European Construction Technology Platform

Focus area
Quality of Life
TOWARDS A SUSTAINABLE BUILT ENVIRONMENT

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1 EXECUTIVE SUMMARY

The role of the Construction Sector is to provide the shelter for human activities The rapid development of humanity calls for radically new and sustainable modus operandi in Construction to optimise the management of natural resources and to maintain the quality of our life and of our built environment.

The object of this initiative is to support EU policies and targets on the impact of construction activities on health, safety and environment. The approach is to change the focus from the technical standpoint to view construction activities from the human perspective.

Four key areas are involved:
1. Reducing Environmental Impacts
2. Mitigating Natural and Man-Made Hazards
3. Improving the Indoor Environment for All
4. More Attractive Work Places

The first ambition of this Focus Area “Quality of Life” is to make possible these Research and Development activities by raising awareness within the Construction Sector towards its social responsibility and by initiating an interactive dialogue with its end users. The second ambition is to promote a new research approach, which brings human concerns to the forefront.
2 INTRODUCTION

The role of the Construction Sector is to provide shelter and its related infrastructure for all human activities: family homes, workplaces, leisure places, and transport infrastructures. It is hard to realise how much our quality of life is dependent on the quality of our built environment and its impact on our way of living, our way of working, our way of moving. This makes the construction sector a key contributor to a sustainable society.

A new human approach is necessary in order to meet the major challenges, which are now posed by the very rapid evolution of humanity:

- The worldwide demographic growth creates an urgent need to implement the concepts of sustainability in our built environment. The Construction Sector has a pivotal role to play in preserving the environment, reducing greenhouse gas concentrations, mitigating existing polluted areas, saving natural resources such as greenfields, water, energy, raw materials.
- Climate change is creating the vital need for major evolutions of our built environment. The Construction Sector has a pivotal role to play in adapting our homes to a more variable climate, in providing the infrastructures which are necessary to control increasingly frequent natural hazards (floods, landslides, earthquakes).
- An increased concern for security issues: the Construction Sector cannot ignore the growing pressure imposed by terrorism on the whole of society.
- Sustainability also means that the Construction Sector must put major efforts into meeting human needs: the impact of indoor environment on human health is still a new domain for research. Finally, in spite of significant progress in recent years it remains unacceptable to see this Sector of activity plagued by one of the most dramatic rates of accidents at work.

European policy takes in account this need for change: a number of European Directives and Action Programmes are now taking account of these concerns, leading to more and more strict regulations on pollution (air, water, soils, etc), on CO2 emissions, on air quality, on nuisances (noise, vibrations), on safety at the workplace, etc. This evolution continuously obliges the Construction Sector to reconsider its production processes.

At the same time, the enlargement of European Union creates the need to upgrade or redevelop a vast proportion of the built environment. A new picture of Europe is being drawn now under our eyes, it is urgent to develop the new methods, the new processes which are needed to make it sustainable: when human needs for safe and comfortable shelters, transport facilities, working places, are made compatible in the long term with a preserved environment. This evolution provides a unique opportunity to introduce a new approach to Construction: it simply must not be missed.

The main mission of this Focus Area is therefore to develop a sustainable relationship between the built environment, nature and citizens.

Quality of life and sustainability are relatively new concerns for the Construction Sector; and meaningful results are urgently needed and must be obtained rapidly. In order to embody these new concerns into the reality of our construction sites, the objective of this Focus Area is to organise efficient research and development efforts, to raise awareness on the new
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requirements of society on our techniques, and to promote a new research approach more focused on human sciences.

This Focus Area Quality of Life is organised in four Working Groups,

**Interaction of built environment with nature**
- WG1: Reducing the Environmental Impacts
- WG2: Mitigating Natural and Man-Made Hazards

**Interaction of built environment with citizens**
- WG3: Improving the Indoor Environment for All
- WG4: More Attractive Work Places

Many issues addressed by this Focus Area also fall in the domain of other Focus Areas of the ECTP: this only reflects the concern to cover all strategic issues properly and in a harmonised way.
3  WG1 Reducing the Environmental Impacts

3.1  Background and Present Situation

Construction activities have a high environmental relevance. The environmental impacts related to construction and building activities (resource consumption, energy consumption, emissions to air, to soil, to water, etc) extend through the whole life cycle of buildings and urban environments.

The impact of the built environment on the natural environment comes mainly from:

- **Inadequate urban planning and management:** Each one of the functions and elements of the urban areas has an environmental impact that will contribute to the overall environmental impact of the city. The accumulation of buildings and other hard surfaces have several negative effects on the environment: soil sealing that enhances the opportunities of flooding, creation of "heat island" effects, shining pollution, concentration of pollution and disturbances (noise, dust.). At this moment, the environmental implications of policy decisions are often not sufficiently considered. Reducing these environmental impacts whilst ensuring a vibrant economy and a healthy, equitable society as a goal of sustainable development. However, many municipalities do not give a sufficiently high priority to improving the environmental performance and quality of their town. So integrated tools are necessary to consider the environmental impact of urban planning decisions along the whole life cycle of the urban environment. One of the most important questions in this point is the 'geographical planning of the different functions (living, working, leisure, warehouses)'. By not planning these, or by planning them poorly, the day by day of the urban areas will not be adequate (without green spaces and public transport, with poor living conditions, etc.) and will generate a substantial environmental impact (associated to the traffic, to the energy consumption, to the waste management, etc.)

- **The use of the land:** Large surfaces of "Greenfield" (natural land, for instance) are used for construction of buildings, transport, infrastructure, etc, in Europe every year. One of main conclusions of the European Corine Land Cover Project\(^1\) is that the amount of urban soil increased exponentially and that the amount of natural land available for other purposes is dramatically diminishing. In order to reduce the use of greenfield a combination of measures can be adopted: The re-use of previously used "brownfield" land, the greater use of underground construction, the adoption of more dense patterns of urban living where it is possible, etc. The revitalisation of urban centres acquires here a huge relevance. There are a lot of centres in Europe’s urban areas that are old and not attractive to live. This lack of attractiveness moves people to the edge of the city, consuming ever more greenfields.

\(^1\) Corine Land Cover (CLC) is a map of the European environmental landscape, based on interpretation of satellite images, CLC provides comparable digital maps of land cover for each country for much of Europe, aimed at environmental analysis and policy making and assessment. CLC was officially launched by the European Environment Agency (EEA) on 17/11/2004 in Brussels. The satellite images can be obtained at the website: http://image2000.jrc.it/
AQUATERRA is one of the first environmental Integrated Projects in the EU Programme 6, active since 1st of June 2004. It has 45 partners organisation in 12 EU countries. One of its objectives is to develop integrated modelling for impact evaluation on climate and land-use changes for definition of long-term schemes

- **The disturbance, disruption, wastes and potential pollution associated with construction works**: At the current times people associate construction works on any scale with disruption. This could be reduced by seeking to complete the works more quickly, by reducing the extent of on-site activities or by changing the process and related plant and equipment (towards a less disruptive process, avoiding heavy machines). An increasing degree of off-site manufacture and assembly will allow an effective reduction of the disturbance and disruption caused by construction works, but the transport of larger individual components will be also disruptive to other communities. More accurate control of the works, and better information systems will assist, for example, by minimising the volume of excavation and reducing the incidence of errors that extend the duration of works.

The 5th Framework project ROADCON, commissioned under the IST programme, has developed a vision for "agile, model-based, knowledge-driven construction". It expressed the vision as: "A construction sector driven by total product life cycle performance and supported by knowledge-intensive and model-based ICT, which provides holistic support for decision making by all stakeholders throughout the various business processes and the whole product life cycle".

- **Urban transport**: Urban transport systems are critical elements of the urban fabric. They give access to goods, services, employment and recreation opportunities, they support the freight traffic and they enable local economies to flourish. However, if the high density of buildings is the main character of towns and cities, high volumes of traffic comes second. Traffic has significant impacts on the environment and on the health of urban citizens, as well as on the overall quality of life in towns. Nearly all of Europe’s urban citizens are exposed to significant air pollution levels. Increasing urban traffic will also counteract efforts made to reduce greenhouse gas emissions. The high level of motorised urban transport also contributes to the increasingly sedentary lifestyles with a range of negative effects on health and life expectancy, notably in relation to cardio-vascular disease. The main challenge in the domain of urban transport is to reduce the number of people using single-occupancy cars (reducing transport-related pollution). On the other hand, urban public transport will meet more stringent demands: a mounting diversification of journey needs and the increase of demands from general public. Therefore this will affect the quality of transport and force the public transport to pursue the satisfaction of customer needs. Public transport will also have to take in account the preservation of environment and sustainable development.

- **Materials**: As much as 50% of all materials extracted from the earth’s crust are transformed into construction materials and products. Buildings (including the embodied energy in construction products and materials) account for as much as 40% of all energy use. Moreover, these same materials, when they enter the waste stream, account for some

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Towards a thematic strategy on the urban environment
50% of all waste generated prior to recovery\(^3\). The amounts of raw material and energy used in construction have to be minimised, as well as produced pollution and wastes. This can be achieved by reusing existing building components such as façades and structures and by making the built environment more flexible, thereby allowing adaptation to changing user requirements. Considering the embodied impact of different building options when deciding whether new-build or refurbishment would be most appropriate approach. A careful choice of materials and components can greatly reduce the embodied impact of construction. Reused or recycled materials are generally preferable to new in terms of sustainability, provided they haven’t been transported over considerable distances or undergone a significant cleaning/repairing processes, which would increase their environmental impact. Where new materials are specified, renewable ones must be preferred.

On the other hand construction materials, components and systems will configure the features of the buildings and the urban environment. High performance materials will facilitate efficient and low environmental impact management at construction stage, during their lifetime (thermal performances, acoustic performances, durability, flexibility,...) and at the end-of-life (deconstruction vs. demolition, reuse-recycling of deconstruction wastes, etc.). Using new lightweight materials in roofing, façades and structures will reduce the dimensions and material requirements of these structures and their foundations.

