W82

CIB

SUSTAINABLE DEVELOPMENT AND THE FUTURE OF CONSTRUCTION

A comparison of visions from various countries

CIB Report Publication 225
ISBN 90-6363-011-5

CIB Working Commission W82
"Future Studies in Construction"

May 1998

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PREFACE

This international CIB W82 Project aimed to answer the following question: *"What will be the consequences of sustainable development on the construction industry by the years 2010?"*

This study was focused on investigating the relationship and clearly defining the links between the principles of sustainable development and the construction sector.

It was launched in 1995 and was carried out with the collaboration of experts coming from countries in Western and Eastern Europe, North America, South Africa and Asia, with the objective to produce this CIB Publication in time for the CIB Gävle Congress.

This publication comprises fourteen national reports and an international synthesis, which give a comparison between visions from various countries on what comprises the notion of "sustainable construction".

There are many issues presented in this publication, all of which illustrate the constraints, policies, influences, recommendations and best practice that help describe sustainable construction. It is therefore of interest for all the actors of the sector (designers, industry, constructors, researchers, users, authorities…) to get a global view on the concept and to evaluate how their action can contribute to this challenge.

This publication should also be used as a source document for future studies and in particular for the development of a CIB Agenda 21 for Sustainable Construction following the CIB Gävle Congress.

Finally, this work must be seen as a living study and is open to an updating process. Input from additional countries, not already involved, is encouraged.

Wim Bakens
CIB Secretary General

EXECUTIVE SUMMARY

This international CIB W82 Project aimed to answer the following question:

"What will be the consequences of sustainable development on the construction industry by the years 2010?"

The study focused on investigating the relationship, and clearly defining the links, between the principles of sustainable development and the construction sector.

The (Kibert) definition for sustainable construction: "*the creation and responsible management of a healthy built environment based on resource efficient and ecological principles*" was taken as a starting point in 1995 when the project was launched. The objective was to interpret and describe its meaning in different participating countries and, if appropriate, to give it a better definition from their national point of view.

The project has involved the collaboration of experts from countries in Western and Eastern Europe, North America, South Africa and Asia, with the objective of producing this CIB Publication in time for the CIB Gävle Congress. The publication resulting from this project comprises fourteen national reports and an international synthesis, which give a comparison between visions from various countries on what comprises the notion of "sustainable construction".

The publication comprises:

Definitions of Sustainable Construction

The word *sustainable* (suggesting the idea of constant, permanent or continuous) is translated to some languages as *durable*. The concept of “durable construction” may change the vision on the intended objectives, laying stress on resistance in time.

Sustainable construction has different approaches and different priorities in various countries. Some of them identify economic, social and cultural aspects as part of their sustainable construction framework, but it is raised as a major issue only in a few countries.

The main emphasis in national definitions lies on ecological impacts to the environment (biodiversity, tolerance of the nature and resources). The problems of poverty and underdevelopment or social equity are sometimes ignored in the definitions of sustainable construction and in addition to economic prerequisites or social questions, numerous other variables and their importance range from country to country.

Such features as density and demography of population, national economy and standard of living, geography and natural hazards, availability of land and water, energy production and supply, the structure of the building sector or the quality of the existing building stock etc. have also an influence and interpretation in national definitions.

The Five Questions

The content of this synthesis is based on answers given to the five questions that formed the main body of the national reports.

1. What kind of buildings will we built in 2010 and how will we adapt existing buildings?
2. How will we design and construct them?
    - What does this entail for **initiating, designing, constructing, maintaining, operating and demolishing** buildings?
3. What kind of materials, services and components will we use then?
    - What does this entail for manufacturers of building products and systems?
4. What kind of skills and standards will be required?
    - What does this entail for **human resources and skills** needed in the construction industry?
5. What kind of cities and settlements will we have in 2010?
    - What does this entail for **city planners** and the built environment?

Strategic Recommendations

The challenge the construction sector is facing today is not only to find the best balance between the various contemporary constraints of the act of building (technical, architectural, social or economic constraints) but also to endeavour to favour "decisions without regret" at every moment in the life cycle of a building, and especially in the construction phase. This chapter summarises the main recommendations given in the national reports towards:

- Building owners and clients should have a very important role in disseminating sustainable construction since they represent the demand of the building sector.
- Initiatives which involve planning, industry and constructors through adapted regulations, standards or fiscal measures and incentives.
- Education and training which should be largely used to have sustainable development concepts well known and accepted by all people.
- Developing a common language.
- Designers adopting a more integrated approach to design.
- Manufacturers of building products assessing the life cycle considerations as the basis of product development.
- Building users should see the environmental issues as one aspect of productivity.
- Building maintenance organisations should see environmental consciousness as a factor of competitiveness.
- The development of adapted tools to help in decision making.
- The improvement of the building process itself

Finally, a general recommendation which is stated is to take action at once to act preventively and to prepare the building sector to changes which are needed in the building process.

Examples of Better Practice

This section presents extracts of the case studies which are presented in the national reports. The full case studies provide an insight into the many approaches people have taken to putting the theory of sustainable construction into practice. It is hoped that these examples will help shape and define our own vision of sustainable construction and encourage the wider application of sustainable construction practices.

In total there are 59 examples presented in this section as follows:

Urban Planning - which includes examples of community planning.
Product development and design - including new uses of traditional materials.
Manufacturing and construction - looking also at new partnerships for construction.
Operation - including integrating new technologies for greater efficiency.
Deconstruction - looking at the long term use of the building.

Final Conclusion

There are many issues presented in this publication all of which illustrate the constraints, policies, influences, recommendations and best practice which help describe sustainable construction. It is therefore of interest for all the actors of the sector (designers, industry, constructors, users, authorities,…) to get a global view on the concept and to evaluate how their action can contribute to this challenge.

Current practices are widely different depending on how well the concept of sustainable building is developed in the various countries. There is also a marked difference between the developed market economies, transition economies and developing economies. The more mature economies pay more attention to the creation of a sustainable building stock either by new developments or by upgrading their existing building stock. In the transition economies the emphasis is on new developments (reduction of housing shortage), by learning from Western experience, and making improvements to their transport networks. In the developing economies social equity is much higher on the agenda than environmental concerns. Social and economic sustainability (e.g. job creation) is given much more thought.

The industry will have to adapt to these new and emerging construction markets which have environmental and social dimensions. Construction businesses will be expected to integrate into, and consider more fully, the issues valued by others at national, regional and community level where the driving forces will be a mixture of political, social and market forces, requiring products which respond to genuine need and concerns.

Finally, this work must be seen as a living study and is open to an updating process. Input from additional countries, not already involved, is strongly encouraged.

CONTENTS

FULL NATIONAL REPORTS

Sustainable Development and the Future of Construction
A comparison of visions from various countries

0. ABSTRACT

This international CIB W82 Project aimed to answer the following question: *"What will be the consequences of sustainable development on the construction industry by the years 2010?"*

This future study was focused on investigating the relationship and clearly defining the links between the principles of sustainable development and the construction sector.

The methodology allowed:
- to present the specificity and orientations of fourteen countries,
- to display clear visions of what the construction sector could be in fifteen/twenty years in the framework of sustainable development in these countries,
- to show proposed ways to reach this goal,
- and to gather the information through an international synthesis stressing the main elements from the various countries.

The study consisted of two main steps:
- a first step was dedicated to national efforts in order to get results at national level, which involved concertation with industry and national representative organisations;
- a second step was dedicated to the international synthesis and the validation and dissemination of the results.

The study led to:
- the identification of the issues, constraints and currently followed policies in the field of sustainable construction in various countries;
- the identification of the changes and adaptations foreseen for the construction sector in these countries through answers given by experts on five questions dealing with:
    - i) the kind of buildings which will be built and how existing buildings will be adapted,
    - ii) the ways of designing and constructing,
    - iii) the kind of materials, services and components,
    - iv) the kind of skills and standards which will be required,
    - v) the kind of cities and settlements which will be developed;
- the analyses of the consequences for the phases of the construction process;
- the definition of recommendations to the main driving actors of the sector;
- an illustration of best practices through some case studies, design methods, buildings or building products.

1. PROJECT OVERVIEW

1.1 Introduction

This international CIB Project was launched at the W82 Amsterdam meeting (spring 1995). In accordance with the scope of this Commission dealing with "Future Studies in Construction" - to supply, analyse and interpret the external (exogenous) factors affecting the development and future of the construction field, and, to produce, formulate and evaluate its future alternative - the Project aimed at answering the following question:

"What will be the consequences of sustainable development on the construction industry by the years 2010?"

"Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs". According to this definition from the World Commission on Environment and Development (1987), it is clear that the various activities of the construction sector have to be regarded and analysed when considering sustainable development. As a matter of fact, on one side, the built environment constitutes one of the main supports (infrastructures, buildings,) of economic development, and, on the other side, its construction has significant impacts on resources (land, materials, energy, water, human/social capital) and on the living and working environment. Hence the construction industry has a lot of direct and indirect links with the various aspects of sustainable development.

The First International Conference on Sustainable Construction held in Tampa in 1994 [1] introduced the following definition of sustainable construction "the creation and responsible maintenance of a healthy built environment based on resource efficient and ecological principles" (Kibert and alii).

This very broad definition must be seen only as a starting point to build a more concrete definition of the concept of sustainable construction and begin to describe the stakes and issues of sustainable development that relate to the construction sector. More research is required to investigate the relationship between sustainable development and the future of construction. As an example among others proposed today, a conceivable sustainable construction road map is given in Figure 1.

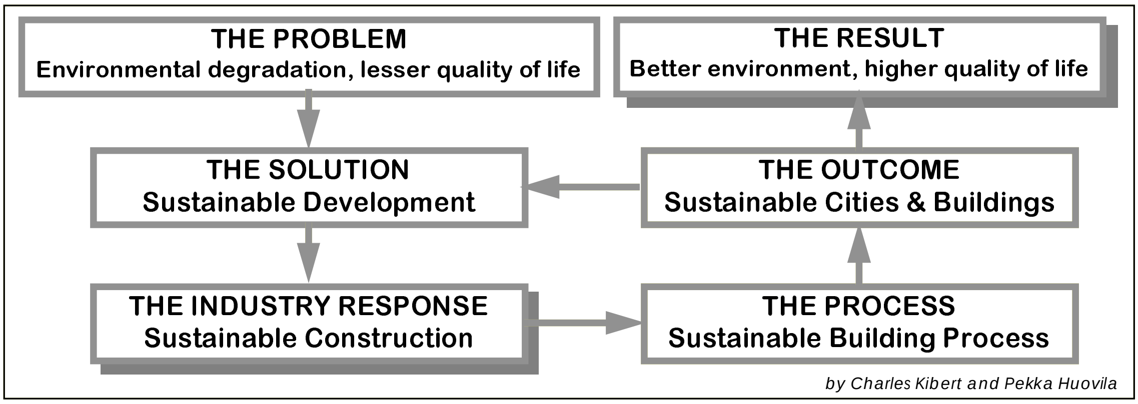

Figure 1: A Conceivable Sustainable Construction Road Map

1.2 Methodology

The Project was focused on the clear definition of the links between the construction sector and the principles of sustainable development. It followed a methodology which had several main characteristics: i) it was an international study allowing to present and to take account of the specificity and orientations of various countries; ii) it was a future study aimed at defining a clear vision of what the construction sector could be in fifteen/twenty years in the framework of sustainable development and how this goal could be reached; iii) it was carried out by experts coming from organisations deeply involved in the topic at national level.

The Project was divided into several tasks (Figure 2) grouped in four phases.

Figure 2: Main Tasks of the Project

Three different co-ordinators were nominated for the first three phases of the project as presented in the next sections: Sandy Halliday, for BSRIA, accepted to lead phase 1, Pekka Huovila, from VTT, led phase 2, and Caspar Richter, from SBR, led phase 3. Luc Bourdeau co-ordinated the last phase dealing with the international synthesis.

About eighteen countries were involved in some or all of these phases and fourteen were able to produce a full National Report (Figure 3).

Countries	**Organisations**	**National Project Leaders**
Belgium (BE)	CSTC	Frans Henderieckx
Finland (FI)	VTT	Pekka Huovila
France (FR)	CSTB	Luc Bourdeau
Hungary (HU)	ETE	Gyorgy Kunszt
Ireland (IE)		C.J. Walsh
Italy (IT)	PMPE - Univ. Florence	Roberto Bologna
Japan (JP)	Univ. of Tokyo	Tomonari Yashiro
Malaysia (MY)	Ministry of Housing	Dang Anom Md. Zin
Netherlands (NL)	TNO	Roel Lanting
Romania (RO)	Urbanproiect	Jana Suler
South Africa (ZA)	CSIR	Chrisna du Plessis
Spain (ES)	UPC	Pere Alavedra
United Kingdom (GB)	BSRIA	Tom Smerdon
United States (US)	GaTech	Godfried Augenbroe

Figure 3: Full National Reports Produced in the Project

Greece (GR) through Aristotle University of Thessaloniki (Dimitris Bikas and Sotiris Milonas) joined the project later and produced a partial contribution which was integrated in the various chapters of the synthesis.

1.3 Phase 1: Definitions of the concept of Sustainable Construction

Phase 1 of the Project sought to identify what each participating country or region understands by "Sustainable Development" and "Sustainable Construction".

The participants of the meeting in October 1995 were asked to present papers which gather national initiatives on Sustainable Construction and to try to discuss about a definition of sustainable construction [2, 3]. It was proposed to start from the definition provided by Kibert and alii.

The intention of the Meeting was to generate an interactive debate consistent with the holistic nature of the subject. In total thirteen papers from ten countries (Canada, Finland, France, Hungary, Netherlands, New Zealand, Palestine, Rumania, United Kingdom and United States) were received and discussed on a wide range of topics.

The meeting consisted of a series of informal interactive sessions to identify common themes and concerns. The papers were extremely diverse but common threads were identified.

Several definitions of "sustainable construction" were offered which reflected the regional diversity and different priorities in the participating countries. The constraints, specific issues and future scenarios specific to every country turned out to have a strong influence on the concept of sustainable construction described in each country as well as the level of priority given to the various issues.

One chapter of the synthesis is dedicated to these aspects.

1.4 Phase 2: Answers to 5 main questions and consequences

The questions to be answered in Phase 2 were the following:
- What kind of buildings will be built in 2010, and how will we adapt existing buildings?
- How will we design and construct them?
- What kind of materials, services and components will be used there?
- What kind of skills and standards will be required?
- What kind of cities and settlements will we have then?

There was no common methodology given to participants on how to find answers to these questions. That was left open to be freely defined in each country: e.g. scenario for sustainable construction, analysis and documentation of expert interviews and brainstorming sessions. National studies consisting of answers to the five questions together with a more precise (i.e. more concrete) definition of sustainable construction from participating countries were asked to be presented in the 4/96 Meeting [4].

It was also decided that the precise content of the coming Phase 3 would be described in this meeting. The intention of i) integrating the activities of other relevant CIB Working commissions and Task Groups and ii) including the presentation of some success stories were already introduced.

Phase 2 was started with Belgium, Finland, France and the Netherlands. The number of participating countries increased soon to ten after Hungary, Italy, Japan, Rumania, United Kingdom and United States decided to join the project.

Taking into account the variety of definitions of the concept which resulted from Phase 1, it was at that stage found to be too early to agree on one common definition for Sustainable Construction. Therefore each country was given the liberty of using the Kibert definition or its own definition for sustainable construction to develop answers to the 5 main questions.

One chapter of the synthesis deals with this phase of the Project.

1.5 Phase 3: National Reports

From the initial results of Phase 2 of the Project rose a need for a common methodology to be applied in Phase 3 enabling a later international synthesis of the national reports.

A methodology was proposed in mid-96, which was based on a multi-dimensional analysis of the problem. Three dimensions were firstly introduced:
- ecological principles (six principles are defined in the construction field in order to meet the three basic goals of Sustainable Development: to eliminate resource depletion, to eliminate environmental degradation, and to create a healthy interior and exterior environment);

- resources (four resources are concerned: land, energy, water and materials);
- life-cycle phases of the construction process (five phases are defined: develop and plan, design, manufacture and construct, operate, deconstruct).

After discussions, it was preferred by most of the countries to use a two-dimensional structure such as presented on Figure 4.

Resources / Process	LAND	ENERGY	WATER	MATERIALS
Urban planning				
Product development & Design				
Manufacturing & Construction				
Operation				
Deconstruction				

Figure 4: Structure for Presenting Consequences in National Reports

The idea was that for each point of this two- or three-dimensional space, it is possible to think about the consequences for the construction industry and therefore to give elements of the answer to the five questions defined earlier.

A general important remark which came from several participating members was that the definition of Sustainable Development and therefore the definition of the ecological goals and principles which were proposed did not fit necessarily the concept in all of the countries. As a matter of fact, it appeared, from the previous contributions on Phases 1 and 2, that the concept from some countries can be much broader than the "ecological" concept proposed here [5, 6, 7].

On the other hand, this methodological approach offers an interesting support for thinking about consequences to the construction industry. It enables a grasp of the overall idea and to debate over the appropriateness of activities meant to contribute to Sustainable Development. It also provides a good instrument to make a synthesis of the national reports.

Therefore, it was agreed to use this methodological approach for Phase 3 of the Project. To solve the problem linked to the general important remark mentioned above, it was agreed to give the possibility to every country to add to each dimension as many topics as needed.

In order to follow a way towards sustainable construction, it was decided to present main national strategic recommendations that could be addressed to the various actors of the construction sector in each country.

One chapter of the synthesis is dedicated to these recommendations.

Finally, it was also agreed that the project participants would present in their National Report best practices of Sustainable Construction from their countries.

One chapter of the synthesis deals with these good practice examples.

1.6 Phase 4: International Synthesis

The last Phase of the Project was an international synthesis of the results (Figure 5). This work started in summer 97 and was based on National Reports. The objective of this synthesis was not to try to derive so far a common universal vision of sustainable construction, but to try to present in a systematic considered way the visions coming from various countries and the associated recommendations addressed to the actors of the construction sector.

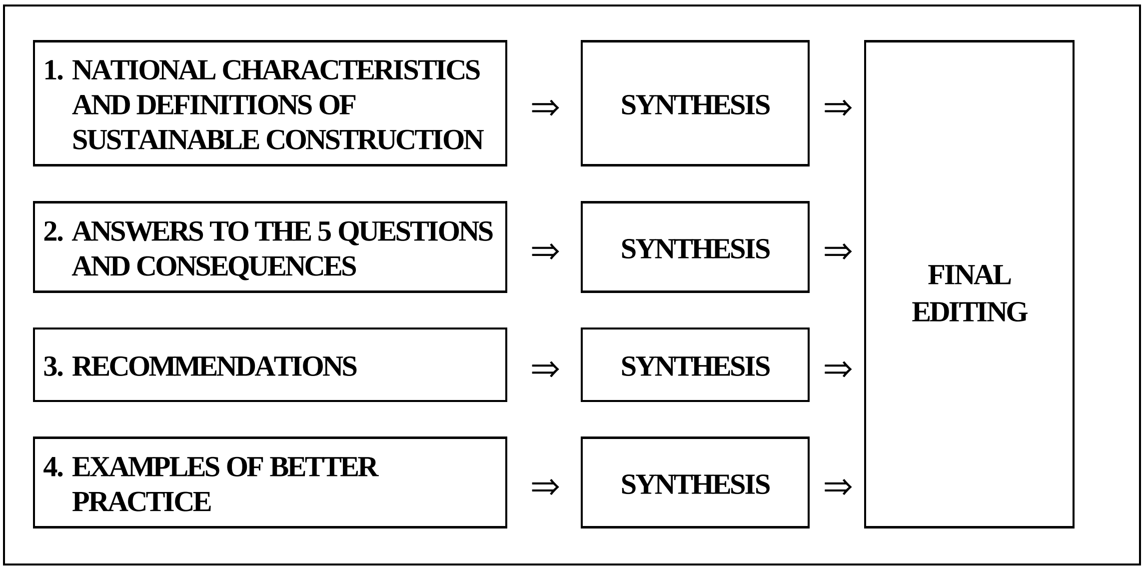

Figure 5: Methodology for the International Synthesis

The final results of the project give an international view of long term contributions from a Sustainable Construction industry for Sustainable Development. Clusters of national differences, due to special issues and national constraints, give more specific views of the different sectors. There are clusters of recommendations, provided in the National Reports, for government, management of construction and industry and for research and development as well as best practices for sustainable design and construction.

Consultation with people outside of the project was also organised at international level. Two papers were presented in Conferences in Tampere in August 1997 [8] and in Paris in June 97 [9]. A workshop was also organised in the framework of this Paris conference and the results presented at the end of the Conference. A paper was also published in the CIB Bulletin [10].

Consultation with CIB people not involved in the project was organised through a workshop held in Paris in March 98, at which contributions were made by experts from other CIB Commissions and from developing countries.

1.7 Conclusion

Sustainable construction should be an important component of achieving sustainable development. However, no clear consensus on the exact meaning of such a concept seems to be agreed today.

At the moment, the Project, presented in conferences and journals [8, 9, 10], led to a set of fourteen national reports and an international synthesis, gathered in this CIB Publication, which contain:

- the identification of the issues, constraints and currently followed policies in the involved countries in the field of sustainable construction;
- the identification of the foreseen changes and adaptations for the construction sector in these countries through answers given by experts on five main questions;
- the analyses of the consequences of sustainable development for the phases of the construction process;
- the identification of main strategic recommendations to be given in these countries to the main driving actors of the construction sector;
- an illustration of best practices through some case studies, design methods, buildings or building products.

The main goal of the present international synthesis was to extract main issues from the national reports, to detect the common ones and to stress the main differences (in scenarios, consequences, recommendations to actors...).

The next step should be to reach a more consensus vision through a global common model (with of course eventually items specific to regions or countries) and to set up indicators and policies to translate this vision into reality.

1.8 Organisation and financing of the Project

The national reports included in this publication and the other national contributions taken into account in the international synthesis were carried out by national research teams that organised their work according to the general framework agreed by the CIB W82 working commission but also according to national circumstances. These teams had their own way of working and also had to arrange their own financing.

The composition of each national team that produced a national report under the responsibility of the co-ordinators listed in Figure 3 can be found in each national report included in this Publication. Most of the national reports were also published or are going to be published in the country in question.

An editing team composed of Luc Bourdeau (CSTB), Pekka Huovila (VTT), Roel Lanting (TNO) and Alan Gilham (BRE) carried out the international synthesis. Chapter 2 was placed under the co-ordination of Pekka Huovila, Chapter 3 under the co-ordination of Roel Lanting, Chapter 4 under the co-ordination of Luc Bourdeau and Chapter 5 under the co-ordination of Alan Gilham, who also assured an English language reviewing.

Luc Bourdeau assured the final editing and the general co-ordination.

