maintaining cultural values

The interventions of the European construction industry in cultural heritage should be guided by conservation experts knowledgeable in the application of recognized ethical principles of conservation which seek to preserve not only the material cultural heritage but to the retain the 'meaning of place' associated with it. A cause-and-effect approach should be applied in order to avoid damage and to ensure protection from the environment and human causes of destruction. Therefore, new integrated knowledge-based conservation processes are needed that will preserve both the tangible and intangible cultural heritage through the study and application of appropriate methods of construction or refurbishment of buildings associated with both moveable and immovable Cultural Heritage. These include ICT and automation of diagnosis and monitoring, the design and application of high added-value materials and structural systems in restoration processes, in order to provide distinctive and attractive workplaces in EU cities rich in cultural heritage.
Protection

- Establish the conditions and develop the instruments for efficient identification of heritage damage and decay;
- Design quality control measures for interventions and planned maintenance;
- Operate with predictive maintenance procedures instead of corrective procedures;
- Select construction materials appropriately for the task, avoiding materials such as cement and concrete in association with the ‘softer’ materials used in cultural heritage;
- Develop diagnostic techniques for historic materials, structures and buildings;
- Identify appropriate methods and systems of management to reduce the impact on the environment and to mitigate climate change effects by minimizing energy consumption, pollution production and CO2 reduction;
- Develop and support new & traditional materials and technologies for the protection of heritage and for energy saving;
- Develop, optimise and disseminate technologies for building diagnosis and management of cultural heritage;
- Where relevant to contribute to the standardisation of the above in collaboration with CEN/TC 346.

Adaptive Re-use

- Create the harmonized approach to application of contemporary and future advanced technologies and materials bearing in mind the long term consequences of intervention in cultural heritage;
- Integrate the principles of sustainable development in approach to heritage preservation by means of application of appropriate materials along with establishing of monitoring in order to identify the short and long term consequences of interventions respecting the European aim in terms of reducing of energy consumption, pollution and CO2;
- Cooperate in development of legal instruments and standards by reporting and analysing the impacts of new and existing ones on planning and execution of conservation works;
- Mechanics and damage analysis of materials and structures;

Becoming sustainable: Meeting socio-economic and environmental requirements

Cultural heritage enriches the collective memory what makes the future of Europe human and friendly to its population. Environmental friendly interventions to reduce not renewable resources consumption and environmental impact, sustainable management of a living cultural heritage for an attractive Europe, and improving safety and security against natural and man-made hazards have to be considered.

Economic competitiveness

- Promote adequate well balanced private/public funds, by considering Cultural heritage as an investment instead of as a cost;
- Encourage involvement of economic and financial expert providing cost effective strategies to maintain the sustainability of medium and long term projects;
- Link the relationship between Tourism and Cultural Heritage with social and economic sustainable policies;
- Preservation of the harmony and continuity in building styles over the centuries, as a key point to attract tourism;
• Detect Cultural Tourism special collectives as an important economic input, and offer them accurate programmes;
• Promote SMES creation in vanguard sectors;

**Environmentally friendly interventions**
• Strengthening of the awareness of impacts to heritage due to sudden and/or gradual actions caused by nature or human activities and develop the techniques that help to mitigate harmful impacts;
• Development the techniques that would help construction industry to carry out interventions in build heritage with minimal impact to its surrounding and function during execution of works;
• Development of new systems and materials for energy saving, compatible with cultural heritage requirements (conservation and barriers)
• Guarantee environmental quality trough criteria, legal frameworks, and controls minimizing impacts and assuming total protection of resources;
• Improve safety and mitigation of natural and man-made risks;

**Integration within the natural environment**
• Design sustainable public transport and infrastructures;
• Incorporate the “cultural site” and “cultural landscape” concept as a catalyst of history, values, lifestyle, tradition and natural environmental character of communities:

**Meeting the interests of the EU building industry**
• Active engagement of European construction industry in cultural heritage safeguarding to give the unique opportunity for its transformation into R&D intensive industry.
• Increase of leading position of EU construction industry in the field through better and more effective interventions and maintenance
• Develop and use of knowledge based tools that allow end users to understand and use new developments also applied in civil field and adapted to Cultural Heritage needs
• Promote innovation through SME’s involved in this field, helping them to adapt to the evolving market environment although maintaining the values of tradition
5. **Strategic Research Agenda (S.R.A.)**

The objectives of Vision 2030 can be achieved by research, development and innovative actions with involvement of all stakeholders interested in Cultural Heritage. The main strategy is to develop research and innovation that could meet the challenges identified in previous paragraphs. It should be implemented through a knowledge-based and interdisciplinary approach for sustainable protection of cultural heritage assuring safety, authenticity and compatibility applying minimum intervention.

As mentioned in section 2.4 – The strategy, the detailed distribution of research efforts will follow two groups each linking together three subgroups of cultural heritage safeguarding areas that reflect the FACH organisation scheme. The first group covers predominantly **preservation of Cultural Heritage**: Assessment, Monitoring & Diagnosis and Materials and Intervention Techniques. The second group is oriented to **sustainability aspects of heritage protection**: Environment & Energy, Management, Exploitation & Maintenance and City & Territorial Aspects.

These areas are **horizontally linked** with the long-term requirement to develop knowledge and its transfer through **education and training** at all educational levels, **Communication technologies** for raising awareness, dissemination and support the direct involvement of SMEs, implementation of sustainability in cultural heritage protection, constant vigilance over **socio-economic impacts** of interventions into cultural heritage and promoting the development of relevant **European directives, codes and standards** and emergency preparedness in response to **natural hazards** such as earthquakes, strong winds, fire and floods. **Art works** will also be considered as a valuable and integral part of the immovable heritage as both are affected by the environment and the microclimates created by historic buildings directly affect the preservation of fixtures, fittings and collections.

Issues addressed by this Focus Area interact also with the issues of all other ECTP Focus Areas what contribute to the homogenisation of activities across the whole European Construction Technological platform. Besides, a close link with the JTI E2B initiative focused on Energy saving and CO₂ reduction should also be promoted in order to take advantage of the possible synergies and to guarantee the best results in the development of efficiency energy services and products specifics for cultural heritage sector going over the existing barriers.

The S.R.A will give rise to an appropriate Action plan specifying a series of priorities to be implemented through private and public research initiatives at European level. As regards public funding, it is expected that the European Union will take these priorities into account in the definition of its work programmes and calls for proposals.
5.1. Assessment, Monitoring & Diagnosis

5.1.1 - Introduction

The current approach normally used to assess the structural safety, damages and/or enhanced moisture on historic structures consists of manual optical inspection, laboratory tests on cored samples and load carrying tests. But the experience has shown that the internal structure of wall, columns, arches etc might be very inhomogeneous and differs significantly at various positions, even if it appears homogeneous from the surface. Without any volume inspection, damages can increase and might suddenly cause complex consequences (e.g. spalling, large cracks, collapse) before they can be detected at the surface. Therefore, procedures and technologies are required which directly control the structure on-site along large areas and volumes and preferable without any significant destruction. For early detection of damages, systems for long term monitoring are required.

During the last decade, several methods have been developed and improved for monitoring and diagnosis based on non-destructive and minor destructive approaches (like radar, ultrasonics, sonics, flat-jack, strain gauges rooted on optical fibres etc). There are promising examples of advanced monitoring including validation elements. Methodologies based on these methods and their complementary combinations have been derived and adapted to different level of inspection. The developed technologies allow having very precise data on the present situation of the building, which allows making diagnosis based on an ample data set. But at time, only in very few cases these methodologies are applied on-site and contribute to the sustainable long-term maintenance of immoveable Cultural Heritage. One reason might be that these services are still too expensive and time consuming. Most of the non-destructive, minor destructive and monitoring techniques are not tested and calibrated for all materials applied in historic construction. Further on, the analysis are still not used friendly and are not acceptable for the end-users. Another topic is the lack of information. The availability of information in Europe as well in the whole world must be improved considerably.

Integrated planning and maintenance, the co-operation of the relevant competent and inspection authorities and the application of optimized technologies will reduce the affordable costs, enable more frequent assessments and thus reduce costs for large interventions. Special attention should be paid on the monitoring and control of microclimate and environmental parameters that could affect the energy consumption, as well as to develop new models for energetic behaviour.

At time, Bridge Management Systems (BMS), e.g., are under development in many countries. Similar management concepts considering longer terms have to be developed for immoveable Cultural Heritage. Here, beside the objective analysis of the present overall situation of the construction, also predictions for the future including foreseeable damages and problems are required.
5.1.2 - Research areas

Medium term

- Development of Non and Minor Destructive Techniques (NDT, MDT) and monitoring technologies of environmental and structural parameters, based on already existing methods or combinations of methods and information or guidance, including:
  - Semi-automatic testing procedures for the effective investigation of large areas to identify critical areas for deeper investigation
  - Sound assessment of the state of conservation of the building and its composing materials.
  - To develop criteria and methodologies for the diagnosis and study of the energy efficiency of historic buildings in historic cities. Analysis of the feasibility and identification of the barriers to undertake actions and include energy saving solutions.
  - Detection and identification of damage processes starting from the surface, which is exposed to the environment, with particular attention to interface processes
  - Indoor and outdoor environment and energy consumption
  - High technology for non- and semi-invasive surveying and documentation of undiscovered archaeological sites
  - Biotechnological techniques for diagnose damage of cultural heritage for providing the identification of unknown species and the diagnosis of microbial contamination
  - Understanding of accuracy and limits of the technologies, also related to different materials
  - Quality assurance for the application of NDT, MDT and monitoring methods as well as for data analysis and interpretation and thus enhancement of reliability of these methods

- Development of intelligent monitoring systems, with the following characteristics:
  - Resistance against environmental influences
  - Efficient and intelligent, thus needing only a minimum service
  - Sensor becoming “mass-products”, at affordable prices
  - Multifunctional sensors for indoor and outdoor monitoring

Long term

- Establishment of guidelines and recommendations about the application of monitoring and diagnosis methods for different testing problems, including remote expert systems and user friendly software for the analysis of gained data

- Development of reliable models to predict the behaviour of historical buildings against material decay, structural faults, natural disasters and energy consumption.

- Long term automatic or semiautomatic monitoring and periodic assessment of cultural heritage as part of a management system, by using robots or scanning systems

- Elaboration of databases containing typical damages, testing problems, methods for assessment, diagnosis and monitoring, case studies, structural models, publications, addresses of stakeholders and experts, research projects, websites etc.
5.1.3 – Contributions of Horizontal Issues

**HI1: Education, Training and Ethics:**

Education and training process is an important, permanent task in the field of WG1 Assessment, Monitoring and Diagnosis. Since this is very important part, it is necessary to form large multidisciplinary networks of experts related to the monitoring, diagnosis and assessment. With their help it is possible to detect the state of the art, although in this field the methods, technologies and measuring instruments are developing every second. Having the database containing typical damages, testing procedures, methods for assessment, diagnosis and monitoring, case studies, structural models, publications, addresses of stakeholders and experts, knowledge and experience from previous and ongoing researches, websites, lifelong professional training could be organized on the several levels: Training of Educators; Training of Professionals; Upgrading of specialized knowledge; Lifelong education of specialized professionals in SMEs

**HI2: Technical standards and specifications**

Standardisation in the field of conservation of cultural property shall: -Improve the efficiency and pertinence of the diagnosis, reduce their costs, with a subsequent better management of funding for the conservation/restoration works and therefore increasing the number of conservation projects and spin-off economic benefits/opportunities for new investment, and consequent job creation;

Give precise and appropriate indication on the kind of diagnostics studies to be performed, avoiding expensive researches, promoting in this way conservation works on an increasing number of artefacts;

The current working areas of CEN/TC 346 in assessment, monitoring and diagnosis, where FACH should be active in are guidelines for a methodological approach to the knowledge of the artefacts and of the materials constituting the artefacts, of the deterioration processes, and of conditions of optimum long term conservation (preservative conservation) preservation work;

**HI3: Preservation of artworks:**

The contribution of the HI3, searching a new way for preservation of artwork, might pursuit an harmonization of vision and sharing of knowledge. All of these strategies may be oriented to three different kinds of artworks: work of art (painting, sculpture, photography, etc.), architecture (cultural heritage and historical buildings in general), environment (also in its relations to the architecture and urban landscape).

In relation to WG1 –Assessment, Monitoring & Diagnosis-, is important to encourage inter-professional exchange in order to sharing knowledge on diagnosis methods, NDT and MDT approaches. Involving also the development of a data bank of European research results, works, publications and services; a data bank elaborated in a harmonious and standard way, especially about the definition of required standards for non destructive methods.

**HI4: Socio-economic aspects:**

The execution of an evaluation, monitorization, and a suitable and constant diagnose from Cultural Heritage is essential not only to avoid non-recoverable losses, but also to avoid the
subsequent necessity to make interventions of greater importance and costs in future damages that could have been avoided with an earlier diagnose.