**Opportunities for construction were reviewed in the NANOCONEX project with the objective of developing a nanotechnology roadmap for construction applications. Nanotechnology can help to produce "conventional" materials (such concrete) with special properties such as the ability to resist attack in aggressive ground conditions, or capable of exceptional performance, for example in strength of ductility.**

- **C&D Wastes\(^4\):** C&DW amount to around 180 million tonnes in the EU each year. About 65% of this is recycled or re-used across the EU-15. A high proportion of it is concrete, bricks and tiles, which is well suited to being crushed and recycled as a substitute for newly quarried aggregates in certain lower grade applications. The nature of C&DW is directly linked to the techniques used to build the structures that are now demolished. Thus, the increasing variety of materials used also increases the complexity of managing demolition waste. Buildings and the built environment account for about half of the material taken from the Earth’s crust and are the source of 480 Kg demolition waste per person per year. Reusing and recycling building waste would significantly reduce the need for landfill sites and for further mineral extraction. The demolition process plays an important role there: it must be planned and organised so as to enable maximum reuse and recycling of materials and components. This is likely to be cost-neutral or even bring costs savings. Another important issue relates to waste reduction from the design, through approaches such as using standardised components or providing space for the recycling bins in the finished buildings. The building process has to be planned and managed in a way that minimises the production of wastes during the construction process.

- **Energy use in buildings:** Heating and lighting of buildings account for the largest single share of energy use (42%, of which 70% is for heating) and about 35% of all greenhouse

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\(^3\) For example, in UK each year there are around 13 million tonnes of materials that are delivered to site but never used.

\(^4\) COMMUNICATION FROM THE COMMISSION. Towards a thematic strategy on the prevention and recycling of waste. Brussels 2003
gas emissions. Poor design and construction methods can have a significant effect on the health of a building’s occupants and can produce buildings that are expensive to maintain, heat and cool, disproportionately affecting the elderly and less affluent social groups. Changing the ways that buildings and built environment are designed, constructed, refurbished and demolished therefore has the potential to significantly improve the environmental and economic performance of towns and cities and the quality of life of urban citizens. The Directive on energy performance of buildings is expected to make a significant step forward by highlighting the very real shortcomings of the generally unsatisfactory energy performance of existing buildings. In this domain, the purpose is to minimise the energy consumption (or even to produce energy) without loss of comfort for the occupants. Several alternatives could be applied for this purpose: acting on the envelope, insulation, efficient and responsive heating and lighting controls, appropriate glazing and shading to avoid overheating in summer, natural ventilation, renewable sources of energy, etc. Customised and intelligent work- and living space offers important opportunities to reduce energy use.

- **Water use in buildings**: This issue relates to the consumption of water and the production of waste water. Sustainability requirements are to reduce the amount of treated water used in the building and to reduce the amount of the wastewater treated in wastewater plants. This can be achieved through using water efficient fittings, control devices, grey-water recycling treatment systems, rain water collection for toilet flushing and irrigation, or even black water recycling, implementation of a Building Management System (BMS), etc.

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**ECO-SERVE** is a large ongoing European Thematic Network dealing with environmental impact of the construction industry. It represents one of the greatest investments in networking activities within the European construction industry. The results will be technical solutions, guidelines etc. contributing to a more competitive and sustainable construction industry, to the benefit of the European society, its citizens and the industry itself.
3.2 Vision

Radical reduction of the negative impacts of the whole life cycle of construction and the built environment through the efficient use of resources and a zero-waste approach.
### 3.3 Medium and Long Term Objectives

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<th>Horiz.</th>
<th>Objectives</th>
<th>Breakthrough</th>
<th>Innovation</th>
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<tbody>
<tr>
<td>Medium Term</td>
<td><strong>Reduce the environmental impacts of manufacturing, of materials and components</strong>&lt;br&gt;- 20% decrease in embodied energy of new builds&lt;br&gt;- 20% reduction of construction waste</td>
<td>Improved manufacturing processes&lt;br&gt;Creation of composite performance indicators and materials rating systems</td>
<td>New manufacturing processes that:&lt;br&gt;- Use less energy&lt;br&gt;- Generate less waste&lt;br&gt;Harmonised Environmental Product Assessment.&lt;br&gt;Components designed to optimise the efficiency of transportation.</td>
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<td><strong>Reduce the environmental impacts of the construction process</strong>&lt;br&gt;- Reduction of impacts on air, water and soils&lt;br&gt;- Reduction of waste, and disturbances mitigation</td>
<td>New integral management systems involving:&lt;br&gt;- Facilities design&lt;br&gt;- Planning&lt;br&gt;- Environmental impact&lt;br&gt;- Disturbance assessments</td>
<td>Application of ‘Information and Communication Technologies’ (ICTs) for the development of integral planning and management systems and tools.</td>
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<td><strong>Regeneration and remediation of land</strong>&lt;br&gt;- 20% regeneration of brownfield sites</td>
<td>Application of technologies for:&lt;br&gt;- Contaminated soil and groundwater management&lt;br&gt;- Monitoring, remediation and containment</td>
<td>New techniques for contaminated soil risk management.&lt;br&gt;Cost-effective technologies for:&lt;br&gt;- Soil remediation&lt;br&gt;- Contamination containment</td>
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<td><strong>Sustainable use of the built environment</strong>&lt;br&gt;- 20% decrease in energy consumption and CO₂ emissions from new builds&lt;br&gt;- 5% decrease in energy consumption and CO₂ emissions from existing structures</td>
<td>Creation of:&lt;br&gt;- New conceptual design for buildings, neighbourhoods and cities&lt;br&gt;- ICTs for sustainable (building) management&lt;br&gt;- Performance indicators and building rating systems&lt;br&gt;- Innovative materials and components&lt;br&gt;Widespread development of existing:&lt;br&gt;- Low consumption and renewable energy markets and technologies</td>
<td>Bioclimatic architecture.&lt;br&gt;ICTs focused in the energy efficiency in buildings and urban environment.&lt;br&gt;ICTs for an integral management of buildings.&lt;br&gt;High performance materials and components (insulation, energy producers, etc.).&lt;br&gt;Technologies to exploit renewable energy resources.</td>
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<td><strong>Sustainable water management</strong>&lt;br&gt;- Reduction in the water consumption and waste water generation of buildings and the urban environment</td>
<td>Development of:&lt;br&gt;- Performance indicators and building rating systems&lt;br&gt;- ICTs for sustainable water management&lt;br&gt;Recycling-reuse of rainwater and wastewater.</td>
<td>ICTs for an integral management of buildings.&lt;br&gt;ICTs focused in water efficiency in buildings and urban environment.&lt;br&gt;Technologies for treatment of wastewater.</td>
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<td>Horiz. Term</td>
<td>Objectives</td>
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| **Medium Term** | Reduce the environmental impacts of the deconstruction process  
- 20% increase in take-up of deconstruction technologies for waste reduction | Development of:  
- Demolition systems focused on the reuse-recycling of materials. | New deconstruction methodologies.  
Improved technologies for the treatment of demolition waste |
|             | Reduce the environmental impacts of manufacturing, materials, and components  
- 35% decrease in embodied energy of new builds  
- 40% reduction of construction waste | New manufacturing processes that incorporate high rates of recycled materials and/or renewable resources | New technologies producing construction components with recycled content.  
New high performance components derived from renewable resources. |
|             | Reduce the environmental impacts of the construction process  
- 20% reduction in the consumption of resources during construction processes  
- Substantial reduction of impacts on air, water and soils  
- Reduction of waste, and disturbances mitigation | Development of:  
- High performance materials that require lower resource inputs than conventional materials  
- New more environmentally benign methods of construction  
Increase in:  
- Off-site construction  
- Efficient planning and management of the construction process | Nanomaterials.  
Tools for predicting the performance of construction products and activities.  
Tools for collaborative work.  
Methods for cleaner construction.  
Manufacture and marketing of ‘fast assembly’ construction components.  
Integral planning and management tools for construction processes.  
Methods for reducing environmental impacts and disturbances during construction. |
|             | Regeneration and remediation of land  
- Widespread use of brownfield sites in preference to greenfield sites | Development of:  
- New approaches for contaminated soil management and remediation | Innovative and cost-effective technologies for:  
- Soil and groundwater management, remediation and containment. |
|             | Sustainable use of the built environment  
- 35% decrease in energy consumption  
- 40% decrease in CO₂ emissions from new builds  
- 15% decrease in energy consumption and CO₂ emissions from existing structures | Development of:  
- Innovative materials and components  
- More efficient systems for energy production  
Further development and refinement of:  
- Established low consumption and renewable energy markets and technologies | Development of smaller and more efficient power generation units based on renewable sources (building and community levels).  
Development of technologies/methods to renovate and refurbish existing structures, significantly improving energy efficiency. |
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|        | Reducing the environmental impacts of hazardous materials  
• Hazardous materials phased out | Declaration of content for all building materials  
• Research on materials with a low environmental impact | Application of ICTs for developing databases and tools for environmental assessment of construction products. |
|        | Sustainable water management  
• Substantial reduction of the water consumption and wastewater generation of buildings and the urban environment | Further development of:  
• Technologies for reducing water consumption  
• Technologies for the recycling-reuse of rainwater and wastewater | Implementation of new distributed waste and wastewater treatment and management systems. |
|        | Reduce the environmental impacts of the deconstruction process  
• 40% increase in take-up of deconstruction technologies for waste reduction  
• Planning for a medium-long term total deconstruction of built environment | Implementation of:  
• New deconstruction methodologies.  
• Improved technologies for the treatment of building wastes. | The design of building components and systems focused on deconstruction processes.  
Development of:  
• Easily disassembled and recyclable components  
• Technologies for the treatment of building wastes |
| Medium Term | Reduce the environmental impacts of manufacturing, materials, and components  
• 50% decrease in embodied energy of new builds  
• 40% waste reduction | Further development and refinement of:  
• Manufacturing processes that incorporate high rates of recycled materials and/or renewable resources  
Further increase the:  
• Durability and functionality of materials | New manufacturing processes for advanced bulk materials.  
Novel construction materials “built” from basic nano-scale components. |
|        | Reduce the environmental impacts of the construction process  
• Humans, ecosystems and biodiversity are not affected by the construction process | Further develop:  
• Methods for off-site construction  
• Just-in-time procurement processes  
• Collaborative working methods  
All procurement procedures focussed on best available technology  
Industrialisation of the construction process | New technologies for construction processes.  
Components focused on fast and easy assembly.  
Tools for a collaborative work.  
Tools for construction process planning and management. |
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| **Sustainable use of the built environment** | • 50% decrease in energy consumption  
• 50% decrease in CO₂ emissions from new builds  
• 30% decrease in energy consumption and CO₂ emissions from existing structures | All buildings to be energy positive  
Cities planned for more sustainable use  
Further develop: Holistic urban planning | Developing new building envelope systems (e.g. roof, walls, and windows) that are able to generate energy. Innovative and more efficient public transport. The parallel virtual city (eAdministration, teleworking, telecare). Planning and simulation tools to predict short, medium and long-term environmental, social and economical impacts. |

| **Reduce the environmental impacts of the deconstruction process** | • Construction and building activities are zero waste generating | Planning and management of construction processes, focused on zero waste generation.  