1.9 References

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10 Bourdeau, L., Huovila, P. (1997) *A CIB W82 Project on "Sustainable Development and the Future of Construction"* in *CIB Information,* October/November - Nr. 4/97, Rotterdam.

2. NATIONAL CHARACTERISTICS AND DEFINITIONS OF SUSTAINABLE CONSTRUCTION

2.1 Introduction

This chapter presents what is understood by sustainable construction in different countries that have participated in this project. Belgian (BE), Finnish (FI), French (FR), Greek (GR), Hungarian (HU), Irish (IE), Italian (IT), Japanese (JP), Malaysian (MY), Dutch (NL), Romanian (RO), South African (ZA), Spanish (ES), British (GB) and American (US) contributions towards sustainable construction definition are presented after describing their national constraints, specific issues and future issues in order to give the context to these definitions. Problems and common elements in the definitions are finally summarised. This synthesis is based on the source documents, the national reports, and no further information has been sought to compensate possible shortages in some details.

Sustainable development has several definitions, such as:
- *"development that meets the needs of the present without compromising that ability of future generations to meet their own needs"* (the BRUNDTLAND Report WCED, 1987);
- *"improving the quality of human life while living within the carrying capacity of supporting ecosystems"* (Caring for the Earth, IUCN/UNEP 1991);
- *"development that delivers basic environmental, social and economic services to all residences of a community without threatening the viability of natural, built and social systems upon which the delivery of those systems depends"* (International Council for Local Environmental Initiatives, ICLEI 1996);
- *"determined to promote economic and social progress for their peoples, taking into account the principle of sustainable development and within the context of the accomplishment of the internal market and of reinforced cohesion and environmental protection, and to implement policies ensuring that advances in economic integration are accompanied by parallel progress in other fields"* (Amsterdam Treaty, 1997).

Sustainable construction is seen as a way for the building industry to respond to achieve sustainable development. All national authors in this project were given the (Kibert) definition for sustainable construction: "*the creation and responsible management of a healthy built environment based on resource efficient and ecological principles*" as a starting point. The task was to interpret and to describe its meaning in their own country and, if appropriate, to give it a better definition from their national point of view. The objective of the international project was then to try to formulate and, if possible, to agree on one common definition for sustainable construction.

2.2 National characteristics and definitions

2.2.1 Belgium

Sustainable construction is not defined in the Belgian national report. The issues of urban development, mobility and infrastructure, quality of dwellings, environmental management planning, soil remediation, energy, construction and demolition waste, RTD initiatives, and information and training issues are treated under the title “Sustainable Construction in Belgium”. It is also reminded that the country is divided in three regions (Flanders, Brussels and Wallonia) that are responsible for their own environmental and building policy and legislation.

2.2.2 Finland

Three recent future scenario works (Figure 6) were selected as a starting point: four Dutch national sustainable development scenarios for the year 2030, four French national future scenarios for 2030, and five Finnish global future scenarios for 2005 and on.

Duurzame Ontwikkeling-scenario (The NL 1996) *Span:* 2030 *Scope:* "Extended economy" forms of capital and their interchangeability	**Bâtiment 2030 / Club Bâtiville** (France 1992) *Span:* 2030 *Scope:* National & European socio-economic variables	**Finland an the possible worlds / SITRA** (Finland 1995) *Span:* 2005 – ? *Scope:* Global development "macro level phenomena"
A1 **Strong Together** Global dominance of environmental values	B1 **Laisser-faire** Strong liberalism + economy in crisis	C1 **Master Plan** Multinational cooperation + political stability + sustainable development
A2 **Strong Alone** National dominance of environmental values	B2 **Croissance duale** "Intermediate scenario": liberalism + fordism + modest economic development	C2 **Merciless Business** Dominance of the market and free capital + economic and political instability
A3 **Considered Sustainment** "Intermediate scenario": modest regulation + technological optimism	B3 **Productivisme** Dominance of the EU level + modest regulation + techndogical optimism + strong economy	C3 **Conflicting Cultures** Cultural blocs + national separatism + economy-driven conflicts
A4 **Weak Sustainment** Market dominance, liberalism + technological optimism + strong economy	B4 **Développement durable** Dominating environmental values on the global and the EU level	C4 **Beyond the End** A fast and severe crisis invoked by competition and economic growth + global disorder + new localism and regionalism
		C5 **Competing Power Blocs** International spheres of influence + hegemony of power blocs + power politics

Figure 6: Dutch, French and Finnish Future Scenarios

The chosen working procedure was first to set sustainable future objectives and then start to accomplish them. Therefore the efforts were focused on describing one desired and realistic future, instead of comparing different alternative scenarios. The mission was understood as not to discuss unsustainable futures. A combination of the Dutch Strong Alone and Strong Together, together with the Finnish Master Plan was chosen as a starting point.

The following issues were identified to characterise national features:

- the availability of free space, and air and water of good quality, is not seen as a problem to be solved and is not striving for environment-saving solutions;
- the climatic conditions in the North of Europe are cold, leading towards energy saving thinking and acting as a self-evident matter;
- in general, the education standard is high, and means for co-operation and large-scale responsibility exist;
- although construction is mainly a home market activity, the market requirements in Central Europe act as a driving force to a larger extent than just to the manufacturing industry, that actively exports their building products;
- success factors are, and certainly will be, associated with competition circumstances in Finland and in Europe.

It is reminded that sustainable development is often treated in three areas: ecological and economical, social and cultural. Sustainable construction in this report emphasises ecologically sustainable construction, which means essentially management of bio-diversity, tolerance of nature, and saving resources. The idea is that achievement of ecologically and economically sustainable construction enables socially and culturally sustainable construction.

Sustainable construction, according to the definition, *"in its own processes and products during their service life, aims at minimising the use of energy and emissions that are harmful for environment and health, and produces relevant information to customers for their decision making"*. For building construction this means:

- intensified energy-efficiency and extensive utilisation of renewable energy sources;
- prolonged service life as a target;
- saving of the natural resources and promotion of the use of by-products;
- reducing waste and emissions;
- recycling building materials;
- supporting the use of local resources;
- implementation of quality assurance and environmental management systems.

The intention is to achieve an environmentally responsible industry and building owners together with environmentally conscious consumers.

2.2.3 France

In France the concepts of sustainable development and of "sustainable construction" are quite new. It is only at the end of the 80's that the problem of links between environment and buildings is really raised. However, the problem of energy savings in buildings has been the topic of a lot of development in France since the oil crisis (and even before). Several energy standards were set up in France since the 70's and the last one in 1989 introduced an advanced approach taking into account all energy consumption factors in the dwelling sector.

The main other environmental preoccupation factors in the construction sector so far were the problems of lead and asbestos, the problem of community wastes, the problem of CFC substitutes in building products and equipment (insulation products and cooling systems), the saving of water in flush systems, and the development of the use of recycled materials for road construction.

Sustainable construction is described in a form of 24 criteria in the following treelike outline (aim: design a sustainable building):

Characterise the design phase

- allow a technico-economic optimisation
    - capability to meet functional requirements (*indirect criterion*)
    - capitalistic impact (*indirect criterion*)
- envisage good construction conditions
    - construction logistics (*direct criterion*)
    - working conditions (*indirect criterion*)
    - impact on personal standing and employment (*indirect criterion*)
    - building site pollution (*direct criterion*)
- lead to minimal resources withdrawal
    - impact on raw materials withdrawal (*direct criterion*)
    - impact on energy resources withdrawal (*direct criterion*)

Master the operation phase

- insure maintaining of use functions
    - life duration - robustness (*indirect criterion*)
    - optimised maintenance (*direct criterion*)
    - consumption/wastes (*direct criterion*)
- master management of interfaces
    - cost of access to collective services (*indirect criterion*)
    - people: safety/health (*indirect criterion*)
    - non material services: TV, phone, ... (*indirect criterion*)
- participate and contribute to urban life
    - transport means inter-modality (*indirect criterion*)
    - integration of proximity services (*indirect criterion*)
    - integration of avoided social costs (*indirect criterion*)
    - impact on property value of location (*indirect criterion*)
    - impact of the construction on local environment (*direct criterion*)

Manage/retrofit/demolition phase

- allow retrofit/refurbishment
    - capability to be adapted (indirect criterion)
    - capability to change end use (indirect criterion)
    - capability to improve performances (direct criterion)
- allow deconstruction
    - aptitude to demolition (*direct criterion*)
    - deconstruction - aptitude to waste reprocessing (*direct criterion*)

Three categories of problems are identified behind the notion of Sustainable Construction:

- Physical problems
  arising from the issue of taking account of natural heritage: the management of resources shortage (essentially energy and water), and the management of damage caused to earth (essentially greenhouse effect);
- Biological problems
  following from the issue of not signing mankind's life away;
- Sociological problems
  evolving from the issue of ensuring an inter- and intra-generation solidarity; these problems have socio-political, socio-economic or socio-cultural facets.

2.2.4 Greece

Economic and social constraints can be characterised as:

- illegal immigration and refugees,
- low birth-rate,
- increase of life expectancy, high portion of aged people,
- urbanisation of rural areas.

Energy production and consumption account for 88 % of all greenhouse gas emissions and 92 % of the CO_2 released in the atmosphere. The energy conservation measures essentially involve:

- the reduction of energy requirements, by incorporating "passive systems" in new buildings, by increasing insulation requirements in new constructions and improving the situation in the existing building stock;
- the rational use of all available energy sources, the introduction of natural gas (in such areas as space and water heating) and the extensive use of solar geysers;
- the introduction of new technologies.

There is no official definition for sustainable construction. It is generally stated that the application of the sustainable development principle must satisfy present-day demands without jeopardising the future generations' right to well-being.

2.2.5 Hungary

In practice, the main issue is to achieve and stabilise EU membership for the country.

Economic and social constraints:

- a serious segregation of the society with connected problems of a minority ethnic group, illegal immigration, and refugee groups,
- a very low birth rate and a fairly high portion of aged people,
- a substantial restructuring of the economy and of the society is continuing, in spite of the previous substantial transition, concerning industry, agriculture, and services.

Environmental constraints:

- air pollution by traffic and industry, especially in the capital district,
- water pollution substantially due to foreign contamination,
- soil pollution,
- waste management in general and specifically nuclear waste treatment,
- almost empty villages and connected social problems of the inhabitants,
- an old building stock needing urgent maintenance and repairs; in places becoming slum areas,
- the lack of resources for renovation and reconstruction,
- the portion of imported materials in new construction.

The conceptual problem of sustainable development is clearly stated. The kernel of sustainable development is defined as the avoiding of bad ecological effects of modern economy, industry, and technology. More problematic use of the term refers to other negative phenomena such as poverty. It is therefore suggested that a new expression 'sustainable development and underdevelopment' would be used which includes the tolerability of underdevelopment. The aim of this extension is to better understand the differences of developed and less developed countries.

The given (Kibert) definition is accepted. The human resources and the clearance of miserable urban areas are indispensable.

2.2.6 Ireland

Although it is not yet known what sustainable development means, the wide scope of this concept is seen with complex inter-relationships between different components: environmental protection, human/social development, cultural development, and economic development. Sustainability of the built environment involves:

- establishing limits on the capacity of the natural environment to sustain itself,
- stopping short of those limits, by a controlled factor of safety, in any further future modification or extension to the built environment,
- altering the nature and course of human development, i.e. sustainable development.

The considered view is that sustainable construction represents a quantum leap in the evolution of design philosophy, and that its relentless progress forward is inevitable.

2.2.7 Italy

Italy is going through an economic phase of transition that started in 1992 and is characterised by:

- restrictive policies in public expenditures, set to reduce the great public debt accumulated during the eighties;
- constant effort of the industry to achieve higher productivity rates, as their main strategy in order to participate in the global exchange market.

The following structural features and problems are identified:
- absence of large amounts of natural raw materials; dependence on foreign countries for 80 % of national needs for fossil fuels;
- different growth measure of the advanced northern regions with respect to the southern regions;
- heavy unemployment figures (national average 12 % and over 20 % in southern regions, mostly the youth population);
- negative birth rate;
- drop in the role of the big enterprises and presence of big public enterprises;
- development entrusted to small-medium enterprise’s vitality, innovation capability and competitiveness in the international market.

A “considered sustainment” scenario for the future can be synthesised:
- adoption of engagements in defence of the local and global environment, which is not to be more ambitious than the main indications at international level;
- increase in processes of endogenous development and of independent decision-making processes of individual administrations that tend to counter-balance the consequences of the lack of economic political lines explicit in the direction of the endurable development on one side and to bringing forward some changes which will in any case be indispensable on the other.

The meaning of sustainable constructions, and more precisely of sustainable buildings, is defined by the following principles:
- complete interaction with the environment, its natural phases and its resources availability;
- they are designed for efficiency of functioning during the time;
- they are designed for the longevity, the re-use and recycling of their materials;
- they are designed to optimise energy efficiency;
- they avoid the production of wastes and dangerous emissions in the phase of construction and during the life itself of the building;
- they foresee air-conditioning elimination, where possible;
- they avoid the use of electricity for heating and cooling, through passive design;
- for their construction local, recyclable and re-useable resources have been utilised;
- they use renewable materials, like wood.

However, in the definition of the sustainable construction concept, it is appropriate to specify that these principles are necessary, but not sufficient in order that to build in a sustainable way, it is fundamental to base our foundation on a sustainable society where harmony exists inside peoples, between peoples and with the planet.

2.2.8 Japan

Key issues in Japan concerning environmental impacts by construction industry are:
- global warming (over 34 % share in national CO_2-emissions by construction activities);

- depletion of tropical forests (33 % of exported tropical timbers are consumed in Japan);
- ozone depletion (the recycling of ozone depleting materials);
- acid rain (although the relative amount produced by the construction industry is quite small);
- construction wastes (about 21 % of industrial waste in 1990);
- capacity of space (the lack of land area);
- short life buildings (the tendency to demolish buildings after quite a short utilisation period);
- global supply chain (the amount of imported resources which generate environmental problems in other countries).

Basic strategies for integrating policies by the Japanese government for the coming decade may be interpreted as some kind of definition of sustainability. These strategies are:

- cyclic utilisation
  realising a socio-economic system with less environmental impacts by cyclic utilisation;
- harmonisation with nature
  harmonised coexistence with living creatures by conservation and restoration of ecological environments;
- participation
  participation of all organisations to the activities toward ’cyclic utilisation’ and ’harmonisation with nature’ under equalled role sharing;
- international framework
  promotion of international collaboration.

Additionally, Building Agenda 21, developed by the Architectural Institute of Japan (AIJ), proposed seven principles for future research activities:

- establishment of the methodology to evaluate life cycle impact of building to the environment, as well as creation of measures to constrain impact by using the methodology;
- producing a code of practice of planning together with reconsideration of the present life style from the aspect of energy consumption;
- prolonging the life of buildings in order to prevent rapid resource consumption;
- reducing energy and water consumption in building operation and setting up measures to use renewable resources;
- planning for sustainable land utilisation and for preventing pollution to water, air and land;
- creating measures for a healthy environment;
- promoting technology transfer and information exchange for international co-operation.

2.2.9 Malaysia

The following issues are identified:

- a large proportion of the population lives in urban settlements;
- illegal immigrants create economic and social problems;
- the availability of land, air and good quality is a problem;
- there is a mushrooming of squatter settlements;
- there is a means for co-operation and large scale responsibility towards sustained development still exists;
- unsustainable urban sprawl;
- depletion of forests continues;
- the hot climate needs policy to sustain the energy as most houses have installed air-conditioning units;
- the volume of road vehicles is alarmingly responsible for the emission of CO_2;
- the management of toxic and industrial waste needs to be reviewed;
- environmental protection during the construction process is needed;
- utilisation of imported building technologies and materials.

The definition given by Kibert definition is adopted.

2.2.10 The Netherlands

The present situation is that:

- the Netherlands has the highest population density in Europe (499 inhabitants/km^2);
- as everywhere else in Europe, life expectancy is on the increase and is projected to reach 76 years in 2010 – at that time those over 65 years will form 24,1 % of the population;
- a large proportion of the population (roughly 90 %) lives in urban settlements and some 30 % of them complain about nuisance from noise and odours;
- water management is of extreme importance;
- there are 185 road vehicles per km^2 and road traffic alone is responsible for 22 % of the national CO_2 emission; projections indicate a 70 % increase in road transport kilometres between 1986 and 2010;
- the problem of allocation of space is not restricted to the country itself but also has a global dimension: in other countries the Netherlands effectively takes up five times its own surface for food production, the production of cattle fodder and the import of timber.

The government policy for the immediate future is aimed at:

- energy saving,
- controlled growth of mobility,
- stringent planning of land use,
- efficient use of raw materials and water.

Long-term government policy is based on the identification of three closely linked sustainability variables: energy, mineral resources, and land use and bio diversity.

The scenario proposed for 2010 is a policy target-based approach. It retains the direction and relative dynamism of the economic and political changes observed during the past years, including trends recently recognised (surprise-free scenario). Agenda 2010 for the Netherlands, together with the key issues for the construction industry is as follows:

Sustainability key issues	*Agenda 2010 (goals)*	*Key issues for the construction industry*
General (socio-economic factors)	Incorporate sustainability into decisions; environmental performance standards into building regulations	Decision-support systems, information technology, interdisciplinary co-operation, re-engineering of building process, incentives for innovative technologies
	Incorporate environmental impacts into the tax system or into prices	Life-cycle costing, full cost pricing
	Full acceptance of the sustainability concept	"Social engineering", education
Energy	30 % increase in all energy efficiency (1995 to 2000)	Embodied energy, energy use and supply, urban planning
	Increased energy performance of buildings (23 % in 2000)	Insulation, intelligent building services, alternative energy sources, maintaining healthy indoor environment
	10 % renewable energy (2020)	Optimal use of solar energy and biomass
	35 % reduction in mobility	Physical planning, public transport, energy-efficient transport systems, teleconferencing, teleworking
	Energy taxes	Energy efficient production
Mineral resources	Decreased use of non-renewable raw materials (annual use of 1 % of established reserves)	Lean design, durable products
	Increased use of renewable raw materials (20 %)	Use of biomass
	Closed-loop recycling (90 %)	Infrastructure for recycling/reuse, product stewardship
	Extended service life of buildings; management strategy for existing building stock	Life-cycle flexibility, regeneration of existing stock, sustainable design and site quality
Land-use and biodiversity	Conserve open areas	Use of third dimension, land reclamation, high density building, right use in right place
	Interconnected wildlife areas	Physical planning of infrastructure, reconstruction
	Conservation of ecosystems	Emissions of building products in use, management of river systems, remediation of soil/water pollution
	Water conservation (25 % reduction in household use by 2010)	Efficient use of drinking water, prevention of water pollution

The official definition for sustainable construction is *"a way of building which aims at reducing (negative) health and environmental impacts caused by the construction process or by buildings or by the built-up environment"*.

A more precise definition of sustainable construction is suggested as *"the reduction of the use of natural resources and the conservation of the life support function of the environment by construction processes, buildings and the built-up environment under the premise that the quality of life is maintained"*. The key verbs in the definition: reduce, conserve and maintain can be interpreted as key issues and principles as follows:

criterion	*key issues*	*principles*
Reduce	Use of energy sources Use of mineral resources Use of water resources Use of land	Minimise depletion through: - reuse - recycling - use of renewable resources - efficient use (extended life-span of products, energy and water efficiency, multiple use of land)
Conserve	Natural areas Bio-diversity	Conserve through: - restricted land use, reducing fragmentation - prevention of toxic emissions Restore through: - remediation
Maintain	Healthy indoor environment Quality of built-up environment	Maintain through: - low emission materials, (energy) efficient ventilation, compliance with occupant's needs - provision of amenities, transport, recreation, security - abatement of noise, pollution and odorous Restore/improve through: - renovation, rehabilitation

At the building level, a sustainable building can be defined as a building that:

- consumes a minimum amount of energy and water over its life span;
- makes efficient use of raw materials (environment-friendly materials, renewable materials, enhanced life cycle, demountability);
- generates a minimum amount of waste and pollution over its life span (durability, recyclability);
- uses a minimum amount of land and integrates well with the natural environment;
- meets its user's needs now and in the future (flexibility, adaptability, site quality);
- creates a healthy indoor environment.

2.2.11 Romania

After almost 50 years of a totalitarian regime, the Romanian society is now undergoing a difficult period characterised by structural changes in economics, politics, legal systems, administration and culture. This process, desired by the entire community, has incurred high social costs, which have to be supported by the present generations, in spite of their previous frustrations. Under these circumstances, the process of establishing sustainable development objectives is highly sensitive, as it should not introduce restraints beyond the tolerable limit of the population.

The adjustment of the society to sustainable development principles requires serious cultural shifting. Some components, such as attitudes are characterised by a considerable inertia, where change will take a long time. The phenomenon is even more difficult if the individuals are under the influence of distorted ideologies. Thus, it is difficult to figure what unanimously accepted means could lead to the moderation of the tendency towards “more”, when in the highly developed countries this notion represented the idea of prosperity while in the ex-socialist countries it represented a tendency that was to be blamed (against equalitarianism). Also, the stimulation of the notions of re-utilisation and recovery may face resistance in those environments where they used to be considered as a sign of poverty. Finally, moderate consumption, so that resources “should also be available to the next generations” is not easily accepted by those whose minimally necessary needs can be hardly satisfied.

Communication is considered as a prerequisite for creating the initial conditions necessary for the sustainable development process, the more so as the signals relating to the lack of functionality or blockage are more alarming. Such signals are:

- at a decision making level:
    - lack of correlation between the sector strategies and the assessment of their feasibility with reference to the legal frame;
    - lack of consistent activity to ensure feed-back by drawing attention to those situations incompatible with the old regulations or with the rigid implementation conditions in relation to research;
    - poor connections with the final user and difficulties in providing the primary data;
- with reference to professions:
    - insufficient collaboration between specialists (engineers, architects, economists, sociologists…);
- with reference to generations:
    - a certain lack of trust in the capacity of the nowadays adults to create something new after having been educated within an obsolete system, to which a certain arrogance of the “clean” generations is added.

The following definitions are referred from the literature for sustainable environment and sustainable development of constructions:

- ’sustainable environment’ means to bequeath the world in such a state as to allow the inhabitants of the future to enjoy a life quality at least similar to the one we built (from Kibert);
- ’sustainable development of constructions’ means to consciously conceive a healthy built environment, based on effective use of resources and ecological principles in order to create, administrate, maintain and rebuild the built environment (from CIBW82 Ascot meeting).

The selected resources are land, energy, water and building materials. The established ecological principles are:

- minimise resource consumption,
- maximise resource re-use,

- use renewable or recyclable resources,
- protect the natural environment,
- create a healthy non-toxic environment,
- pursue excellent quality in creating the built environment.

Life quality is unsatisfactory in relation to the national and European standards determining a priority orientation towards achieving European living standards. In fact, at European level, it is already recognised that the developed countries may envisage “the maintenance or improved life quality together with the diminution of resource consumption” as objectives of sustainable development while the less developed countries will focus on “the improvement of life quality without an exaggerated increase of resource consumption” or “the increase of the average material consumption”.