The Work Group 1 (WG1) approaches in a suitable manner the different socio-economic aspects that derive from this line of action, proposing to consider issues such as evaluation, monitoring and diagnose as another aspect of the Cultural Heritage management that has to be demanded and adopted by the different stakeholders. For this is indispensable, as it is proposed, the development of NDT and MDT (Non and Minor Destructive Techniques) and other intelligent technologies for the continuous monitorization of Cultural Heritage and its production to smaller costs that turns them into an attainable product that will led to its generalized application. The lack of information (one of the outstanding problems than arise from this scope) is the origin of important inefficiencies in the allocation of resources, whose solution, as proposed, is to improve and to generalize the information addressed to the stakeholders involved in the Cultural Heritage management through soft regulation\(^\text{18}\) (recommendations, guidelines, etc.). To do this, it is necessary to implicate the different authorities and competent organisms from this scope through the creation of data bases with a generalized access to the different agents, or on teaching activities oriented to all the professionals who take part in this field.

HI5: Disaster prevention & Risk Management:

Disaster planning and risk management are of direct relevance and importance to WG1, assessment, monitoring and diagnosis. Whilst the over-arching aim of this WG is to devise methods of monitoring and predicting the natural decay mechanisms of cultural heritage buildings, short-term disasters such as fires, floods, earthquakes, etc. will have a significant impact on these predictions. Given that with the increasing importance of climate change, more extreme weather events are predicted to occur in the next few decades, the importance of disaster planning and risk management become clear.

The climate change impacts mentioned could, when operating in tandem, pose a grave danger to the stability, rate of decay and performance of a building.

By anticipating these effects of climate change and the issues associated with them, the likelihood of buildings undergoing a serious failure is reduced. Disaster planning and risk management should be a major consideration when devising analytical techniques and predictive algorithms for the decay processes of historic buildings.

Understanding the pre-existing structure in terms of design, materials and layout are important when considering how to repair or rebuild a building struck by disaster. New technologies such as 3D scanning and imaging allow for an electronic record of a building to be kept and referred back to should the need arise to re-build a structure. Understanding the existing building and it's surroundings pre-disaster will inform efforts to address the damage caused by a disaster and prevent future similar incidents.

1. Supply of appropriate materials; material characterisation. Knowledge of the material used to construct a building will inform not only the decay processes that it may undergo naturally, but also what materials need to be sourced in order to produce a sympathetic repair or rebuilding in keeping with the original structure. For any given building, the database of materials present within it used for monitoring decay processes could be used to serve this second purpose.

2. Skills and labour. Understanding the original building structure should also hold information about the manner in which a building was constructed. This will inform both the analysis of

\(^{18}\) Norms and directrix that are not compulsory.
material decay as well as what techniques may be required in order to accurately re-create or repair a building. From this, people with the appropriate craft skills can be found or trained to carry out such work.

3. Prevention of repeated damage. The assessment, monitoring and diagnosis WG is well placed to determine what factors may have been responsible for a high level of damage caused to a building by a disaster, either in terms of the vulnerable structure and its materials or the surrounding environment. Therefore, any recommendations given to those responsible for repair or rebuilding work to help reduce the chances of a repeat occurrence could come from this WG. These may be matters such as management of rain water goods, use of materials under specific environmental conditions or reinforced structural aspects, for example.

5.1.4 – Targets and key performance indicators 2030

- NDT and MDT methods are widely known and its use increases in 200 % as reliable and effective means for investigation
- Cost reduction of maintenance is about 30 %
- Monitoring devices are assembled to critical parts of the buildings, and they are regularly demanded by stakeholders
- Large multidisciplinary networks of experts related to the monitoring, diagnosis and assessment of Cultural heritage have been established

5.1.5 - Strategy

For the development of the future scenario, advanced technologies still has to be developed. Also of main importance is the co-operation with the other working groups of Focus Area as well as the dissemination of the scientific and technological knowledge.

The following advanced technologies also related to the application to new materials (WG 2) have to be developed:
- non-destructive and minor destructive testing methods
- sensors for monitoring
- procedures for long-term maintenance

These technologies can be connected to methodologies considering different stages during lifecycle:
- assessment of the structure before restoration and/or before change of utilisation
- quality assurance of restoration work
- monitoring and maintenance during the usage of the building, including energy efficiency

The realization can be performed through the large research projects (collaborative projects in 7th Framework Programme) and case studies.

Structural modelling is an important part of assessment and has to be developed through the experimental testing of structural components and entire structural systems in prototype dimensions. The mathematical models should be calibrated, verified and valuated by cross-compared results of experimental and computational examinations and by the extensive parametric studies.
For the selection and application of the developed technologies, methodologies and procedures, guidelines and recommendations has to be developed on national and international level. The dissemination of these guidelines and recommendations can be performed through teaching and training courses together with group of Management, Exploitation and Maintenance. The tools for implementation can be developed through professional associations (RILEM etc.) and training courses.

The management system integrating structural assessment, monitoring and diagnosis should be developed in WG 5 Management, Exploitation and Maintenance using the methodologies and procedures for diagnosis and monitoring. The input to the development of a management system in WG 5 can be performed in WG 1 by delivering experiences gained through case studies. Besides, monitoring, control and prediction of energy consumption in these buildings should be consider in conjunction with WG4.

A database containing methods for assessment, diagnosis and monitoring, case studies, publications, addresses of stakeholders and experts etc. should be set up in the next future by the members of the WG. The database should be fed during the next 20 years providing knowledge and dissemination. Input into the database can also come from all other working groups of FACH. The specific support action model can be used to carry out this target.

To reduce the risk for waste of resources through duplicate research and development the specific activities should be coordinated with and contribute to the standardisation work of CEN/TC 346.

Most strong links with horizontal issues involve education and training of educators and professionals, involvement of SMEs in the R&D and technology transfer processes, as well as development of cost effective methods for diagnosis.

5.2. Materials

5.2.1 - Introduction

Many interventions in cultural heritage buildings in Europe appear to need a new restoration within 20 years, where 50-100 years is desired. Extreme, negative cases of damages re-appearing within one or two years do even exist. Cultural heritage is multivalent, i.e. many values, other than economical, are represented. The economic benefits (total economic value) of conserving cultural heritage generally surpass the costs of conservation; ineffective interventions, however, negatively affect this balance. In addition, conservation itself, and by consequence cultural heritage values and sustainability may be affected to a considerable extent.

Precise data on both the performance of restoration materials and on their compatibility are lacking. No systematic analysis has been made of the many situations available in the best open air laboratory, constituted by the restored monuments themselves, nor is (in most cases) their state of conservation monitored. Applicability of compatible smart materials with additional functionality in the field of CH has to be assessed in order to evaluate their possible contribution to preventive conservation and thus implicitly to the sustainability of the monument as a whole.

Both materials and structures of many historic buildings are suffering by various decay mechanisms and pathologies, hence their lifetime is restricted and conservation interventions
are necessary. Keeping heritage alive historic buildings have often to be adapted to new functions and requirements (including energy saving) whereas at the same time interventions and transformations have to guarantee safety and to preserve authenticity. From recent restoration history it has become clear that materials and structures have also suffered from decay due to incompatible materials and interventions. Consequently socio-economic investments are devaluated and the expectations for their return for the protection of CH are failing.

Therefore the most important problems to deal with in the field of materials are:

- Conservation materials and interventions that are improper and incompatible (with the original materials and structures and or with the environment) may lead to the development of further deterioration and may trigger and accelerate the pathology of historic structures. More specifically, modern materials (cement, epoxy resins, polymers and others) if used without proper evaluation of their effectiveness and their compatibility with the original ones. However, also the use of traditional materials, if reproduced empirically without any know-how trying to simulate historic technologies and materials, display a black box approach, which does not assure a positive final result and it often leads to failure.

- Conservation applications are not effective without:
  - without knowledge of decay mechanisms acting on original materials and structures are not effective.
  - without strategic planning on the monument scale that will be based on environmental and sustainability impact assessment

An effective protection of Cultural Heritage needs to be based on new knowledge from thorough research. This research should take into account that:

- Materials are characterized by mineralogical, petrographic, physico-chemical, physico-mechanical properties distributed inhomogeneously through their mass and sometimes even changing in the course of time, due to f.e. environmental stresses.
- The system materials/environment is a dynamic system defined both by intrinsic and extrinsic factors.
- The integrated system materials/structure/environment and the balance within this system is very complex since the durability and the (environmental) performance of the materials has to be accomplished during an extremely long service life.
- Better knowledge of historic materials and their performance in historic structures is necessary in order to permit the re-engineering of repair materials on the basis of the old material and in such a way that they will be compatible with the original fabric. Only then their performance and service life will be improved.

The preservation and conservation techniques to be employed should also be innovative, in the sense of fitting in the philosophy of sustainable preservation. The development of know-how on compatible materials and techniques, on environmental impact assessment and on strategic planning methodologies can support scientific decision making for sustainable preservation of Historic Cities and monuments.

Activities should be communicated with and contribute to the standardisation work of CEN/TC 346. Moreover, to benefit from the already established expertise and knowledge, education and training courses should be developed in collaboration with the European university level conservation-restoration courses.
In order to guarantee a better, more sustainable and more cost-effective preservation of the European cultural heritage, more attention has to be paid to the concept of preventive conservation. Preservation of monumental / cultural heritage values is, conform the Charter of Venice, the leading principle in dealing with monuments and cultural heritage materials. As almost any intervention will inevitably result in loss of original material, respect for values has to be combined with durability of conservation materials and/or interventions. Their perpetually prolonged service life makes sustainability an implicit property of monumental buildings. Durability and sustainability of interventions and conservation materials is essential to maintain the implicit sustainability of cultural heritage. Despite the fact that several research projects from the 3rd till the 6th FP have significantly contributed to a better understanding of degradation mechanisms of historic materials, many important questions from restoration practice are still open. These questions concentrate on compatibility of materials and/or interventions and are directly related to the question how to decide on materials to be used: what are the essential factors determining compatibility or non-compatibility and how to assess them?

5.2.2 – Research areas

Short term

- Assessment of materials performance: Knowledge and understanding of the performance of materials is essential in order to choose better materials or approaches, and to design new materials contributing to preventive conservation. In this respect, three research areas are essential, viz.
  - Understanding durability of historic materials in monuments.
  - Assessment of behaviour of materials used (over the past years) for restoration, including their degradation
  - Definition of procedures on how to assess compatibility or non-compatibility in specific cases

- Diagnosis and decision making: Development of knowledge based diagnosis and decision making to preserve authentic materials and structures, based on the development of Specifications, Codes, Directives, Standards, Methodologies related to knowledge and integrated diagnosis of historic materials, compatible materials and conservation interventions (including possibilities and risks of treatments of historical materials), repair/construction materials for the conservation of monuments and historic buildings, compatibility evaluation and testing. It will be an important basis for maintenance and preventive conservation is documentation of:
  - the state of conservation
  - diagnosis of damages
  - materials, treatments and techniques used in (previous) interventions

In order to guarantee a sound diagnosis and enable data mining to evaluate the performance and durability of intervention materials and treatments, there is an evident need of knowledge-based tools to organize and analyze data and support decision making.

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19 EU specific support action, project SPRECOMAH 2006 – 2008 (7th FP)
Medium term

- Development of an integral strategy for value assessment (and options for interventions) of cultural heritage (ranging from the level of historic town and the landscape) up to the materials used
- Creation of a knowledge based industry for production of proper materials for protection and adaptation of Cultural Heritage, such as:
  - Reengineering composite materials with enhanced durability, energy saving and storage and serviceability
  - Advanced materials employing nano – bio – technologies but with service oriented design to assure compatibility and to comply with the special needs for the proper protection of CH
- Establishment of quality assurance protocols (monitoring and control) for new replacement materials

Long term

- Development of smart materials: Modern materials engineering and technology covers a range of emerging possibilities arising from new materials like nano- and biomaterials, materials with additional functionalities, such as self-healing or self-cleaning, or materials with an improved resistance to degradation mechanisms. Although these developments at first sight appear to fit in the concept of preventive conservation. The challenge is to development smart, more durable and more effective conservation methods and materials that are really compatible with historic materials. Questions to be answered are how to translate successful applications of smart materials in other areas to preventive conservation and whether their durability and their contribution to durability and sustainability of a monument as a whole are better than traditional materials and treatments.
- Modification, adaptation and improvement of the most recent discoveries in materials and technologies (renewable energy systems) applies to immoveable Cultural Heritage, to achieve at the same time a better conservation of moveable Cultural Heritage and a reduction in dependence on fossil fuels by re-using and recycling materials and installation of renewable energy systems
- Embedded intelligence to materials structures and molecular dynamics
- Validation of quality control system

5.2.3 - Contributions of Horizontal Issues

HI1: Education, Training and Ethics:

Education and training process in the field of structural materials of historic buildings is very important, permanent task in WG2 Materials. Since this is very important part, it is necessary to form large multidisciplinary networks of experts related to the materials. With their help it is possible to create European Data Bases regarding materials durability and decay, performance data of materials used in past interventions; and effectiveness, compatibility and sustainability of conservation materials, a wide net of laboratories which can coordinate compatibility evaluation and testing of repair materials established all over EU which will be very helpful. Developing of Lifelong educational and training process could be organized on the several levels, including formal Education according to Bologna System.