### 3.4 Strategy

**Urban planning and management:** Urban environment must be planned, constructed and maintained considering its whole life cycle. Several scales are involved on this approach: cities, quarters, districts and buildings.

- New conceptual design of buildings, neighbourhoods and cities: design of buildings, quarters, and cities considering their whole life cycle (flexible buildings, multifunctional buildings, etc). Implementation of ICTs for a sustainable management of buildings, quarters and cities (sensors, actuators, management based on computer tools, etc.) (2010)
- Implementation of methodologies and tools for the environmental design and further management of buildings (building behaviour simulation tools in relation to energy, water, acoustic, that consider the building and its environment, for instance) quarters and cities (urban planning, brownfield sites, roads, railways, etc.) and regions that consider their whole life cycle (2020)
- Planning and simulation tools to predict short, medium and long term environmental, social and economical impacts (2030)
- The parallel virtual city (eAdministration, teleworking, telecare, etc.) (2030)

**Use - reuse of land:** The purpose of the research in this field is clear: the reduction of use of greenfield and the enhanced use of brownfield sites. Research will be in relation to:

- Application of technologies for soil and groundwater management, monitoring, remediation and containment: Development of methodologies and tools for the risk assessment of contaminated soils for the assessment of the impact on human health and ecosystems. (2010)
- Development of technologies supporting the decision taking (environmental-economical-social) about brownfield sites regeneration (2020)
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- Development of cost-effective technologies for the remediation-containment of contaminated soils. (2010)
- Development of new cost-effective technologies for the remediation-containment of contaminated soils (2020)

**The construction process:** Disruption caused by construction works must be reduced. This issue relates to a more efficient construction process and to the development of environmentally friendly activities. Research activities in this area relate to:

- New integral management systems involving facilities design, planning, environmental impact and disturbance assessments: development of tolls for the simulation and prediction of environmental impacts and disturbances related to construction processes. Integration of these tools with design and planning tools (2010)
- Methodologies and technologies for the reduction of environmental impact (for instance: technologies for in-situ waste treatment or reuse; technologies for emissions containment) against soil, surface water, groundwater, air, and for mitigation of nuisances (vibrations mitigation, noise barriers, dust containment, low-noise and low-dust construction techniques, etc.) (2010)
- Development of new materials to isolate construction works from the surrounding environment (Zero nuisance activity) (2020)
- Industrialisation of the construction processes (industrialisation changes from an on-site construction process to a more controlled factory construction process): new manufacturing methods, new architectural typology based on 2D and 3D components, new components, new connections and interfaces, new on-site assembly methods, etc. (2020)
- Development of tools for collaborative works (2020)

**Urban transport:** Innovation in urban transport relates to the improvement of public transport as an alternative for the reduction of single-occupancy cars.

- Development of Personalised Public Transport, accessible for all (special attention groups) (2010)
- Underground logistics system with centres at the edge of urban area (no trucks in city centre) integrated with utilities (2030)
- Innovative and more efficient public transport (2030)

**Materials:** From an environmental point of view the construction materials have to reduce their resource consumption, embodied energy, and waste by-products. All these issues are involved in the improvement of manufacturing process and in the improvement of performances of construction materials and components. Proposed research agenda will take into consideration the following activities:

- Creation of performance indicators for materials and buildings; development of performance rating systems for materials and buildings (2010)
- Harmonised Environmental Product Assessment (2010)
- Application of ICTs for the development of databases and tools for the environmental assessment of construction products (2010)
- Declaration of content of all building materials. Development of materials that have lower environmental impact without loss of functional performances. (2020)
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- Improved manufacturing processes: Development and improvement of manufacturing technologies that use recycled materials (construction wastes, sediments, slag, waste metals, plastics, etc.) instead of raw materials (minerals, metals, petroleum components, etc.) and/or generate less waste during manufacturing process and/or reduce energy consumption. (2010)
- Design of construction components that optimise their transportation (2010)
- Development of high performance materials and components (with enhanced thermal, acoustic, durability, flexibility, … properties) (2010)
- Novel construction materials, with extreme strength and toughness, no health hazard, acceptable degree of sustainability of resources, environmentally harmless, built form nano-scale components such as bio-mimetic materials, composites with self-adjusting interfaces, shape-memory or self-repairing or strain hardening materials, nanoparticles, nanotubes and nanofibres, …(2020)
- Development of new permeable (porous) materials for urban construction (foundations, etc.) and motorways (2020)
- Developing new manufacturing processes for advanced bulk materials based in nanotechnologies (low energy cement, ductile cements, corrosion resistant steel, novel binders, tougher concrete, nano-layers/coatings, bio-active surfaces, tougher ceramics, self-cleaning glass…) (2030)

C&D Wastes: The demolition process must optimise the reuse and recycling of materials and components. To allow this the demolition-deconstruction processes have to be considered from the early stages of design. Research on this area will consider:

- Development of new methodologies for a better deconstruction of buildings focused on the reuse-recycling of deconstruction materials (or wastes) (2010)
- Implementation of these technologies at a large scale (2020)
- Design, development and implementation of building components and processes focused on deconstruction processes: fast and easy disassembly components, components that can be easily separated in several easily recycled materials (metals, glass, plastics, cementitious materials, etc.). (2020)
- Improving technologies for a efficient and cost-effective treatment of building wastes (2010)
- Innovative technologies for the recycling/ reuse of building wastes (2030)

Energy use in buildings: The use of the buildings and built environments have at this moment high environmental impacts in terms of energy consumption (and consequently, CO2 emissions). The research in this area will be focused on the transformation of the buildings and built environment from elements with a negative energy balance to elements with a neutral or positive energy balance. Research on this area will be in relation to:

- Implementation of existing low energy consumption technologies (bioclimatic buildings, for instance). Implementation of existing renewable energy technologies (PV panels, solar collectors, bio-generation, etc) at building and neighbourhood community levels. (2010)
- Development of new technologies for the efficient energy management of built environment. Development of new technologies for efficient and clean energy production (flexible photovoltaic materials, fuel cells, etc) (2010)
- Innovative materials and components: building envelope technologies and air handling systems that reduce drastically the heating and cooling needs. New flexible photovoltaic materials that can be used on building envelope components, etc. (2020)
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- Development of smaller and more efficient power generation units based on renewable sources, at building and neighbourhood communal level. (2020)
- Development of technologies/methods to renovate and refurbish existing buildings to significantly improve performances: energy efficiency (easily assembled insulation systems, improved glazing systems, integrated photovoltaic generation systems, etc.), flexibility, maintenance, de-construction, etc. (2020)
- Developing new building envelope (roof, wall, windows, …) systems that are able to generate energy (2030)

**Water use in buildings:** The use of the buildings and built environments have at this moment a high ratio of treated water **water consumption as well as wastewater generation, occupants transportation** processes, etc. The research on this area will be focused on the reduction of this water consumption through the reuse-recycling of natural waters (rainwater, for instance) and waste waters:

- Implementation of new distributed waste and wastewater treatment and management systems (2020)
4 WG2 Mitigating Natural and Man-Made Hazards

4.1 Background and Present Situation

Background

Safety in the built environment is a fundamental right. Article 25 of the United Nations Universal Declaration of Human Rights from 1948 states that “Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services …”. This working group is focussed on natural and man-made hazards that affect and threatens humans, property and the built environment.

Earthquakes, landslides, floods, windstorms, coastal erosion and land subsidence are common natural hazards, either sudden, moderate or slow, and they all affect and disrupt society and the built and natural environment by loss of life, loss of stock, loss of housing, evacuation, economic loss, contamination and loss of health. Instability of infrastructure under hazards, i.e. electricity, telephone, gas and water pipes, roads, bridges and railways, are a serious hindrance for the immediate aid to areas struck by hazards. The trend shows an increasing impact due to growing population in vulnerable areas and increasing intensity due to expected climate changes. The potential damage and socio-economic loss is tremendous.

The socio-economic impact of major natural hazards during the last century in Europe is shown in Table 1 (source: www.geotechnet.org).

<table>
<thead>
<tr>
<th>Hazards</th>
<th>Affected persons</th>
<th>Deaths</th>
<th>Costs Billion Euro</th>
<th>Frequency per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floods</td>
<td>6 700 000</td>
<td>10 000</td>
<td>105</td>
<td>0.45</td>
</tr>
<tr>
<td>Landslides</td>
<td>500 000</td>
<td>16 000</td>
<td>200</td>
<td>17</td>
</tr>
<tr>
<td>Earthquakes</td>
<td>2 500 000</td>
<td>23 000</td>
<td>323</td>
<td>0.32</td>
</tr>
</tbody>
</table>

In Table 2 are shown the impact and occurrence of major natural hazards during the last five years in Europe (source: www.cred.be).

<table>
<thead>
<tr>
<th>Hazards</th>
<th>Affected persons</th>
<th>Deaths</th>
<th>Costs Billion Euro</th>
<th>Frequency per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floods</td>
<td>483 000</td>
<td>162</td>
<td>24.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Landslides</td>
<td>-</td>
<td>13</td>
<td>-</td>
<td>0.2</td>
</tr>
<tr>
<td>Earthquakes</td>
<td>9 000</td>
<td>30</td>
<td>1.3</td>
<td>0.33</td>
</tr>
<tr>
<td>Wind storms</td>
<td>21 000</td>
<td>147</td>
<td>0.4</td>
<td>5.6</td>
</tr>
</tbody>
</table>

Table 1 and Table 2 show a trend that the number of affected persons and damage per event increased while number of death decreases. The number of floods increased more or less in line with the occurrence of wind storms.
Statistically, in Europe relatively large numbers of natural hazards are expected over the next 50 years, each with a possibility of hundreds of deaths and tremendous economic losses, more
as the population increases. The oil industry defines natural hazards in deep water as a main risk and a top research priority; consequences of hazard-triggered accidents offshore in terms of loss of life and environmental damage are catastrophic. Climate research indicates more extreme weather conditions over the next 50 years, leading to increased vulnerability. The indirect health and socio-economic impact is a multiple of the number of affected persons. In the last 10 years WHO reported more than 1000 deaths in Europe related to health problems induced by natural hazards. It is necessary to develop common planning and design rules throughout Europe that would allow planners and designers to improve the security of our built environment to a socially acceptable standard.