2.2.12 South Africa

We are reminded that the concept of sustainability has been practised by indigenous people worldwide for thousands of years. However, few, if any, have managed to couple sustainability with what the western mindset terms “development”. Those cultures who have lived the most sustainable lifestyles were often also the ones considered extremely “backward” or “underdeveloped”.

The definitions of sustainable development are often vague and ambiguous. Achieving “quality of life” and “quality of the built environment” does not necessarily go in hand with sustainable development as long as “quality of life” is not redefined. In South Africa, social equity is much higher on the agenda than environmental concerns, and therefore more thought is given to the impact of construction on social and economic sustainability.

2.2.13 Spain

Sustainable construction is not defined in the Spanish draft national report. The evaluation criteria with regard to the sustainability concept group the fields of environmental quality, spatial structure, cohesion and social life quality, and local economy.

2.2.14 United Kingdom

The GB report uses the given Kibert definition for the purposes of the study.

2.2.15 United States

National concerns are:
- CFCs emitted by building air conditioners and building material processes;
- a wide diversity of climatic zones, bio-regional sustainability issues, and various building codes in different states, respectively;

- inner cities with steadily deteriorating urban infrastructures;
- unsustainable urban sprawl;
- ’brownfields’: abandoned and potentially contaminated industrial and other plants;
- a deregulation tendency which makes control issues difficult;
- mainly local and community-driven sustainability movements.

Constraints are:
- consumption oriented attitudes and low public awareness of sustainability;
- the domination of short term economic indicators;
- a general mistrust towards federal involvement;
- difficulties of imposing energy and pollution taxes;
- difficulties in funding, maintaining and expanding public infrastructure;
- no ’stakeholder’ acting on behalf of the building stock and the workers.

Specific issues (by the US Building Futures Council, 1997) are:
- superfund reauthorization and risk sharing,
- cleanup standards,
- brownfields,
- environmental justice,
- environment infrastructure privatisation,
- navigation improvements (the provision of channels for container ships),
- environmental protection during the construction process,
- water minimisation and recycling.

Sustainable construction is not given a new definition in the draft of the US report. It is stated that sustainability calls for a new approach and aiming for a sustainable built environment it requires a paradigm shift [Vanegas, DuBose & Pearce, 1996]. A framework is proposed to take a broader look both in time (full life cycle assessments) and space (the object in its wider system settings), than it is used to do in traditional engineering.

2.3 Conclusions

Sustainable construction is seen as the building industry’s response to achieving sustainable development. The (Kibert) definition for sustainable construction: *“the creation and responsible management of a healthy built environment based on resource efficient and ecological principles”* was taken as a starting point for this project. The objective was to interpret and to describe its meaning in different countries and, if appropriate, to give it a better definition from their national point of view.

The word *sustainable* (suggesting the idea of constant, permanent or continuous) is translated to some languages (e.g. Dutch, Finnish, Romanian or French) as *durable*. The concept of “durable construction” may change the vision on the intended objectives, laying stress on resistance in time.

Sustainable construction has different approaches and different priorities in different countries. Some of them identify economic, social and cultural as part of their sustainable construction framework, but it is raised as a major issue only in a few countries. The main emphasis in national definitions is on ecological impacts to the environment (bio-diversity, tolerance of nature and resources).

The problems of poverty and underdevelopment or social equity are sometimes ignored in the definitions of sustainable construction. In addition to economic prerequisites or social questions, numerous other variables and their importance vary from country to country. Features such as density and demography of population, national economy and standard of living, geography and natural hazards, availability of land and water, energy production and supply, the structure of the building sector or the quality of the existing building stock, etc., all have an influence and interpretation in national definitions.

Figure 7 (based on [Vanegas, DuBose & Pearce, 1996]) tries to illustrate how traditional engineering will be widened, when environmental demands are considered. The economic and socio-cultural issues are presented in the global context together with the environmental issues.

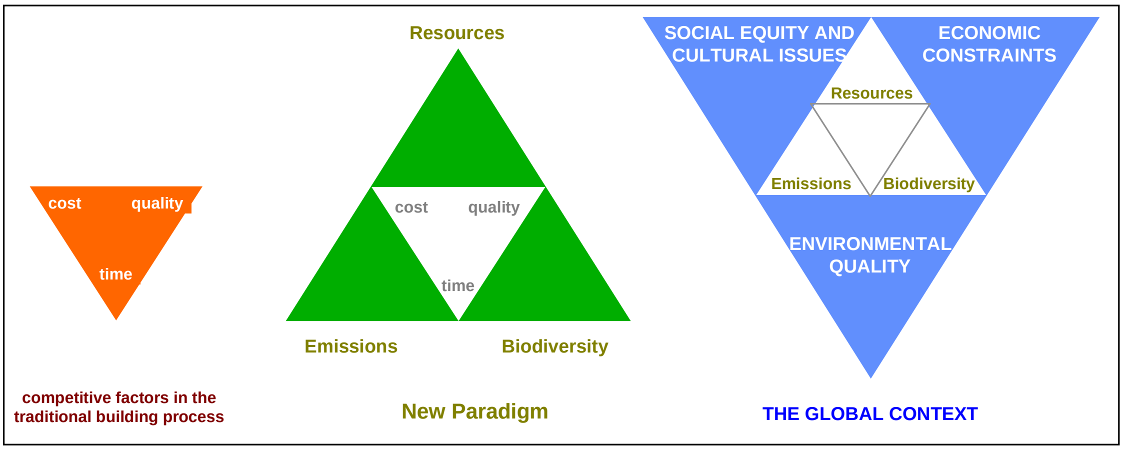

Figure 7: The New Approach in a Global Context

The categories of problems identified behind the notion of sustainable construction can also be classified as:

- physical problems linked to the issue of resources;
- biological problems linked to the life of mankind;
- sociological problems having socio-political, socio-economic or socio-cultural facets.

The key elements in various sustainable construction definitions are:

- reducing the use of energy sources and depletion of mineral resources;
- conserving natural areas and bio-diversity;

- maintaining the quality of the built environment and management of healthy indoor environments.

In a more detailed level, the following extrinsic or intrinsic topics are identified:
- quality and property value (BE, FI, FR, IT),
- meeting user needs in the future, flexibility, adaptability (FR, NL),
- prolonged service life (FR, FI, JP, NL),
- use of local resources (FI, IT),
- building process (FR),
- efficient land use (FR, JP, NL),
- water saving (JP, NL),
- use of by-products (FI),
- distribution of relevant information to their decision making (FI),
- immaterial services (FR),
- urban development and mobility (BE, FR, NL),
- human resources (HU),
- local economy (ES).

The proposed short definitions of sustainable construction are considered as good guidelines or as a general framework to be developed further and to be agreed on at a national level. In a short form they remain too general and are often found too vague and ambiguous. At a detailed level, local constraints, specific features and national priorities have to be taken into account. Therefore, agreeing on a common short definition at this stage was not seen as an important issue in this project.

3. ANSWERS TO THE FIVE QUESTIONS

3.1 Introduction

The content of this synthesis is based on answers given on the five questions that formed the main body of the national reports.

The main question to be answered in each national report was:

*"What will be the **consequences** of sustainable development to the **construction industry** by the year 2010?"*

The ancillary questions to be answered were:
1. What kind of buildings will we built in 2010 and how will we adapt existing buildings?
2. How will we design and construct them?
    - What does this entail for initiating, designing, constructing, maintaining, operating and demolishing buildings?
3. What kind of materials, services and components will we use then?
    - What does this entail for manufacturers of building products and systems?
4. What kind of skills and standards will be required?
    - What does this entail for human resources and skills needed in the construction industry?
5. What kind of cities and settlements will we have in 2010?
    - What does this entail for city planners and the built environment?

Each ancillary question raises an issue that should be further elaborated in terms of consequences for the construction industry as a whole. The answers to the questions were to be subdivided into four topics of environmental concern (land, energy, water and materials), although not all national reports fully adopted this format.

In this chapter of the synthesis, the answers to question 1 and 2 are combined. The subdivision into the four topics as outlined above was retained as far as possible. In the appendix tables, the answers given by the countries are classified into two sections: 'main issues' and 'consequences'.

3.2 Answers to the questions

3.2.1 What kind of buildings will we build in 2010 and how will we adapt existing buildings?

This question was merged with the second one that includes several subquestions:
- How will we design and construct them?

- What are the consequences for initiating, designing, constructing, maintaining, operating and demolishing buildings?

These subquestions address the whole building process and its actors. The synthesis of the answers given is subdivided into the following sections:
- Initiative and design
- Construction and deconstruction
- Operation and maintenance.

On the whole it is not expected that buildings will look much different from what they now appear. Major changes involve their functionality (flexibility/adaptability and life cycle performance) and energy performance. A vital topic mentioned by most countries will be the refurbishment or conversion of existing ill-performing buildings mainly for housing purposes.

3.2.1.1 Consequences for initiative and design

These consequences are summarised in Table 1.

3.2.1.1.1 Land

The issues with respect to the use of land address three aspects:
- efficient use of land,
- design for long service life,
- adapt/convert existing buildings.

The choice of site and land use land has not only local environmental effects, but also social and economic impacts. Efficient use of land appears to be vital for those countries where population density is high and mainly confined to urban areas (e.g. the Netherlands, South Africa, Malaysia). Solutions are sought in buildings combining more functions at the same time, better use of the underground (industrial/commercial buildings) and optimising the use of the roof surface (parking, recreation).

Improving the longevity of new buildings was mentioned by most countries as a means to conserve space and to push back the need of new land for development. Consequences are:
- design for flexibility and adaptability including support/fit-out modularity,
- better use of (environmental) life cycle costing techniques and quality control,
- better understanding of the needs and requirements of future users.

To extend service life of existing buildings refurbishment and retrofit activities will increase substantially requiring new technologies like light weight constructions for building extension and new tools like decision support systems (refurbishment/redestination versus demolition) and condition assessment techniques.

3.2.1.1.2 Energy

Emerging new energy saving technologies marked as being successful in the next decade involve super insulation, passive heating/cooling, day lighting/passive lighting together with the use of renewable energy sources. These technologies will require new designs of roof, facade and foundations (e.g. for heat/cold storage). Another consequence is that architects and designers should integrate their building and system designs allowing easy retrofit of these components during the lifetime of the building.

Many national reports stress the importance of safeguarding indoor air quality and climate in connection with strong penetration of energy saving technology in building design.

In some countries (e.g. Finland, Greece) fuel switching will become important requiring hybrid systems for heating.

Although the energy saving potentials within the existing building stock are quite high, the topic of improvement of the energy performance of existing buildings was only mentioned by a small number of countries. There is a need for new retrofit technologies that are economically affordable to building owners.

3.2.1.1.3 Water

Drinking water conservation and reduction of sewage water will lead to building integrated water saving equipment. In South Africa the focus is on waterless sanitation systems and landscaping with draught resistant plants.

3.2.1.1.4 Materials

The differences between countries are not very large with regard to this topic. Selection of materials should be based on their environmental performance and on their individual service life. Optimisation will take place using eco-balance tools. Jointing and assembly should be designed to allow for easy disassembly (reversible building process). In the developing world a balance is sought between improved indigenous technologies (self-built) and mass-produced units (prefab) in order to cope with the housing demand. There is a need to improve the life expectancy of indigenous building technologies and materials, instead of replacing them with alien technology.

Other specific issues mentioned are building integrated waste collection systems and improved techniques for better acoustic insulation.

3.2.1.1.5 Other aspects

Because the design process will become more important and more complex there is an urgent need for an integrated approach requiring among others co-engineering partnerships between designers, engineers and manufacturers and the development of advanced (environmental) design tools. Information technology will be used in integrated design models to provide a seamless flow of information during the life of a project providing continuous feedback loops. This will enable all project participants to work together in exchanging design information and apply design tools to optimise the design and construction process.

Environmental product information systems and environmental accounting of buildings will assist clients and designers in designing more environmental friendly buildings. Environmental awareness of architects can also be raised by post completion design assessment and feed back as mentioned in by several countries.

Some countries raised the question whether a demand for these buildings will really emerge. Information and communication next to customer participation are by many countries seen as the solution to this question.

3.2.1.2 Consequences for construction and deconstruction

These consequences are summarised in Table 2.

3.2.1.2.1 Land

Obviously this is not the main issue for contractors. Topics mentioned are:
- improved site management to protect nature,
- redevelopment of heavily polluted or derelict areas.

3.2.1.2.2 Energy/water

Again this is an issue of minor importance although the minimisation of transportation needs for construction and deconstruction is an important topic with cost-saving potential.

3.2.1.2.3 Materials

For building contractors the consequences mentioned pertain mostly to material use and facilitation of material recycling:
- use of local materials and reuse of serviceable building parts;
- construct for disassembly using modular approaches;
- labelling of components to facilitate selective removal and recycling;
- introduction of quality standards for recycled materials;
- contractors to produce operating and maintenance manuals for buildings and systems.

In the developing world the creation of jobs is important and where appropriate contractors will use more labour intensive construction methods and improved indigenous materials.

The importance of renewal engineering will exceed that of new constructions at least in the developed market economies. Opportunities for contractors lie in:

- developing refurbishment processes which cause minimal disruption to occupants and the immediate environment;
- developing modular systems for refurbishment.

Demolition contractors will have to develop new deconstruction and stripping techniques to facilitate optimal recycling and re-use of building materials.

3.2.1.2.4 Other aspects

An important number of topics were raised concerning the re-engineering of the building process Important business opportunities were identified by the various countries:

- increased partnership between designers, contractors and manufacturers; new styles of procurement;
- better management of the building process through total quality management and improved project co-ordination facilities;
- specialisation in specific market segments (e.g. refurbishment) or construction systems (e.g. robotic construction);
- opportunities for recycling (in particular in the developing economies) and brokering services.

3.2.1.3 Consequences for operation and maintenance

These consequences are summarised in Table 3.

3.2.1.3.1 Land/materials

Sustainable management of buildings also implies the extension of the service life of buildings in order to prevent the uptake of more land for new developments. For building managers, the following issues were presented in the national reports:

- adapt buildings for the future needs of occupants;
- re-commission old non-functioning buildings for new functions;
- consider both within an ecological and economic context the benefits of decommissioning versus regeneration;
- use planned maintenance and refurbishment programmes.

3.2.1.3.2 Energy

The widening gap between the energy performance of old and new buildings calls for extensive retrofit programmes and organisation and management procedures:

- retrofit of installations,
- domotics and energy management systems,
- extended use of day lighting,
- better control of indoor air quality, noise and health risks.

3.2.1.3.3 Water

Water management in existing buildings may well lead to substantial savings. Topics mentioned are retrofitting buildings with water saving equipment like rainwater and grey water storage and use facilities together with water saving guidelines for building managers.

3.2.1.3.4 Other aspects

From the national reports a consensus emerges about better education of facility managers and building owners with respect to environmental issues, leading to recommendations such as:
- use of feedback mechanism to increase awareness;
- use of facilities maintenance and management systems, manuals and guides;
- adoption of performance standards for existing buildings.

3.2.2 What kind of materials, services and components will we use then and what are the consequences for manufacturers of building products and systems?

Many of the issues raised are a logical result of the future needs of the construction industry realising buildings in the coming decade (Table 4).

3.2.2.1 Land

The indirect use of land for the production of building materials is extensive. Large scale quarrying of minerals for the construction industry in highly populated areas may lead to unacceptable loss of natural areas. Many countries stress in their reports that the environmental performance of building materials should be improved by:
- use of renewable materials and the use of local resources;
- considering full life cycle energy cost;
- improved durability;
- low emissions during use;
- recyclability.

For components that can be easily reused, the first priority is durability and long service life. For components that are difficult to reuse the requirement will be easy biodegradability.

3.2.2.2 Energy

A high demand for energy saving technologies was identified. Systems that will be introduced in the near future are:
- heat recovery and storage,
- small CHP-units,
- electrical heat pumps,

- PV-cells,
- passive and hybrid technologies for heating and cooling,
- passive lighting systems,
- translucent insulation,
- advanced sensor technology and building domotics,
- new acoustic/thermal insulation materials and systems.

The demand will not only focus on new buildings but also on the existing stock. The consequence will be that the developed systems must also be easily retrofitted in the existing building fabric.

South Africa expects that high technology production systems, materials with high embodied energy and poor energy saving attributes will still be used, especially in the mass housing market.

3.2.2.3 Water

What is said about energy saving also applies to water saving equipment although this issue is only mentioned by a few countries (GR, NL, MY, ZA). Components include rainwater storage systems, low flow showerheads, dual flush toilets and self-composting toilets.

3.2.2.4 Materials

Quite a few countries expect an increased responsibility of manufacturers for their products from cradle to grave. This being far from imaginary will force manufacturers into the development of:

- new materials, recycled or made from renewable resources,
- plug-in systems, easy to disassemble and re-use,
- standardisation and modularity of components,
- improved tools for the prediction of service life of components and systems,
- new logistics for closed-loop recycling,
- on-line product information systems (Internet).

3.2.2.5 Other aspects

The penetration of new technologies will also lead to new building concepts. A closer co-operation between architects and building material manufacturers is expected in product development. As a consequence subsystems will be fully integrated in building components for roofs and facades (function integrated systems).

3.2.3 What kind of skills and standards will be required and what does this entail for human resources and skills needed in the construction industry?

The following main points of interest have been identified around this subject (see also Table 5).

3.2.3.1 Human resources

On the building sites specialised jobs will gradually disappear in favour of multi-skilled autonomous crews. The emphasis will lie on assembly and disassembly techniques and the ability to handle both new and old materials.

The building process itself will become more complicated requiring excellent management skills and integrated knowledge of the whole process (life cycle thinking). Information technology will impact on all aspects of the building process, requiring the skills necessary to cope with this level of information transfer.

Increasingly new forms of partnership will be adopted like design build and operating contracting. Professional barriers will become less important and the focus will be on risk management

Total quality management and better us of feedback mechanisms will improve the performance of all partners involved in the process.

3.2.3.2 Decision making processes

Incorporating sustainability into the decision making process requires:
- public participation,
- new decision support systems making full use of information technology,
- skills in negotiating and facilitating.

3.2.3.3 Education

To overcome professional barriers and to improve knowledge on the cause-effect relations of decisions taken, interdisciplinary education of designers and construction engineers is needed. This refers in particular to specialisation in environmental issues.

Other important groups of actors mentioned in the field of better training in environmental matters were building operators and facility managers.

3.2.3.4 Public awareness

Full acceptance of the concept of sustainability by the public at large can be achieved by demonstration projects and information campaigns. Special attention was called for better information on self-building (GB). Incorporation of environmental costs in the tax system may also add to more awareness.

3.2.3.5 Standard and regulations

To make the environmental performance measurable and certifiable, more tools are needed such as:
- performance based standards in the building codes,

- ‘green’ certification and eco-labelling systems based on LCA.

In South Africa the perspective is standards will have to be adapted to suit local traditions and indigenous building technologies.

3.2.4 What kind of cities and settlements will we have in 2010 and what are the consequences for city planners and the built environment?

The main changes expected with respect to urban development are centred on the following issues: use of land, energy conservation and social sustainability (Table 6). The major issues facing South Africa are the eradication of spatial segregation and the integration of the various apartheid townships in the city structure and its economy.

3.2.4.1 Land

All countries concerned stress the need for efficient use of land and the conservation of open space and the structure of existing settlements. The consequences for the built environment and city planners can be summarised as follows:

Better use of available space within the city limits leading to:
- restricting urban sprawl and avoid fragmentation of the countryside;
- remediation of brownfield site involving new soil cleaning technologies;
- adaptation and regeneration of the existing built environment taking account of future needs.

Countries with a high degree of urbanisation and a high population density like the Netherlands and Japan expect a more intensive use of land involving underground building and the double use of land simultaneously creating new open space for recreation.

Compact communities where housing, work, services, facilities and public transports are all within walking distance will emerge. Some of these will be developed as self-sufficient settlements with ecological closed-loop systems.

The separation on racial and economic lines faces South Africa with the special concern of spatial integration of employment and residence. Development corridors will be used to integrate the various areas and integration into one metropolitan management structure will contribute to social sustainability and improved service delivery. Urban agriculture will be actively encouraged to compensate for the loss of land through urbanisation.

3.2.4.2 Energy and traffic

Energy is a topic that received much attention in all national reports. It is anticipated that energy conservation at the level of districts or whole cities will rely more on local sources and renewable sources. The main issue will be the upgrading of the energy performance of the existing building stock. New developments are expected for autonomous or self-sufficient buildings with respect to energy supply. An issue in South Africa and Malaysia is the provision of energy for cooking and heating to the disadvantaged in a socially, economically sustainable way.

In the next decade traffic reduction will be an important issue. Transport infrastructure will be an integral part of site development along with advanced public transport systems. Information technology is used to optimise the capacity of existing transportation networks. In the emerging economies (e.g. Hungary, Romania, Malaysia) there is a need for modernisation of the transport networks while the aim in South Africa is to localise resource use in order to cut down on the needs for more super highways.

3.2.4.3 Water

Dehydration and water conservation is a topic receiving increasing attention at least in highly populated countries and developing countries (like South Africa, Malaysia). Both new and existing settlements will reduce their consumption of high quality drinking water by relying more on rainwater and the cascade use of drinking water. Most countries mention urban water management and groundwater protection. The major consequences will be to create closed water systems and to reduce urban run-off (porous brick paves). A special concern in Malaysia is the adequate supply of clean drinking water.

3.2.4.4 Materials

Major efforts are needed to upgrade the ageing underground infrastructure (sewage systems, water supply networks, etc). New in-situ repair techniques will be developed. In the developing world the emphasis is on catching up with the backlog of infrastructure provisions and installing more sustainable options to begin with.

Also urban waste management creates opportunities for new collection systems and waste recycling or energy production from waste.

3.2.4.5 Other aspects

Social sustainability needs much attention as well in city planning as in urban renewal. Issues mentioned are:

- respect for the existing city fabric and retaining rural settlement structures;
- develop city master-plan based on sustainability principles (sustainable renewal);
- function integration at city and district level;
- more public involvement in new developments and interventions in existing settlements;
- ‘affordable housing’ projects (Hungary, Romania, South Africa);
- crime prevention through environmental design (South Africa).

3.3 Conclusions

Current practices are widely different depending on how well the concept of sustainable building is developed in the various countries. There is also a marked difference between the developed market economies, transition economies and developing economies. The more mature economies pay more attention to the creation of a sustainable building stock either by new developments or by upgrading their existing building stock. In the transition economies the emphasis is on new developments largely to reduce the housing shortage and to improve their transport networks. In the developing economies social equity is much higher on the agenda than environmental concerns. Social and economic sustainability (e.g. job creation) is given much more thought.

However looking further ahead there is less divergence in the issues identified.