HI2: Technical standards and specifications
Standardisation in the field of conservation of cultural property shall help to develop and improve products, materials, equipment and technologies to be specifically used for the conservation of cultural property;

The current working areas of CEN/TC 346 in materials, where FACH should be active in are test and analysis methods (in laboratory and in-situ) for the evaluation of the performance of the products and methodologies to be used in the conservation work (ordinary and/or extraordinary maintenance);

**HI3: Preservation of artworks:**

The contribution of the HI3, searching a new way for preservation of artwork, should pursue a harmonization of vision and sharing of knowledge. All of these strategies may be oriented to three different kinds of artworks: work of art (painting, sculpture, photography, etc.), architecture (cultural heritage and historical buildings in general), environment (also in its relations to the architecture and urban landscape).

In relation to WG2 –Material-, is important to encourage inter-professional exchange in order to sharing knowledge on historical and modern materials characteristics, pathology, and methodology of conservation and rehabilitation. Involving also the development of a data bank of European research results, works, publications and services; a data bank elaborated in a harmonious and standard way, approaching to a technical lexicon of material typology, kind of pathology, structural techniques and diagnostics.

**HI4: Socio-economic aspects:**

The materials of which Cultural Heritage is composed presents a high risk of deterioration due in part to its long life cycle as well as the confluence of a series of environmental factors and conditioners. At the time of approaching this line of work it is necessary to take into account that this deterioration not only affects the survival of Cultural Heritage, but also the quality of life of the people who coexist with it.

The Working Group 2 (WG2) approaches in a suitable manner the implications and socio-economic aspects related to this line of work. The necessity to base the interventions in the Cultural Heritage upon a deeper knowledge of the materials and upon processes of deterioration, as well as on the compatibility and long term effectiveness of new materials is properly highlighted. Evaluation and strategic planning previous to any intervention will allow to maximize the yield of investments made, not only from an economic point of view, but also from the perspective of social benefits on the long term.

**HI5: Disaster prevention & Risk Management:**

Understanding the nature of materials is an integral part of caring for our cultural heritage. How a material or a range of material responds in the face of a disaster will determine the extent to which our cultural heritage will survive disasters, and to what extent repairs and replacements may be needed. In addition to how a material can withstand a single disastrous event, how materials respond to the increasing influence of climate change will impact on the likelihood of facing a damaging event.

The climate change impacts mentioned could, when operating in tandem, pose a grave danger to the stability, rate of decay and performance of building materials.

Understanding the materials that comprise our cultural heritage and how they interact with the environment is key to their sustainability. Planning for disasters and managing risks is also a key part of maintaining out stock: by anticipating the effects of climate change and the issues
associated with them, the likelihood of building materials undergoing a serious failure in the face of a disaster is reduced.

Analysis of materials and their degradation processes is an essential part of post-disaster restoration of a structure. For example, if part of a building is destroyed, the correct materials need to be sourced and used as replacements. Hence, a full understanding of the materials used in building structures is vitally important.

WG2 is well placed to take the lead in this area. As part of the overall strategy of understanding materials, conservation treatments and “smart” materials, how these react to a disaster is important.

1. Supply of appropriate materials; sourcing. In order to ensure that similar materials are available should a disaster strike, an assessment of material supply is necessary. WG2 can determine the material properties that are necessary and that can be used to examine nearby sources of materials (i.e. quarries, forests, foundries, etc.) to determine if there is a shortfall in any area.

2. Skills and labour. Following on from the first point regarding material supply, should the skills to use the materials correctly not be available, this poses an extreme problem for building repair or reconstruction. For example, in terms of stone the right elements in terms of quarrying, stonemasonry, carving etc. may be needed to authentically reproduce the characteristics of a damaged structure. In terms of timber, skills such as felling, working and carving are necessary in order to translate the raw material in to an integral part of the structure. An assessment of how materials are utilised is needed to ensure the execution of WG2’s main aims.

3. Prevention of repeated damage. WG2 is well placed to take this issue forward from their aims of developing “smart, memory-, self-adjusted, self-cleaning and self-healing materials” and assessing the durability of materials to environmental stresses, including identifying those most resistant to future damage.

**HI6: Communication, Dissemination and direct involvement of SMEs**

5.2.4 - Targets and key performance indicators 2030

- European Data Bases regarding materials durability and decay; performance data of materials used in past interventions; and effectiveness, compatibility and sustainability of conservation materials, have been developed
- A wide net of laboratories to coordinate compatibility evaluation and testing of repair materials is established all over the EU
- Improvement of durability of interventions in 40 % through the use of new knowledge based materials
- Increasing of use of recycled materials and sub products for the conservation of historical buildings in 20 %
- Reduce the energy consumption of buildings, by using adequate materials
5.2.5 - Strategy

The vision of the European Cultural Heritage regarding Materials requires R&T innovations and defines new research strategy, that should be embodied in the philosophy of large research projects calls of proposal (FP7, etc.), complying to the primary criteria of Compatibility, Safety and Sustainability.

In addition, a sufficient cooperation of FACH to SMEs sector is indispensable in order to assure a strong link between research, industry and end-users. In this way the construction and materials industry will readjust its priorities in order to face the modern, urban architectural heritage end of lifetime by producing and using innovative, advanced, and more durable and sustainable materials.

To reduce the risk for waste of resources through duplicate research and development the specific activities should be coordinated with and contribute to the standardisation work of CEN/TC 346. Moreover, to benefit from and contribute to the already established expertise and knowledge, education and training courses should be developed in collaboration with the European university level conservation-restoration courses.

The development of new materials for energy saving, that are compatible with cultural heritage requirements should be afforded together with WG4.

On the other hand, several EU Policies are required for implementation of the vision regarding the Materials used for restoration interventions, such as:

- Reviewing existing EU Directives that are harmful to CH (earthquake protection codes, masonry codes, e.t.c.) mainly because they are adjusted to modern materials (i.e. cement, concrete).
- Developing European Directives and Standards regarding the Conservation Materials and Techniques that permit the Quality Control and Assurance. As a leverage for proper practices in the Construction and Materials industry.
- Developing European Data Bases regarding Materials durability and decay, performance data of materials used in past interventions through history on monuments, effectiveness, compatibility and sustainability of conservation materials / interventions
- Developing a wide net of Laboratories to coordinate in diagnostic methods and compatibility evaluation and testing of repair materials
- Developing education and training courses (p.ex. through technical committees -RILEM, etc.) in order to assure the dissemination of the innovative knowledge to the scientists, engineers, technicians, etc. and to strengthen the link between the theory and the practice.

5.3. Intervention Techniques

5.3.1 - Introduction

During the last twenty/thirty years many efforts have been made by the industry, by the research institutions and by designers to develop both new materials/techniques and new ways of using the traditional ones in order to repair and strengthen historic constructions. This happened under the strong pressure of both economical/social interests (as modern uses require changes due to higher loads and/or to more sophisticated services inside the buildings) and of the high risk of losses due to progressive deterioration and strong damages caused by environmental causes (natural, like climate and weather conditions or destructive actions like earthquakes, or artificial, like pollution).
These efforts led to actual significant advancements in the way how repair/strengthening of historic construction are currently made, first from the cultural and then from the technical/technological points of view. From the cultural point of view the main achievement was in the way the design of the interventions is carried out: basically very sophisticated knowledge-based and interdisciplinary approaches are now available to select solutions capable to satisfy both safety and conservation requirements. The search for compatible, removable or repeatable interventions, capable of causing as minimum as possible changes to the existing conditions is based on more and more reliable and generally agreed procedures. From the technical/technological point of view, the expertise in dealing with traditional materials and construction techniques is continuously increasing, together with the capacity of improving their performances by appropriate combination with modern materials and techniques. Furthermore, despite the above-mentioned achievements, the currently available reparation/strengthening techniques are not only expensive but also require special equipment and fulfilling a lot of necessary conditions for execution (like for example: strict weather conditions, special preparation of environment and basis for reparation, etc.)²⁰.

From this point of view, the adoption of existing traditional intervention techniques is desirable; some of those techniques, well known and widely adopted in the past, are nowadays disused. This might be due either to the development of new and more effective intervention techniques or to a lack of interest because of the low cost of the traditional techniques or to the unavailability of workmanship capable of applying it.

At the same time, the need for comprehensive intervention strategies (in the sense of design principles to be followed to obtain the desired performances, along with clear definitions of both the principles and the performances) is becoming more and more evident. The need of clearly defined and agreed upon strategies, at first glance less evident than the need of really effective intervention techniques, is immediately evident when the intervention is either on a complex of buildings, rather than a single building, or on a whole building, rather than a single structural element of it.

Actually, the behaviour of a complex of strictly interconnected buildings (as found in most historical centres) significantly differs from that of each single building in the complex. This implies that intervening on a single building could result in an improvement of its behaviour, but the ensemble behaviour will be dramatically modified, most likely in a negative and uncontrollable way. This kind of problem is general and particularly significant in seismic prone areas.

The objectives are those of: a) identifying intervention strategies that make use of interdisciplinary competences aiming at reducing the risk while preserving the authenticity and identity of the cultural heritage, be it single buildings or complex city fabrics, according to the fundamental principles of minimum intervention, compatibility, interpretability and reversibility and while fulfilling the basic requirements of value and use; b) developing appropriate intervention techniques with critical sense and with due consideration of performance issues.

²⁰ “Recommendations for the Analysis, Conservation and Structural Restoration of Architectural Heritage” INTERNATIONAL SCIENTIFIC COMMITTEE FOR ANALYSIS AND RESTORATION OF STRUCTURES OF ARCHITECTURAL HERITAGE (ISCARSAH) OF ICOMOS.
This can be achieved either by using traditional techniques in “innovative” manner or, if strictly necessary, by using new technologies to integrate the traditional ones where they are deficient.

5.3.2 – Research areas

Medium term

- Elaboration of a Data base of typologies and morphology of different structural elements, defined at different geographical level
- Elaboration of catalogue of intervention techniques with respect to their effectiveness in terms of performance requirements to be attained, their compatibility - interpretability – reversibility
- Development of effective and reliable traditional and innovative “smooth” interventions techniques that alter at the minimum level the historic structure’s character
- Optimisation of single or combined techniques for application. Proposal of integrated intervention systems
- Selection of enhanced and intelligent systems and selection of a number of pilot sites for case studies application
- Improvement of analytical tools for structural assessment and simulation of interventions
- Development of smart systems for monitoring the intervention and real time modification of the working conditions

Long term

- Development of structural protocols; development and update of guidelines, Standardization of techniques and procedures
- Identification of proper methodology for analysis of seismic vulnerability and hazard mitigation
- Optimisation of all obtained results from financial and efficiency point of view (reduction of cost and duration of interventions)
- Larger sale application of integrated interventions making use of smart technologies, with enhancement of durability and removability
- Setting up of cultural and technological programmes for exporting technologies and knowledge to third and in particular developing countries

5.3.3 – Contributions of Horizontal Issues

HI1: Education, Training and Ethics:

Education and training is essential for development of this sector. It should be organized on the formal and informal level through the networks of expert and knowledge databases by the ECTP in collaboration with National technology Platforms.

The first step in organized multidisciplinary networks of experts related to the intervention techniques should be to create European Data Bases regarding the existing state of the art in this field, addresses of experts, typical traditional and modern techniques, typical traditional and modern materials, case studies of successful less invasive techniques, new smart systems, list of manufacturers and developers of innovative smart material as well as traditional, providers of ‘smart’ systems, publications, addresses of stakeholders, knowledge and experience from previous and ongoing researches, websites. In this WG, Education & training is especially
important for SME's. Besides, continuous dissemination to developing countries should be undertaken.

**HI2: Technical standards and specifications**

Standardisation in the field of conservation of cultural property shall help to improve new intervention techniques, that is, products, materials, equipment and technologies to be specifically used for the conservation of cultural property;

The current working areas of CEN/TC 346 in intervention techniques, where FACH should be active are related to testing and analysis methods (in laboratory and in-situ) for the evaluation of the performance of the products, techniques and methodologies to be used in the conservation work (ordinary and/or extraordinary maintenance);

**HI3: Preservation of artworks:**

The contribution of the HI3, searching a new way for preservation of artwork, should pursue a harmonization of vision and sharing of knowledge. All of these strategies may be oriented to three different kinds of artworks: work of art (painting, sculpture, photography, etc.), architecture (cultural heritage and historical buildings in general), environment (also in its relations to the architecture and urban landscape).

In relation to WG3 -Intervention techniques-, is important to encourage inter-professional exchange in order to sharing methodology of conservation and rehabilitation, innovative and traditional intervention techniques. Involving also the development of a data bank of European research results, works, publications and services; a data bank elaborated in a harmonious and standard way. It's also important to promote access to continuous formation of specialized craftsmen.

**HI4: Socio-economic aspects:**

Nowadays the interventions in Cultural Heritage must comply with two types of demand in a simultaneous form: a private demand based in the utility that can be derived from the present use of Cultural Heritage (value of use), and a social demand derived from the utility reported to the society from the existence and conservation of these Cultural Heritage elements (value of non-use). Therefore, the efforts must be focused on the adjustment of these Cultural Heritage elements onto the requirements of their present use that will allow the generation of an economic yield in addition to social advantage and, at the same time, the conservation of their cultural values in the long term.

This WG3 approaches in a suitable manner the socio-economic implications regarding the Cultural Heritage interventions, with a group of proposals that will improve long term effectiveness and economic yield. Nevertheless, it could be interesting to contemplate a possible line of work to develop and impulse the recovery of traditional and artisan trades, and also for the training of people in these matters.