The perception of threat by man-made hazards and the public opinion on associated risks has changed and is a common subject in the media and on the political agendas. The acceptance of terrorist threats is decreasing whilst the impact magnitude of possible terrorist attacks is increasing. Vulnerable buildings and networks have to be assessed and protected to meet new defined safety standards.

In densely populated areas of Europe people work and live near industrial facilities and industrial accidents are recognised as potential serious hazards not only for employees but also for neighbouring offices and housing areas. Each year several large accidents are reported in Europe; a few examples for such incidents are:

- Glycol explosion of a chemical plant, Antwerp, Belgium, 1989
- Explosion of fireworks plant, Enschede, The Netherlands, 2000
- Blast furnace gas explosion at H.-Wenzel power plant, Duisburg, Germany, 2001

Scenarios of industrial hazardous accidents cover explosions with possible ensuing fire and show similarity with the effects of terrorist attacks. In Table 3 the impact and occurrence of major industrial hazards during the last five years in Europe are shown (source: www.cred.be).

<table>
<thead>
<tr>
<th>Hazards</th>
<th>Affected persons</th>
<th>Deaths</th>
<th>Costs Billion Euro</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial accidents</td>
<td>18000</td>
<td>68</td>
<td>10</td>
<td>7</td>
</tr>
</tbody>
</table>

People want to feel as safe and secure in public places as they do in their homes, but they are beginning to recognise that their work place or public gathering place may be subjected to conditions that go beyond the design basis of the structure. Man-made hazards, whether through explosion, impact or fire, usually are not analysed or accommodated for in design. It is increasingly recognised that the structural engineering aspects of buildings and structures must also be viewed in light of safety against man-made hazards. The European society will ask for acceptable solutions in order to design structures in which people can live and work safely. As this topic is unfortunately becoming more relevant in the near future, authorities and industry have to prepare and provide the necessary solutions. Though direct social aspects as savings of life and health are central, economic aspects should not be neglected – primarily the reduction of damage is substantial in this consideration.

The challenge is for the construction sector to respond to this trend in an efficient, sustainable and economic manner. To assess and mitigate the risk due to hazards, to accommodate for hazards in design, and to ensure exchange of new technologies for optimum solutions with regard to sustainability, safety, spatial demand and maintenance, there is an urgent need to encourage multi-disciplinarity in an applied science approach and in hazard-vulnerability assessment.
**RTD State of art**

**Floods**

There is a great variety of flood protection policies and the safety offered by flood defence systems varies quite a lot in the different European states. The available codes of practice include only simple and mainly empirical methods. In many countries in Europe no safety levels are prescribed and indicated safety levels range from a return period of extreme water levels less than 100 to 1000 years. In the Netherlands legally prescribed safety levels range from 2000 to 10000 years. In the usually applied flood risk assessment the focus is only on structure height versus water level and possible flood consequences as well as structural failures due to mechanisms like strength, erosion and human interventions are hardly considered. Proper maintenance is rarely performed in time. Each country facing the threat of floods has developed its own system of protection measures according to local conditions, the core of which consists of construction and maintenance of flood defence structures.

**Landslides**

At present the predictability of occurrence of landslides is weak and the current status of landslide inventory is far from being satisfactorily, with the exception of Italy. Soil conditions vary widely all over Europe and standardisation, though started in the late nineties, has only partly been achieved, with many national varieties remaining unassessed. With expanding populations people have settled in areas vulnerable to landslides without any awareness. The relation of land sliding with ground water levels is understood, but the influence of climate changes triggering landslides is unknown. Applied diversion and stabilisation works are usually fairly simple and there are only a few specific and sophisticated early warning systems in operation (avalanches).

**Earthquakes**

New buildings and civil structures, which are designed according to the present state-of-the-art seismic codes are supposed to resist the assumed design earthquakes. However, recent earthquakes have also revealed that some building construction practices are not necessarily safe. For example non-ductile reinforced concrete construction, often with masonry infill – a construction method that is quite popular throughout Europe - is a proven “serial killer” during earthquakes. For the large stock of existing buildings and civil structures effective vulnerability assessment methods as well as affordable retrofit strategies remains an urgent target for research. Innovative concepts for seismic design of new and existing buildings, dams, networks and infrastructures have to be developed in order to protect the built environment.

**Windstorms / tornados**

At present comprehensive engineering knowledge is available on the design for normal wind conditions. However, recent extreme winds will require further data acquisition and possibly higher design values, especially for the envelope of buildings. For especially destructive events, such as tornados no comprehensive models, let alone code regulations are available in Europe.
Risk assessment

Comprehensive threat and vulnerability analysis and risk assessment helps to rationally grasp potential threats, vulnerabilities and risks and prevents expensive piecemeal responses to extraordinary events. Presently, it is not uncommon to spent millions of euros on perceived risks whilst statistically significant risks may go unaddressed. Especially for man-made hazards (terrorist threats and industrial hazards), considering randomness and independence of occurrence as well as the limited opportunity to obtain experimental data to make informed decisions, risk assessment methods will be a rational way of improving safety and security of people in the built environment. For years, the airline and the nuclear industries have used formal risk assessment tools to improve design and safety margins. At this time, few risk- and vulnerability-assessment tools have been designed specially for buildings and civil structures.

Protection structures

Structural systems to resist exceptional loads are presently dominated by massive reinforced concrete. The design of these protection structures is mostly based on design experience and rules of military and nuclear facilities. For the application to civil structures and modern office buildings or assembly halls unobtrusive and aesthetic protection structures would be required, i.e. addressing architectural aspects of the design to a larger extent. For extreme events such as aircraft impact on high-rise buildings no structural design solutions, which could be accepted by the market are presently available. Considering the building envelope blast proof windows and doors are available, whilst there is a need for complete window/wall-systems for new construction and hardening of existing buildings. Devices or materials improving the ductility/damping of major structural elements’ response and hence mitigating the effects of blast or impact actions at reasonable costs are hardly available for structural engineering application.

Analysis and design tools

The holistic assessment of structures to withstand man-made hazards requires sophisticated dynamic analysis, which reflects the complicated non-linear inelastic material behaviour far beyond the design load. Computational results must be judged by displacement parameters such as ultimate strain or rotation capacity. Here only a limited amount of experimental data is available, mostly derived from tests on reinforced concrete structures by the military. Complex, but realistic scenarios (e.g. like 9/11 attack on WTC) cannot be fully simulated by today’s software packages. For the actual engineering design at present often simple, but conservative diagrams for load determination are employed. Full 3D CFD (Computational Fluid Dynamics) codes are also available but because of the large computation time required they are only applicable to selected tasks. Economic design however requires engineering tools, which allows the evaluation of multiple threat scenarios and design options. Such tools need to be developed. Guidelines exist for certain industries or institutions, e.g. governmental buildings and nuclear industry, but are not available for general use. Here is a need to develop common rules throughout Europe that would allow planners and designers to improve the security of our built environment to an acceptable standard.
**4.2 Vision**

*The impact of natural and man-made hazards on built environment are quantified and managed in a safe and reliable manner at the European level, risks can be rationally evaluated and the built environment in Europe accordingly protected.*

Against the devastating effects of natural hazards, increasing under expected climate changes, robust and economic mitigation measures will be developed, to be implemented in the design and maintenance of protection works, infrastructure, buildings and in the preservation of the natural environment.

The risk arising from man-made hazards is assessed in a rational manner; the structural behaviour of buildings and structures for extreme loading is fully understood; new materials form the basis for an effective and aesthetic protection of the built environment against terrorist threats and accidents.
### 4.3 Medium and Long Term Objectives

<table>
<thead>
<tr>
<th>Term</th>
<th>Objectives</th>
<th>Breakthrough</th>
<th>Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>Eliminate the uncertainty and the unpredictability.</td>
<td>Natural hazards are assessed. Developing fundamental understanding of natural and geological processes</td>
<td>- Knowledge of hazards and their distribution and probability. - Knowledge of related assets and their distribution and condition. - Development of innovative sensor technologies for monitoring the behaviour of soils and constructions under natural hazards. - New techniques for analysis (including mathematical models), mapping, monitoring and early detection of natural hazards</td>
</tr>
<tr>
<td>Term</td>
<td>Man-made hazards are assessed. Developing fundamental understanding of risks allowing rational decisions on civil protection</td>
<td></td>
<td>- Establishment of general risk analysis and risk management tools for the protection of the built environment against Man-Made Hazards. - Available construction techniques and materials are improved to mitigate Man-Made Hazards</td>
</tr>
<tr>
<td>Term</td>
<td>Man-made hazards are reduced. The response of buildings and structures to extreme loading is fully understood.</td>
<td></td>
<td>- Development of practical computer simulation methods for the determination of load conditions, global and local damage as well as progressive collapse assessment. - Verification of simulation methods for vulnerability assessment through large scale testing. - Technologically improved, aesthetic protection materials and structures at reasonable costs. - European design rules for buildings and structures subjected to man-made Hazards. - Reliable vulnerability mapping (pre disaster) and damage assessment (post disaster) methods.</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>In</th>
<th>Objectives</th>
<th>Breakthrough</th>
<th>Innovation</th>
</tr>
</thead>
</table>
| Long Term | Natural and Man-Made Hazards are quantified and managed in a safe and reliable manner at a European level. The built environment is rationally protected. | Natural and Man-Made Hazards are controlled. Integration and co-ordination of interdisciplinary expertise, actively including end-users and policy-makers. Dissemination by education and training. Maintaining of preparedness and awareness. | - Proven advances in predictability and insurability of natural hazards.  
- Establish a strong framework to enable exchange of information and knowledge.  
- Training program for young research scientists and continuing education program for promotion and dissemination of gained excellence.  
- Operational alert systems for natural hazards all over Europe.  
- New smart protection materials and structures at reasonable costs for extreme loading.  
- Simplified computer-aided design tools based on comprehensive computer simulations. |

4.4 Strategy

Human, environmental and economic consequences can be significantly reduced from an improved understanding of the geological processes and dedicated research on natural hazards, which should produce solid and economic remedial measures being included in design and maintenance of protection works, infrastructure and buildings. At present, studies on socio-economic impact of natural hazards (www.geotechnet.org), trends and occurrence of natural hazards (www.ered.be) provide a basis for developing a clear vision for 2030 and a corresponding research agenda. For the first stage (medium term) a proposal for an IP will be established with a focus area on the assessment of risks in soils and foundations related to natural hazards.