Use of land

The prevention of urban decline and the reduction of urban sprawl are concerns expressed by most countries. In the Western and Eastern European countries conservation of open space and safeguarding the structure of rural settlements is a major issue. Some divergence is seen between high-density building versus low-density building. In highly urbanised countries (the Netherlands) there is a tendency towards high density building while in other countries with high density mega-cities (Japan, Greece) there is a move towards low density building. Efficient use of land is sought in increasing the longevity of new buildings through flexibility and adaptability and more refurbishment activities to increase the life span of existing buildings.

To achieve social and economic equity, South African city planners will have to deal with new concepts integrating the current spatial and racial segregation into viable city structures.

Energy and traffic

The main issues adopted in practice turn out to be energy saving measures. Almost every country indicates a need for improved energy efficiency of buildings and the built environment. The main topics mentioned focus on the use of renewable energy, local energy resources and a wide range of opportunities for producers to market innovative energy saving materials and systems. However, in South Africa and Malaysia the major concern is how to provide energy and other services to the disadvantaged in a sustainable way.

Traffic reduction is an issue common to all countries and solutions ranging from better physical planning to increased use of information technology are mentioned. Contrary to this, the emerging economies express an urgent need for improved transportation networks in order to be competitive with their more developed neighbours. In the United States of America the car-oriented transportation infrastructure and the low petrol prices offer no significant scope for major changes in mobility. South Africa aims at preventing future mobility problems and an emerging need for superhighways by using local resources and promoting self-sufficiency of communities.

Water

Water saving in the built environment is a topic receiving increasing attention in European countries (e.g. Mediterranean countries). South Africa and the Netherlands particularly mention dehydration and drainage of water tables.

Materials and waste

The difference between countries with respect to the environmental performance of building materials and the recycling of building and demolition waste are not very large. Main topics are renewable materials, recyclable/reusable materials, easy disassembly, standardised dimensions, low embodied energy, and non-toxic materials. The advantage of the emerging economies and the developing economies is that they already have a long tradition in the use of traditional materials, many of which are sustainable. The aim is to continue this tradition in order to prevent problems from arising in the first place. The developing world aims at improving the life expectancy of indigenous building technologies and materials and to assure that labour intensive materials and methods remain in use. Although, to cope with housing shortages mass-produced units using high energy building systems will still be needed.

Other aspects

Many issues were raised under this heading, especially topics around social and economic sustainability. Their consequences relate predominantly to process innovation with emphasis on public participation, consumer participation, interdisciplinarity, co-engineering and re-engineering of the building process as means to a better incorporation of sustainability issues in decision making.

Skills and standards

Professional barriers will become less important and a need will emerge for multi-skilled, multi-disciplinary managers and operators. To overcome existing professional barriers many countries stress the need for interdisciplinary education.

Sustainability is a new aspect among the many issues governing decision making in the building process. This requires more specialisation of stakeholders in environmental matters. Eco-labelling, certification and environmental standards were mentioned by many as an expedient to that cause.

3.4 Summary Tables

Table 1: What kind of buildings will we built and how will we adapt existing buildings? **a) What does this entail for initiating and designing?**		
Resources	**Main issues**	**Consequences**
Land	• Efficient use of land (FR, NL, FI, HU, BE, IT, GB, GR, ZA, MY)	• Multi-functional buildings (NL, FI, GB, GR, ZA, MY) • Temporary or transportable buildings (NL)
	• Intensive use of land (NL)	• Flat roofs for recreational purposes (NL) • Double use of land (above and underground) (NL)
	• Longevity of buildings (NL, IT, FR, FI, GB, JP, US, IE, ZA, MY)	• Design for flexibility/adaptability (NL, FR, FI, GB, ES, US, ZA, MY) • Support/infill modularity (NL, BE, GB, JP, US) • Design for life cycle performance and high quality (IT, FR, FI, JP, IE, US, ZA, MY) • Standards for longevity in building codes (GB) • Environmental life cycle costing tools LCA + LCC (NL, FI, GB, US, ZA) • Understand needs and requirements of future users (NL, FI, IT, MY)
	• Site assessment	• Consideration of local environment (climate, topography, visual impact, noise, local economy) (ES, RO, ZA, MY) • Environmental/social impact assessment and public participation (ZA)
	• Greater use of existing buildings (GB, NL, FR, FI, HU, RO, BE, IT, ES, GR, MY)	• Redestination/conversion of non-functioning buildings (NL, FI, ZA, MY) • More refurbishment and retrofit activities (FR, NL, FI, HU, RO, GR) • Refurbishment techniques (vertical/horizontal extensions; lightweight constructions) (NL, HU, US) • Performance standards for regenerating existing building stock (NL) • Better condition assessment methods (HU) • Decision support tools: demolition versus renewal (NL, GB, ES, IE)
Energy	• Energy-efficient buildings (NL, FI, IT, FR, BE, GB, JP, GR, MY)	• Integrated design for energy efficiency (roof/facade design; heat/cold storage) (NL, FR, FI, IT, US, ZA, MY) • Super insulation (GB, ES); airtight construction (US) • Renewable energy sources (FI, NL, GB, ES, US, GR, ZA, MY) • Safeguarding indoor environment (NL, FR, HU, IT, US, ZA, MY)

	• Optimising heating/ cooling/lighting	• Bio-climatic construction (ES) • Day lighting/passive lighting (FI, GB, ES, GR, ZA) • Refrain from air conditioning (IT, MY) • Passive heating/cooling (IT, FR, NL, FI, GB, ES, GR, ZA, MY); Optimise building mass (FR) • Energy management systems (GB, ES, ZA) • Design for short service life if new technology will emerge in near future (FI, NL)
	• Fuel switching will become important (FI)	• Hybrid systems for heating (FI, GR)
	• Upgrading energy performance of existing building stock (NL, HU)	• Heat recovery systems (NL, ZA), improved insulation systems (NL, ES) • Individual metering of energy consumption (HU)
Water	• Drinking water conservation (NL, GB, BE, ZA, MY)	• Building integrated water saving equipment; greywater use (NL, FI, GB, IT, ES, US, ZA)
	• Reduction of sewage water (FI, ZA)	• Waterless sanitation systems (ZA)
Materials	• Upgrading existing building stock (NL)	• New function integrated components for retrofitting (NL)
	• Waste management (NL, HU, FR)	• Building integrated waste collection systems (NL, FR) • Utilise collective organic waste as energy source (ZA)
	• Acoustic insulation (BE)	• Improved products (BE)
	• Durable building materials (NL, FI, FR, ZA, MY)	• Durable coating systems (NL, ZA, MY) • Improve life expectancy of indigenous building technologies and materials (ZA) Selection based on individual service life (FI)
	• Non-toxic materials and climate control	• More consideration of health and environmental toxicity (LCA) (FR, IT, ZA, MY)
	• Recyclable/reusable buildings (NL, BE, ES, MY	• Design for disassembly (reversible building process) (NL, FR, ES, US, MY) • Recyclability of short lived components (FI, ZA)
	• Raw material efficient building	• Use of local materials and traditional building methods (IT, FR, RO, US, GR, ZA, MY) • Lightweight constructions (NL, FR, US, MY) • Renewable or recycled materials (NL, IT, GB, RO, ZA) • Materials with low embodied energy (FR, JP, US, ZA)
Other aspects	• Will an environmental demand emerge	• More information and communication (FR, NL, MY) • Experimental projects (FR) • Customer participation (NL, FI, GB, FR, MY) • Environmental accounting of buildings (FI, GB, MY)
	• Affordable housing (ZA, MY)	• Balanced mix of indigenous technologies (self-built) and mass-produced units (prefab) (ZA, MY)

	• Increase in tele-working (NL, FR, MY)	• New building designs taking account of tele-working and IT applications. (NL, FR, MY)
	• Design process is becoming more important (FI)	• Performance based design approach (US) • Optimisation through eco-balance tools (LCA/LCC) (FI, GB, IT, ZA, MY) • Tools for assessment of social and economic impact of buildings (ZA) • Interdisciplinary approach (ES); integrated approach (US); co-engineering (US) • Adopt open building approach (NL, US) • Integration of building functionality's (FR, GB, MY) • Integrated project database and design model (ZA) • Post completion design assessment and feedback (GB, ZA, MY)

Table 2: What kind of buildings will we built and how will we adapt existing buildings?

b) What does this entail for constructing and demolishing?

Resources	Main issues	Consequences
Land	• Protect nature	• Insure flora and wildlife protection (FR, MY) • No blasting to create building site (FI, MY)
	• How to cope with existing soil pollution	• Advanced in-situ remediation technologies (GB) • Fiscal measures to promote redevelopment of land (GB)
Energy	• Energy efficient construction sites	• Minimise transportation need to the site (FI, FR, GR, ZA, MY) • Energy saving refurbishment (FI, GR, MY)
Water	• Water saving	• Reduce water consumption on site (ES, ZA)
Materials	• Efficient use of materials/recycling	• Produce operating manuals for buildings and systems (FR, MY) • Use of local materials; reuse of serviceable building parts (FI, IT, GB, RO, US, ZA) • Use more labour intensive materials and construction methods (ZA) • Construct for disassembly (NL, FR, US, MY); Modular approach (GB, FI, ES, US, MY) • Expand industrialised building practices (US, JP, NL) • On site waste management (FR, FI, ES, US, MY) • New deconstruction/stripping techniques for optimal recycling (NL, FI, IT, HU, ES, US, ZA) • Labelling of products to facilitate selective removal and recycling (FR, MY) • Quality standards for recyclable waste (FI) and recycled materials (GB)

	• Renewal engineering becomes more important	• Waste utilisation for energy production (FI) • Refurbishment without nuisance for occupants (NL, FR, MY) • In-situ diagnosis and repair techniques (NL) • Modular systems for upgrading existing buildings (JP)
Other aspects	• Optimise building process	• Build, operate and transfer constructions (NL); Turn key process (FR, MY) • More specialisation in specific market segments or building systems (NL, FI, IT) • Increased partnership between designers, contractors and manufacturers (IT, NL, JP, GB, US, MY) • Improved project co-ordination facilities (US) • Total quality management (NL, FI, GR); quality standards for whole buildings (NL, GB, GR, MY) • Improved site logistics (FR, NL, MY) • Improved working conditions (FR, ZA, MY), more robotic construction (GB, NL, ZA) • Improved indigenous building technologies (ZA) • Combination of excellent human skill and more automation (JP) • Closer link between deconstruction and recycling processes (NL) • Business opportunities for recycling (ZA, MY): Service leasing (FI); Brokering services (GB)

Table 3: What kind of buildings will we built and how will we adapt existing buildings?

b) What does this entail for operating and maintenance?

Resources	Main issues	Consequences
Land	• Minimise non-public transportation needs	• Education of building managers and employees (GB, GR)
Energy	• Optimise energy consumption	• Tools and systems for energy management (FI, IT, ES, GR, ZA) • Extended use of day lighting (FI) • Easy retrofit of energy saving systems (NL, MY)
Water	• Optimise water consumption	• Use of rain water and re-use of grey water (FR, GR, ZA) • Tools and systems for water management (FI, ES, GR, MY)
Materials	• Extend service life of buildings	• Decision support systems to make a choice between building refurbishment or demolition (FI, NL, IT, IE, MY) • Adapt buildings for future needs of occupants (NL, HU, GR, MY) • Re-commission old non-functioning buildings for new functions e.g. housing) (NL, HU, ZA)

		• Planned maintenance and refurbishment programmes (GB, JP, GR, MY) • Use of durable finishes and fittings (ZA)
Other aspects	• Awareness of building operators and users	• Facilities maintenance and management systems (FMMS) (ZA); Tools for control (manuals, guides) (IT, FI, MY) • Education, feedback and standards (GB, IT, FI) • Management of operation costs (FI, IE) • Better control of IAQ/noise and health risks (FR, FI, GB, MY) • Develop performance standards for existing buildings (NL)

Table 4: What kind of materials, services and components will we use then? What does this entail for manufacturers of building products and systems?

Resources	**Main issues**	**Consequences**
Land	• Life cycle performance of building products	• Renewable materials, use of local resources, durability, low emissions in use, recyclability. (NL, BE, IT, JP, IE, ZA, MY); • Environmental performance indicators (US) • Genetically engineered renewable materials (wood) (ZA)
Energy	• Energy performance of building products/ systems	• Consider full life cycle energy (NL, IT, JP, US, ZA, MY)
	• Energy saving	• Optimum use of new technologies: Heat recovery and storage, CHP-units, Electrical heat pumps, PV-cells, passive and hybrid technologies for heating and cooling, sensor technology; building domotics, passive lighting systems, translucent insulation (NL, HU, IT, ES, US, GR, ZA, MY) • Systems for easy retrofit in existing buildings (NL, IT, US, MY)
Water	• Water saving systems	• Rain water storage systems, cascade use of water (NL, GR); water saving components (ZA) • Integrate into building design (NL, MY)
Materials	• Product stewardship (cradle to grave)	• Plug-in systems, easy disassembly and re-use (NL, IT, US, ZA, MY) • Logistics for re-use and closed-loop recycling. (NL, MY) • Exchangeability of components through standardised dimensions (NL, ES, US, MY) • Online electronic product information systems (Internet) (US) • Zero-emission manufacturing; use of by-products from other industries (ZA)
Other aspects	• Low emission products	• Advanced coating systems and pre-treatment in the factory (NL) • Standards for composition and leaching (BE) • Healthy non-toxic/non-allergenic materials (MY)
	• Need for improved sound proofing of (existing) buildings	• Development of new materials/systems for easy retrofit (NL)
	• New building concepts	• More co-makership between architects and building material manufacturers. (NL, US) • Function integrated systems (IT, NL)
	• Technical service life	• Improved tools to predict service life of components and systems (NL) • Ability for self-diagnosis, self-healing and structural control (ZA)

Table 5: What kind of skills and standards will be required?	
Main issues	**Consequences**
Qualified labour	• Expertise, autonomy and responsibility (FI, MY) • Skills to cope with Information Technology for information transfer (ZA) • Multi-skilled crews; non-specialisation; professional barriers become less important (FI, NL, BE, GR) • Multi-skilled operators trained in non-destructive disassembly techniques (NL, JP, IE) • Multi-skilled labour able to handle both old and new materials (NL, FI, GR, MY)
Building process management becomes more complicated	• Integrated knowledge of whole building process (IT, GR, MY) • Design, build and operate contracting; partnership; risk management (GB, NL) • Performance based project management (FR); Excellent skills to manage the construction process (JP) • Better quality control (HU, FI) • Better use of feedback (GB) • Better training of building operators (GB)
Decision making processes becoming more complicated	• Use of information technology to support life cycle thinking (NL, GB, ZA) • Pubic participation; skills in negotiation and facilitation (ZA) • Life cycle costing tools (NL, US) • Risk assessment (health and environment) (IT)
More need for interdisciplinary education	• New curricula for designers and construction engineers to overcome professional barriers (NL, GB, U, IE, GR) • More specialisation in adapting building stock to meet future needs (NL, IE) • More specialisation in environmental issues (BE, IT, GR, ZA, MY)
Public awareness should increase	• Better information on self-building (GB) • Environmental taxes (BE, GB) • Demonstration projects, information campaigns (FR, BE, GR)
Standards and regulations	• Performance based (environmental) building regulations (FI, NL, US, MY) • Certification and eco-labelling (IT, GB, JP, ES, US) • Standards should suit local practices and indigenous technologies (ZA)

Table 6: What will cities look like and what are the consequences for city planners ?		
Resources	**Main issues**	**Consequences**
Land	• Efficient use of land (NL, FI, HU, BE, IT, GB, US, GR, JP, RO, ZA, MY)	• Reduce urban sprawl (NL, FI, HU, ES, US, GR, ZA, MY) • Denser cities and infill development of vacant spaces within city limits (ZA, NL, MY) • Adaptation and regeneration of the existing built environment taking account of future needs (NL, GB, FR, BE, IT, RO, US, ZA, MY) • Remediation of brownfield sites (GB, FI, HU, IT, ZA) • New soil cleaning technologies (FI, NL) • Land reclamation for industrial use (NL) • More low density building (JP, GR)
	• Intensive use of land (NL, MY)	• High density building (NL, MY), underground building (NL); double use of land (NL, FI) • Underground drilling techniques (NL) • Building in nuisance zones (NL) • Combined transport corridors (roads, rail, cables, ducts) (NL, MY)
	• Compact development and integration (ZA)	• Location of low income residential areas within the developed city limits; Integration through development corridors (ZA) • Compact self-sufficient communities (ZA) • Integration of apartheid townships in city structure and its economy; one metropolitan management structure with improved service delivery (ZA)
	• Conservation of open space and green areas (FR, FI, NL, HU, JP, BE, IT, ES, GR, MY)	• Creating space by underground construction (NL) • Encouragement of urban agriculture (ZA) • No fragmentation, no ribbon building (BE, NL) • Taking account of dangers of flooding, landslides, earthquakes (HU, ES)
Energy	• Reduce energy consumption (NL, FI, IT, GB, MY, GR)	• Use local resources, district heating, CHP, renewable sources (NL, FI, GB, GR) • Do complete site and (energy) resource assessment (US, MY) • Upgrading energy efficiency of existing building stock (GB, NL, HU, GR) • Self-sufficient settlements (NL, FI, IT, ZA)
	• Energy provision (ZA, MY)	• Sustainable/affordable energy provision to the disadvantaged (ZA)
	• Reduce transport needs (FR, NL, FI, BE, IT, GB, MY)	• Transport infrastructure is integral part of site development (GB, NL, FR, FI, BE, US, ZA, MY) • Site development along public transport corridors (GB) • Advanced public transport systems (FR, FI, HU, IT, MY)

	• Optimising transport infrastructure (NL, FR, FI, HU, GR, MY)	• Information technology for optimising existing capacity (NL, FI) • Modernisation of the transport infrastructure (HU, RO, GR, MY)
Water	• Drinking water conservation (NL, GB, US, MY)	• Structured refurbishment to increase efficiency (GB) • Combined use of drinking water and grey water (GB, NL, US, MY) • Adequate and clean water supply (MY)
	• Urban water management, groundwater protection (FR, FI, NL, HU, ZA, MY)	• Closed systems, no run-off to sewage system (NL, ZA, MY) • Landscaping with draught resistant plants (ZA)
	• Coastal management (NL)	• Building with nature (NL)
Materials	• Upgrading under-ground infrastructure (NL, MY)	• New in-situ diagnosis and repair techniques (NL, MY)
	• Urban waste management (NL, HU, ZA, MY)	• Building integrated systems; underground collection and transport (NL) • Recycling and reuse of waste (ZA) • Integrated waste management systems
	• Building materials	• Use of local materials (no transportation) (FI, ZA, GR, MY)
Other aspects	• Social sustainability (NL, GB, HU, ZA, FR, RO, GR, MY)	• Spatial integration of employment and residence (NL, GB, ZA) • Accessibility, function integration offering services and recreation (NL, FR, FI, ZA, MY) • Design for future value; City masterplan HU; respect for existing city fabric (FR, NL, HU) • Equitable distribution of community facilities and economic opportunities; Create sustainable local social and economic community systems (eco-villages) (‘ubuntu’ concept) (ZA) • ‘Affordable housing’ projects (HU, RO, ZA) • Maintain rural settlement structure (HU, GR, MY) • Crime prevention through environmental design (ZA)
	• Sustainable planning (NL, GB, IE, IT, ZA)	• Integrated physical planning and design methodologies (ZA) • Public involvement in development (citizens’ juries) (GB, ZA, MY) • Decision making tools to weigh the pros and cons of the combined sustainability issues (NL) • Imply ecological principles in physical planning (IT, NL, GB, IE, MY)
	• Urban renewal (NL)	• Renewal engineering without disrupting living and working conditions (NL)

4. STRATEGIC RECOMMENDATIONS

4.1 Introduction

The content of this chapter is based on the elements given in the part "Recommendations" of the available national reports. Fifteen national contributions have been taken into consideration, that is to say the Belgian (BE), Finnish (FI), French (FR), Greek (GR), Hungarian (HU), Irish (IE), Italian (IT), Japanese (JP), Malaysian (MY), Dutch (NL), Romanian (RO), South African (ZA), Spanish (ES), British (GB) and American (US) contributions.

This synthesis of the national recommendations includes two parts. The first one gives the main features of the recommendations introduced by each national report. The second one tries to present a condensed and organised view of all the recommendations.

4.2 Main features of national recommendations

4.2.1 Belgium

In its conclusion, the Belgian report introduces some main issues for the future, which can be seen as recommendations:

- increasing regulation on the use of land with more respect for open space and green areas,
- stimulating renovation of existing buildings,
- increasing mobility planning and new related concepts for city planning,
- increasing waste prevention and recycling,
- increasing environmental "taxes" (waste treatments, emissions...),
- saving resources (energy, water, primary materials),
- putting more emphasis at the R/D level on global studies such as life cycle analysis and multi-criteria evaluation of materials, services, constructions...

4.2.2 Finland

The recommendations given in the Finish report are gathered in the conclusion of the report. They are directed at nine categories of actors of the building sector, in the following way:

- building owners: setting concrete environmental demands for the design and the maintenance phases, taking care of property values considered as a tool for productivity,
- building users: considering environmental qualities as one selection criteria, seeing environmental issues as one factor affecting space use productivity, operating the building in an environmentally friendly way,

- clients: selecting project partners on their environmental expertise, making sure that environmental goals are considered by the owner,
- designers: considering environmental qualities of construction materials as a starting point, optimising the design process, developing methods and tools to assess the numerous variables involved,
- manufacturers of building products: seeing life cycle considerations as the basis of product development, stressing environmental qualities in the product information, minimising environmental impact of production processes,
- contractors: seeing environmental consciousness as a factor of competitiveness, reducing environmental impacts of business processes (site operations, logistics and material selections),
- building maintenance organisations: seeing environmental consciousness as a factor of competitiveness, showing initiatives and giving feedback to building owners regarding environmental issues, expecting co-operation from suppliers and partners,
- officials: creating mechanisms that lead to life cycle thinking, considering environment as one criteria in all buildings, using appropriate guidance (regulations, supervision and sanctions),
- researchers: producing environmental qualities for building parts and buildings, developing methods and means to be used by professionals, pushing life cycle thinking as the guiding principle for construction processes, producing research based information to contribute to the "ethical discussion".

4.2.3 France

The part of the French report that deals with recommendations introduces three categories:

- a <u>general strategic recommendation</u> which insists on the way of positioning the construction sector into the global approach of sustainable development:
    - to define a few simple but strategic and sensitive issues,
    - to focus on important recognised aspects,
    - to approach sustainable construction through three <u>problem categories</u>:
        - physical problems linked to the issue of taking account of natural heritage,
        - biological problems linked to the issue of not signing mankind's life away,
        - sociological problems linked to the issue of ensuring an inter- and intra-generation solidarity,
- eight main technical recommendations:
    - going on with energy savings policy,
    - improving air quality,
    - decreasing health risks,
    - improving waste management (work sites and communities),
    - foreseeing fresh water shortage,
    - developing construction materials saving,
    - developing assessment methods,

    - modulating the "Building-to-Last" concept,
- the necessity to take action at once to act preventively and to prepare the building sector to changes which are needed in the construction process.