**HI5: Disaster prevention & Risk Management:**

Intervening in order to preserve a building, or a collection of buildings, is an ongoing process in many areas of cultural heritage. As such, better understanding of how these processes work, and taking a more sympathetic and holistic view will enhance the longevity and performance of the building or buildings undergoing treatment. This WG has identified seismic vulnerability and hazard mitigation as areas for analysis. As well as the impact of single-event disasters, the
effects of climate change on the interventions that take place on traditional buildings is important, in order to reduce the risk of damaging our cultural heritage.

The climate change impacts could, when operating in tandem, pose a grave danger to the stability, rate of decay and performance of building materials. This, in turn, will impact on the demand for and performance of interventions to sustain a building in the longer term.

The building fabric is at risk from climate change. If dealt with inappropriately, building stability may be compromised, and buildings will become more susceptible to the effects of disasters. Planning for disasters and managing risks is also a key part of maintaining our stock: by anticipating the effects of climate change and the issues associated with them, the likelihood of building materials undergoing a serious failure in the face of a disaster is reduced.

WG3 has many important priority areas dealing with how to interact with a cultural heritage structure in a manner that is sympathetic to the authenticity and character of the structure, while acting in the interests of preserving the structure for the future. While much of the WG focus is on interventions on existing structures with a view to preserving them in situ, much of the WG’s priorities can be considered in a post-disaster sense.

1. Supply of appropriate materials. One priority of WG3 is the “development of databases of different structural elements and typologies defined at a different geographical level”. With these databases, it will allow for a greater understanding of the types of materials needed for the accurate repair or reconstruction of severely damages structures.

2. Skills and labour. The priority of identifying strategies for the design of interventions by analysis of the behaviour of single elements within a structure or a whole structure is reliant on having the skills necessary to understand and interpret how elements fit in to a structure during a repair or restoration.

3. Prevention of repeated damage. This WG has set as a priority an identification of seismic activity and hazard mitigation. By expanding this in terms of climate change vulnerability (part I of this document), a more complete analysis of the risks posed to already damaged buildings may take place.

5.3.4 - Targets and key performance indicators 2030

- 10 % reduction of risk by wider knowledge of materials and techniques and using new tools for permanent monitoring of behaviour of executed interventions and validation/recapitulation of achieved results
- Increase cost-effectiveness of interventions in 15 % by identification and implementation of real societal and industrial requirements concerning new materials and production processes
- Regular use of traditional and increase of innovative techniques by works above their connection and behaviour/duration in time
- 20 % increase of presence of European experts and technologies in developing countries by continuous dissemination of knowledge about realized works via web or other mass media.

5.3.5 - Strategy

The possibility of having the vision transformed into reality is strongly based on substantial improvements of the theoretical/experimental tools that are now available to assess the current and forecast the future (after the intervention has been made) physical/mechanical behavior of
existing buildings. These require of course precise preliminary characterization from the physical/mechanical point of view of every new material/technique, and of their possible integration (also with the existing ones) by adequate experimental investigations and theoretical modelling. High performance materials will be the main subject of investigation, as far as their interaction with existing materials and construction techniques is concerned. Reducing uncertainties is in fact the primary requirement for reducing the interventions, increasing their reliability and effectiveness -e, reducing at the same time the risk of compromising the “value” of the historic constructions. For the reduction of uncertainties also the organization of already existing knowledge, which is wide but not systemized, through catalogues and databases, is necessary. All these challenges will be achieved through a strong collaboration with WG1 and WG2.

The second substantial step would be producing integrated intervention systems based on smart/active techniques: smart monitoring systems will allow, via WEB, for a continuous control of how the repaired/strengthened structure reacts in real use conditions and, thanks to continuous interaction (via AI/Expert systems) of the collected data from the field with the above mentioned models, for real time modifications of the working conditions. The research objectives will be pursued by fostering cooperation among building companies, manufacturer and developer of innovative and traditional materials, developer, designer, manufacturer of innovative aseismic devices and of active ‘smart’ systems, service providers (design firms, inspector, etc), researchers and operators, owners, end-users (public bodies and others), regional & national platforms, through meetings, seminars, proposals, projects, creation of data bases and networks, to be made in close cooperation with other WGs of the same Focus Area.

As integral part of FACH activities educational program should be created and efficiently realized, which allows training not only new staff for realization of innovative intervention techniques, but also experienced staff to use the discovered intervention techniques and recovery of traditional artisan trades. Moreover, the export of the technologies made available in third countries, will be fostered through on-purpose developed dissemination strategies. It has then to be stressed that during the whole duration of FACH activities, the identification of changed conditions and adaptation of objectives, vision, breakthroughs has to be carried out, in order to keep real societal and industrial expectations.

5.4. Environment & Energy

5.4.1 – Introduction

The future society needs to develop its understanding of the nature of moveable and immovable cultural heritage environments through the development of risk management methodologies, models and tools. The historic buildings need to adapt to future environments where the climate is changing and the emissions in the air are also changing and must be reduced in specific dangerous compounds. The research can show how this should be done adapting our historic indoor and outdoor environments to environmental and climate change.

The building sector uses about one third of all the raw materials and energy produced in Europe and over half of the electricity. As a result of improved legislation (i.e. building codes and insulation standards), the use of new building materials and more efficient equipment, much progress has been achieved in energy efficient and environmentally friendly new buildings over the past decade. On the other hand, higher living and working standards, along with the introduction of new equipment and appliances, including air conditioning may counterbalance these savings and actually increase the average energy consumption in buildings and create
considerable problems at peak load unless more sustainable construction strategies and for the adaptive re-use of existing buildings and sound principles of indoor environmental management are implemented. Thus, energy conservation efforts, while maintaining the required indoor environments for conservation of cultural heritage and indoor air quality, is a continuous struggle in helping to minimize dependency on fossil fuel sources, reduce their environmental impact and secure an appropriate energy balance.

Building practices in the past have not properly addressed current concerns on how the use of energy in buildings can be optimized directly and indirectly by the use of retrofitting techniques and environmental effects minimized in terms of pollution and energy supply. Past installations of energy systems were realised at a time when the burning of fossil fuels was not the serious problem it is today and when conservation conditions were not well understood. As a result of past research in the field of conservation and environmental management of cultural heritage, scientists and end users devoted to conservation of cultural heritage today have a clearer picture of the conservation and environmental needs of historic buildings and what is appropriate to install in terms of infrastructure and services. A clear distinction between the construction requirements of domestic, commercial or industrial buildings and the conservation of cultural heritage is emerging. There is a new generation of professionals (engineers, architects, scientists, project managers etc.) emerging who have greater in-depth scientific knowledge of conservation problems combined with an understanding of the environmental, social and political drivers, that working alongside the construction industry will together produce more sustainable solutions that respect cultural heritage, environmental and energy conservation to be implemented.

Ageing installations and facilities create even greater challenges. Existing buildings are often costly to operate in terms of the environment and energy; they can cause serious indoor environmental quality problems in terms of people comfort and conservation conditions, which may also be related to the original installation having been inappropriately designed. There is a need for research into what might be appropriate structural and infrastructural modifications and improvements. This approach is preferable to demolition because existing buildings constitute a huge investment in material resources and human skills, and the existing building stock is an enormous pool of private and public investment. According to studies carried out by the European Action ‘Cooperation in the field of Scientific and Technical Research’ (COST), the estimated value of Europe’s Urban Heritage amounts to about 40 trillion Euro for the housing stock alone.

Adaptive re-use (i.e. changes in use and upgrades or improvements) of the existing and ageing building stock offers an opportunity to take cost-effective measures to transform it into resource-efficient and environmentally-sound buildings, increasing its social and financial value. Similar opportunities may exist even during building renovation (i.e. repairs and restoration to good condition). On the other hand, heritage buildings are usually very energy effective, especially in cities, and, therefore, it could be considered as an example to be recovered for the design of new cities and buildings. Scientific knowledge of conservation and the environment can improve the refurbishment and operational effectiveness and efficiency of buildings in a number of ways: lowering of energy consumption and costs, and the reduction in maintenance cycles and costs thus improving user satisfaction through careful management. In line with this approach is the need to use alternative forms of energy because while there may be circumstances when conventional energy saving measures may not be appropriate to cultural heritage, other low energy measures suitable for cultural heritage need to be developed. The paramount consideration is the conservation of scarce resources both in terms of fossil fuels as well as the scarce resource of cultural heritage.
While developing synergies between energy conservation and the conservation of cultural heritage will contribute in a small way to the mitigation of climate change, there will inevitably be a range of environmental threats to historical buildings that will need to be considered including meteorological changes; pollutants; vibration and subsidence; earthquakes and landslides; floods and variations in aquifer levels, etc.

Protecting the immoveable and moveable cultural heritage is of primary benefit, but it may also be financially attractive. Studies are needed on building refurbishment costs compared to demolition and new construction, which may be more expensive depending on land values. The application of science to the evaluation of different kinds of environmental impacts on cultural heritage should focus on new intelligent diagnostic and monitoring systems that will give efficient tools to enable users to deal with exceptional as well as “normal” events.

In conformity with sustainability principles, it makes more sense than ever now to adapt old buildings to new uses. There have even been suggestions that new construction should be given a lower priority over improvements to the existing stock, its functional quality and durability. In any event, an immediate goal must be that new buildings are constructed sustainably by exploit new scientific knowledge and technologies in the architectural and engineering aspects of construction.

5.4.2 – Research areas

Medium term

- To develop our understanding of the nature of moveable and immoveable cultural heritage environments (eg. mixing of air in cases and rooms and the interaction of water with complex building structures) through the development of risk management methodologies, models and tools.

- To map and research microenvironments and the interface between environment and surfaces that create stresses on moveable and immoveable cultural heritage. Development of understanding between physical changes in cultural heritage and citizens’ concern over changes in appearance through advanced and non-destructive techniques for damage diagnosis.

- To perform reliable analyses related to climatic conditions, together with the type of building (churches, castles, ...) and type of use, in order to try to find possible reserves and energy saving goals.

- To identify the optimum management and use of old and new buildings in terms of energy saving to avoid damage to historic materials, objects, fixtures, fittings and structures and respecting the health and comfort of building users.

- To identify sustainable solutions in terms of conservation of the moveable and immovable cultural heritage, use of non-renewable energy sources and cost-effectiveness in the design, construction, operation and maintenance of old and new museum/ galleries /archive...etc going over the existing barriers.

- To identify the most sustainable sources of alternative energy supplies for environmental control systems for the protection of moveable and immovable cultural heritage in order to reduce pollutant and CO₂ emissions, running, management and maintenance costs through the combined use of environmental impact assessments and conservation management plans.
To identify zones with the highest concentration of cultural heritage in the context of climatology, environmental (biological, chemical, physical) and geological characteristics that could be adapted to exploit alternative energy supplies and appropriate conservation measures in order to create synergies between stewardship of cultural heritage and the natural environment for the development of sustainable mitigation and adaptation strategies.

To apply new and satellite technologies (including SAR microwave and radar monitor) and multi-spectral scanners to assess damage to moveable and immovable cultural heritage (structural, bio-deterioration, blackening, etc) due to the action of the environment and to devise new products and methodologies for sustainable conservation.

**Long term**

- To create a global map of different refurbishment and renovation options with the aim of establishing the options that combine long life cycles and sustained functionality of historic buildings.
- To investigate more detailed evidence for climate change impact on cultural heritage and provide strategic answers.
- To promote the integrity of building envelope, collections and surrounding environment to highlight best practice in the environmental management of cultural heritage saving energy and reducing the pollution impact in historical centres where is high the concentration of historical buildings.
- To develop intelligent systems on different scales, based on networks of sensors and diagnostic tools, to control the effects of environmental events (external, internal and also from the subsoil) on historical buildings to provide inputs into risk management.
- To assess technologies for “energy optimised buildings” and active, renewable-based systems, for heating and cooling, for their performance and integration into the historic character of cultural heritage going over the existing barriers and finding the best and suitable solutions.
- To identify the most sustainable sources of alternative energy supplies and to adapt them for environmental control systems for the protection of moveable and immovable cultural heritage.
- To integrate strategic impact assessments, environmental impact assessments, conservation management plans and preventive management plans for the conservation of the immovable and moveable heritage.
- To develop databases containing relevant specific works that identify processes suitable for use in historic buildings as practical decision-making tools.

**5.4.3 - Contributions of Horizontal Issues**

**HI1: Education, Training and Ethics:**

Education and training in organized multidisciplinary networks of experts related to the energy & environment should be to create European Data Bases regarding the existing state of the art in this field, addresses of experts, typical traditional and modern techniques of refurbishment,
technique for heating and ventilation of CH object as less invasive as possible, case studies of successful techniques, new smart systems for monitoring the temperature and moisture content, available software for modelling the object under thermal load and their accuracy, list of manufacturers and developers of innovative smart systems, publications, addresses of stakeholders, knowledge and experience from previous and ongoing researches, websites, etc.