Since natural and man-made hazards do not respect national boundaries, coordinated and collaborative research is required at European level to eliminate the uncertainty, the unpredictability and the consequences of natural and man-made hazards. The ultimate aim is to achieve timely and appropriate holistic solutions so that losses and disruption by natural and man-made hazards become marginal, acceptable and insurable. Mitigation of natural and man-made hazards should be reached by the development of integrated assessment, management and prevention methods, new materials and technologies. The disproportionate risk of loss and damage by natural and man-made hazards such as earthquake, flooding, fire, storm, landslide, blast, traffic and waste disposal are considered.
Research Areas

Medium Term

- Develop risk assessment, management methods and insurability
  a. Advanced hazards mapping and monitoring systems
  b. Event specific vulnerability mapping
  c. Innovative risk assessment improving safety of people from man-made hazards
  d. Risk management including new models and tools for risk and safety management integrating issues such as safety culture, public awareness, emergency preparedness, business processes, roles and responsibilities, training and competency, quality and performance management
  e. Decision Support System for priorities and impacts of risk mitigation

- Development and harmonization of European guidelines for performance based and innovative design related to
  a. Earthquake resistant structures
  b. Flood and erosion defence system (river and coast)
  c. Triggering and propagation of landslide (on and off shore)
  d. Tsunamis
  e. Man-made hazards to industrial facilities and especially exposed buildings and infrastructure
  f. Fire safety design of buildings and underground premises.

Long Term

- Prediction and simulation tools for hazard impacts to the built environment
  a. Prediction and simulation of built environment and soils
  b. Engineering tools for multiple threat scenarios and design options
  c. Programs for calamity simulation and training
  d. Advanced constitutive equations for soils and building materials
  e. Prediction and development of mitigation strategies for structural vibrations (e.g. windstorms, explosion, traffic)
  f. Upgrading and development of testing methodologies and infrastructures for vulnerability assessment and calibration of numerical models.

- Development of protection systems, techniques and materials
  a. Simple and easy to handle seismic strategies to retrofit existing non-ductile buildings, particularly residential houses and cultural heritage
  b. Approaches and materials to retrofit existing hazard mitigation systems to accommodate for climate change and land use
  c. Unobtrusive and aesthetic protection structures against man-made hazards (e.g. impact, blast or fire).
  d. Development and application of innovative construction methods
  e. Developing methods to improve the resistance of existing buildings against extreme weather conditions
  f. Extensive soil stabilisation using bio- and chemo-technology (cementation)
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- Remedial measures  
  a. Develop specific warning systems  
  b. Develop specific post-disaster strategies according to risk category and source  
  c. Raising awareness and alertness of the public.

- Consequences of climate change on built environment  
  a. Understanding of increasing effects of torrential rains, floods, windstorms, coastal erosion etc. on structures

Long Term Targets

- Proven advances in predictability and insurability of natural hazards.
- Reliable vulnerability mapping (pre-disaster) and damage assessment (post disaster) methods are applicable
- A strong framework to enable exchange of information and knowledge is established.
- Training program for young research scientists and continuing education program for promotion and dissemination of gained excellence
- Protection and alert systems for natural hazards all over Europe.
- People living in hazards-vulnerable areas are prepared by continuous dedicated training for counter acting against hazards and their effects.
- Practical computer simulation methods for the determination of load conditions, global and local damage as well as progressive damage assessment are developed. Simplified computer-aided design tools based on comprehensive computer simulations are widely available.
- “Soil on Demand” feasible by sophisticated bio- and chemo-technologies
- Technologically improved, aesthetic protection materials and structures are available at reasonable cost to withstand extreme actions.
- European design guidelines for buildings and structures subjected to natural and man-made hazards are available, defining load scenarios and a minimum standard of hazard protection.
5  WG3 Improving the Indoor Environment for All

5.1  Background and Present Situation

The well being of the people is largely affected by health and comfort conditions during the main activities living, working and transportation in an enclosed space, in which European citizens spend more than 90% of their time. In more than 40% of the enclosed spaces people suffer health and comfort related complaints and illnesses. 5

Improving health and comfort of the European population in those spaces has consequently a huge potential for economic and societal benefits leading to increased productivity, reduced sick leave and medical costs, but also by the prevention of liabilities. For example the total annual financial burden of lung disease in Europe is estimated at 102 billion Euros, a figure comparable to the GDP of Ireland.6

Also, many people today are excluded from using parts of the built environment which were not designed with due care of the different needs of persons. Accessible indoor environments allow persons with disabilities and persons with reduced mobility, including many elderly persons, to live a more independent life and to stay autonomous longer. It is estimated that there are more than 50 millions persons older than 65 years and around 50 millions disabled persons in EU today. Therefore, accessibility has a direct impact on both social and economical characteristics of a sustainable society.

Apart from health and comfort, people also want to feel safe and secure in their built environment. In this WG, the feeling of safety is taken into account by acknowledging the characteristics of the environment that can influence this feeling, such as for example lighting conditions or signs.

External hazards, whether natural or man-made, which have a direct effect on the building structure (explosions, flooding, earth quakes, high wind speeds) and not directly on the occupants are not taken into account. On the other hand, hazards that are solely focused on the persons in that built environment, such as the release of toxic gases through a mechanical ventilation system will be taken into account.

Housing

Health, comfort and safety are particularly pronounced in the area of social housing, where the deterioration of the existing building stock and the need for renovation is a European priority.

Social housing across Europe-25 numbers over 55 million dwellings; much of this housing is of poor quality, creating problems of ill-health and insecurity for the occupants and ongoing maintenance problems for the owners. At the moment more than 170 million people live in mass housing areas constructed in the post war period. Recent research by the World Health Organization (WHO) shows an obvious trend for time spent in the home to be increasing, especially with younger and older ages.

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5 Philomena M. Bluyssen et al, 2004, ECOSPACE®: Human-friendly, safe and efficient spaces through integration of knowledge and technological innovations from different sectors, disciplines and stakeholders, with a focus on (social) housing, B4E conference, oct 14-15, Maastricht.

6 European Lung White Book, European Respiratory Society (ERS) and the European Lung Foundation (ELF), November 2003
Moreover houses suitable for all are lacking, as European and national regulations and standards on accessibility are not available. This situation will generate dependence and solitude for the disabled and the elderly, and will make their total integration in the community even more difficult. This is a critical issue to reach an inclusive European society based on equality of rights.

Early findings of a recent pan-European housing survey by WHO clearly indicate a link between present-day housing conditions, including the immediate environment, and human health and well-being. These data confirm that the indoor dwelling characteristics that most affect human health are connected to thermal comfort, lighting, moisture, mould and noise.

Moisture and mould problems are estimated to occur in 15-30% of the European housing stock. It is only in recent years that a link between the effects of indoor fungi on allergic reactions and respiratory infections has become widely known. Approximately 20% of the European population are allergic to mites and fungi, and the prevalence of asthma and allergies in domestic buildings is increasing. In Europe asthma affects one of the seven children, and children in Western Europe experience rates 10-fold than those in Eastern Europe.

**Office environment**
A more comfortable and healthier indoor environment will result in fewer people with complaints. Indoor environment quality (IEQ) complaints affect the absence due to sickness of office workers by virtue of Sick Building Syndrome (SBS) and the building-related illnesses (BRI). Losses in work productivity and performance have a direct, financial impact on businesses.

Only 20% of the building stock can be qualified as healthy, implying that in 80% a potential benefit of 1 to 6% improved productivity is present. In the US (270 million inhabitants), annual savings and productivity gains have been achieved as a result of the reduced incidence of allergies and asthma, as a direct result of remediating the causes and the symptoms of sick building syndrome. This has led to direct improvements in worker performance that are themselves directly related to comfort. Transfer of these figures to Europe-15 (375 million inhabitants) is shown in the table below. It demonstrates the enormous potential for savings:

<table>
<thead>
<tr>
<th>Buildings</th>
<th>Savings (€/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced Allergies and asthma (based on a reduction of 8 to 25% of medical costs)</td>
<td>3-6</td>
</tr>
<tr>
<td>Reduced Sick building Syndrome symptoms (based on 20-50% reduction and 2% productivity improvement)</td>
<td>15-45</td>
</tr>
<tr>
<td>Increased productivity due to comfort related improvements (based on 0.5-5% increase in worker performance)</td>
<td>30-240</td>
</tr>
</tbody>
</table>

**Table 1 Estimated savings for EU15 from more comfortable and healthy indoor environment.**
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An American committee defined building related health effects as a priority research need for improving the health of workers in indoor environments and points out that a lack of documentation and evidence on the benefits from investing in good indoor environmental quality is a barrier to further improvements in practice.  

High density environments  
Educational facilities, day-care institutions etc. are in general environments in which many persons gather in one space during the day. In high density environments hygienic quality (influence the risk of catching a disease), personal control of the ambient environment, etc. are specific problems that need attention.  

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5.2 Vision

Considering the present situation with respect to the health and comfort conditions of people in enclosed spaces, the ultimate vision of WG 3 is:

*A built indoor environment in which healthy and comfortable occupants live, move and work.*

In which both targets of the WHO and the EU are taken into account.

<table>
<thead>
<tr>
<th>The health targets specified by the WHO Europe (WHO, 2000):</th>
</tr>
</thead>
<tbody>
<tr>
<td>- “By the year 2015, people in the Region should live in a safer physical environment, with exposure to contaminants hazardous to health at levels not exceeding internationally agreed standard.” (European Health21 target 10) and</td>
</tr>
<tr>
<td>- “By the year 2015, people in the Region should have greater opportunities to live in healthy physical and social environments at home, at school, at the workplace and in the local community.” (European Health31 target 13)</td>
</tr>
</tbody>
</table>

Kyoto protocol target:
“to reduce the demand for energy by 18% by the year 2010, to contribute to meeting the EU’s commitments to combat climate change and to improve the security of energy supply”

"to achieve a quality of the environment where the levels of man – made contaminants, including different types of radiation, do not give rise to significant impacts on or risks to human health."