4.2.4 Greece

The Greece partner who joined the project listed a set of strategic recommendations that are reported below:

- the need for land use regulations with respect for green areas and open space,
- the planing for renovation of the existing building stock,
- the introduction of rules and regulations regarding sustainability in construction,
- the introduction of standards dealing with longevity and multiple use of buildings,
- the completion of the highways national system,
- sustainable urban development,
- the saving of resources in construction activities,
- support for environmentally friendly materials,
- the development of educational programmes in the higher levels,
- training courses and practice dissemination,
- life-cycle considerations in product development.

4.2.5 Hungary

The part of the Hungarian report which deals with recommendations stresses essentially on aspects of "strategic recommendations for the management of construction companies", as the related section is entitled. The two main aspects raised are:

- the need for a thorough study of the ongoing processes in the national and international building field,
- the need for short- as well as long-term forecasts of construction activities.

In addition, three main tasks are identified for the Hungarian construction industry:

- the completion of the system of superhighways with the major concern of minimising negative environmental effects,
- the serving of trade and industry building needs, with an organising of the work to cause minimum trouble,
- the creation and renovation of residential buildings.

4.2.6 Ireland

The Irish report includes a chapter that deals with recommendations for action:

- setting up a high-level national research group to examine the concept (taking account of human and social development),
- establishing a national forum on Sustainable Construction to develop a suitable response to the concept,
- compiling a first set of "performance indicators" to cover:
    - the process of construction,

    - completed buildings and civil engineering projects,
    - the operation of existing construction works,
    - de-construction and disposal (including re-use).
- developing a concerted programme of awareness raising and education.

4.2.7 Italy

The part of the Italian report that deals with recommendations stresses four main aspects:
- the introduction of rules and standards for sustainability and eco-compatibility in the planning and design activities,
- continuous and permanent education,
- control of the construction activity: definition of sustainable and responsible construction companies and manufacturers,
- exploitation "built and natural inheritance" as a resource.

4.2.8 Japan

The Japanese report introduces recommendations that are directly derived from the listing of the main barriers against a comprehensive approach by the whole construction industry. These recommendations deal with:
- the dissemination of knowledge about responsibilities,
- the development and dissemination of methodologies for reviewing environmental impacts,
- education and training,
- agreements in terms of role sharing and responsibility allocation in the projects,
- good practice dissemination,
- comprehensive data bases,
- encouraging development of environmentally friendly materials and technologies,
- awarding,
- developing environmental management systems,
- creating a profession of "construction environment consultant"

4.2.9 Malaysia

The Malaysian reports introduces recommendations in five domains:
- policies
    - continuing and re-emphasising existing regulations and strategies,
    - reviewing and developing measurable performance standards,
    - promoting interdisciplinary training and courses,
    - promoting awareness and R&D on sustainable development,
- design
    - developing new design standards,
    - adopting open system,
    - adopting and adapting jointing and assembly techniques,

    - imposing minimum recycled material content,
    - considering environmental qualities of material,
    - adopting more integrated approach to design,
- manufacturing
    - product development based on life cycle consideration,
    - practising better waste management,
    - practising reliable labelling scheme,
    - reengineering production process of standardised elements,
- construction
    - reducing environmental impact during process,
    - reengineering process to meet the concept of open building,
    - increasing partnership between designers and manufacturers,
- operation and maintenance
    - establishing maintenance programs,
    - developing and applying decision support system for refurbishment.

4.2.10 Netherlands

Two parts of the Dutch report mainly deal with recommendations.

One of these parts is dedicated to the listing of R&D themes that are needed by 2010:
- issues and associated tools linked to the incorporation of environmental costs into the economic system,
- the improvement of the building process itself,
- several R&D needs in the technical field; eight themes have been identified:
    - impact of human activities on ecological systems,
    - performance-based environmental standards,
    - tools for the certification of life-cycle performance of buildings,
    - models for the service life prediction,
    - dynamic behaviour of constructions in soft soils,
    - renewal engineering methods,
    - innovative design, systems and products for energy-efficiency goals: integration of solar systems, retrofitting adapted systems...
    - understanding of the natural sand transport phenomena.

The other part is dedicated to strategic recommendations towards five main topics or categories of actors:
- public and private policies: measurable performance standards to be developed, training courses and interdisciplinary training,
- management and business practices,
- design technology: new design standards for designers, open systems, advanced jointing and assembly techniques,
- construction: open building, process reengineering,
- materials and systems: new function integrated building components, durability, reparability and retrofit ability of the products.

4.2.11 Romania

The recommendation chapter of the Romanian report deals with the problem of including Sustainable Development concepts in the economy.

The main problem is that life quality improvement, which is an absolute priority objective, leads to numerous investments which in the end imply a high pressure on environment, unless complementary actions are provided. The economy re-launching does not favour very ambitious objectives in relation with Sustainable Development even if the construction sector is one of the most dynamic ones.

Some correction could be gained through training and knowledge transfer (which is not easy because effects do not emerge in the short term). Communication is also a prerequisite of the new concept success, but communication will be successful only if:
- a common language is accepted,
- a multilingual glossary of the sustainable development concept is defined,
- a collection of worldwide practised methods for the assessment of constructions is available.

4.2.12 South Africa

The strategic recommendations included in the South African report are gathered under four main headings which correspond to four main aspects of sustainability applied to the construction sector: environmental sustainability, economic sustainability, social sustainability and technical sustainability.

The main items mentioned under these headings are listed below:
- environmental sustainability
    - land: to be chosen not only according to environmental factors, but also according to the impact it will have on the local community in terms of socio-economic factors, development aiming for compact land use,
    - energy: address the issue of energy provision for the poor, energy efficient design of low cost housing, use renewable energies, consider embodied energy for the choice of materials and construction technologies,
    - water: install water-saving devices in both new and existing buildings, capture rain water, reduce water run-off in landscaping,
    - materials: develop the use of indigenous construction materials, set up incentives for developing new environmentally friendly building materials and improving the performance of existing ones,
- economic sustainability
    - basis for competition: the three factors are quality (satisfying the clients needs), profitability and sustainability; apply quality indices and service life prediction in building design and construction process,
    - poverty alleviation: combine labour intensive methods with skills transfer, outsourcing to local actors instead of importing manpower,

    - finance options: set up creative finance solutions to help development for the poor,
- social sustainability
    - public participation: develop a methodology for true public participation,
    - gender equity: work towards greater gender equity especially in blue collar employment,
    - cultural acknowledgement and spiritual well-being: include the concept of 'ubuntu' in the construction industry decision making and operation to contribute to sustainable development,
    - education: adaptation of tertiary curricula, continuous re-education of professionals, raising awareness in clients end educating the end-user,
- technical sustainability
    - decision support: make an inventory of all life cycle costs and identify suitable indices for measuring pertinent performance,
    - indigenous technology: develop the life expectancy of indigenous construction materials and technologies.

4.2.13 Spain

The following recommendations are presented in order to fulfil the ecological objectives mentioned in the Spanish report:

- promoting the eco-labelling of buildings,
- reducing the environmental impact of the construction waste through its minimisation and recycling,
- taking into consideration, during the design phase, the impact on health, comfort and security of users,
- promoting maintenance and rehabilitation of buildings as a strategy to enlarge their period of use,
- increasing the degree of environmental education of technicians in order to introduce these criteria into the sector,
- accelerating the integration of ecological constructive solutions in the construction companies by means of including them in the administration promoted constructions,
- promoting investment in the environment by means of fiscal deductions and/or eco-tax that burden the process of contaminating or consuming.

4.2.14 United Kingdom

The recommendations which are presented in the GB report are in fact distributed among the various chapters of the document: development and planning, design, construction, operation, deconstruction.

These recommendations are also clearly addressed to three identified categories of actors acting at the levels of government, education, or R&D.

The main items mentioned deal with:

- development and planning: amendment of the planning system, fiscal measures for sustainable construction and redevelopment of brownfield sites, refurbishment program to implement the Home Energy Conservation Act and water conservation, improvement of contaminated land clean-up procedures,
- design: fiscal incentives for environmentally friendly materials, measures to reduce the adversarial nature of building design, increase (longevity) building standards, reliable labelling scheme, imposing minimum recycled material content, better information and education,
- construction: impose strict built quality standards, greater information on self-building, investigate social sustainability issues surrounding self-build,
- operation: impose noise insulation standards, education on implications of sustainability for activities, building handbooks, develop usable environmental accounting tools,
- deconstruction: brokering service for waste construction materials, quality standards for reused/recycled materials.

4.2.15 United States

The recommendation chapter of the American report deals with metrics, process, policy, technology and education. The main items mentioned are:

- metrics: apply finance and accounting theory to the valuation of new energy and efficiency options, develop new appropriate eco-rating procedures for integral sustainability assessment, develop a complete set of environmental performance indicators, define procedures to obtain reliable LCA data of materials and components and build a data base, develop nation wide accepted performance based specifications for materials and systems,
- process: re-engineer the way the building process is regulated, develop and embed collaborative engineering models, protocols and systems into collaborative CAD environments, develop useful tools and multi-disciplinary integrated design environments, build co-engineering partnerships for customised product development and remove barriers to shorten time to market,
- policy: imagine new concepts rather than incremental improvements for sustainable development, develop energy savings in buildings, streamline innovation, develop performance standards, building guidelines and practices, target technologies that produce buildings that use 50% less energy than today, identify best practices and promote proven technologies, establish a process to manage liability concerns,
- technology: design for recyclability, expand industrialised building practices, develop co-makership alliances to develop integrated solutions, develop plug and play building components that are re-configurable, explore an international dimension to system modularity in building components and systems,
- education: expand education and training on implementing new technologies and building practices, share knowledge with developing countries and adopt local sustainability metrics in exported technologies.

4.3 Condensed view of all recommendations

4.3.1 General recommendations

A few general recommendations are given, which cannot be addressed to a specific actor of the sector but in fact should be addressed to all of them.

The way of positioning the construction sector into the global approach of sustainable development should be clarified and clearly claimed. It is proposed for instance to define a few simple but strategic and sensitive issues, to focus on important recognised aspects, and to approach sustainable construction through three problem categories:

- physical problems linked to the issue of taking account of natural heritage
- biological problems linked to the issue of not signing mankind's life away
- sociological problems linked to the issue of ensuring an inter- and intra-generation solidarity

It should be also stated that it is needed to take action at once to act preventively and to prepare the building sector to changes, which are needed in the construction process.

Several reports recommend taking account of human/social development as an important component of "sustainable development".

At last it should be borne in mind that for certain countries the economy re-launching does not favour very ambitious objectives in relation with Sustainable Development even if the construction sector is one of the most dynamic ones.

Table 7: Main general recommendations

- defining few simple but strategic and sensitive issues (FR)
- focusing on important recognised aspects (FR)
- approaching sustainable construction through three problem categories (FR):
    - physical problems linked to the issue of taking account of natural heritage
    - biological problems linked to the issue of not signing mankind's life away
    - sociological problems linked to the issue of ensuring an inter- and intra-generation solidarity
- taking action at once to act preventively and to prepare the building sector to changes which are needed in the construction process (FR)
- taking account of human/social development as an important component of "sustainable development" (IE)
- being conscious that for certain countries the economy re-launching does not favour very ambitious objectives in relation with Sustainable Development (RO)

4.3.2 Clients, owners, developers and investors

These actors should have a very important role in disseminating sustainable construction, since they represent the demand of the building sector.

They should set concrete environmental demands to the parties involved in the design process, as well as to the final product, during the initial design phase.

They should also set concrete goals regarding building maintenance that are based on environmentally friendly methods and include these goals in, for example, the building maintenance agreements.

They should also assure the productivity of their own business by emphasising environmental issues, quality and preservation of property values.

Table 8: Main recommendations to clients, owners, developers and investors

- setting concrete environmental demands for the design phase (FI)
- setting concrete environmental demands for the maintenance phase (FI)
- taking care of property values considered as a tool for productivity (FI)
- establishing maintenance programs (MY)
- developing and applying decision support system for refurbishment (MY)
- setting up creative finance solutions to help development for the poor (ZA)

4.3.3 Authorities

In a market economy, the demand expressed by the building owners could be seen as the only factor, which will lead to a development of sustainable construction. However, in many countries (excepted Germany and to a less degree Northern European countries), the lack of interest from the population does not pull the market. In France, for instance, the demand from the private or public building owners is very low, excepted when there is a regulation (waste) or when the population pressure is quite high (health problems or work site nuisances).

In these conditions several reports introduce the need of a voluntary policy from the authorities. It is why besides an education and training policy already mentioned, several proposed recommendations deal with financial incentives, regulation, labelling...

A general recommendation deals for instance with the establishing of high-level national research groups, which would examine the concept of "sustainable development" and its practical implementation in a given country. A national forum should also be established to develop a suitable response, in built form, to that concept and to act as a focus for construction related activities at national level. Human / social development should require special attention in these areas.

As far as objectives and goals could be set up in the framework of a voluntary policy, officials should consider environmentally sound construction as one criterion in all buildings. They should envisage measures to reduce the adversarial nature of building design. They should also confirm the creation and existence of mechanisms that lead to life cycle thinking. A specific attention should be borne to saving resources (land -both above ground and underground-, energy, water, and raw materials) and to waste prevention and recycling.

The increasing of building standards should be seen as a global objective in general, with a specific need for introducing standards that deal with longevity and multiple use of buildings in particular.

The stimulation of renovation of existing buildings is also seen as a necessary general objective for authorities.

Finally land and human settlements patrimony should be exploited in terms of resource more than constraint, in the perspective of real economic development with effects in all sectors.

As far as planning is concerned, the introducing of rules and standards for sustainability and eco-compatibility in the planning activities is referred to, at each level of the transforming activities of the land and human settlements. This should also deal with the interdependencies between the different levels of planning and design. Generally speaking, the planning system should be amended in order to promote sustainable development. More mobility planning should be reached. Car use should be reduced and public transport favoured. Home-working and combining office and living space should be increased.

An increased regulation on the use of land with more respect for open space and green areas should be envisaged. In certain countries refurbishment and use of brownfield sites is recognised as essential to make construction more sustainable and incentives from government such as fiscal measures should be set up as means of achieving this.

Finally, in certain countries such as Hungary, the need for completing the system of superhighways and other infrastructure with the major concern of minimising negative environmental effects is stressed.

As far as construction materials and the products industry are concerned, authorities should encourage them to provide environment-friendly materials since these are not available at reasonable prices on the market today. Awards for good practice and fiscal incentives could be a solution. Imposing a minimum recycled material content for all building material is also suggested.

As far as construction is concerned, it is recognised that rules, standards and certification schemes for sustainability and eco-compatibility should be introduced into the design activities. More generally, officials should use appropriate guidance (regulations, supervision and sanctions) in order to achieve environmental goals. Measurable performance standards based on sustainability principles at the levels of both urban development and building design should be drafted, as well as long-term targets for a step by step approach for future development set up.

Like for products and materials, fiscal incentives should also be developed for environmentally friendly construction activities.

Some control of the construction activity is also suggested, for instance through increased public responsibility on behalf of the construction companies or even through an increase of the environmental taxes on waste or emissions.

More drastically, it is also recommended to impose strict built quality standards for all building types to cover new build and refurbishment projects, to impose for instance severe noise insulation standards.

Quality standards for reused/recycled materials, which minimise concerns over their use, but do not place undue barriers to their sale, should also be introduced.

Finally, the creating of a profession of "construction environment consultant" is suggested.

Table 9: Main recommendations to authorities

General initiative

- setting up a high-level national research group to examine the concept (IE)
- establishing a national forum on Sustainable Construction to develop a suitable response to the concept (IE)
- developing a methodology for true public participation (ZA)

Objectives

- considering environment as one criterion in all buildings (FI)
- measures to reduce the adversarial nature of building design (GB)
- creating mechanisms that lead to life cycle thinking (FI)
- saving resources (energy, water, primary materials) (BE, GR)
- developing energy savings in buildings (US)
- increasing waste prevention and recycling (BE)
- increase (longevity) building standards (GB)
- promoting maintenance of buildings as a strategy to enlarge their period of use (ES)
- stimulating renovation of existing buildings (BE, ES, GR)
- the creating and renovating of residential buildings (HU)
- exploiting the resource "built and natural inheritance" (IT)
- imagining new concepts rather than incremental improvements for sustainable development (US)

Initiatives towards planning

- the introducing of rules and standard for sustainability and eco-compatibility in the planning activities (GR, IT)
- amendment of the planning system (GB)
- increasing mobility planning and new related concepts for city planning (BE)
- increasing regulation on the use of land with more respect for open space and green areas (BE, GR)
- fiscal measures for redevelopment of brownfield sites (GB)
- reduce water run-off in landscaping (ZA)
- land to be chosen according to environmental factors and according to socio-economic impact on local community; development aiming for compact land use (ZA)
- the improvement of transportation corridors necessary for social and economic development in a way which minimises its negative impact on the environment (HU, IT)

Initiatives towards industry

- the encouraging of environmentally friendly materials and technologies (GR, JP)
- fiscal incentives for environmentally friendly materials (GB)
- incentives for developing new environmentally friendly building materials and improving the performance of existing ones (ZA)
- awarding (JP)
- imposing minimum recycled material content (GB)

Initiatives towards construction

- promoting awareness and R&D on sustainable development (MY)
- the introducing of rules and standard for sustainability and eco-compatibility in the design activities (GR, IT)
- continuing and re-emphasising existing regulations and strategies (MY)
- the introducing of standard dealing with longevity and multiple use of buildings (GR)
- using appropriate guidance (regulations, supervision and sanctions) (FI)
- measurable performance standards to be developed (MY, NL)
- fiscal measures for sustainable construction (GB)
- promoting investment in the environment by means of fiscal deductions and/or eco-tax that burden the process of contaminating or consuming (ES)
- promoting the eco-labelling of buildings (ES)
- identify best practices and promote proven technologies (US)
- building guidelines and practices (US)
- the control of the construction activity (IT)
- increasing environmental “taxes” (waste treatments, emissions,…) (BE)
- construction: impose strict built quality standards (GB)
- operation: impose noise insulation standards (GB)
- deconstruction : quality standards for reused/recycled materials (GB)
- energy: address the issue if energy provision for the poor; use renewable energies (ZA)
- creating a profession of “construction environment consultant” (JP)
- refurbishment program to implement the Home Energy Conservation Act and water conservation (GB)

4.3.4 Education and training

An important feeling is that education and training should be largely used to have sustainable development concepts well known and accepted by all people. In particular, understanding the impact of the construction sector on the global environment is not matured in the whole construction industry or within authorities.

The need of a large concerted program of awareness raising and education is often mentioned. The programs should aim, not only, at all of the actors of the construction industry, but also the public, politicians, and government administrators. Sustainable building principles should be incorporated into the curricula of training courses for architects, designers and construction engineers.

Not only initial, but also continuous and permanent education of the operators should be promoted.

Building designers should be better educated to adopt a more integrated approach to design, to appreciate the fundamentals of sustainable building design, and how to interpret environmental labelling.

Construction firms should be approached at the level of the executive board members about the significance of their responsibility to the global environment. Methodologies for environmental impact reviewing should be disseminated. Training of employees and operatives should be promoted. Agreements in terms of role sharing and responsibility allocation among the members of the “construction team” in the projects should be established.

Interdisciplinary training in design, construction and exploitation processes should be favoured as much as possible and good practice examples should be largely disseminated.

People operating buildings should be educated on the implications of sustainability for personal and professional activities if a more efficient operation of buildings is obtained.

Table 10: Main recommendations on education and training

- education and training (JP)
- developing a concerted programme of awareness raising and education (IE)
- developing educational programmes in the higher levels (IT)
- better information and education towards designers (GB)
- raising awareness in clients end educating the end-user (ZA)
- the continuous and permanent education (ES, IT, ZA)
- the dissemination of knowledge about responsibilities (JP)
- training courses and interdisciplinary training (GR, MY, NL)
- good practice dissemination (GR, JP)
- education on implications of sustainability for building operation/use activities (GB)
- greater information on self-building (GB)
- expanding education and training on implementing new technologies and building practices (US)
- sharing knowledge with developing countries and adopting local sustainability metrics in exported technologies (US)
- communication will be successful only if (RO):
    - a common language is accepted
    - a multilingual glossary of the sustainable development concept is defined
    - a collection of world-wide practised methods for the assessment of constructions is available

In countries where the self-build movement is particularly strong (GB for instance), greater information on self-building should be disseminated.

However, because sustainability effects do not emerge in the short term, communication will be successful only if certain conditions are met. At least, the following conditions seem to be necessary:

- a common language is accepted,
- a multilingual glossary of the sustainable development concept is defined,

- a collection of world-wide practised methods for the assessment of constructions is available.

4.3.5 Designers

As already mentioned, designers should adopt a more integrated approach to design, appreciate the fundamentals of sustainable building design, and know how to interpret environmental labelling.

Designers should consider the environmental qualities of construction materials as a starting point of the design. They should develop design solutions from the point of view of environmental goals of the final product, develop the design process together with other professionals in order to achieve the optimal situation, and use methods and tools which will enable them to control not just the static's and cost but many other variables, such as life span and maintenance intervals, pollutants and health factors, heating and moisture, technology…

The attention of designers should focus on the exploitation stage during functional design (long service-life and flexibility of the building during its use). Technical design should focus on the durability of components, as well as the reparability and (de)construct-ability of components by adopting open systems and advanced jointing and assembly techniques.

Table 11: Main recommendations to designers

- considering environmental qualities of construction materials as a starting point (FI)
- optimising the design process (FI)
- developing methods and tools to assess the numerous variables involved (FI)
- taking into consideration the impact on health, comfort and security of users (ES)
- paying attention to functional design, durability, reparability and (de)construct-ability (NL)
- designing for recyclability (US)
- developing new design standards (MY)
- adopting and adapting open system and jointing and assembly techniques (MY)
- imposing minimum recycled material content (MY)
- considering environmental qualities of material (MY)
- adopting more integrated approach to design (MY)
- applying quality indices and service life prediction in building design (ZA)

4.3.6 Industry

Manufacturers of building products should see the life cycle considerations (environmental impacts, life span) as the basis of product development. Another stake should be to minimise actively the environmental harms of their own production processes.

In order to inform users, manufacturers should explain in the product information the environmental qualities based on life cycle analysis, together with information regarding use and conditions of use, recycling - and stick to this.

Manufacturers should co-operate with designers in creating new designs (jointing/assembly technologies, flexible engineering and system modularity) for new building designs as well as for renewal projects. Co-operation with related industries (e.g. plastic manufacturers, electronics) should be attempted to develop new function integrated building components. Manufacturers should improve the durability, reparability and retrofit ability of their products.