**HI2: Technical standards and specifications**

The current working areas of CEN/TC 346 in environment, where FACH should be active in are developing test and analysis methods for the diagnosis and for the characterisation of the artefacts and of their state of conservation with regards to outdoor and indoor environmental parameters. An action of FACH members devoted to define a standardisation of the materials and active systems towards a reduction of energy consumption would be also stimulated.

**HI3: Preservation of artworks:**

The contribution of the HI3, searching a new way for preservation of artwork, might pursue an harmonization of vision and sharing of knowledge. All of these strategies may be oriented to three different kinds of artworks: work of art (painting, sculpture, photography, etc.), architecture (cultural heritage and historical buildings in general), environment (also in its relations to the architecture and urban landscape).

In relation to WG4 -Environment & Energy-, the HI3 need to enforce a condivisible point of view in the comprehension of indissoluble relations between architecture and environment, especially in the way of sustainability. An enforce that may be reached with a responsible communication and condivision of energy efficiency problems: professional seminars, cultural trips (involving partners to appreciate virtuous experiences) and exhibitions.

**HI4: Socio-economic aspects:**

The WG4 comes from an assumption or idea raised a long time ago from the Cultural Heritage scope, like it is the fact that the conservation and rehabilitation of the historical buildings presents smaller costs with regard to the buildings of new construction. Related to this it is necessary to make a special emphasis, because the social benefits that it entails, in the fact that this type of activities generates a greater number of jobs, since conservation and rehabilitation tasks are more intensive from manual labour in contrast of the new labour, in which the costs of the capital absorbs a greater proportion of the resources. Energy efficiency and thermal comfort is a high challenge needed to revitalise historic towns.

**HI5: Disaster prevention & Risk Management:**

This working group aims to promote methods which will reduce the impact of climate change, such as energy efficiency. Climate change is set to become the biggest risk facing our cultural heritage, as it will promote extreme weather events such as droughts, floods, landslides, storms, etc. Whilst altering buildings to become more energy efficient is undoubtedly a worthwhile cause, these very same buildings may be at risk from the effects of climate change in the meantime, as the occurrence of extreme weather events is increasing.

WG4 aims to tackle many of the issues at the heart of climate change; however, with Governmental guidelines on energy efficiency in place, and pressure to carry out energy efficient works on buildings, including traditional buildings, striking a balance between saving energy and being sympathetic to the building is essential.
Whilst this WG does not directly approach the subject of climate change adaptation, it is key to reducing the impacts of climate change in the longer term. However, measures must be taken to ensure that by introducing energy efficient measures in to buildings; the fabric of the building is not weakened, making it more susceptible to the effects of disasters.

This WG is very closely aligned to planning for buildings post-disaster in that it’s primary focus is on refurbishment of buildings and material use. It may be the case that if a building is struck by disaster, that time is seen as the opportunity to implement some of the strategies offered by WG4. Much of what WG4 aims to examine in relation to materials and new skills are of direct relevance to the aim of authentic repair of heritage buildings.

1. Supply of appropriate materials. WG4 has two key aims that are directly related to this: the first, is the use of natural resources and the re-use and recycling of materials. Many materials become available for recycling from damaged or destroyed structures, and can be utilised in the repair of other structures. This is common practise in cases where a natural material supply is no longer available but there is still a demand for materials. The second aim that is of relevance to post-disaster planning is the development of an integrated supply train for procurement to maximise use of local materials. This is essential in that the majority of traditional buildings were constructed with locally available material, that may not be available now due to skills shortages, quarry closures, etc. Addressing this issue directly will aid in ensuring that in the event of a disaster, appropriate materials are available to repair a building and it is not allowed to fall in to ruin.

2. Skills and labour. Again, WG4 directly addresses this issue through the aim: provision of specific training to construction workers through the transfer of skills from the cultural heritage sector. In order to undertake a large scale repair or reconstruction project that is sympathetic to traditional construction methods, traditional skills must be used by the contractors used in the process. This may involve elements of re-training and instruction, but will be a requirement in projects such as this.

3. Prevention of repeated damage. The core of WG4 is to improve the energy efficiency of historic buildings in order to reduce the effects of climate change. This will on some level improve the risks relating to repeated damage to traditional buildings. Other efforts by this WG are focussed more on analysis and improving historic buildings, rather than ensuring that disasters do not strike again.

5.4.4 – Targets and key performance indicators 2030

- Improvements in environmental conditions, indoor air quality in refurbished buildings for sound conservation of moveable and immovable cultural heritage and occupant satisfaction
- Reduction in dependence on fossil fuels in 10% by re-using and recycling materials, using new materials for the reduction of energy consume and installation of renewable energy systems
- Contribution in reduction of pollution and CO₂ production
- Promotion of energy efficiency in historic buildings
- Minimization of the use of natural resources and the impact on the environment through re-use and recycling of materials
• Promotion of maintenance of cultural heritage to avoid unnecessary repairs
• Provision of specific training to construction workers through the transfer of skills from the cultural heritage sector
• Maintenance of natural assets to enhance the local landscape
• Development of an integrated supply chain for procurement to maximize the use of local materials, products and services
• Decrease in restoration interventions and costs

5.4.5 - Strategy

The Strategy of this WG is set against the background of heritage institutions facing the challenges posed by the indoor environmental needs of the moveable and immovable cultural heritage, climate change issues, widespread disinterest in funding maintenance and investment based on reduced public budgets. This Strategy is based on the opportunity to utilise the science of cultural heritage and the adapted science and technology in the civil field to benefit the refurbishment of the existing building stock through quality inputs of conservation and environmental knowledge to produce resource-efficient and environmentally-sound buildings that have an increased social and financial value.

Future environmental challenges that are facing cultural heritage today are different than those in the past. They are more dynamic, fast changing and presenting old problems in ways that may not be immediately recognisable. They may be old problems in different guises as well as new problems. Although the new challenges of environment (energy and climate) appear to be well understood, the tools and the decision-making protocols that will be needed, must be at wholly different level of sophistication to what they have been to date. From the present set of tools, more advanced tools need to be developed in the areas of management of information, risk assessment and risk preparedness.

This strategy is based on the need to demonstrate step-by-step the way forward for improvement to the whole environmental system composed of cultural heritage that need to be protected and the environment that has to be safeguarded both from natural as well as human causes of damage.

The revitalisation of historic towns and its socioeconomic impact can be positively affected by the energy efficiency in these buildings.

5.5. Management, Exploitation and Maintenance

5.5.1 - Introduction

Cultural Heritage Management concept has been supporting a constant evolution throughout time, as it has been adapted from individual elements to an integral vision, participating in the strengthening of identity, access, knowledge and sustainability, against the old concept of conservation of Cultural Heritage just as a duty and an economic cost, instead of an investment.

Buildings, cities and territories have to establish rich interactions through the preservation, restoration, transmission and integration of Cultural Heritage on its social, cultural and natural
environment. It is essential to avoid the isolation of Cultural Heritage from its surrounding, an isolation that frequently causes social rejects, irreversible non-desirable historical interventions and works causing high environmental impact.

Historical buildings and monuments, historical towns and cultural sites could contribute to the cultural, social and economical development to push urban regeneration and regional development processes, as tourism is considered the most important industry of XXIst century. In a general economic term, culture and tourism are related to the evolution of societies away from traditional industries towards the service sector, attracting investment and jobs in creative sectors.

Main aspects of the evolution from past Cultural Heritage Management to current tendencies are:
- Enlargement of scale: from individual elements to Sets of monuments and historic towns are managed together
- Integration of Intangible, Natural and Cultural Heritage
- Management based on social, environmental and economical aspects integrated to technical aspects, and integrated in holistic strategic plans
- Accessibility for everybody, comfort and user-friendly adaptation of refurbished cultural buildings and sites for a living cultural heritage
- New tools to improve the communication and the public participation in cultural heritage to develop a European citizen interaction
- Conservation of Cultural Heritage is an investment for the Administration and private bodies
- Use and re-use of Historical Buildings as a key element for the social regeneration of old cities
- Recovering of authentic Cultural Heritage values
- Dissemination is a key instrument to approach Cultural Heritage to the Society at all steps of the restoration process
- Predictive maintenance of monuments is a common strategy within the conservation strategies

5.5.2 - Research areas

Medium term
- Development of Cultural Heritage rational management and dissemination strategies and tools, including:
  - Structural assessment, monitoring, diagnosis, planning, rehabilitation, maintenance, conservation, knowledge management, economic management, education, awareness management
  - Identification of authentic CH values and establishment of criteria and tools to preserve them
  - Development of strategies for Cultural Heritage cataloguing and prioritisation through appropriate ICT’s systems to manage the information generated
  - Development of methods, criteria and tools for better understanding and accessibility of Cultural Heritage.
- Promotion of sustainable and flexible use of Cultural Heritage, mostly reconciliation between Cultural Heritage and tourism by developing:
  - Fostering the efficient and harmless use of heritage in relation with cultural tourism
  - New socio-economical models generating resources and protecting the environment
- Integral strategic planning of Cultural Heritage assets that result to Cultural Tourism development plan, as an alternative type to the conventional massive tourism
- Project management tools, such as: Time planning, Funding scheme, Mobilisation and allocation of funds (public sector), Motivation and incentives to mobilise private sector’s investments and entrepreneurship, Job creation
- Integrated project including archaeological sites as well as management of cultural landscapes even of rural settlements and industrial heritage; accessibility and fruition of leisure resources, the stability of ecosystems and the management of other fundamental resources of the territory
- Platforms and sociologic techniques that facilitate the interaction between public, private and citizens

Establishment of dissemination plans and tools of the whole Cultural Heritage conservation process (monument and environment, study, diagnosis, intervention) to provide added value to CH and ensure accessibility for all citizens

Development of pan-European model and strategy for tracking of changes of Heritage building due to natural impacts and maintenance interventions

Development of tools and systems to prevent service life of ancient and new materials and structures

Long term

Development of Cultural Heritage holistic and integral management strategies and tools, including:
- New operative frameworks integrating multicultural assets of the Tangible and Intangible Cultural Heritage
- Development of joint strategies and methodologies to consider groups of synergetic monuments as a whole
- Establishment of strategies anchoring the scaling up of public investments, capacity building, domestic resource mobilization, and official development assistance
- Development of ICT tools to create a management system considering the whole conservation/restoration process
- Use of Cultural heritage as an environment dynamisator for public, private and citizens, by establishing the value of cultural assets and developing new management tools based on multidisciplinary networks

Use of new ICTs technologies, to get new generations of EU citizens closer to CH and sensible to preserve it

Development of methodologies and establishment of appropriate criteria to elaborate sustainable and reliable predictive maintenance plans of European Built Heritage, including efficient and cost effective use

Development of new directives for the refurbishment and construction of conservation/exhibition buildings devoted to a better conservation of CH and at the same time the human comfort and a higher energy saving.

Introduce the concept of comfort (accessibility, habitability and safety) in Cultural assets, to increase their added value for the citizen

Development of tools and systems to prevent service life of ancient and new materials and structures

5.5.3 - Contributions of Horizontal Issues

HI1: Education, Training and Ethics:
Education and training in organized multidisciplinary networks of experts related to the management, exploitation and maintenance which should create European Data Bases regarding the existing state of the art in this field, addresses of experts, case studies of successful CH management concept with integral vision, case studies of successful interaction of CH object in social, natural and cultural environment to avoid isolation, case studies of successful CH objects influence to the cultural, social and economical development of region, case studies of successful integration of intangible, Natural and Cultural Heritage, cases of holistic strategic plans, new smart systems for monitoring, planning, rehabilitation, maintenance, conservation, knowledge and economic management, publications, addresses of stakeholders, Administration and private bodies, knowledge and experience from previous and ongoing researches, websites.

**HI2: Technical standards and specifications**

Standardisation in the field of conservation of cultural property shall increase longevity and reduce maintenance costs of conservation works, therefore reducing costs on a long-term range because conservation operations will be spaced out.

The current working areas of CEN/TC 346 in management and maintenance, where FACH should be active in are:

- Terminology relevant to movable and immovable artefacts, and to the conservation of the artefacts and of the material constituting the artefacts themselves, so that a common European terminology can be created;
  - Test and analysis methods for the evaluation of conservation conditions of indoor cultural property. In particular, standardisation on transportation and packaging methods, shall take in due accounts the needs and problems related to itinerant exhibitions and exchanges of works of art, in the permanent presentation conditions in museums, galleries, libraries and archives, in temporary exhibit galleries, in stores and in transport packaging.

**HI3: Preservation of artworks:**

The contribution of the HI3, searching a new way for preservation of artwork, might pursue an harmonization of vision and sharing of knowledge. All of these strategies may be oriented to three different kinds of artworks: work of art (painting, sculpture, photography, etc.), architecture (cultural heritage and historical buildings in general), environment (also in its relations to the architecture and urban landscape).

In relation to WG5 –Management, exploitation and maintenance-, we need to encourage the condivision of different experiences understanding the utmost importance of an enlargement of scale and the integration of natural and cultural heritage. To promoting an efficient integration should be encourage: cultural trips involving different partners (from administrations, private societies and universities), seminars; searching to sharing experiences and elaborating harmonized approaches to management.