“Consider the development of adequate European standards in all areas related to the built environment, including planning, design, construction and use of buildings, and safety evacuation procedures for people with disabilities.”
5.3 Medium and Long Term Objectives

The general objective is an Healthy, comfortable, accessible and safe indoor environment for all. This objective splits in the following ones under the general aim of considering needs of all occupants:

<table>
<thead>
<tr>
<th>Horiz.</th>
<th>Objectives</th>
<th>Breakthrough</th>
<th>Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium Term</td>
<td>Reduction of the number of accidents in homes due to poor indoor environment by 50%. Improved feeling of safety at home; at work and on the way.</td>
<td>Better understanding of the impact of the built indoor environment on health, comfort and feeling of safety</td>
<td></td>
</tr>
<tr>
<td>Long Term</td>
<td>Improved general well-being of people by creating a better indoor environment (lighting, air, acoustical, thermal comfort) with at least 20%. Increase productivity at the work place by 5%.</td>
<td>Development of harmonised assessment methods from the human point of view (holistic approach.</td>
<td></td>
</tr>
<tr>
<td>Long Term</td>
<td>Reduction of Sick Building Symptoms by 20%. Reduction of number of people suffering from asthma, allergies and other respiratory diseases due to unacceptable indoor environmental conditions, by at least 20%. Optimisation of healthy and comfortable indoor environments on the one hand and sustainable, low energy built environment on the other hand.</td>
<td>Innovative concepts for safe, comfortable and healthy indoor environments with full participation of all stakeholders in environment and health.</td>
<td></td>
</tr>
</tbody>
</table>

5.4 Strategy

In order to realise these objectives the following steps must be taken:

*Medium-term*

1. Better understanding of the impact of the built indoor environment on health, comfort and feeling of safety. This understanding has two sides:
   a. Understanding the demands, desires and needs of all occupants, expressed in harmonised performance indicators for health, comfort and feeling of safety; and
   b. Understanding the information chain required and improving the information transfer.
2. Development of harmonised assessment methods from the human point of view (holistic approach), focused on:
   a. objective relations between stimulus and perceptual behaviour; and
   b. sensors, actuators and systems that anticipate human perception.
3. Improved and updated knowledge of relevant needs for different groups including persons with impaired cognitive, sensorial or motor capacity, applying a comprehensive approach which considers:
   a. the requirements for different groups and
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b. their interaction with the different environments.

Long-term

4. Innovative concepts for safe, comfortable and healthy indoor environments with full participation of all stakeholders in environment and health, comprising of:
   a. new alliances between demand and supply; and
   b. matching demand and supply.

5. Realisation of healthy, comfortable and safe indoor environments, making use of the above and of:
   a. innovative sustainable and smart materials and systems accessible to all people; and
   b. new construction, operation and maintenance processes.

The ambition of healthy, comfortable and safe indoor spaces on the one hand and the target of smart and sustainable spaces on the other appear to be conflicting and counter-productive, and may have serious implications for innovations in the building industry. Compared to other industrial sectors, R&D in the construction sector is at a comparatively lower level, hampering the needed transition to demand-driven production and the needed shift from products to services.
Integration of different sectors, disciplines, stakeholders and organisations, focused on communication and understanding between the different stakeholders, is therefore a paramount.
6  WG4 More Attractive Work Places

6.1  Background and Present Situation

This document capitalises on the findings and strategy developed by E-Core. In particular, its chapter *Enhancing Construction Employment* identified the following themes:

- Under enhancing the quality of work
  - Fostering personal development and teamwork
  - Providing through improved communication ubiquitous access to knowledge and training
- Under improving the work environment
  - Developing new site equipment and mechanisation
  - Implementing industrialisation adapted to the construction context
  - Health and safety for workers.

State of affairs

The Construction Industry has the poorest Health and Safety (H&S) record of any major industry. The probability of construction workers being killed is 3 times higher than the average for all industries, and the probability of being injured is 2 times higher. Figure 2 reflects the perception of construction workers as the most concerned by the consequences of their occupation on their Health and Safety: 43% of them think their health and safety is at risk because of their work, the highest score, well above the average 27% .

![Bar chart showing workers reporting absences over the last 12 months due to an accident at work in 1999](image)

*Fig. 1* Workers reporting absences over the last 12 months due to an accident at work in 1999

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9 Third European survey on working conditions 2000 - European Foundation for the Improvement of Living and Working Conditions.
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![Chart](chart.png)

**Fig. 2** Workers who think their health or safety is at risk because of their work, by sector

Considerable disparities exist between countries, construction firms and the types of construction works they undertake. Clearly some types of activity (e.g. underground work, demolition, etc.) are far more dangerous than others and some are more prone to recurring accidents (scaffolding, working at heights etc.). Moreover, some countries and some firms enforce much stricter Health & Safety regimes than others.

The following statistics give the fatality rates (per 100,000 employees) in various European countries. One can see that contextual factors and work processes must be at play to explain wide differences in results.

<table>
<thead>
<tr>
<th></th>
<th>Sweden</th>
<th>UK</th>
<th>France</th>
<th>Spain</th>
<th>Portugal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatalities</td>
<td>1.1</td>
<td>1.7</td>
<td>3.4</td>
<td>4.7</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Cross-national benchmarking and analysis is a key factor for issuing an advanced, robust and “universal” framework from which context specific solutions may be derived.

The consequences of this situation are considerable and widely underestimated. Internationally recognised accidents direct cost figures (US-NSC) estimate the cost of a disabling accident at $33,000 USD and of a fatality at $1 million USD. On this basis, direct cost figures, the cost of accidents in Europe can be estimated at 16 billion € or 2% of the sector’s share in GDP. Total costs including indirect costs are even higher. In addition, gains in health and safety (due to leaner processes) go along with gains in productivity (lean production). An extrapolation then easily justifies that the economic impact at European level is of the order of several tenths percent of GDP.

There is also a very high associated cost in terms of social and image aspects. Injured workers and their families suffer for years after accidents to their bodies and in their social lives. The whole industry tends to suffer from a poor image in society and fails to attract the better calibre workforce it deserves as well as fewer female workers. Construction tends to be a
laggard in adopting new technologies. It is also one of the sectors with the highest proportion of unskilled workers, although this is changing as the industry grows in sophistication.

This poor image is not just linked to the health and safety aspects, but also to the unattractive physical work place itself. Tasks on site still rely on manual activities particularly on building sites while tools and equipment are usually of the inert type and rarely exhibit some form of embedded intelligence. Mechanisation is the case of some specialist operations such as deep foundations and earthmoving. Attempts to introduce industrialisation (building processes minimising site activities) have been only partially successful.

**Diagnosis**

The health and safety at work issue is presently managed from national standpoints. The definitions of accidents, of serious accidents, of accidents during travel time etc. are all different from one country to another. Norms to record time lost, taxonomies of accidents or illness are all different, and severity rate calculations are even more incoherent. Even conditions in which records are kept are different since in some countries the first few days off work are deducted from salaries and wages, while in other countries they are all paid: when the level of individual responsibility is different, the level of results is also different and consequently the interpretation of statistics must again be different.

Until today, industrial approaches to H&S have rightly privileged regulatory control. Increasingly stringent regulations are regularly issued and their implementation recorded by works inspectors. Furthermore, the function of health and safety during construction has been externalised in that H&S coordinators are nominated for each project. This approach brought definite progress by also resulted into diluting the sense of responsibility of companies and individuals. This approach is presently showing its limitations.

Most recent efforts have put the emphasis on design issues. The most recent European regulations, responding to reports that dangerous situations may find their origin upstream in project development, particularly at the design stage, have rightly highlighted the role and responsibility of designers in H&S issues.

An important feature of the construction industry is the traditional, fragmented and often extensive supply chain and in particular the separate allocation of works to several independent parties which ultimately co-operate within a single evolutionary work place. The often defective division of responsibilities between a general contractor, co-contractors and their sub-contractors is a frequent prime cause of avoidable accidents, and needs to be constantly addressed: typically none of the site stakeholders consciously feels an overall sense of responsibility and could really exercise a proper control or establish a truly preventive policy on all site issues.

The ultimate progress that can be made on construction sites is to improve plant and equipment and to mechanise the process. But such a major change deeply affecting the facilities to be built would not occur unless mastered or integrated around a single point of responsibility focussed on site knowledge.10

More than in any other industrial sector, construction relies heavily on the strength of character of its employees, and their ability to address recurring contingencies during the

10 E-Core Strategy ibidem Chapter 5.2 p40-43.
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course of project development. This is all the more pertinent given the overall fragmentation of the industry and the lack of a single point of responsibility. It can be further observed that the more successful construction projects are often those where a balance between individual aspirations and collective aspects and teamwork can be put in place across legally or contractually independent entities.

RTD State of art

Human science is increasingly taking a significant share of scientific effort. But this is far from being widespread. Moreover, this is restricted to specialist approaches (psychology at work, occupational medicine, sociology at work organisations, etc.) without any globally structured approach.

Most regulations and RTD work programmes concentrate their efforts on technological issues: new systems of scaffolding, new safety helmets, warning devices for vehicles, etc. This technological approach must give place to a new approach, giving human sciences a leading role over technology and placing the human dimension at the forefront.

Coordination of national efforts between different countries is almost negligible. Exchanges of experience are now starting through networking of some specialised institutes and national experts.

Production is an active area of research. However it does not touch so much the dimension of industrialisation and development that must be studied within the concept of integration:

- Towards end-user satisfaction
- Under a single point of responsibility
- Focussed around site knowledge and experience.

Knowledge: research activities in this field are mainly at the downstream side of research in similar fields for other industrial sectors. But the picking up and dissemination of technologies in that field are slow as they all require deeply rooted adaptations to satisfy the true particularities of the construction sector which have not been taken in consideration early enough. The future really calls for the efficient use of ICT, as emphasised in the FIATECH strategy\(^\text{11}\), specific programmes and projects focussed on construction issues and led by construction industry stakeholders.

\(^{11}\) Fiatech strategy paper [www.fiatech.org](http://www.fiatech.org)
6.2 Vision

Construction sites are a safe, attractive work place for communicating construction teams.