In order to facilitate recycling of materials, it is also suggested to industry to establish some kind of brokering service for waste construction materials.

Countries like Hungary also recommend the serving of the trade and industry needs, with an organisation of the work causing minimum trouble.

Table 12: Main recommendations to industry

- seeing life cycle considerations as the basis of product development (FI, GR, MY)
- minimising environmental harms of production processes (FI)
- stressing environmental qualities in the product information (FI)
- practising reliable labelling scheme (MY)
- materials and systems: new function integrated building components, durability, reparability and retrofit ability of the products (NL)
- reengineering production process of standardised elements (MY)
- practising better waste management (MY)
- brokering service for waste construction materials after deconstruction (GB)
- the serving of the trade and industry building needs, with an organisation of the work causing minimum trouble (HU)
- increasing partnership between designers and manufacturers (MY)
- working towards greater gender equity especially in blue collar employment (ZA)
- include the concept of ‘ubuntu’ in the construction industry decision making and operation to contribute to sustainable development (cultural acknowledgement and spiritual well-being) (ZA)
- expanding industrialised building practices, developing co-makership alliances to develop integrated solutions, developing plug and play building components that are re-configurable, exploring an international dimension to system modularity in building components and systems (US)

4.3.7 Contractors

It is recommended to contractors to see environmental consciousness as a factor of competitiveness and to develop their own services to be environmentally sound.

That includes reducing the environmental impact of their own business processes regarding, for example, site operations, logistics and material selections.

That includes informing owner's of the environmental impacts regarding the construction project, to make sure that environmental goals are part of the owner's demands and implementation plans and, if needed to set them together with the owner.

That includes to select the parties involved in the building project based on their expertise on environmental issues, and to require readiness from other parties (sub-contractors, material and product suppliers) to work in co-operation towards environmentally sound goals. That should lead for instance to establish agreement in terms of role sharing and responsibility allocation among members of the "construction team" in the projects (including clients). It is also necessary to keep a budget for sustainable construction, or to set up information networks to introduce good practice to other departments of the firm.

Environmental management systems should be developed.

It is also proposed that efficient production in construction should be met by open industrialisation and by making decisions (setting requirements) at different scale levels ("open building"). This would create a controlled process that would be beneficial to sustainability in terms of better quality, less squandering of raw materials, and less building and demolition waste. Large companies could take the lead by re-engineering their processes and by developing complete consumer-oriented (flexible) concepts that use standardised production methods that are universal applicable, independent of project type or size. A strong balance should be established between demand-side (user requirements) and supply-side (production techniques). Small companies should specialise in market segments or specific trades, and should seek a competitive edge by standing out in terms of sustainable construction.

Table 13: Main recommendations to contractors

- seeing environmental consciousness as a factor of competitiveness (FI)
- reducing environmental impacts of business processes (site operations, logistics and material selections) (FI, MY)
- selecting project partners on their environmental expertise (FI)
- making sure that environmental goals are considered by the owner (FI)
- agreements in terms of role sharing and responsibility allocation in the projects (JP)
- project life cycle management (NL)
- reengineering process to meet the concept of open building (MY)
- developing environment management systems (JP)
- apply quality indices and service life prediction in construction process (ZA)
- combining labour intensive methods with skills transfer, outsourcing to local actors instead of importing manpower (ZA)

4.3.8 Building users

Building users should act as a demanding customer when selecting spaces and considering the environmental qualities of the building over its life span as one selection criterion.

They should see the environmental issues as one aspect of comfort and consequently as one factor that affects the productivity of the use of the spaces.

They should develop their own activities to be more environmentally friendly in the occupied building.

Table 14: Main recommendations to building users

- considering environmental qualities as one selection criteria (FI)
- seeing environmental issues as one factor affecting space use productivity (FI)
- operating the building in an environmentally friendly way (FI)

4.3.9 Building maintenance organisations

Building maintenance organisations should see environmental consciousness as a factor of competitiveness and develop their own services to be environmentally sound.

Table 15: Main recommendations to building maintenance organisations

- seeing environmental consciousness as a factor of competitiveness (FI)
- showing initiatives and give feedback to building owners regarding environmental issues (FI)
- expecting co-operation from suppliers and partners (FI)

They should correct their own processes so that they are based on sound environmental thinking, show initiative and give feedback to the building owners regarding environmental issues. They should expect co-operation from suppliers and partners regarding environmental issues.

4.3.10 Technical and R&D recommendations

A lot of technical and R&D recommendations are addressed. Below is a list of these topics which are mentioned in the chapter "recommendations" and which are therefore considered as particularly important for sustainable construction. A few examples of specific aspects mentioned by some countries are also listed.

Table 16: Main recommendations on R&D topics

Built environment and ecological systems

- understanding impact of built environment on eco-systems (FI, FR, IE, NL)
- impact of human activities on ecological systems (NL)
- producing research based information to contribute to the “ethical discussion” (FI, FR, IE, NL)
- producing environmental qualities for building parts and buildings (FI)
- investigating problems and solutions for the sprawl of city agglomerations (HU)

Energy saving

- going on with energy savings policy (FR)
- targeting technologies that produce buildings that use 50% less energy than today (US)
- having an integrated approach to the use of energy (NL)
- innovative design, systems and products for energy-efficiency goals: integration of solar (and other renewable energy) systems, retrofitting adapted systems… (IT, NL)
- developing energy efficient design of low cost housing (ZA)
- assessment of embodied energy for the choice of materials and construction technologies (ZA)

Health and comfort

- understanding impact of built environment on health (FI, FR, IE, NL)
- improving air quality (FR, HU)
- decreasing health risks (FR)

- investigating social sustainability of self-build (GB)
- improving clean-up procedure for contaminated land (GB)

Waste

- bettering waste management (work sites and communities) (FR)
- reducing the environmental impact of construction waste through minimisation and recycling (ES)

Resources saving

- foreseeing fresh water shortage (FR)
- water-saving devices in both new and existing buildings (ZA)
- systems for capturing rain water (ZA)
- developing construction materials saving (FR)
- developing the use of indigenous construction materials (ZA)
- recycling, re-use and substitution by renewable materials (FR, HU, IE, IT)
- developing ways for an efficient use of raw materials (service life, system repair and retrofit, improved quality of materials, components and services) (NL)
- developing new innovative materials (IT)
- dynamic behaviour of constructions in soft soils (NL)
- understanding of the natural sand transport phenomena (NL)
- improvement of contaminated land clean-up procedures (GB)
- on-line products information systems (FR, US)
- improving durability of coatings (HU)
- developing the life expectancy of indigenous construction materials and technologies (ZA)

Building Stock

- upgrading performance of existing building stock (FR, IT, HU, NL)
- developing non destructive diagnostic tools for condition assessment (HU, NL)
- models for service life prediction (NL)
- new technologies/systems for renovating and retrofitting (FR, HU, IT, NL)

Tools

- developing methods and means to be used by professionals (FI)
- best practices in sustainable buildings (HU)
- building handbooks (GB)
- developing assessment methods (FR)
- performance-based environmental standards (IE, NL, US)
- reliable labelling scheme (GB)
- putting more emphasis at the R/D level on global studies such as life cycle analysis and multi-criteria evaluation of materials, services, constructions... (BE)
- tools for the assessment and certification of life-cycle performance of buildings (GB, NL)
- inventory of all life cycle costs and suitable indices for measuring pertinent performance (ZA)
- issues/tools linked to the incorporation of environmental costs into the economic system (NL)
- usable environmental accounting tools for construction projects and building operators (GB)
- modulating the “Building-to-Last” concept (FR)
- models for the service life prediction (NL)
- tools to estimate preference for temporary buildings or long-lasting buildings (GB)
- comprehensive data bases (JP)
- develop usable environmental operation accounting tools (GB)
- the development and dissemination of methodologies of reviewing environmental impacts (JP)
- compiling a first set of "performance indicators" to cover (BE, FR, GB, IE, JP, US):
    - the process of construction
    - completed buildings and civil engineering projects
    - the operation of existing construction works
- de-construction and disposal (including re-use) (IE)

- tolerance levels for radio-active building materials (HU)

Building process

- the need of short- as well as at long-term forecasts of construction activities (HU)
- the need of a thorough study of the ongoing processes in the national and international building field (HU)
- the improvement of the building process itself (NL)
- pushing life cycle thinking as the guiding principle for construction processes (FI)
- renewal engineering methods (NL)
- management and business practices (NL)
- design technology: new design standards for designers, open systems, advanced jointing and assembly techniques (NL)
- construction: open building, process reengineering (NL)
- materials and systems: new function integrated building components, durability, reparability and retrofit ability of the products (NL)
- investigate social sustainability issues surrounding self-build (GB)

4.4 Conclusions

The challenge the construction sector is facing today is not only to find the best balance between the various contemporary constraints of the building act (technical, architectural, social or economic constraints) but also to endeavour to favour "decisions without regret" in the compromise solutions that the building act necessitates at every moment in the life cycle of a building, and especially in the construction phase.

The previous chapters dealing with definitions of sustainable construction and visions of the various consequences of a sustainable development for the building sector showed already the complexity of the items which are raised and the role of nearly all of the numerous actors of the sector. This chapter tried to summarise the main recommendations given in the national reports towards these actors: clients, owners, developers, investors, authorities, educators, designers, industrialists, contractors, users, maintenance people, researchers…

Building owners and clients should have a very important role in disseminating sustainable construction since they represent the demand of the building sector. They should set concrete environmental specifications to the parties involved in the design process. They should also assure the productivity of their own business by emphasising environmental issues, quality and preservation of property values.

If the demand cannot be seen as a sufficient pulling factor, a voluntary policy by authorities is needed. They should favour the development of a suitable response to the concept of sustainable construction, stimulate the actors, take measures, create mechanisms… Initiatives should be especially taken towards planning, industry and constructors through adapted regulations, standards or fiscal measures and incentives.

An important feeling is that education and training should be largely used to have sustainable development concepts well known and accepted by all people. In particular, understanding the impact of the construction sector on the global environment is not mature in the whole construction industry and within authorities. This awareness raising and education program should aim not only at all the actors of the construction industry but also the public, politicians and government administrators. However a preliminary condition is to reach a common language.

Designers should adopt a more integrated approach to design, appreciate the fundamentals of sustainable building design, and know how to interpret environmental labelling. They should consider the environmental qualities of construction materials as a starting point of the design, but also focus on the exploitation phase during functional design.

Manufacturers of building products should see the life cycle considerations as the basis of product development. They should co-operate with designers in creating new designs and facilitate recycling of materials.

Building users should see the environmental issues as one aspect of comfort and consequently as one factor that affects the productivity of the use of the spaces.

Building maintenance organisations should see environmental consciousness as a factor of competitiveness and should expect co-operation from suppliers and partners regarding environmental issues.

A lot of technical and R&D recommendations are finally addressed in order to produce environmental quality for building components and buildings. Most of these recommendations deal with energy saving, health and comfort, waste management, and resources saving. An important part of the recommendations is concentrated on the development of adapted tools to help designers and other actors to introduce sustainability concern in the compromise decisions they have to take at every moment. The improvement of the building process itself is also considered as a significant topic for research activities.

Finally, a general recommendation that is stated is to take action at once to act preventively and to prepare the building sector to changes which are needed in the building process.

5. EXAMPLES OF BETTER PRACTICE

5.1 Introduction

5.1.1 Background to this chapter

The idea for this chapter came from discussions amongst the project team at a progress review meeting in Budapest in November 1997. It was realised that the reports presented scenarios for sustainable construction in the year 2010 from the broadest point of view. What the construction industry would require was an understanding of better practice and what the key drivers of change would be. The first suggested title for this section was “Market Opportunities” recognising that the development of new market opportunities would be a key driver of change in the industry. Based on the principles of a market economy this is true. However, it has become evident, as the national reports are completed, that sustainable construction means different things in different countries and solutions will need to be found which are suitable for organisations in market economies, transition economies and developing economies.

Therefore, in order to reflect the wide range of responses which have already been made and those which might be expected from construction industries throughout the world, the chapter is entitled: “Examples of Better Practice”.

5.1.2 Considering the industry perspective

For many in the construction industry the components of sustainable development pose unfamiliar challenges. They involve a wide range of stakeholders many of which have not been direct participants in construction activities before and may also be experiencing dramatic change in their own sphere of activity. Whilst the construction process and built environment have a substantial impact on people’s lives many of the social, environmental and broader economic issues which characterise sustainable development are not considered in the current construction industry protocols and practices. Therefore, for construction activities to become sustainable those in the industry must find ways of “buying-in” to the principles of sustainable development by:

- initially, building an understanding of sustainable development;
- secondly, identifying how their activities impact upon others, in relation to the aims of sustainable development;
- thirdly, defining and accepting their role in its achievement;
- and finally, putting theory into practice.

5.2 Better practice case studies

This section presents extracts of the case studies which are presented in the national reports. The full case studies provide an insight into the many approaches people have taken to putting the theory of sustainable construction into practice. It is hoped that these examples will help shape and define our own vision of sustainable construction and encourage the wider application of sustainable construction practices. There is no attempt to grade, rank or value the examples presented although an attempt has been made to categorise them in line with the five areas of investigation carried through many of the national reports. These are:

1. Urban planning - which includes any examples of community planning
2. Product development and design - including new uses of traditional materials
3. Manufacturing and construction - looking also at new partnerships for construction
4. Operation - including integrating new technologies for greater efficiency
5. Deconstruction.

In total there are 59 examples presented in this section, categorised as follows:

1.	Urban planning	20 examples
2.	Product development and design	17 examples
3.	Manufacturing and construction	6 examples
4.	Operation	15 examples
5.	Deconstruction	2 examples

In themselves they make an interesting indication of the current priorities and the types of organisations who can be leaders in sustainable construction practice.

5.2.1 Urban planning

The Centre for Sustainable Construction (Heusden-Zolder) - Belgium

Principles: centre for the community, demonstration project

A new Centre of sustainable construction is planned for construction in a renovated ancient mine building. The work will be carried-out as a large demonstration project and will contain conference- and meeting rooms, demonstration facilities, space for starting companies a child museum etc. In the neighbourhood of the centre, there is space for demonstration buildings and for new companies, operating within the framework of sustainable construction. The centre is a joint initiative between the Construction sector (BBRI, Federation of construction industry, etc), the Energy sector and Public authorities (Flemish Waste Administration, Water Supply Administration, etc). The centre will co-ordinate different initiatives in Belgium in the field of sustainable construction, stimulate application, demonstrate new technologies and show concrete products and services.

The mobility plan of the city of Hasselt - Belgium

Principles: traffic management

This is one example of the public transport plans developed for some Belgian towns. An interesting case study is the city of Hasselt, where a global mobility plan is implemented. Elements of this plan are:

- traffic black points were inventoried and as much as possible soluted;
- a “speed reduction plan”: 30 and 50km/hr in inhabited areas; 70 and 90 for other roads;
- the inner ring of the city is completely reorganised:
    - reduction of a 4 lane-road to a 2 lane one;
    - traffic is only admitted in 1 direction;
    - the new space is used for “slow traffic” (walking and biking) and trees;
- a complete network of bike-lanes;
- public traffic:
    - increase of the bus traffic by a factor 4;
    - all busses are free within the city;
- large parking outside town, free bus-shuttles to the centre.

The first months of the new public transport organisation showed an increase of the use of busses with a factor 10 and a considerable decrease of car traffic within the centre of town.

Ecological criteria for experimental construction (Viikki) - Finland

Principles: ecological design principles for city sites, enhancing regulation

The purpose of the criteria developed in this project is to be appended to regulations concerning building practices at city sites. The City of Helsinki and the Eco-Community Project organised a design competition for experimental building in a rural area including ecologically sensitive and valuable protected waterfronts at Viikki near the centre of Helsinki. The competition aimed to save nature and natural resources, to have a high quality with regards to their architecture and functionality of the dwellings, and to be feasible to construct. The competition also was a means for a search for solutions which follow the principles of sustainable development and which could be more generally applicable. A group of building consultants devised a tool for the ecological assessment of building plans which defines minimum ecological levels for building and estimates the ecological degree of various development projects. Minimum ecological levels for building have been dimensioned to enable their implementation in residential construction to be carried out at a reasonable additional cost. The fulfilling of ecological criteria will also achieve cost savings during the use period.

Electric and District Heating Energy Plant (Vuosaari B) - Finland

Principles: community planning, energy efficiency

About 50 % of the heat from the new energy plant, Vuosaari B are used in the densely built area of Helsinki. The plant uses natural gas as its fuel and produces a nominal electric power of ca. 450 MW. The fuel is fossil but offers the advantage of practically no particle and sulphur emissions. The NO_x emissions are low: for NO_2 only 35 mg /MJ of fuel. In comparison, modern coal-fuelled plants emit ca. 50 mg/MJ, and 10 years ago typical emissions for coal were above 200 mg/MJ. Also carbon dioxide emissions are low, only 56 g/MJ (more than 90 g/MJ for coal).

The heat from Vuosaari B is lead outside of this area, to North and East parts of the city, via a new 20 km long district heat tunnel (an investment of ca. 500 million FIM). About 90 % of the building volume in Helsinki are covered by district heating.

Le Clos des Vignes - France

Principles: Site integration

Integration of the site with specific characteristics from the geographical, cultural and social points of view is the main characteristic of this development comprising 56 flats at SAINT MAX (Meurthe et Moselle - Eastern France). It includes 6 flats dedicated to disabled people. . Several themes have been considered in this operation, such as the site integration but also water and domestic waste management. Also, the history and geography of this site have been taken into account for the gardens and surroundings. Various communications have been conducted with local inhabitants and timber (from the Vosges forests) has been heavily used in the construction, on the façades and inside the common areas.

Place du Vigneron - FRANCE

Principles: Visual comfort and integration

This project in UNIEUX (Loire - southwest of Paris) is for 44 flats and stores. This REX HQE, with three 5-storeys buildings, takes place in a heavy restoration of the centre of a middle-size town. The problem of visual comfort has been studied in particular. A light shaft, located in the middle of each building, brings "second lighting" to landings, bathrooms and livingrooms. The natural lighting concept includes also:

- larger glazing in the light shaft at the lowest floors in order to balance the lack of light,
- "transparent" lifts to improve natural lighting of landings and lifts,
- appropriate design of the window frames,
- light-coloured cladding and covering,

All these topics have been deeply through modelling/simulation and laboratory testing.

Urban Planning case study SALINE - OSTIA ANTICA, ROMA, 1995 - Italy

Principles: nature protection, renewal and recyclable

Saline-Ostia Antica represents an urban organism covering 900 ha on the outskirts of Rome, whose history has alternated between consolidation and cycles of decline. With the recent agricultural reclamation operation, it has regained its structure and identity. But today the agricultural crisis and progression of the built city are compromising the morphological and structural continuity. The project will reconstruct the relationship between built city, agriculture, and natural environment in a visibly global system. The organisation of innovative technological elements such as the "Energetic Power Ecostations" will re-establish the flow of circulation, infrastructure, and create new urban polarities.

The New Urban Masterplan of Cavalese (Trento) 1991 - Italy

Principles: conserve, re-use, integrate

The urban masterplan of the Municipality of Cavalese promotes a series of technical and co-ordinated measures, normative for energy savings interventions, discouraging law evasion, for an adequate solar energy use in the new buildings constructions and/or in retrofitting and in general in the research of building quality and in the valorisation of existing buildings.

Five levels of building intervention are checked in the Cavalese masterplan, some of them enter directly in the normative and technical advisory, while some other belong more properly at the dimensional-program- management of the administration. The first two levels individuate the planning level and the building level, which much more are involved in the sustainable development of the city.

'Environment symbiosis' building and NEXT 21 projects in Osaka City - Japan

Principles: harmonisation with nature

Japanese traditional culture involves the paradigm of harmonisation with nature. It is acceptable for Japanese people to define human as only one of the players in the environment.

Based on these cultural bases, the word of 'environment symbiosis' building is more frequently used than sustainable building, environmental conscious buildings and green buildings in Japan.

Housing and Urban Development Corporation (HUDC) and local councils are now constructing environment' friendly' estates in nation-wide. Remarkable example is Fukasawa Housing Complex in Setagaya-ku Tokyo. It is typical example of environment symbiosis building. It was designed by architect Kazuo Iwamura. He involves feasible environmental friendly measures in the council housing project where budget is extremely tight.

LEIDSE RIJN: development of a new medium sized town. - Netherlands

Principles: public consultation, partnership, new construction methods and technologies,

Leidse Rijn will be a new residential district of the city of Utrecht. The area is still predominantly agricultural, but is also very diverse. The new residential development will consist of 30,000 homes, which will house about 100,000 people. In effect, it means that a medium-sized town will be created out of nothing.

The urban planners have adopted a new approach in Leidse Rijn which used a multidisciplinary committee to assess claims put forward by interest groups affected by the development. The various members of the project team went to all the public meetings, armed with the maps. "A great deal of attention was focused on communication in the project. Listening and explaining was a very important part of the design process. The team, only two-thirds of which were local government officials, all worked together in one room, which is very unusual.”

Working in this way increased the range of options and the following initiatives have been developed:

- Use of land - An underground motorway uses a method never used before bringing the ideal of compact development a lot closer.
- Energy - The energy performance of the dwellings will be 40% better than the current legal requirements. Moreover district heating will be applied.Transportation and mobility - Another point of attention was the concurrent development of a high quality public transportation system.
- Water - A 50% decrease in the consumption of high quality drinking water will be realised by using a double water supply system. One system supplying drinking water quality and one system supplying lightly treated surface water for washing, toilet flushing, etc. The sewage system is only designed to transport domestic wastewater. Rainwater is infiltrated in the groundwater or discharged in the existing waterways.

Orange Farm Informal Settlement, Johannesburg - South Africa

Principles: self-governance, community participation

This settlement is an example of entrepreneurial self-governance. Lacking any formal municipal structure, the community embarked on a creative approach to develop the area. The community identified the leaders in the community, people known for resourcefulness and community concern. A self-governance structure, the Orange Farm Creative Action Development Forum was formed - an acceptable local structure for community development to improve the management and delivery of essential services. The community has since mobilised and channelled development funds through this forum and successfully developed schools and other services for the community. Several people in the forum have received national honours for their endeavours. The Centre of Lifelong Learning of the Technikon Southern Africa has made the principles established by the forum the basis for a special Integrated Community Building Programme, which encourages communities to be more self-reliant and self-responsible in their planning, decision-making and actions. (Hill, RC, and al., 1998)

Tlholego Development Project, Rustenburg - South Africa

Principles: rural planning, integration, appropriate technologies

The Tlholego Development Project (TDP) was established in 1991, in order to pilot research and development into sustainable technologies for rural development. These technologies include: ecological building, household food security, natural waste management, permaculture and education/training on these subjects.