**HI4: Socio-economic aspects:**

The WG5 approaches in a suitable manner the different socio-economic aspects linked to the management, exploitation and maintenance of Cultural Heritage. Starting off from the consideration of the role of Heritage in terms of economic, social and cultural development, and in line with the main doctrinal currents, an integral management of the different types of
Cultural Heritage is expound, based in a flexible and sustainable use of them. Among other proposals, it is worth to highlight the incorporation of the new Information and Communication Technologies (ICT) in the management and diffusion of the Cultural Heritage and, mainly, the Geographic Information Systems (GIS), very useful in the identification of synergies and in the strategic management of monument groups like authentic territorial systems of Heritage. Another idea that stands out, also approached in this proposal, is the necessity that in the Cultural Heritage management scope, tourism is a medium and not an aim on itself. It has to be fomented, in this sense, the cultural tourism, which, by definition, is based on the cultural values of the goods, and that reduces the negative impacts in relation to the tourism of masses on the protection and conservation of Cultural Heritage. In addition, this type of tourism generates greater income than other tourist segments, reason why it can contribute in the long term, in greater extent, to the sustainability of the Cultural Heritage system.

Nevertheless, it is suggested a greater emphasis on the management of the Cultural Heritage spreading oriented to the product or, in other words, in the management oriented to satisfy the specific necessities and demands of visitors and tourists by means of product development based on market segmentation, that is, the development of products oriented to each type of target people: children, adults, the elderly, etc. In this sense, it would be interesting to explore the different options that cultural marketing offers: oriented to product, quality, oriented to learning, etc.

**HI5: Disaster prevention & Risk Management:**

WG5 carries a broad range of activities, based around the theme of setting up strategies to sustain heritage in to the future. In this important field, disaster planning should take place. The central theme of this WG aims to both preserve and promote the use of cultural heritage; when disaster strikes, a management system should be in place in order to better preserve the cultural heritage artefact in question, and keep it in a condition such that it may recover from a disaster to become useable again in the future. Small management issues such as ensuring proper maintenance, having in place appropriate drainage and fire-fighting goods, etc., could make the difference between a building surviving a disaster and being re-used, and irreparable damage. Managing and maintaining buildings in a changing environment are essential also to the best possible management strategies proposed by WG5.

By anticipating these effects of climate change and the issues associated with them, the likelihood of buildings undergoing a serious failure is reduced. Disaster planning and risk management should be a major consideration when devising management strategies for traditional buildings.

WG5 carries a broad range of activities, based around the theme of setting up strategies to sustain heritage into the future. In this important field, post disaster planning should take place. The creation of strategies for handling disasters is becoming common for important monuments and sites such as castles. However, disasters striking vast areas of land that affect cultural heritage that is inhabited by people will also require a thought-out strategy of disaster and post-disaster planning.

1. Material Supply. In terms of disaster and post-disaster planning, identification of local sources of materials to effect repairs or reconstructions will be necessary. This includes identification of suppliers that can provide the quantity necessary to carry out a specific job. This issue should form a part of the strategy dealing with disasters.

2. Skills and Labour. Following on from the materials supply, the disaster plan should also include contractors with the necessary skills and qualifications to work on traditional materials.
and traditional buildings or territories. This should be part of an integrated disaster management tool.

3. Prevention of repeated damage. Following a disaster, an assessment of the management strategies performance and weaknesses should be carried out in order to improve and update the document to allow for more effective handling of disasters. This can include new strategies and tools, and be flexible enough to incorporate newly available tools to allow for disaster planning ensuring that heritage structures are better able to withstand disasters.

5.5.4 - Targets and key performance indicators 2030

- Database of European Cultural Heritage with 70 % of European monuments included
- 70 % of European monuments are managed with new sustainable models based on Strategic or Master Plans
- 50 % of Cultural Heritage is accessible to all citizens
- Communication plans based on new VR/AR tools are installed in 50 % of European monuments
- Increase of tourism benefits in 30 % through rational exploitation of Cultural Heritage
- 70 % of European monuments have a predictive maintenance plan
- 90 % of new EU generation is sensible to Cultural Heritage preservation
- Reliability of Service life models of new materials and structures is estimated in 60 %

5.5.5 - Strategy

In terms of management, main innovations required to get a holistic approach is: Cultural routes at transregional scale (mid term) and European or trans European scale (long term); New operative frameworks integrating Tangible and Intangible Cultural Heritage and Joint strategies and methodologies to consider groups of synergetic monuments as a whole. All these strategies will be developed in collaboration with other Working Groups.

Criteria to give priorities to the different interventions required for integral conservations strategy need innovation based on: Strategies and methodologies to develop and adapt Master Plans to the specific monument characteristics and systems to manage the information generated.

The information management and dissemination related to this complex processes require a high development and adaptation of ICT’s, Virtual/Augmented Reality and GIS technologies. The update of all information necessary for this process will be undertaking together with WG 1, 2 and 3.

The importance of periodic maintenance process of a monument should be increasing from now through: Reliable maintenance plans of monuments and historical districts, traditional architecture; Sustainable and reliable predictive maintenance strategies; Tools and systems to prevent service life of ancient and new materials and structures, and development of strategies and products to ensure the cost effective maintenance of the building once in use (including energy issues).

From now to the future, Cultural Heritage should be an investment for public and private bodies by means of: New socio-economical models generate resources and protect the environment and Urban and territorial planning strategies integrating tourism as a mean but not a goal.
Besides, the increase of comfort in ancient buildings is a key issue to guarantee the real value of Cultural Heritage.

Sensible citizens should participate more and more in interactive processes to get an integrate and sustainable Cultural Heritage management through adequate dissemination of Cultural Heritage, by means of new ICT’s, such as Virtual and Augmented Reality will be used for: Real communication plans; New Virtual Reality and other dissemination techniques to Cultural heritage; Awareness raising sensibilisation of scholars by using new technologies (virtual reality, ...); Education and training of professional and educators. Transference of CH policies and awareness strategies from EU all over the world. The main innovation generated by the rest of the WG will be showed to the citizens by using these strategies.

5.6. City and Territorial Aspects

5.6.1 – Introduction

Urban planning generally and in historic cities especially in the last decades has not exhibited any remarkable success and development. Only exceptionally, the safeguarding and enhancement planning in historic cities helped to survive valuable urban historic complexes. Much worse situation we can see in landscape and countryside where excessive development, mostly associated with tourism and sprawl, has been damaging also natural heritage. The planning procedures are extremely long and the results ineffective.

Another problem of historic cities can be seen in a gradual disintegration of their cultural heritage from the natural life of a city, which might finally cause losses of tangible as well as intangible cultural heritage. This process is again worsened by non-realistic urban and conservation planning and in some cases even due to conservation policy.

This is even more evident if we look at a lower scale at the historic city fabrics, where deterioration and weakening processes are not properly counteracted because of lack of appropriate theoretical methods and practical tools, including criteria and suitable indicators. Statistical and survey data collected in historic environment are incomplete, aggregated or completely lacking, which prevents to develop appropriate integrated conservation policies. Besides, historical city centres located in earthquake-prone areas become even more vulnerable if not adequately treated against seismic risk.

The most significant threats on our cultural and natural heritage environment are coming from large civil and structural engineering facilities (high speed trains, motorways, airports, large size canals, European network, etc.). Their incidence on city and territorial landscape development is high and difficult to "control" because they develop independently their logic at various geographical scales and never miss to strongly constraint the others levels.

Public participation necessary for sustainable development has been in many European countries underestimated and has not been sufficiently developed. It concerns not only governance, decision making and management of cultural heritage assets, but also the awareness, education, research collaboration and impact assessment campaigns.

Tourism activities are unevenly developed and focused on iconic cultural objects or natural heritage areas, which suffer excessively, even though there is an enormous potential of “softer” tourism goals. The associated infrastructure is being built without fitting and preserving the given natural and historical conditions and values as well as with little attention to environmental impacts, (mostly from transport).
Historical urban grid system should be exploited for remedial territorial planning taking advantage of all positive characteristics of historic settlements and cultural and natural heritage assets. New methodologies have to be developed to avoid idealism and utopia of former urban planning which did not consider properly the time effects and investment capacities. Besides, the idea of energy efficiency in historic cities and energy management at a scale of the historic urban areas should be developed in order to guarantee the new environmental and societal requirements with the consequent impact in the economy contributing therefore to the three pillars of the sustainability (economy, society and environment). New soft and hard communication means and many visionary EU projects should be developed to solve problems of "distributed" or remote workplace, sharing vehicles, new means of short distance transport, underground development, etc. All this can help to safeguard the existing settlement (and cultural landscape) pattern and help to create a new modern settlement grid supplied with appropriate technological background. This is also an important challenge for construction (and other) industries.

5.6.2 - Research areas

Medium term

- New planning and decision-making to incorporate and protect cultural heritage in the urban context, considering citizen’s lifestyles for cultural enrichment; management of risks while being accessible to a growing public to assure the economic benefits of sustainable tourism; preservation of the memory of cultural heritage while integrating it into the changing city
- Upgrading the role of public space, in particular with regard to its contribution to the social and cultural development of European population. Methods of better integrating public space within urban environments and ensuring continuity of public space
- Development of policies, partnership and networks on safeguarding and enhancement of cultural and natural heritage territorial values.
- Innovation in ICTs and nanotechnology based sensors to survey, documentation and management of historic environment; monitoring and controlling historic environment; and promotion of citizens participation in the protection of Cultural Heritage
- Monitoring and early warning systems for critical deterioration of historic environment.
- Development of a deeper knowledge about the real energetic situation in historic towns all over the Europe.
- Analysis of social aspects and style of life that hinders the energy efficiency in historic cities, and establishment of proper recommendations to change them, adapted to the old buildings situation.

Long term

- Refinement of tools for intergrading land use planning with other issues such as transport planning, waste management, tourism, etc., to fully optimise the use of the land (hence avoiding urban sprawl) while minimising resources consumption.  
- Improvement of security and reduction of criminality by new holistic urban management approaches which integrate diverse aspects such as the promotion and extension of the public space (e.g. to the expenses of the road network). 
- Multi parameter risk assessment and prevention measures in territories with cultural heritage values. Indicators of critical deterioration of territorial cultural heritage values. 
- New venues and approaches stimulating and exploiting value of cultural and territorial diversity and unity.
• Best practice for inter-regional public participation, communication and networking of units with cultural and natural heritage territorial values.

• Potential and exploitation of European historic environment and urbanisation for establishment of a Pan-European Urbanized Environment planning.

• Identification and design of new technologies, materials, products, systems and solutions, compatible with immovable Cultural Heritage requirements, to achieve efficient energy and accessibility rehabilitation of historic cities and buildings. This includes façade architectural elements, windows, internal walls, tiles and roofs, renewable installations, etc..

• Development of sustainability indicators and specifications to fulfil environment, energy and cultural requirements, in terms of energy efficiency and accessibility of historic urban areas going over the barriers.

5.6.3 - Contributions of Horizontal Issues

HI1: Education, Training and Ethics:

Education and training is of the most importance for development of this sector. Since the problems could be solved only on multidisciplinary level, it should be organized on the formal and informal level through the networks of multidisciplinary experts through the actions and exchanges of knowledge and experiences on European level and then distributed through National channels.

The first step should be organization of multidisciplinary networks of experts related to the urban planning (incorporation of cultural heritage in the urban context, emphasis of the public space meaning), sustainable tourism, policy makers, innovators in ICTs and nanotechnology, monitoring experts which should provide early warning systems for all kind of dangerous that could be detected (deterioration processes, fire and other kind of disaster, construction instability etc.). Multidisciplinary network of experts should create existing state of the art in this field, addresses of experts, case studies of successful CH management concept with integral vision, case studies of successful interaction of CH object in social, natural and cultural environment to avoid isolation, case studies of successful CH objects influence to the economical development of region, case studies of successful integration of intangible, Natural and Cultural Heritage, cases of holistic strategic plans, new smart systems for monitoring, planning, rehabilitation, maintenance, conservation, knowledge and economic management, publications, addresses of stakeholders, Administration and private bodies, knowledge and experience from previous and ongoing researches, websites. Second step is to transfer the knowledge and experience to all the professions that are included in city and territorial aspects. Public opinion on the subjects should be also noted through the questioners, public debates etc.

HI2: Technical standards and specifications

Standardisation in the field of conservation of cultural assets at urban and territorial lever deals with the development of policies to establish the conservation protocols at these levels. The establishment of terminology relevant to movable and immovable artefacts, so that a common European terminology can be created; and the evaluation of conservation strategies at urban and territorial level are the most relevant items in this WG.

HI3: Preservation of artworks:
The contribution of the HI3, searching a new way for preservation of artwork, might pursue an harmonization of vision and sharing of knowledge. All of these strategies may be oriented to three different kinds of artworks: work of art (painting, sculpture, photography, etc.), architecture (cultural heritage and historical buildings in general), environment (also in its relations to the architecture and urban landscape).

In relation to WG6 –City and territorial aspects-, is important to encourage inter-professional exchanges (seminars, cultural trips and exhibitions) in order to sharing knowledge on the urban planning experiences; especially in the way of integration between modern demands for urban living and historical centre. Social and economic intervention bust be integrated in a enlarged dimension, sharing experiences who have been capable to improve historical centre respecting modern way of life.