This vision may be defined in more detail by the following goals:

- to reach a 0-accident and 0-work related disease record;
- to improve the image of the sector;
- sites use high level skills and a minimum amount of low-level skills;
- to give ubiquitous access to knowledge to the whole workforce;
- to enhance the level of the sense of responsibility – balanced between the collective and individual dimensions;
- to improve the level of the education of the workforce;
- to attract a higher level of new as well as female recruits into the industry.

Achieving the health and safety goal will lead to a significant improvement in working conditions in the construction industry. A fall in the number of accidents and fatalities to the average levels of general industry will avoid the suffering of about 400,000 workers and the death of more than 750 workers each year; it will dramatically improve the quality of life for these workers and their relatives, and also raise the competitiveness and image of the sector.

However, beyond the direct and indirect cost impacts of improved Health and Safety conditions, there is a strong positive relationship with productivity and quality. A higher level of safety, responsibility, knowledge access, work environment calls for measures that increase productivity on construction sites and, consequently, increases value for money as well as profit margins.

Finally, the considered initiatives will implement the European move towards the Lisbon Strategy goals\(^\text{12}\): “Improved quality of work is closely inter-linked with the move towards a competitive and knowledge-based economy and should be pursued through a concerted effort by all actors and particularly through social dialogue.”

\(^\text{12}\) European Council in Brussels, 11 June 2003
6.3 Medium and Long Term Objectives

The ultimate vision of the construction industry given in the preceding paragraph can be detailed in the following agenda over the period from now until 2030 as further explained in the next paragraph.

<table>
<thead>
<tr>
<th>Horiz.</th>
<th>Objectives</th>
<th>Breakthrough</th>
<th>Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium Term</td>
<td><strong>Health &amp; Safety</strong>&lt;br&gt;H &amp; S records of front runners at level of the average level across all sectors. 25% improvement in construction average records.</td>
<td>European Initiative for Health and Safety in Construction Unified measurement system Free and voluntary certification label. Inherently safe site construction teams. Inherently safe work procedures for 25% of the construction activities. Safer and healthier working clothes.</td>
<td>New co-operative working / teaming methods. Modus operandi for human aspects of site construction teams. Self-appropriated work procedures. First prototypes of eXtended Safety Belt 13 New textiles and intelligent devices incorporated in working clothes for safety, comfort and performance.</td>
</tr>
<tr>
<td></td>
<td><strong>Personal development and teamwork</strong>&lt;br&gt;Promoting a more human-friendly work environment</td>
<td>Organisations balancing individual aspirations and a collective sense of responsibility.</td>
<td>New co-operative working / teaming methods</td>
</tr>
<tr>
<td></td>
<td><strong>Personal development and teamwork</strong>&lt;br&gt;Most projects above 100 million € implemented in an integrated manner.</td>
<td>Experimental model for integration.</td>
<td>New co-operative working / teaming methods; Self-appropriated work procedures; Adapted model of industrialisation</td>
</tr>
<tr>
<td></td>
<td><strong>Knowledge</strong>&lt;br&gt;100% of sites including temporary or maintenance connected to Internet and project centres.</td>
<td>Services interoperable within the context of prevailing site and business processes.</td>
<td></td>
</tr>
<tr>
<td>Long Term</td>
<td><strong>Health &amp; Safety</strong>&lt;br&gt;H &amp; S records of front runners at twice the level of the leading industrial sectors.</td>
<td>Ubiquitous access to H&amp;S knowledge. Mechanization.</td>
<td>Active and intelligent eXtended Safety Belts. More robust and resilient working methods.</td>
</tr>
<tr>
<td></td>
<td><strong>Personal development and teamwork</strong>&lt;br&gt;All projects above 50 million € implemented in an integrated manner</td>
<td></td>
<td>More robust and resilient working methods.</td>
</tr>
<tr>
<td></td>
<td><strong>Knowledge / Physical work environment</strong>&lt;br&gt;100% of team leaders connected to Internet and project centres.</td>
<td>Mobile sites effectively connected.</td>
<td>More robust and resilient working methods. Tools for seamless integration of site workers.</td>
</tr>
</tbody>
</table>

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13 eXtended Safety Belt refers to any device – hardware or software – that provides tools, equipment, machines, construction sites, workers an efficient active barrier against hazard occurrences. It is a generalisation of the safety belt device providing car drivers and passengers with a barrier minimising the impacts of accidents on themselves.
## European Construction Technology Platform
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<table>
<thead>
<tr>
<th>Horiz.</th>
<th>Objectives</th>
<th>Breakthrough</th>
<th>Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Physical work environment</strong>&lt;br&gt;Amount of site human resources reduced by 10% for the same level of overall activity.</td>
<td>Industrialisation benefits really demonstrated.</td>
<td>More robust and resilient working methods. Site compliant methods for off-site production</td>
</tr>
<tr>
<td>Long Term</td>
<td><strong>Health &amp; Safety</strong>&lt;br&gt;Construction records at a level better than the industry average. H &amp; S records of front runners at the level of the leading industrial sector.</td>
<td>Industrialization more and more in effective use.</td>
<td>New industrialised, automated construction processes. Comprehensive human-friendly construction team model</td>
</tr>
<tr>
<td></td>
<td><strong>Personal development and teamwork</strong>&lt;br&gt;All projects above 10 million € implemented in an integrated manner.</td>
<td></td>
<td>Comprehensive human-friendly construction team model</td>
</tr>
<tr>
<td></td>
<td><strong>Personal development and teamwork</strong>&lt;br&gt;Attractivity to female workers at the level of the overall industry average.</td>
<td></td>
<td>Comprehensive human-friendly construction team model</td>
</tr>
<tr>
<td></td>
<td><strong>Knowledge</strong>&lt;br&gt;Project and general knowledge accessible to all through comprehensive range of high value added services.</td>
<td></td>
<td>Comprehensive model of construction knowledge and its efficient use;</td>
</tr>
<tr>
<td></td>
<td><strong>Knowledge</strong>&lt;br&gt;Educational level at the level of the overall industry average.</td>
<td></td>
<td>Comprehensive model of construction knowledge and its efficient use;</td>
</tr>
<tr>
<td></td>
<td><strong>Physical work environment</strong>&lt;br&gt;Amount of site human resources diminished by 30% for the same level of overall activity.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.4 Strategy

Given the fragmentation of construction processes and the very high human content of any progress to be achieved through RTD, it is unlikely that progress will arise or be disseminated in the same manner as for new technologies that are embedded in machines, materials, work methods, software. The profound re-engineering (of culture, values and processes) which is needed must be freely accessible and presented in such a way that industry stakeholders could to share with the RTD community the initial questioning, the development of RTD activities as well as the user friendly results that should ultimately become available.

In the case of Health & Safety, this will be best achieved through the creation of a specific European Initiative for H&S in Construction bringing together all relevant voluntary stakeholders (industrial and others) concerned with construction and with health and safety at work. This European Initiative would be given the opportunity to follow and witness all RTD activities from inception to completion. It would also serve as a launching pad for a H&S label established on the basis of voluntary certification covering projects, contractors, material suppliers, plant suppliers, working methods, etc.

Europe presents an extremely broad spread of cultures, business approaches and working methods, not to mention languages that will continue to act as barriers to progress if national independent approaches are maintained. On the other hand this wide experimental base will provide a much more robust foundation for investigation and research. Results will be obtained more quickly and will be inherently resilient to context disparities.

Health and Safety for workers

The first phase of the research agenda will involve an appraisal of current data and existing studies in the member states that identifies the principal causes of accidents and occupational diseases, the statistics collected by Eurostat in the member states and a comparison of the incoherencies in their definition and collection. The information gleaned from this first phase would form the base line out from which all RTD and industrial activities can be supported.

Construction sites are by their very nature (unpredictable evolutionary context), inherently dangerous places and uncertainty will always be present however detailed the risk assessment studies. This is a particular feature that is quite specific to this industry and not present in manufacturing or chemical industries for example. It calls for specific RTD programmes.

However one should note that site construction teams are always the potential victims but have the necessary practical knowledge to analyse situations, and are the sole actors in a capacity to re-engineer – on a real time basis – their work processes. “Joined-up thinking” and coherent collaboration by all the parties involved – but centred around the site workforce and management and integrating individual and collective dimensions - is essential from the initial design stage right through to completion.

It is therefore essential that human science based on a global approach encompassing all relevant scientific disciplines (psychology, organisation, sociology, occupational medicine, ergonomics etc.) develops a new model for putting together site construction teams beginning with site teams and progressively enlarging them to project construction teams which will then have the capacity to re-engineer on a permanent basis the complete supply and construction chain. The source of progress will be not so much in analysing past accidents rather than in analysing near-miss situations or even just “normal” situations. Indeed, the
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reality is that human organisation such as site teams are permanently readjusting their activities to avoid accidents. It is only when this instinctive compromising activity is over done that accidents – in a given situation of permanent uncertainty – actually occur.

This new modus operandi will have to be developed “in situ” through the application of “intervention research” and progressively enlarged to cope with the wider variability of situations that arise in construction projects: project size, company size, type of work, position in the value chain.

Workforce and stakeholder empowerment is the right way to make further progress. Without opposing the regulatory approach, it is most important to reinstate a sense of responsibility into all stakeholders – so that the externalisation of responsibility is no longer possible – and to adopt a single point of responsibility on site providing in return the power to act. Such a new approach, in line with the much broader policy of Corporate Social Responsibility, should at last find its means of implementation through the establishment, on a sound scientific basis – coming from the research agenda -, of a H&S label whereby projects, companies, processes, equipment, training tools, H&S education materials may be certified on a free and voluntary basis by an independent but representative H&S construction platform.

Organisations, so modelled, will be in a position to re-engineer and develop by themselves adaptive work and business procedures that will develop an inherently safe construction system. These procedures will have to be developed to cover the complete range of activities.

New materials and new technologies, particularly but not only ICT, will offer numerous opportunities for improving the health and safety records of the industry. These will be able to provide and deliver their full potential only at that point in time since the human context and organisation (site teams and procedures) will place the site construction teams in a situation empowering them to adopt or to direct development of the fit-for-purpose technologies and tools they really need.

Promising technologies may in particular be very beneficial in the development of:
extended Safety belt (XSB): providing sites, facilities under construction, constructional plant, workers with safety devices that either prevent accidents or safeguard their consequences. Such XSB may operate on an inert basis (physical phenomena), or on an active basis (embedded intelligence for example to detect hazardous situations).