The Tlholego village pilot is an important demonstration in the replacement of sub-standard housing with high quality, affordable houses, which use modern techniques of unburned brick and appropriate technologies. One of the main objectives of Tlholego is to establish a rural settlement model, which demonstrates to South Africans real options for living sustainably in the 21st century.

A Zonal urban plan for Sighisoara - Romania

Principles: regeneration, heritage conservation, urban planning, regulations

The city of Sighisoara developed around the medieval firtress built in the XIVth century. The city has experienced cycles of development and decline which resulted in recent years in the wholesale demolition and "neutralisation" of the specific character of the city and its environment.

In 1991 a pilot project commenced to develop an urban zonal plan and to reinstate construction regulations which had been abandoned for over 40 years. The new building regulations contain provision for:

- protection and classification of certain buildings,
- spatial re-organisation,
- protection and revitalisation of green spaces,
- improving quality of surrounding areas,
- functional re-organising and aesthetic regulation,
- diversity by restructuring,
- patterns for public services,
- land transactions.

Urban regeneration and rehabilitation, apartment blocks, Targoviste - Romania

Principles: urban regeneration, improved quality of life

The core of this project is based on the refurbishment of apartment blocks built in the 1960's which provided the most basic living conditions. The main objectives of the project were to improve living conditions and the external out-look. The choice of rehabilitation has resulted in costs accounting for only 45% of the cost of new build and through careful design the number of apartments has been retained but the following improvements have been achieved:

- 25-30% increase in living space,
- improved thermal insulation,
- improved quality,
- updated infrastructure,
- new storage space,
- improved external aesthetics.

Additional benefits in the quality of the urban framework and surrounding residential area have been realised.

Metropolitan Territorial Plan for Barcelona - Spain

Principles: balancing quality of life in developments, integrated transport

Although not ratified, this plan tries to avoid the habitual and undesirable situation that is generated in the surroundings of large cities. The objective of this plan is to obtain a homogenisation of the living quality throughout the congested urban centre and the dispersed territory surrounding the city. The Plan proposes a solution based on distributing the territory in a system of "open spaces" and "metropolitan islands" where high quality services and communications are provided to encourage less dispersion.

An interesting proposal of the Plan is the system of segregated roadways, structured as a homogenous and orthogonal network, that will channels the through traffic. This system is complemented with a net of “civic” thoroughfares and service corridors that will channel the intra-metropolitan short distance transport flows and serve, at the same time, to carry the different main service networks (water, electricity, gas, telephones...).

Car Free Housing Development - Edinburgh, Scotland - UK

Principles: integrated transport planning, mixed development

This scheme is being developed on disused rail land in Edinburgh, and is due to be ready for a mixture of rented, bought and social housing by 2000. It will consist of 121 flats which will provide energy efficient homes in a car free environment. People wanting to buy or rent flats will have to sign an agreement not to own a car and have no plans to buy one. Edinburgh City Council plans to extend its ‘car club’ to the development, allowing residents to hire vehicles preferentially. Two new bus routes and a possible new suburban railway station, will provide sufficient public transport services for the residents. The land that would have normally been allocated for parking will be used for terraced gardens, allotments and reed beds. The site is to be developed to a density of around 50 units to the acre, a high density compared to typical developments.

Holy Island Retreat Centre, Scotland - UK

Principles: holistic design, integrated, autonomous community

This project, yet to be started, is intended to be a truly sustainable development on an island off the west coast of Scotland. It will house a Buddhist community, who desired to be part of a sustainable environment and a wholly self-sustaining community. Thus, the design had to take account of agricultural needs, integration of water and crops, waste management and disposal, and rigorous energy efficiency strategies. The overall objectives of the project were:

- to be energy self-sufficient;
- to be water self-sufficient;
- for all waste to be processed on site or recycled.

The community plans to self-build a part of the project on site soon. Although for some parts of the construction precise finishes are required (such as for the back walls, roof and facades), other less critical areas present the possibility of self-build for the community.

Planned Unit Developments - USA

Principles: self-sufficiency, integration, community

Village Homes - The development of Village Homes in Davis, California was begun in 1975 and was based on principles of self-sufficiency, community, energy conservation and market appeal. It occupies 70 acres and was designed for 200 homes. The main components of the development are narrow streets, cul-de-sacs, on-street parking, interconnected pedestrian ways, communal green space, including agricultural land, smaller lots, and the orientation of every house lot for southern exposure. Commercial and recreational uses were provided in the community centre to decrease automobile usage.

Dewees Island - Dewees Island is a 1,206-acre barrier island off the coast of South Carolina. The premise of the development is a high-end retreat in tune with the 350 acres of existing wildlife preserves on the island. Environmental regulations for wetlands and coastal development as well as environmental groups placed severe restrictions on development. As part of a community outreach environmental education program, the developers built an education centre on the island for visitors and residents to have an information source to learn about the native flora, fauna, and ecosystems.

Civano -Tuscon Solar Village - Civano in Tucson, AZ is the first attempt to create a new land development with social amenities, affordable housing, and a job-to-housing balance required to make it economically feasible while also designing in energy and water efficiencies in the buildings, landscape and infrastructure.

Traditional Neighborhood Development (TND) - USA

Principles: integrated communities

Traditional neighborhood development (TND) grew out of Andres Duany and Elizabeth Plater-Zybek’s belief in the connection between community form and function. If the structural elements which embody a traditional American small town are recreated in new and infill developments then the values and functions of community will follow. TND ordinances go beyond the measurable character of land uses by also defining aesthetic and materials codes for buildings.

Seaside in Florida - was the first built expression of the TND principles begun in the mid 1980's. The 80-acre town is expected to grow to about 650 dwellings and 2,000 residents. The plan consists of a mixed-use town center located off the main through-road with a pattern of limited access streets radiating outward to the small-detached single-family home lots. A grid overlay ties the radial streets together and connects to the main through road, distributing traffic throughout the community. Parking is limited to areas outside the development and on-street within the development. A strict architectural code determines the materials and appearance of the development as well as ensuring certain features such as front porches and picket fences which are meant to engender community interaction.

Haymount, Virginia - is a 4,000 dwelling unit, 1,605-acre development on farmland in eastern Virginia on the Rappahannock River. The land planning process used an extensive environmental assessment overlay mapping process that outlined all environmentally sensitive areas and individual trees of 18 inches in diameter or greater. The multi-disciplinary planning team, common to the best of sustainable construction, included planners, landscape architects, architects, engineers, and hydrologists.

Harbor Town in Memphis, Tennessee - is built on an island in the Mississippi River in Memphis, Tennessee. The development is meant to embody the traditional values of a Southern town through its physical character. The plan is a combination of a grid and axial street system, with three major focal points. The homes are built on smaller lots, 3,000 to 5,000 sq. ft., with front porches, many small neighborhood parks, and back alleys with parking on the streets. Smaller single family homes are designed in the «shotgun» style, a traditional form so-called because it utilizes a circulation spine through the building from front to back, with the front and back doors in line. This style makes cross-ventilation feasible with front and back porches to cool the air as it passes. The rectangular shell, the circulation path which passes from one room to the next without use of a hallway, and the use of one room for living, dining, and kitchen, reduces materials use to the absolute minimum.

Celebration in Florida - is a 4,900-acre new town developed by The Celebration Company, a subsidiary of The Walt Disney Company, and opened in 1996. Celebration was to create a model of neo-traditional planning. The major design elements are; a central commercial “downtown” core, mixed housing types, a public school, health facilities, a 109 acre office park, and a golf course. An advanced infrastructure system of telecommunications and fiber optics, pedestrian paths and trails are all intended to reduce transportation needs and create a pedestrian friendly environment. The development uses a series of guidelines and controls, including approved builders and stylistic controls, for the architecture of housing types. These types range from townhouse to single family, with designs based on traditional American architecture. The land development pattern creates a secondary street network of alleys and hidden or rear-located garages to remove vehicles from the principal street frontage.

Transit Oriented Development (TOD) - USA

Principles: transportation efficiency

The architect and planner Peter Calthorpe developed the design strategy for cities called Transit Oriented Development (TOD) in the 1980’s. The foundation for this development type centered around mass-transit is the high rate of automobile use in the USA. TOD is an attempt to alter the patterns of transport use in the US. The guiding force is transportation efficiency and the fundamental connections between home and work and one community to the next. 'Pedestrian pockets' link the nodes of commerce and transit stops with the residential and recreational areas in close proximity. TOD is explicitly energy conserving by supporting mass-transit, pedestrian access, density and mixed-use, infill around existing transportation infrastructure and consequently, the preservation of surrounding natural areas. One example of a TOD is Laguna West in Sacramento, California.

5.2.2 Product development and design

Pleiade - Belgium

Principles: energy efficiency, integrated design

The PLEIADE (Passive Low Energy Innovative Architectural DEsign) dwelling is the Belgian contribution in the framework of the Task XIII project of the International Energy Agency (IEA). It is a two-storey row house of about 240m² net floor area (including the attic which is part of the inhabited space) located in the new city of Louvain-la-Neuve. Special attention is given to the integration of the bioclimatic architectural concepts, the achievement of good thermal comfort in winter and summer, and good indoor air quality. Accordingly the design of the envelope was important. Daylighting the central part of this 10-m deep row house was another objective. Features include: a balanced ventilation system with heat recovery, shading of the south-facing glazing, night-time natural ventilation, two heating systems - a gas air heating system and an electrical heating system, a control system for optimal energy use and thermal comfort, improved double glazing (Argon filling and double low-emissivity coating).

CFC-Free Low-Energy Office Building (METOP) - Finland

Principles: low energy systems

The building module prototype METOP for a low-energy office building was built for testing the performance of new structural, electrotechnical and HVAC solutions developed in different development projects of different companies. The main objective was to put into practice good indoor air quality, thermal comfort and low energy consumption simultaneously and economically. Its heating energy consumption was measured 13 kWh/m^3 (55 kWh/m^2), which is 60 % lower than the average consumption in Finnish office buildings. The consumption of electricity was 16 kWh/m^3 (72 kWh/m^2), which is equal to average consumption. According to the measurements, there was no problem with the indoor air quality. Concentration of odours, radon, particles, microbes, volatile organic (VOC) and other chemical compounds were low. Thermal indoor climate was pleasant in winter and in summer. The satisfaction index was over 90 %.

Energy-Conscious Dwelling (Soidintie) - Finland

Principles: linking design selection with operating efficiency

The purpose was to find out the actual influence of structural and technical systems on construction costs and comfortable dwelling when ecological alternatives are favoured. The goal was a 30 per cent reduction of annual heating energy without significantly increasing construction costs. First, performance and costs of various exterior walls and windows were calculated. A trade-off comparison between a better thermal insulation of exterior walls and windows and, on the other hand, building costs and dwelling comfort was performed. The results indicated the fact that a better insulation gives an opportunity of using floor and air heating based on low temperature technique.

Les Jardins de Rabaudy - France

Principles: Environmental quality of materials, site integration

In this REX HQE situated in the hearth of a protected "green zone" in CASTANET TOLOSAN (Haute Garonne - West-southern France), a heavy attention has been brought to the integration of the buildings and their neighbourhood into the site. The choice of environmentally friendly materials has been deeply studied and the following materials have been chosen for the 50 rental houses:

- baked clay (tiles, 20-cm-hollow bricks, facing bricks, window ledges, chimney ducts, life cycle studied with an industrialist),
- wood (skeleton, shutters, garage doors, internal doors, plinths, stairs),
- zinc (gutters),
- traditional coating,
- non toxic glue,
- labelled paints.

“Internet” Office and Ecohouse Pavilion, Lough Derg - Ireland

Principles: eco-design, integration of new technologies

This project was completed in 1995 and provided an imaginative extension to an existing building which included many special features. State-of-the-art environmental technology was incorporated in the design including PV cells, low-pollution, “breathing” materials.

The pavilion is south facing in order to maximise the passive solar energy and an existing well was incorporated into the design to allow for irrigation of a year round vegetable garden as well as for cooling purposes.

Building component case study, the active intelligent window - Italy

Principles: renewable energies, advanced technology

The Active Intelligent Window comprises of a range of elements each with specific or variable functions depending on outdoor conditions. The elements are contained in two main sections: the upper section contains the glazing panels, which in turn enclose variable transparency film operated on a roller system. The lower section is within a compartment clad on the interior by a filter panel and on the exterior by a punctured opaque glass panel; contained within these panels is the rotary heat exchanger and an upper and lower fan for air intake and exhaust respectively. The intelligent control system and sensors are also located here, as well as the local control for the different configurations. The heating strategy of the window covers the concepts of solar collection, heat storage and heat distribution; while the cooling strategy refers to solar control, internal gain minimising and heat dissipation. The entire unit is contained by a PVC frame that allows the insertion of the whole element into the building structure, as well the substitution of damaged elements.

OM Solar House - Japan

Principles: modularity, innovative technology

A specific type of passive solar house called the OM solar house has been rapidly disseminated among timber framed houses. Around ten thousand OM solar houses have been constructed in Japan.

Novalis - Ubuntu Centre (Kenilworth, Cape Town) - South Africa

Principles: holistic design

The centre is to function as a training facility for teachers in the Waldorf system of education. The structure is to be a *building for the human soul*, and thus the main emphasis in the design was the quality of the spaces and indoor environment that are created in the building.

Physical and spiritual well being was an important issue for the Novalis-Ubuntu Centre as part of their whole educational philosophy. A ‘geomancer’ was commissioned to identify ‘geopathic stress spots’. These are points of adverse or negative energies that usually originate from underground water sources, magnetic grid lines and radiation, amongst others. Where buildings are sited above them, these forces become confined within the buildings and are said to cause stress and illness in people working within these buildings. Organic forms and human scaled designs further contribute to the well being of occupants of the centre.

The client’s brief also stipulated that training of local workers on site was compulsory, and labour intensive construction methods were used.

The Barn, Kuthumba Nature Reserve, Plettenberg Bay - South Africa

Principles: use of traditional materials, deconstruction, community involvement

The Barn is to provide accommodation for visitors to this private nature reserve and makes use of clay construction techniques, organic building forms and the use of natural materials to create buildings that are environmentally sensitive, as well as being sensitive to the surrounding landscape. A gum pole structure was used with wattle and daub infill panels.

The wattle, an alien plant, was harvested from the surrounding indigenous forest. Other materials used for the infill panels were locally-sourced clay, and straw that had been treated with old motor car oil. Thatch was used as a roofing material.

Provision was made for the reuse of grey water and a wetland sewage system is used.

The Barn also addressed the issue of deconstruction as the main construction materials used, clay and wood, are recyclable after demolition.

A ‘clay building festival’ was organised for the local community and friends to do most of the clay mixing and panel infill work. Local workers were trained in clay construction during the building of the Barn.

The Klein Constantia Wine Cellar - South Africa

Principles: effective use of materials

The Cellar provide an example of the way in which conventional building materials and methods can be used to create energy efficient and biophysically sensitive design solutions. It features passive design measures that involve orientating buildings and using materials in such a way as to make the most of natural energy for lighting, ventilation and temperature control. The cellar is partly buried, thereby making use of the insulating properties of soil. The roof is built of brick vaults filled with high mass concrete, which adds to the insulating properties of the building. These and other design features allow natural regulation of temperatures within the building and have eliminated the need for mechanical systems to maintain required temperatures. The cellar won an Eskom Design Award for energy efficiency in 1990.

The choice of site avoided damage to vulnerable farmland and vegetation that would have resulted from using the initially proposed site. The alternative site chosen was an old ‘grey’ site that had been used in the past to support farm sheds and other buildings. These old ruined buildings were demolished and the new cellar built on the site. Thus, no new land had to be cleared or damaged by the construction process.

House of Mr. Justice HA Fagan, Cape Town - South Africa

Principles: passive design

Apart from design measures involving the orientation of the building and using materials in a way that makes the most of natural energy, lighting and temperature control, the Fagan house also uses passive solar design to regulate internal air temperatures. This building uses a combination of a large skylight on a north-facing roof, situated above a heavy concrete floor finished in terracotta tiles. The tiled floor acts as a heat sink, absorbing the heat entering via the skylight, and releasing it at night or in winter months. The rooms were designed to maximise the flow of heat from this heat sink throughout the house. Large, adjustable blinds below the skylight prevent excessive heat gain in summer.

A six flat block with solar conduit in Horta, Barcelona - Spain

Principles: conserve, re-use

This building consists of three floors and a parking level and has been equipped with bioclimatical solutions to satisfy the ventilation, air conditioning and lighting requirements. One of the most novel characteristics of this building is the incorporation of a solar conduit for the illumination of the kitchens which is also used at the same time to provide natural ventilation. Other bioclimatic measures have been applied to this building for the ventilation and illumination of the parking areas and stairs also incorporate skylights. Another main field of consideration has been power saving in heating and the insulation of walls using HD polystyrene to improve thermal inertia. In the main facade, oriented to the Southeast, there are 53.2 m^2 of double glazed windows, whereas in the rear facade there are 14.5 m^2. This improves solar lighting, reduces the thermal losses and allows the crossed ventilation in summer. Thanks to the gains obtained from the passive solar pick up and the good insulation, the degree of power saving in heating reaches the 68%.

Eco Centre - Groundwork South Tyneside, England - UK

Principles: design for autonomy

Designed to lead by example, this building (completed in 1996) was originally intended to be totally self-sufficient, creating the UK’s first truly autonomous office. Cost considerations have prevented this vision being wholly fulfilled, but the combination of low energy design, water conservation and on-site electricity generation means that the Eco Centre places only a small burden on the local utility supplies. The building obtains its heating and cooling via a ground source heat pump, recycles human waste via composting toilets, recovers rainwater for fire sprinklers and toilets, and uses greywater for site irrigation.

The construction materials were obtained where possible from renewable sources and recycled materials were used. The building is timber framed, with timber supporting the roof structure and internal brickwork supporting the intermediate floor slab. The reclaimed bricks came ready cleaned and palleted. The building is 30% double-glazed, with the timber window frames from a sustainable timber source.

Hellmuth, Obata & Kassabaum (HOK) - USA

Principles: design tools for sustainable development

Being one of the world's largest design firms, HOK has demonstrated a special commitment to sustainable construction through implementing a variety of procedures, guideline databases and protocols to stimulate and support the generation of sustainable designs.

A significant element is the 'Sustainable Design Guide', which is a tool to assist project teams in defining and prioritizing sustainable design goals. The checklist is organized by three design phases: Pre-Design, design and Documentation, Construction Administration, and by sustainable design topic: Planning and Site work, Energy, Building Materials, Indoor Air Quality, Water Conservation, and Recycling and waste Management.

Rocky Mountain Institute - Office and Residence - USA

Principles: design principles for energy efficiency and sustainability

The Rocky Mountain Institute (RMI) is a non-profit organization that promotes energy-efficiency and sustainable construction world-wide, based in Snowmass, Colorado. The founder of the Institute, Amory Lovins has become an renowned expert in the design of energy-efficient building systems with a focus on lighting and the calculation and documentation of the benefits of efficient commercial building systems for both utility savings and productivity gains resulting from good indoor environmental quality. RMI focuses on the reduction of electrical power consumption due to the enormous environmental costs of its production.

Sustainable Development and Construction Initiative, Inc. Abacoa Residences - USA

Principles: mixed commercial development, environmental design

Sustainable Development and Construction Initiative, Inc. (SDCI), is a non-profit group centered around the University of Florida, Center for Construction and Environment, in Gainesville, Florida. The group consists of academics, architects, developers, engineers, building contractors, and energy and waste specialists devoted to sustainable construction education and implementation. The Abacoa development in Jupiter, Florida is a 2,000 acre mixed-use development that is expected to build-out in 20 years at 6,000 dwellings, plus approximately 3,000,000 sq. ft. of commercial space, a university branch and a baseball training camp. The development is located adjacent to a mass-transit rail system which links it to cities along the Florida southeast coast. The existing land is pine flatwoods and agricultural land that is expected to be restored to its native ecosystems within the community as a whole and through a wildlife corridor “greenway” which extends completely through the development.

Croxton Collaborative - Audubon House

Principles: holistic design principles and practice

The Croxton Collaborative architectural firm is one of the leading U.S. architectural practitioners of green design and construction. They have been involved in several high profile design projects including the Natural Resources Defence Council office renovation and the National Audubon Society office renovation, both in New York City.

The Audubon House was created from the renovation of an 1891 office building, reusing the resources and restoring the architectural character of an existing structure instead of building a new building. A major component of the effort was the multi-disciplinary approach that also brings the client and non-traditional consultants such as environmental scientists and indoor air quality experts into the design team to a greater extent than is typical. This holistic approach was utilized to realize sustainability design goals of a healthy and pleasant working environment, environmental soundness, and quantifiable dollar, energy and material-use reduction.

5.2.3 Manufacturing and construction

Business based on recycling of wastes (SKJ Companies) - Finland

Principles: eco-efficiency, recycling

SKJ Companies, a subsidiary of the Finnish steel group, Rautaruukki Oy, is responsible for utilising the by-products of the steel industry. Activities cover the whole range of the by-product business from by-product treatment to product development, marketing and export. SKJ has developed into products and is marketing approximately 90% of the above mentioned by-products of Finnish steel industry totalling about 1.4 million tonnes. Slags are the largest product group by volume, and they are marketed to road construction, agriculture and the building materials industry. SKJ companies have activities in the fields of by-product treatment, product development and technology know-how. With regard to the technology know-how SKJ also has activities within export. The primary export countries have been Russia and East European countries.

National Package for Sustainable Building - Netherlands

Principles: good practice, demonstration, standards, whole industry participation

A national package for sustainable building has been drawn up by the building industry and is aimed mainly at the residential market. The State Secretary for Housing, Spatial Planning and the Environment has added a recommendation that should give substance to the principle of sustainable building from 1996. Thirteen organisations were involved in drawing up the national package for sustainable building.

The national package for sustainable building consists of some 160 voluntary measures. The involvement of many trade associations and the clear nature of the package mean that it should become standard for everyone. Sustainable building is therefore also to be incorporated in the Housing Act. Those who decide to work with the national package now will therefore have an advantage in terms of experience and know-how when the measures become mandatory.

SA Wildlife College (Kruger National Park) - South Africa

Principles: construction in partnership

The college is claimed to be the most advanced example of sustainable architecture built in South Africa to date. Much of the design is determined by energy and resource efficiency considerations. The protection of natural systems was a high priority, given the pristine natural environment that surrounds the college. The design and construction processes involved local communities as much as possible, to ensure the equitable sharing of the social and economic benefits ensuing from the construction of the college. Locally obtained materials that can be sustainably harvested and managed (e.g. thatch) were used.

Most of the building work was contracted to the Bushbuck Ridge Builders Association, a consortium of Murray and Roberts (one of the largest construction firms in South Africa) and local builders and artisans. As far as possible local suppliers, craft workers and manufacturers were supported by the development. Unskilled labour was recruited from 11 surrounding villages. Over the 18-month construction period, the project provided employment for an average of 200 people, of whom 40% were women.