**HI4: Socio-economic aspects:**

WG6 approaches in a suitable manner the diverse and complex socio-economic implications derived from this line of work, although, however, a greater emphasis could be made in certain aspects:

Firstly, the necessity to drive urban planning and to carry out special plans like one of the best mechanisms to protect Cultural Heritage and to integrate it into city life, avoiding problems that are arising in many European urban limits, like the gentrification, or even the abandonment of them. The urban and territorial planning must necessarily be coordinated along other policies and, in special, with the conservation and tourism policies, that must be based in a suitable management and in the proper use of cultural advantages of the territory as a whole.

Secondly, the inevitable necessity to advance in the elaboration of statistics and cultural indicators relative to Cultural Heritage, and to gather aspects not only related to their conservation, but also to its use, diffusion, social and economic impacts of all its surroundings, etc. Closely related to the just mentioned, it is the necessity to introduce evaluation procedures in the design and implementation of the Cultural Heritage policies. That will force to gather data collection mechanisms over the different aspects and results derived from these type of policies (knowledge, protection, conservation and diffusion), and, on the other hand, will let to provide these type of policies with a greater efficiency and efficacy in the attainment of its objectives.

**HI5: Disaster prevention & Risk Management:**

Historical cities and landscapes are important areas of cultural heritage, as they can represent a rich heritage in a way that single buildings or monuments cannot. In terms of risk management & disaster planning, it may be necessary to consider not only a single building, but a collection of buildings close together, such as in a city. A disaster can strike in urban areas, and destroy large amounts of heritage stock at once. Taking a city-wide or territory-wide perspective may allow for better disaster planning and risk management, such that when disaster does strike actions can be taken to minimize the losses.

Climate change is an issue that promotes disasters by way of extreme weather conditions and flooding. This can take place across areas such as cities or large sectors of land.

Co-ordinating the effects of climate change in a manner that is sympathetic to historic building conservation, yet maintaining the highest possible level of adaptation can lead to a reduction in

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21 This term refers to, approximately, the expulsion of habitual inhabitants of the urban area (generally with a medium-low income), in favor of population with greater levels of income when the rehabilitation and renovation of the urban area has been carried out.
the effects of disasters should they strike on a territory-wide basis. Disaster planning and risk management should be a major consideration when considering traditional buildings in a city or territory.

Historical cities and landscapes are important areas of cultural heritage, as they can represent a rich heritage in a way that single buildings or monuments cannot. In terms of post disaster planning, this presents logistical issues that are not present when single structures or buildings are seriously damaged. The amount of work required to effect repairs on a large scale such as within a city is greatly increased, as is the amount of material needed. This also causes a great deal of disruption for residents, commuters, etc. who are affected by the repair works that are ongoing.

1. Material Supply. Should a large section of heritage stock be damaged or destroyed by a disaster, a lot of material will be needed for the repair work. Sourcing of the correct materials takes on the additional dimension of sourcing the capability to provide adequate supplies in a short space of time. This may require sourcing on a national or international scale, should local sources not be able to accommodate.

2. Skills and Labour. Commensurate with the materials, a large workforce may be required at short notice with the skills and abilities to correctly utilise the materials. It is during the post disaster period that there will be the greatest danger that unskilled or unqualified workers are used to work on heritage stock, a problem exacerbated by the volume of work necessary in a city or territorial environment. This logistical problem requires that a workforce may be needed from neighbouring regions to ensure the quality of the work remains high.

3. Prevention of repeated disaster. Following a disaster, an assessment of how the city or territorial anti-disaster mechanisms worked should be undertaken, for example assessing the effectiveness of flood defences. This assessment will allow for new designs to be introduced, or a strengthening of existing measures.

5.6.4 – Targets and key performance indicators 2030

- Increase of safeguarding and enhancement of cultural and natural heritage territorial values through knowledge based and public participation, communication and networking supported policies, strategies, technologies and tools

- Indicators and natural/societal hazards for critical deterioration of territorial cultural heritage values are available

- Pan-European inter-settlement grid methodology fully developed and available for use in all European regions.

- Cultural holistic management tools and best practice within cities and territories development planning.

- Safeguarding and consolidation of cultural heritage values in risk in territories improved by 40%

5.6.5 - Strategy

Conservation policies are to be based on a stepwise process, which enables to safeguard in time all cultural heritage values and prepares conditions for individual interventions according to the needs, risks, capacities and opportunities. Holistic planning in historic cities ensures cultural heritage safeguarding and use in a dynamic way defining solution corridors that determine acceptable limits for change of the city in time, which will facilitate to cope with the built heritage at different scales and according to the designers' best intentions and reflects also the
time direction towards the past landscape. Improved urban planning in historic cities and territories will use complex data from Geographical Information Systems tailored specially for the safeguarding and enhancement values as well as monitoring dangers and changes in historic environment and its rational management. Technological support for such activities will take advantage of development in information technologies, nanotechnologies and biotechnologies for innovation of sensors, indicators, measurement and control processes. New techniques are required to identify, regulate and monitor territorial objects, which cannot be addressed either at the city or the regional levels, like waterways, coastal areas, and engineering artefacts. Here the EU and regional policy instruments are to be accompanied with the support of enhanced technological tools.
6. Organization

6.1. Organizational Chart of the Focus Area Cultural Heritage (FACH)

The organization of FACH is structured according to the 6 following Working Groups and the 5-transversal/horizontal issues:

WG 1: Assessment, monitoring and diagnosis; WG 2 Materials; WG 3 Intervention techniques; WG 4 Environment and energy; WG 5 Management, exploitation and maintenance; WG 6 City and territorial aspects; it also covers and meets - according to a conceptual matrix - the 5 following complementary/transversal objectives: - knowledge supporting education and training, and communication – technical standards and specifications – preservation of artworks (conservation and restoration of the movable cultural heritage)– socio-economic aspects – disaster prevention and risk management.

FOCUS AREA CULTURAL HERITAGE:

Leadership (coordinators):
- Roko Zamic, GI ZRMK
- Isabel Rodriguez-Maribona, Labein-Tecnalia
- Kristian Engberg, Maxit-Saint Gobain

FACH Task Group composed of:
- Working Group Coordinators
- Horizontal Issues Coordinators

GENERAL and ASSOCIATED MEMBERS

Working Group 1
Assessment, Monitoring & Diagnosis
Johanna Leissner, Fraunhofer
Jacques Akerboom, Monumentenwacht

Working Group 2
Materials
Rob Van Hees, TNO
Antonia Moropoulou, NTUA/TCG

Working Group 3
Intervention Techniques
Agnieszka Gilun, Mostostal Warszawa S.A.

Horizontal Issue 1
Knowledge supporting education and training and communication
Vlatka Rajcic, University of Zagreb

Horizontal Issue 2
Technical standards and specifications
Katarina Malaga, CBI Swedish Cement and Concrete Institute

Horizontal Issue 3
Preservation of artworks
Pedro Martin Lerones, CARTIF

Horizontal Issue 4
Socio-economic strategies and tools
Isabel Rodriguez-Maribona, Labein-Tecnalia

Horizontal Issue 5
Disaster prevention and risk management
Roberto di Giulio, Universita di Ferrara

Working Group 4
Environment & Energy
Adriana Bernardi, CNR-ISAC
Angela Ruiz, ACCIONA

Working Group 5
Management, Exploitation & Maintenance
Milos Drdacky, ITAM CAS Prague

Working Group 6
City & Territorial Aspects
Jacques Teller, LEMA-University of Liege
Leadership coordinators

The Focus Area Cultural Heritage is led jointly by Isabel Rodriguez, isabel@labein.es, representative of “Labein”, Spain, by Roko Žarnic, rzarnic@fgg.uni-lj.si, who is representing “BCEI ZRMK”, Ljubljana and University of Ljubljana and by Kristian Engberg, kristian.engberg@maxit-group.com, representative from Maxit-Saint Gobain, France. The three leaders represent the Large industry (Maxit-Saint Gobain), the Small enterprise (ZRMK) and the research institutions (Labein). All three are members of ECTP Support Group where they represent the Focus Area Cultural Heritage and coordinate this Focus Area, as well as with the coordinators of the other Focus Areas.

Task Group:

The activities of Focus Area are coordinated and driven by a Task Group. Task Group members are the coordinators/leaders of the working groups and of the horizontal issues groups. At the Task Group meetings the working group coordinators make sure that at least one of them can participate.

Members of the Task Group are:

Jacques Akerboom, Monumentenwacht, Netherlands
Johanna Leissner, Fraunhofer, Germany
Adriana Bernardi, National Research Council-ISAC, Padova, Italy
Milos Drdacky, ITAM CAS Prague, Czech Republic
Kristian Engberg, Maxit-Group, Sweden
Agnieszka Gilun, Mostostal, Poland
Pedro Lerones, CARTIF, Spain
Katarina Malaga, CBI Swedish Cement and Concrete Institute, Sweden
Antonia Moropoulou, NTUA/TCG, Greece
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Roberto di Giulio, Università di Ferrara, Italy
Jacques Teller, LEMA-University of Liege, Belgium
Rob van Hees, TNO, Netherlands,
Roko Žarnič, BCEI ZRMK, University of Ljubljana, Slovenia
## Members of FACH

<table>
<thead>
<tr>
<th>NAME</th>
<th>INSTITUTION</th>
</tr>
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<td>Abuzeid Nasser</td>
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<td>Akerboom, Jacques</td>
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6.2. General and Associated Members

Membership of the Focus Area is open to all European interested organizations, and will be accepted after a written request to the Focus Area leaders, with the nomination of a liaison person and with the express commitment to participate in the working group activities and with a clause to support the level of dissemination of the information received accordingly with the rules established in the group.

The members will come from:

Clients and Users
Equipment manufacturers and Materials suppliers
Contractors
Architectural and Engineering Firms
Research Institutions and Universities
Government bodies and nongovernmental institutions

The Focus Area will particularly encourage the participation of SME’s and organizations from the New Accession Countries. The Focus Area will encourage the participation of women and the task force of the Group will maintain a record for their participation to achieve a significant role.

Potential Associated Members (including NGOs active in cultural heritage): ICOMOS, EUROPA NOSTRA, ICCROM, World Heritage Cities (European part).

6.3. SME’S involvement and relation with clients and users

Together with Working Groups, FACH will have a strong relationship with ECTP Advisory Group on SMEs and Advisory Group Clients and Users recently created by the ECTP Support Group.

The overall objective of Advisory Group on SMEs is to reinforce the SMEs / SME Groupings involvement in European research and innovation activities: the ECTP, the FP7 as well as in NTPs and National RTD programmes.

This AG on SMEs is co-lead by BBRI and Labein (also involved on FACH).

An Action Plan for SMEs involvement in the ECTP and future FP7 activities have been launched and approved by the ECTP SG in which three kind of actions have been included:

1. Support activities
   - SMEs Advisory Group Enlargement (members of the FACH are well represented such Labein, Futuretec and Acciona)
   - Identification and information on construction SMEs RTD participation (FP6 CH projects are included
   - Good practice identification on SME Involvement
   - Completion of specific fiche (s) for dedicated calls for FP7 collaborative projects dedicated to SMEs to be forwarded to the EC (to be discussed with CH responsible officers)
   - Start building up real FP7 proposal ideas for SME involvement
2. Dissemination Activities: Workshop, conferences, etc

3. Management activities: AG on SMEs meetings, reporting

For not staying in a close circle of experts and better covering the special interest of SMEs, a particular effort will be done to incorporate relevant SMEs to the different working groups of the FACH and to the ECTP AG on SMEs and in the process of building up real proposals.

Similarly appropriated links will be established between FACH and the Advisory Group on client end-user organisations. Its main objective is to assure that users and societies views and needs are reflected in ECTP. Involvement of this kind of organisations in future FP7 proposal is also a must.

This Advisory Group on Clients & Users is lead by SB i. which is a member of the SG and CSTB as ECTP Secretariat is member of the Advisory Group and also of the CHRAF project what will facilitate coordination.