- Clothing improved with new textiles and intelligent devices.

- H&S knowledge management: giving ubiquitous, simple and ergonomic access for site workers to all information flows having relevance to H&S issues for exercising a more permanent and real time vigilance and risk assessment of their activities in a pro-active manner, whilst capitalising their experience in a re-active attitude, and for developing as and when needed, the re-engineering of their construction process should it be suddenly necessary.

- Mechanisation: these technologies have a very high potential in that they will give the site teams the possibility to plan their activities with the minimum demand of physical human activity, thereby diminishing the occurrences of dangers and hazards, although the remaining activities may ultimately be more severe in their potential consequences.

- Industrialisation: transferring to the largest possible extent on-site activities to off-site activities – providing the latter remain inherently safer – is probably one of the most promising approaches. However, construction activity is “site-embedded” and ultimately cannot be avoided. The key innovation needed is therefore the development of site-compliant off-site supply chains. Either, the supplementary H&S measures required for site installation or assembly of products is simultaneously developed in order to be inherently safe, (as a consequence of calling upon the knowledge of site teams in order to obtain a satisfactory result), or otherwise it risks not being engineered properly and consequently industrialisation will not be efficient in improving H&S records whilst continuing to deliver construction projects that satisfy the requirements of end-users.

Subsequent to the European enlargement and increasing globalisation, construction sites and projects are increasingly multicultural and multilingual that make the treatment of risk more and more delicate. This dimension needs to be taken right upfront in the research agenda so that human science tools, including but not limited to ICT tools, are developed properly.

**Personal development and teamwork**

The approach in that domain is basically the same as the one detailed – in as much as human and social sciences are concerned – for health and safety for workers except that it targets at the business processes, especially those linked to the satisfaction of end-users and Society as a whole (sustainability) and to the satisfaction of the companies shareholders (productivity).

From this standpoint, developments performed in view of better health and safety can be expanded to include other views. Health and safety, of primary importance and offering the further advantage of a well focussed action, will then act as a test bed for developing appropriate models more quickly. Their transfer to other areas will be achieved more easily thereafter.

Naturally the lead time between RTD activities focussed on health and safety and their broadening to encompass wider objectives should be limited to just a few years.
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The introduction of a European Initiative for Health and Safety in Construction described above should also be a valid idea in this theme, but the differences in terms of interested stakeholders will justify the creation of a specific new European Initiative.

The results drawn from this theme should also serve as input into the following two themes. Also, the output of this theme will have much to do with all other focus areas, particularly in their process dimensions in order to achieve integration.

Knowledge

Knowledge flow and management is a fundamental element of any business process and of project development. It must be approached in accordance with existing roadmaps already addressing this issue such as the ROADCON or the FIATECH strategies already mentioned.. It will serve the objectives of satisfying the workers (any skill, any trade, any hierarchical position), and of eventually Enhancing construction employment through raising the knowledge level of the workforce and the rewarding character of activities themselves.

Physical work environment

This theme could be described as achieving the Digital Site on the one hand whilst reducing site activities to the unavoidable minimum required on the other or the “Minimum Activity Site”. Again some existing roadmaps like ROADCON and FIATECH address this theme. It needs expanding to encompass the developments of industrialisation, first exploring the business conditions for success. And the diagnosis advanced here is to validate the concept of integration as already explained above as well as in E-Core. Innovative research projects are needed in this domain to develop efficient new technologies increasing the industrialisation of the construction process.
7 INTERFACING WITH OTHER F.A.s

The Focus Area TOWARDS A SUSTAINABLE BUILT ENVIRONMENT is a horizontal area. As a result, it will interface with the other Focus Areas of the ECTP.

Identifying these interfaces will be under the responsibility of Focus Area Leaders, through their communications to the other F.A. Leaders and to the Support Group.

Objective of this vision document is to identify the domains where research is vital to meet the social demands imposed to the Construction Sector. At this level, overlapping between Focus Areas is not critical and is accepted, as the aim is to identify all demands, without any major omission.

A deeper cooperation between Focus Areas will be undertaken by F.A. Leaders for the definition of the Strategic Research Agendas, in order to come up with coordinated research propositions and calendars.

8 IMPLEMENTATION PLAN

The implementation of actions identified in this document will be implemented through the following instruments :

- at European level, through the coming Framework Programme launched by the European Commission (FP7) and through its variety of instruments: research projects (STREP, IP, JTI) and networks: the Strategic Research Agenda will provide a relevant basis where the EC will establish further calls of the FP7;

- at the level of Member States, by integrating in this effort the relevant National Projects, and using the Focus Area National Platforms as a communication tool. This Focus Area will identify the relevant national projects and will establish a physical link with these projects by inviting them (co-ordinators, partners) to actively participate;

The Focus Area is rich of about 100 members, representing most of the supply chain of the construction industry: users, governments, owners, contractors, materials providers, research institutions, universities. Still are missing more representatives of users and of government; and SMEs; new representatives of social partners (unions, etc). Assistance of National Platforms will be requested to identify potential members participating or linking to the F.A.
APPENDIX 1 - ORGANISATION OF THE FOCUS AREA

1 Organisation Chart of the Focus Area

2 Leadership
Soletanche Bachy and Hochtief Construction will jointly lead the focus area.
Leaders are:
Jean-Pierre Hamelin, from Soletanche Bachy - jphamelin@soletanche-bachy.com
Bernhard Hauke, from Hochtief Construction - bernhard.hauke@hochtief.de

Leaders will be in charge of:
- Animation of the F.A. : preparing F.A. meetings (core group meetings, plenary meetings) , maintaining the F.A. website;
- Coordination of the workgroups;
- Preparation of the F.A deliverables ( Vision 2030, Strategic Research Agenda, etc..) and more generally of all documents requested by the EC, by the HLG or the SG;
- Liaising with other F.As of the ECTP through their participation to the Support Group
- Maintaining the membership list

3 Core Group
The Core Group is composed of the F.A. Leaders and of the Leaders of the F.A. Working Groups.

The Core Group can take assistance of any member of the F.A.
4 Working Groups
Two leaders or more working together lead working Groups.

Leaders of the Work Groups are in charge of:
   Animating the Working Group
   Participating to the F.A. Core Group meetings and F.A. Plenary meetings
   Producing the information and synthesis documents needed by F.A. leaders.

Working Groups are established by the Core Group. Their number and fields of activities can be adjusted by the Core Group to fit with the evolution of the needs of the ECTP and to adjust to the on-going works of other Focus Areas.

Initial list of Working Groups is established as the following

4.1 WG1. Reducing the environmental impacts
Leaders :
   Alberto Bonilla, from Labein
   Antonio Burgueno from FCC

4.2 WG2. Mitigating Natural and Man-Made Hazards
Leaders :
   Frans Barends, from Geodelft
   Bernhard Hauke, from Hochtief Construction,
   Meindert Van from Geodelft

4.3 WG3. Improving the Indoor Environment for All
Leaders :
   Philomenas Bluyssen, from TNO Bouw
   Ana-Cruz Garcia from IBV

4.4 WG4 More Attractive Workplace
Leaders are :
   John Goodall, from FIEC
   Vincent Cousin, from Processus & Innovation

5 Membership

5.1 Admission of Members
Membership of the Focus Area is open to all European interested organisations, 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.
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Members are expected from the following organisations types :

Clients and Users
Social organisations (unions)
Contractors
Architectural and Engineering Firms
Specialised service providers
Equipment manufacturers and Materials suppliers
Research Institutions and Universities
Financial institutions, Insurance companies
Government bodies, including civil defence and police department
EC

The Focus Area will particularly encourage the participation of SME’s and organisations 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.

5.2 Participation of Members
Participation of Members will under the following forms :

• Participation to the F.A. plenary meetings ;
• Participation to one or several of the Working Groups : participation to meetings, web forums, contributions to the working documents ;
• Liaising with other European or National initiatives ;
• Proposing new F.A. Members ;
• Etc …. ( initiatives are most welcome !)

Members will participate at their own costs.
Membership list is given in Annex 1.1. It is maintained by the F.A. Leaders.

6 Planning
Planning of the activities of the F.A. is continuously adjusted to the requirements of the HLG and the SG.

Planning is given in Annex 1.2. It is maintained by the F.A Leaders.

7 Links
The F.A. has the objective to continuously identify other European initiatives which are related to its 4 domains of action.

The following links have been identified :

<table>
<thead>
<tr>
<th>LINK TO</th>
<th>PERSONS IN CHARGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP Industrial Safety</td>
<td>Bernhard Hauke; co-leader of FA</td>
</tr>
<tr>
<td></td>
<td>Olivier Salvi – INERIS, from the TP-IS</td>
</tr>
</tbody>
</table>
The FA Quality of Life gathers 128 members, as follows:

<table>
<thead>
<tr>
<th>Last Name</th>
<th>First Name</th>
<th>Company</th>
<th>e-mail</th>
</tr>
</thead>
<tbody>
<tr>
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<td>F</td>
<td>Amberg Engineering</td>
<td><a href="mailto:famberg@amberg.ch">famberg@amberg.ch</a></td>
</tr>
<tr>
<td>Arvanitidis</td>
<td>Nikolaos</td>
<td>IGME</td>
<td><a href="mailto:narvanitidis@thes.igme.gr">narvanitidis@thes.igme.gr</a></td>
</tr>
<tr>
<td>Baeppler</td>
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<td>Herrenknecht</td>
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**European Construction Technology Platform**

**Focus Area : Quality of Life - Towards a Sustainable Built Environment**

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European Construction Technology Platform  
Focus Area : Quality of Life - Towards a Sustainable Built Environment

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APPENDIX 3: UPDATED PLANNING (20/10/05)

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<td>Vision 2030 of the ECTP ready to be endorsed by the 1st HLG Meeting</td>
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<td>30 March 2005</td>
<td>1st Draft of the ECTP Strategic Agenda</td>
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<td>26 April 2005</td>
<td>2nd Draft of the ECTP Strategic Agenda</td>
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<td>21 June 2005</td>
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<tr>
<td>25 October 2005</td>
<td>ECTP Plenary Meeting, in Paris</td>
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<tr>
<td>22 November 2005</td>
<td>3rd HLG Meeting</td>
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<tr>
<td>1 January 2006</td>
<td>Start of the FP7</td>
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