This Advisory Group covers a wide spectrum of organisations such as: EDF-European Disability Forum, ICCF-International Construction clients Forum, AGE- The European Older People’s Platform, OWHC- Organisation of World Heritage Cities, CECODHAS- European Liaison Committee for Social Housing and particularly related to cultural heritage such as Monumentwacht Nederland, ICOMOS-International Council on Monuments and Sites, CHEDI-Culture, Heritage&Development-International, etc.
6.4. Links with other ECTP - FAs

The focus areas of the ECTP and Working Groups somehow linked to FACH’s WGs are:

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<td>Focus Area</td>
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<tr>
<td>Cities and Buildings (CAB)</td>
<td>D’APPOLONIA: De Laurentis, Raimondo (<a href="mailto:raimondo.delaurentiis@dappolonia.it">raimondo.delaurentiis@dappolonia.it</a>)</td>
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<td>SINTEF: Krigsvoll, Guri (<a href="mailto:guri.krisvoll@sintef.no">guri.krisvoll@sintef.no</a>)</td>
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<td>ACCIONA: Javier Mardaras (<a href="mailto:jmardara@accion.es">jmardara@accion.es</a>)</td>
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<td>Quality of life (QOL)</td>
<td>BAUEN MIT STAHL: Bernhard Hauke (<a href="mailto:Bernhard.Hauke@hochtief.de">Bernhard.Hauke@hochtief.de</a>)</td>
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<td>SOLETANCHE-BACHY France: Jean-Pierre Hamelin (<a href="mailto:Jean-Pierre.HAMELIN@soletanche-bachy.com">Jean-Pierre.HAMELIN@soletanche-bachy.com</a>)</td>
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<td>Materials (MAT)</td>
<td>SAINT GOBAIN: Roger de Block (<a href="mailto:roger.deblock@saint-gobain.com">roger.deblock@saint-gobain.com</a>)</td>
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<td>HEIDELBERG CEMENT: Wolfgang Dienemann (<a href="mailto:wolfgang.dienemann@htc-gmbh.com">wolfgang.dienemann@htc-gmbh.com</a>)</td>
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<td>UNIVERSITE DE LA MARCHE: Gian Marco Revel (<a href="mailto:Gm.revel@mm.univpm.it">Gm.revel@mm.univpm.it</a>)</td>
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<td>Processes &amp; ICT’s (P&amp;ICT)</td>
<td>ARUP: Jeremy Watson <a href="mailto:jeremy.watson@arup.com">jeremy.watson@arup.com</a></td>
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<td>VTT: Matti Hannus (<a href="mailto:matti.hannus@vtt.fi">matti.hannus@vtt.fi</a>)</td>
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Working groups and issues addressed by FACH interact also with other Working groups and issues of other Focus Areas that will contribute to the homogenisation of activities across the whole ECTP, as mentioned before. Following matrix shows the interaction between different WG of every Focus Area with Focus Area Cultural Heritage:
6.5. Links between FACH and E2B JTI

The growing importance of culture is closely linked to recent economic development trends. Firstly, the increasing importance of CH in Europe is related to the evolution of societies away from traditional industries towards the service sector. Secondly, changes in lifestyle and growing leisure time create more demand for leisure activities, including culture. At the same time the human comfort is one of the main goals of the life. Both trends tend to encourage economically viable aspects of culture.

The city and village are probably one of the most important working places for the Construction Industry and an addressable market. Their urgent need for restructuring and re-qualification has already been observed everywhere in Europe. Knowing that these territories contain a significant quantity of existing buildings and monuments, the necessity arises to re-use them systematically as a basic support for restructuring the place. Re-use, upgrading and adaptation to new functions of historic buildings are a pre-requisite for sustainable development and for conservation of the historic environment.

The need to save energy and reduce CO2 emissions make it necessary to adapt our cities to mixed use (housing, services and working places in the same area), so that traffic movements are reduced. This means the historic centres of European cities have to be transformed to a better place to live, work and visit. This concept is also linked to the concept of improving the level of accessibility of our cities, as retail activities are literally flowing outside city centres, which threatened the sustainability of historic centres.

Many building assignments take place within the historic context of existing buildings, urban structures or cultural landscapes. Building in the historic context requires an attitude of architects and planners to be conscious of existing qualities in their plans and designs.

Apart from conservation of monumental values, the necessity of saving natural resources, without renounce of the reached human comfort, in general leads to a better re-use of existing infrastructures and buildings. Already approximately 80% of the buildings and structures of the future city are already constructed [reference?]. As a consequence of that, it is expected an increase of the activities of refurbishment and rehabilitation, representing, nowadays, about 40% of construction activities. Historic buildings, c.q. monuments may perform an exemplary role. Research closely related to the process of intervention and transformation is necessary.

Further, Cultural Heritage is closely related to other economic activities, as tourism. As the conservation and transformation of CH buildings may be considered very knowledge intensive, the effective implementation of new and innovative technologies will lead to an important economic impact, mainly related to the creation of new jobs. Further, a general change of the local image and the increase of visitors and activities related to them are economically important. Cultural Heritage is a key to the economic competitiveness of Europe, with €340 billion annual turnover and 8 million workers.

To promote the importance of the historic centres as key areas to improve sustainability, it is crucial now to ensure that the present requirements demanded by the citizens, in terms of habitability, that are usually achieved in new housing, are also reached by transformation of historic buildings and centres in historic areas. These requirements mostly refer to energy efficiency, accessibility, new functions and infrastructures.

In spite of the need to fulfil these requirements, the integrity and authenticity of Cultural Heritage buildings of these areas should be preserved, and, therefore, most of the solutions designed and
used for normal buildings can not easily be applied in rehabilitation and/or refurbishment of historic buildings. On top of that, historic buildings are excluded from the Energy Performance of Buildings Directive 2002/91, and often any new opportunities for sustainable technologies to be included are constrained by legislative, social, technical and economic barriers. Nevertheless the conservation, modification, intervention and transformation of architectural and urban heritage in a broad sense need to become an important aspect of the architectural practice.

These old solutions and new discoveries developed mainly in a civil contest aimed to save energy and preserve our environment needs to be modified, improved and adapted for the particular needs of the immoveable and moveable Cultural Heritage.

The necessity to solve this conflict is restraining the potentiality of the historic areas as an ideal place to live, work and visit, and urgent research is needed to establish the means to determine habitability requirements and to design new (transformation) solutions able to reach them.

The overall objective of E2B JTI is to deliver, implement and optimize building and district concepts that have the technical, economic and social potential to drastically cut the energy consumption and reduce CO₂ emissions from the existing and new buildings at the overall scale of the European Union.

E2B JTI will speed up research on key technologies and develop a competitive industry in the fields of energy efficient products and services, with the main purpose of reaching the goals set forth for 2020 and 2050 to address climate change issues and contribute to improve EU energy independence thereby transforming this challenge into a business opportunity "E2B JTI: Energy Efficient Buildings Joint Technology Initiative" is an initiative where FACH members are interested in and which is being approved by the Commission in the following months.

During the General Launching Meeting in Brussels the 28th February 2008 was still underlined the JTI is interested toward Cultural Heritage.

A special working group focused on Cultural Heritage studies and applications will be established inside the JTI E2B in the next future.

Main issues included in this SRA that could be developed through the JTI E2B are included in WG1: Assessment, monitoring and diagnosis; WG2: Materials; WG4: Environment and energy (this WG is very closely related to JTI E2B goal); WG5: Management, exploitation and maintenance, and WG6: City and territorial aspects.

Following, the strategy and contents to include energy efficiency issues in cultural heritage assets are presented, with regards to the present FACH structure and SRA contents:

**WG1: Assessment, monitoring and diagnosis**

The determination of the present situation of indoor and outdoor parameters that could have an influence in the microclimate is a key issue to reduce energy demand and to increase the comfort of these buildings. Continuous monitoring of these environmental conditions should be performed, and reliable and cost-effective tools to perform these activities should be developed.

Besides, adequate modelling on the behaviour of historic buildings (whose building elements and materials are different from present constructions), should be also developed to assess on the measures to be taken into account and to evaluate the feasibility of these measures.
In this sense, the strategies to be developed in this WG will include:

- Sound assessment of the state of conservation of the building and its composing materials.
- To develop criteria and methodologies for the diagnosis and study of the energy efficiency of historic buildings in historic cities. Analysis of the feasibility and identification of the barriers to undertake actions and include energy saving solutions.
- Detection and identification of damage processes starting from the surface, which is exposed to the environment, with particular attention to interface processes.
- Indoor and outdoor environment and energy consumption.

**WG2: Materials**

To reach the new energy efficiency requirements, new materials should be developed. In new buildings, their requirements could allow the use of a high range of new materials that are being to be developed with this aim.

However, the special requirements of Cultural Heritage, including compatibility with old materials; adaptation to already built elements that could not be removed, aesthetic impact and integrity of cultural heritage buildings, historic and architectonical values, etc., need the development of specific materials. In some occasions, these materials have not been developed for standard buildings, as they could not be competitive in cost, but should be specially developed for cultural heritage issues.

In this sense, the strategies to be developed in this WG will include:

- Development of "self-learning", memory, self-adjusted, self-cleaning, self-healing, energy-efficient and smart materials to implement with safety and compatibility to authentic materials and structures and ensure their extensive reuse.
- Modification, adaptation and improvement of the most recent discoveries in materials and technologies (renewable energy systems) applies to immovable Cultural Heritage, to achieve at the same time a better conservation of moveable Cultural Heritage and a reduction in dependence on fossil fuels by re-using and recycling materials and installation of renewable energy systems.

**WG4: Environment and energy**

This WG is closely linked with JTI E2B, as one of the major goals of this WG is the development of new solutions to adapt cultural heritage to the new requirements, including environmental needs (reduction of energy consumption and climatic change) and also social needs (higher demand of comfort conditions).

Main topics to be developed in this WG refers to:

- To perform reliable analyses related to climatic conditions, together with the type of building (churches, castles, ...) and type of use, in order to try to find possible reserves and energy saving goals.
• To identify the optimum management and use of old and new buildings in terms of energy saving to avoid damage to historic materials, objects, fixtures, fittings and structures and respecting the health and comfort of building users.

• To identify sustainable solutions in terms of conservation of the moveable and immoveable cultural heritage, use of non-renewable energy sources and cost-effectiveness in the design, construction, operation and maintenance of new museum/galleries/archive...etc.

• To identify the most sustainable sources of alternative energy supplies for environmental control systems for the protection of moveable and immoveable cultural heritage in order to reduce pollutant emissions, running, management and maintenance costs through the combined use of environmental impact assessments and conservation management plans.

• To identify zones with the highest concentration of cultural heritage in the context of climatology, environmental (biological, chemical, physical) and geological characteristics that could be adapted to exploit alternative energy supplies and appropriate conservation measures in order to create synergies between stewardship of cultural heritage and the natural environment for the development of sustainable mitigation and adaptation strategies.

• To investigate more detailed evidence for climate change impact on cultural heritage and provide strategic answers.

• To promote the integrity of building envelope, collections and surrounding environment to highlight best practice in the environmental management of cultural heritage.

• To develop intelligent systems on different scales, based on networks of sensors and diagnostic tools, to control the effects of environmental events (external, internal and also from the subsoil) on historical buildings to provide inputs into risk management

• To assess technologies for “energy optimised buildings” and active, renewable-based systems, for heating and cooling, for their performance and integration into the historic character of cultural heritage.

• To identify the most sustainable sources of alternative energy supplies for environmental control systems for the protection of moveable and immoveable cultural heritage.

• To integrate strategic impact assessments, environmental impact assessments, conservation management plans and preventive management plans for the conservation of the immoveable and moveable heritage.

**WG5: Management, exploitation and maintenance**

Conservation and maintenance of historic buildings mostly depends on the added value of these buildings to the society, and, therefore, they should be adapted to the new requirements and better living/use conditions.

In this sense, the strategies to be developed in this WG will include:

• Energy efficiency and reduction of energy costs, in order to guarantee reliable and cost effective maintenance plans

• Adaptation of cultural heritage issues to the new comfort requirements that are currently demanded by the citizens, to increase the value of these elements, and to guarantee their suitability in certain cases (museums, ...)

• Development of methodologies and establishment of appropriate criteria to elaborate sustainable and reliable predictive maintenance plans of European Built Heritage, including efficient and cost effective use
• Development of new directives for the refurbishment and construction of conservation/exhibition buildings devoted to a better conservation of CH and at the same time the human comfort and a higher energy saving.

• Introduce the concept of comfort (accessibility, habitability and safety) in Cultural assets, to increase their added value for the citizen

WG6: City and territorial aspects

At present, most of the European historic urban areas are not properly recognised as ideas places to live and work. Main aspects that hinder this perception is the lack of accessibility and poor comfort and habitability conditions.

Regarding living conditions, new management strategies to increase the energy consumption should be developed at urban scale.

Besides, new cost effective solutions, specially adapted for historic cities housing, should be developed.

The strategies to be developed in this WG will include:

• Refinement of tools for intergrading land use planning with other issues such as transport planning, waste management, tourism, etc., to fully optimise the use of the land (hence avoiding urban sprawl) while minimising resources consumption.

• Development of a deeper knowledge about the real energetic situation in historic towns all over the Europe.

• Analysis of social aspects and style of life that hinders the energy efficiency in historic cities, and establishment of proper recommendations to change them, adapted to the old buildings situation.

• Identification and design of new technologies, products, systems and solutions, compatible with immoveable Cultural Heritage requirements, to achieve efficient energy and accessibility rehabilitation of historic cities and buildings. This includes façade architectural elements, windows, internal walls, tiles and roofs, renewable installations, etc.

• Development of sustainability indicators and specifications to fulfil environment, energy and cultural requirements, in terms of energy efficiency and accessibility of historic urban areas.
7. Financial aspects

The resources to be used for the implementation of activities and tasks of the working FACH groups will come mainly from the participating organizations, by covering their own costs.

From end of 2006 to march 2008, some support from EU DG Research was obtained particularly to assist the FACH Secretariat and coordination of activities including the reimbursement of travelling costs of Task Group Members. This funding was established through CHRAF proposal, an EU project developed under the call for proposals FP6-SSP5 5A, 8.1. B.3.6 “Task 7” to support cultural heritage research activities: to help identify priorities and develop strategies as input to the European Construction Technology Platform (ECTP) and its strategic Research Agenda, as well as to future FP7 activities regarding cultural heritage research; in particular to support the organisation of the Focus Area “cultural heritage” of the ECTP. EU budget: 150.000 €. The duration of CHRAF has been 18 months (starting date: 01/10/2006).