Straw Bale Farmhouse, Wales - UK

Principles: new construction techniques, use of natural materials

This straw farmhouse, costing in the region of £15,000, is situated in a small village in mid Wales. It is built with large bales of tightly compacted straw, and sits on a concrete foundation. The house will be centrally heated by a solid fuel stove attached to a boiler, but as the straw bales are estimated to provide ten times more insulation than manufactured blocks, the house is very energy efficient. The building’s roof will be insulated with wool, supplied by the farm’s own sheep, and is built from wood cut from a nearby forest and machined by a local supplier. The owner hopes to finish the roof with timber shingles, again made out of the local wood. All of the windows and most of the other timbers used in construction were reclaimed.

Interface Inc. - USA

Principles: eco-efficiency

Interface, Inc is a $1 billion a year international manufacturer and marketer of commercial interior products: carpet tile, broadloom carpet, fabrics, raised flooring and specialty chemicals. Energy efficiency projects first received serious attention at Interface in 1995. The interest in reducing energy consumption has been driven by two different but compatible forces: Interface's CEO, Ray Anderson and COO, Charlie Eitel.

The company has launched an enterprise wide initiative called QUEST (Quality Utilizing Employee Suggestions and Teamwork) aimed to eliminate all waste. Waste is broadly defined as anything that goes into end products that does not come out as value to the customer.

In 1994 CEO Ray Anderson created a movement called EcoSense to push Interface toward sustainability and the two programs together have resulted in thousands of projects ranging from lighting retrofits to photovoltaïc arrays, saving the company a cumulative $40 million.

Habitat for Humanity - USA

Principles: new ways of working, community, partnership, team work

Habitat for Humanity is a non-profit non-denominational religious international organization devoted to the construction of 10,000 low-income housing units annually. The group sells completed homes to qualified participants with interest-free loans. Participants are obligated to contribute personal sweat-equity in the construction of both their own home as well as others, along with community volunteers and vendors who contribute labor and materials. Homes are constructed over the course of several weekends when a full crew of dozens of volunteers assembles for intensive housing-raising sessions.

The Jordan Commons project is a 200 home, 40-acre project meant to provide affordable sustainable housing in the lower-income community of Homestead, Florida which was severely damaged by Hurricane Andrew in 1992. The principles of community, community services, energy-efficiency, and affordability make this project a comprehensive approach to sustainable development. Specifically, the ideas of environmental responsibility, economic viability, and social equity are combined in one project using housing as the foundation.

5.2.4 Operation

Le Pré de la Cour - France

Principles: energy and water management

A block of flats and 5 houses have been built in Meillonas (Ain - Eastern France) in a small village of 1000 inhabitants. The owner (OPAC HLM de l'Ain) has looked for decreasing the services charges and has given importance to energy and water saving solutions.

Three technical solutions to collect and store rain water have been envisaged:
1. A total collecting of rainwater above the last floor, with a distribution to all toilets by gravity, which implies overraising the roof.
2. A storage under the first floor, which implies a pump and a surpressing device.
3. A solution which is a mix of the two previous ones. This solution allows for an easy collecting and a storage below the first floor, and a distribution by gravity from a buffer storage at the top of the building. A small pump, powered by solar photovoltaïc cells, ensures the water transfer to the storage. This solution has been chosen, but without the solar cells.

Elementary School of Ponzano, Emploli, - Italy

Principles: conserve, integrating renewable

The project of the school building poses an interesting problem for the energy designer from the point of view of energy conservation. Occupancy is both various and impermanent: classrooms are used to a greater or lesser extent according to their function; the length of a school day is generally shorter than a working day but after hours activities in the form of cleaning and extra curricular/adult education courses result in the extension of energy utilisation in any given day. Defining the areas where energy is used and sequentially identifying the areas of waste is the logical and essential process which must be executed. The energy saving strategy in this school building includes:

1. *Ventilated roof*
2. *Super-insulation of walls and roof*
3. *Insulating glazing*
4. *Natural ventilation*
5. *Thermal bridges*
6. *Buffer space*
7. *Special glazing*

Retrofitting Historical building case study integration of renewable energies, Bianchi Palace, Perugia 1995 - Italy

Principles: Conserve, re-use

The basis of the case study project for Bianchi Palace derives from important historical research on the environmental and climatic morphological matrices, the project is a part of the Rebuild Pilot Project and was launched under the RECITE Programme of the European Union, in response to their policy for the promotion of renewable energies.

Principal concepts of the project

- Functional and energetic rationalisation in the use of the building (atrium, elevator, services, horizontal and vertical distribution elements).
- Elimination of the sixth floor addition.
- Emphasis on the reconstruction of the "Atrium", as a reminder of the original "corte", with the function of vertical element distributing energy flows for solar passive heating, passive cooling and natural illumination of the internal spaces.
- Utilisation of the consistent masses of the wall structure as thermal accumulation elements (for cooling or heating according to the different seasonal conditions).
- The transparent covering system, composed holographic- optical elements and photovoltaïc modules, allows to direct solar radiation into the atrium below in order to illuminate the internal spaces and thermally charge the existing wall masses during warm periods, while it allows to intercept direct solar radiation during warm periods, directioning it towards the photovoltaïc modules in order to produce electric energy. Due to the "chimney-effect", the atrium also permits the cooling of its wall masses during the nighttime in warm periods, for the passive cooling of the building.

- Integration of the bioclimatic system with technical systems through the use of the same air circulation system; expulsion air as cool source for the heat pump during warm periods in order to increase its efficiency.

Eco – Balance Dwellings in Nieuwland – Amersfoort – The Netherlands

Principles: energy and water management, integration of renewable technologies

The Eco Balance dwellings in Amersfoort have been designed to incorporate the best technology currently available. Many measures adopted form also part of the National Package Sustainable Construction.

The main emphasis lies on energy saving and water saving.

Green Buildings for Africa Programme - South Africa

Principles: energy efficiency, optimal use of resources

This is an assessment system that was developed by the Division of Building Technology at the Council for Scientific and Industrial Research (CSIR*)*, to encourage and reward building owners who voluntarily implement profitable energy-efficiency upgrades in their buildings, i.e. to go beyond the normal requirements and to ensure sustainable development through the optimal use of non-renewable resources and the sustainable use of renewable resources with the minimum damage and risk to the environment and human health, whilst maintaining a healthy economy.

It uses the Green Buildings Environmental Assessment, the first such system in South Africa for existing commercial and industrial buildings. The system specifies a range of environmental issues covering the design, maintenance, operation and management of existing office buildings. Credits are awarded where the said issues have been addressed and satisfied. The system will be tested and refined in the 'Green Buildings for Africa' showcase programme.

Although the initial thrust of the programme is on energy efficiency, it also has the scope to address many other environmental dimensions that are reflected in the assessment system. It covers both global and local issues. These issues are approached firstly from the perspective of the Building and its services and secondly with regards to the operation and management of the building.

Facilities Management and Information System (FMIS) - South Africa

Principles: management system

Facilities Planning and Management Programme, Division of Building Technology, CSIR

The system allows detailed information to be captured on capacity, condition, suitability and the likely cost of ensuring continued functionality in existing facilities. A graphic visualisation language component enables people from different disciplines to understand and interpret data quickly, and to make informed decisions.

System of management of the facilities in a large commercial building in Barcelona - Spain

Principles: management systems, energy efficiency, integration

In the Barcelona-Glòries commercial building a control and management system has been installed. This system allows to control, in unified and efficient way, the electrical consumption, the lighting system, the air conditioning, the low voltage distribution, the ventilation, the garden watering, the electricity-generating groups (used in the rush hours of consumption as auxiliary generators) fire-protection systems, cesspools and the elevators.

This centralised management system is helped by other solutions more usual to see as: low solar factor glazing, free-cooling system to diminish the heat pumps operation at intermediate weather, the installation of time-lag switches in the auxiliary premises.

All these systems allow a power saving of 25% in relation to the electrical consumption forecast initially done.

Air conditioning system in a building of the Universitat Pompeu Fabra in Barcelona - Spain

Principles: integration of renewable technologies for management

The “Jaume I” building of the “Universitat Pomeu Fabra” is the result of remodelling the old military barracks of the “Parc de la Ciutadella”. The building has strong air conditioning requirements. During most of the year, a simultaneous provision of cooling and heating is needed. Taking in consideration the water volume extracted by the pumps which control the phreatic level, the possibility of installing water condensed machines, that allow to obtain optimal power results (because they provide cold and warm water simultaneously), was studied. After a hydrologic study of the zone, it was determined the existence of two water-bearing strata, the higher one located between 6 and 12 m deep and the lower one located between 30 and 35m deep, both of them separated by an impermeable layer, it was chosen to take water from the higher one and, once used, inject it in the lower one. With this solution the water of the subsoil can be controlled and the phreatic level maintained at a level that does not endanger the building, while, at the same time, water is injected in the lower water-bearing strata contributing to recover it from the marine intrusion.

Other solutions adopted in this building are: the use of the free-cooling system, cold and warm radiating ground, individualised air conditioning system for each space and management of the air conditioning and lighting systems based on presence detectors and computer control.

Thermal-photovoltaïc building of the Pompeu Fabra Library in Mataro, Barcelona - Spain.

Principles: integration of renewable technologies

The building that houses the Pompeu Fabra Library in Mataró have been designed attending to reach an optimal balance between energy saving, comfort, lighting, aesthetic and economy. In order to achieve this objective photovoltaïc panels, formed by prefabricated multifunctional modules with a large surface were integrated in the building. The project has served to show the possibilities that the European photovoltaïc industry offers, and to show the different technologic possibilities using monocrystalline cells, policrystalline cells and of amorphous silicon cells in their opaque and semitransparent versions.

The system is formed by a photovoltaïc system installed in the facade. This system is constituted by semitransparent multifunctional photovoltaïc modules formed by solar photovoltaïc policrystalline silicon cells, and four rows of 37º inclined photovoltaïc skylights installed in the cover. The building absorbs or gives energy to the network depending on if its power consumption exceeds its power generating capacity or if its power generating capacity exceed its power consumption. Another feature of the project is the use of the hot air obtained in the chamber formed between the solar modules and a transparent glazed wall. This hot air is used in winter as preheated air in the conventional heating system of the building as well as it is expelled outside of the building in summer. This thermal system allows a power saving upper than the 30%.

The Oxford photovoltaïc House, England - UK

Principles: autonomous operation

The house was designed by Dr. Sue Roaf of Oxford Brookes University and has the only UK example of a domestic photovoltaïc roof. The aim of the project was to demonstrate that by creating a superinsulated low energy house a photovoltaïc array is a technically feasible method of supplying a significant proportion of the energy required.

The energy saving measures, integrated into the building design, lead to a reduced electricity demand, so that the PV array is able to produce a greater percentage of the energy needs of the occupants than would be possible in a typical situation. During the winter approximately 44% of the total average 24-hour load is met by the array. The area in which the house is situated receives approximately 4 hours of sun per day in the summer, but only 0.6 in the winter. A major problem of domestic rather than commercial building PV systems is that the times of peak energy production (daytime) are times of minimum load. Maximum loads occur in the evening and in winter, when production is low. In this case, a system of battery storage of the excess production was rejected in favour of an importing and exporting energy to the National Grid.

Autonomous House, Southwell, England - UK

Principles: design for autonomy, energy efficiency, integration

This house is the only example in the UK of a fully occupied urban autonomous dwelling. It is of a conventional appearance, located in a medium density country town. It is extremely energy and water efficient, and uses a range of autonomous technologies.

Energy needs for the Southwell autonomous house are met entirely by solar gains, heat production from inhabitants, a wood-burning stove, and a 20-m2 bank of photovoltaïc panels. This generates around 1800 kWh of electricity per year, which passes directly through an inverter when being used within the house. Surplus electricity is sold to the grid, which also provides extra power to the house when needed.

The demand for water use within the house is reduced by the inclusion of a chambered composting toilet connected to two ground floor toilets. All of the water for the house comes from rainwater collection.

The house requires very little extra maintenance than a conventional, utility served house. The composting toilet needs no cleaning, but has to be stirred every six weeks. Most problems that do occur can be sorted out as normal, by an electrician or plumber.

Ebworth, England - UK

Principles: water conservation and management

The Ebworth Centre is a National Trust property consisting of woodland and six farm buildings that are now in the process of conversion into an Education Centre, offices and countryside workshops, with the inclusion of several environmental features. The buildings are listed and the local planning authority has been closely involved with the conversion to date Rigorous conditions have been associated with the planning permissions granted so far with the visual aspect of the estate having been of great consideration and which has limited the technologies appropriate on the site, as has the need to restore the buildings in a vernacular style.

There is no mains water connection to the buildings and fresh water is sourced from a nearby stream by means of a hydraulic ram pump. Water conservation on the site is maximised by use of composting toilets that serve the main visitor area. The model used has three toilet cubicles whose waste pipes all connect to one main chamber. Greywater from the hand basins in toilets, the kitchen sink and the workshops is discharged into a soakaway via a grease trap. Several problems have been experienced with this system due to the clogging of the perforated pipes with grease and other substances, however these have been rectified by slight structural changes and the careful consideration of the type of substances disposed of in the sinks.

The on-site warden’s house has conventional plumbing, however all the waste from the house is treated in a system of bark rings and reed beds. Future modifications are planned, including the direct linking of the liquid effluent from the composting toilets with the reedbeds. The greywater from the kitchen and workshop may also be connected to the reedbeds, eliminating the problems that have occurred with the soakaway.

Allerton Park, Leeds, England - UK

Principles: autonomous operation

This development is a terrace of three self-built houses in Leeds. One of the priorities of the self-builders was to attain total autonomy from water and sewage mains systems. This is enabled by the use of a composting toilet in each house, which means that there is no sewage effluent to be disposed of. Grey water from all remaining discharge sources is passed through a grease trap and collected communally in an underground storage tank. The water is then discharged to a vertical flow reed bed and from there to a pond via a submersible pump. The pond water is also supplemented by rainwater draining from the surrounding land. The reedbed and pond system overflow directly to a soakaway. The water is finally pumped to a storage tank through a mesh filter and then a 12.5-micron filter (which has an automatic backwash facility).

Environmental Showcase Home - USA

Principles: demonstration, conservation

The largest single user-group of the Good Cents Environmental Home Program is various electrical utilities around the country. The Arizona Public Service utility in Phoenix, Arizona, used the guidelines of the Goods Cents program and consultation with Steve Loken of CRBT to design and build a demonstration home using all of the sustainable construction goals of energy, water and material conservation. Water-use and extreme variations in temperature are paramount concerns in the desert Southwest, whereas a high availability of solar energy presents a unique opportunity for the utilisation of solar energy systems.

Southern California Gas Company - Energy Resource Center - USA

Principles: energy efficiency, recycling

Southern California Gas Company is one of the largest utilities in the U.S. In 1995 they completed the Energy Resource Center for large commercial customers that utilizes the cutting-edge of material and energy resource efficiency in a model sustainable construction showcase and educational facility. This 43,000-sq. ft. office building in Downey, California uses an existing office building that was partially dismantled and renovated. Approximately 400 tons or 70% of the original building materials were either reused directly or put into recycled waste stream. The building cost between $5.9 million and $6.5 million to build, excluding an estimated $3.2 million saved by using the existing site and materials. The specific green features of the building add about $225,000 to $275,000 to the cost, but operating savings are expected to be $25,000 dollars a year giving a simple payback of 10 years.

5.2.5 Deconstruction

The recycled house - Belgium

Principles: re-useable materials, design for deconstruction

This demonstration project concerns the construction of a demonstration building incorporating a significant proportion of new materials derived from recycling building debris and from the reuse of waste or by-products from other industrial sectors. The goal is to demonstrate that it is possible in the construction sector to make use of a high proportion of recycled materials without harming in any way the functional properties of the building or without increasing the construction costs. The project covers all the traditional phases of construction. It begins with the planning stage and includes materials selection, specifications, etc. until completion of the building and the access routes. It will be built on CSTC experimental station site at Limelette (Ottignies - Louvain-la-Neuve) and will consequently be accessible at all times.

Ecological Single-Family House (Marjala) - Finland

Principles: Ecological compatibility, local materials

The aim was to develop and build a house that during its life cycle disturbs the processes of nature as little as possible, e.g. exists in harmony with nature. The house should be a simple and cheap basic house for everyone, still having good architectural quality and providing occupants good quality and flexible living spaces. The Marjala house [13] is built largely of wood and wood products using local products, simple technical solutions, repetition of same details and components, thus decreasing the number of different components. It gets its energy for heating and hot water from firewood and sun and achieves a heating energy requirement 42-50 % of that of eight reference houses. It is supplied with an owner’s manual and service instructions for the next 50 years.

5.3 Factors influencing change

5.3.1 The challenge for construction

How can the industry transform the demand for sustainable development into an opportunity, to create and access new markets, find innovative responses which satisfy traditional industry demands and the new societal demands for sustainable development?

The challenge for the industry is to identify new and innovative practices, technologies and ways of working which satisfy the need for a modern, competitive, efficient, responsive and socially responsible industry. This is an enormous challenge; however, the achievement of sustainable construction will depend on the construction industry’s willingness and ability to drive much of this change. It is evident from the examples of better practice presented in this report that many organisations have achieved new and exciting results from the innovative use of new and existing technologies, integrated planning and design, new partnerships and new ways of working. Yet it is also evident from the national reports that characteristics such as: conservatism; risk aversion; conflict and highly competitive trading environments, are common to many market lead and centrally funded construction industries with the consequential lack of change necessary to achieve a sustainable construction industry.

Typical concerns throughout the construction industry are common to many industries or sectors that are well established. Why should I change? What are the areas of risk and security? How can I profit and what will it cost me? Who are the key stakeholders in sustainable decision making processes? Which construction activities contribute or conflict with sustainable development? What are the market potentials and competitive threats? What should I do and how can I do it?

The examples of better practice presented in this report will provide stimulus and inspiration for many people. However, the following sections provide further direction, ideas and, perhaps, understanding about how different organisations can adopt sustainable construction practices and thereby contribute to sustainable development.

5.3.2 External drivers for change

There is considerable evidence to suggest that the dominant driving forces for sustainable development will remain external to the construction industry. It is likely also that they will remain politically orientated at local, regional, national and global levels. In global terms we will all be aware of the commitments made at Rio in 1992, HABITAT II and Kyoto in 1997. The decisions and commitments made at these summit meetings are already having an impact on national policy in terms of energy efficiency, habitat protection, pollution control and social provision. Initiatives more closely aligned with regional and local construction businesses include Local Agenda 21, another example of a key driving force for change. Whilst there has been little, if any, impact on business so far there is evidence that measures are being introduced to increase the integration of business into the principles and activities of LA21.

Such measures include [1]:

- setting up a representative, multi-sectoral planning body or “stakeholder forum” as the co-ordinating and policy group for developing and monitoring a long-term sustainable development action plan;

- implementing a consultation programme with community groups, NGOs, businesses, churches, professional groups and unions to identify proposals and priorities for action;
- setting up monitoring and reporting procedures that hold the local authority, business and households accountable to the action plan.

In Holland in 1989 the Environmental Council for the Construction Industry (MBB) was set up on the initiative of a number of organisations within the construction industry, with a brief to formulate a joint approach to environmental problems. The council consisting of representatives of construction industry associations and umbrella organisations is the main forum for consultations between government and construction industry on ways of implementing environmental policy in the sector. It monitors how well targeted approaches in the National Environmental Policy Plan are carried out by this particular sector. The Council also drafted in conjunction with government the Declaration of Environmental Targets for Construction and Housing in 1995 and has input into the National Environmental Policy Plan for the coming period, providing information and advice.

Participation in the Council can generally be taken as a willingness to reach binding agreements, whether they take the form of government regulations or self-regulation by industry.

An important factor that will affect how industry responds to sustainable development is the state of the nation. This could mean the wealth of a country, its economic and political structure, its position in the development cycle, its cultural heritage, national values and aspirations.

Whilst in the UK or the USA, we might see a market opportunity in selling longer lasting services rather than product, and valuing the ability to reuse and recycle materials, in Romania, the mechanism of recycling may be rejected because, reuse and recycling are still seen as signs of poverty and the “opportunity” which is highly valued is the increasing ability to afford new products. [Romania national report].

In Hungary there is the need to complete superhighways which form a vital international road-trading network. Yet in many countries with developed market economies, there is a move to integrated transport policies primarily targeted at reducing the use of cars and lorries. [Hungarian national report]

In South Africa, social equity is higher on the agenda than environmental concern. Therefore, more thought is given to the impact of construction on social and economic sustainability. In South Africa, for instance, the majority of the population is under the age of 25. The construction industry is thus geared towards job creation and more about labour intensive practices. This approach has obviously different objectives than the practice of system building in Holland or off-site fabrication in many countries such as the UK, Japan and USA. The move towards mechanisation and robotics is to improve quality, reduce cost and reduce construction times.

5.3.3 Possible strategies for change

The Greening of Industry report [2] lists four strategies for change which industry can take towards sustainable development:

- the defensive strategy,

- the offensive strategy,
- the eco-efficiency strategy,
- the sustainability strategy.

These four strategy definitions provide a useful framework on which to analyse the opportunities which might be taken by construction businesses. Cross-referenced with current examples it is possible to build a comprehensive picture of what sustainable construction might mean to different construction firms in different countries.

5.3.3.1 The defensive strategy - complying with regulation

This is a typical response from organisations in the construction industry where quality is largely governed by regulations. Typically, the cost of the environmental component in an industrial activity is counted as a cost of compliance with regulation and minimum standards. Often, the cost of non-compliance is the primary motivator to make improvements and so to reduce the environmental impact of industrial operations. For some the solution might be to find an environmentally less sensitive site or to conceal the impacts altogether.

Organisations motivated by predictability and security are likely to predominate in this approach. Organisations with a hierarchic culture are likely to concentrate on activities like systems that monitor performance and report outcomes. Market orientated organisations will take account of regulation as a matter of good judgement to minimise future risk of non-compliance.

Typically, in organisations that follow this strategy, there will be low levels of environmental awareness and understanding although there are some notable exceptions.

Undoubtedly there will be many construction businesses which continue to respond to change in this way and, unless there is a dramatic change in the construction industry as a whole, this confirms the importance of continuously developing regulations which underpin improved performance in the industry. It is likely that the market opportunities arising in this category will continue to be in the form of:

- specialist consultancy,
- systems development and monitoring,
- development of technologies for monitoring and remediation,
- environmental monitoring services such as pollution control, etc,
- development of regulations.

Four good examples of raising standards through regulation and codes from the Netherlands

1. The Dutch building codes rely on a performance base approach. At the present Building Decree environmental requirements are mainly focussed on energy saving and indoor air quality (asbestos, formaldehyde). For new buildings an energy performance standard was developed. This performance-based standard is formulated in such a way that the standard can be easily tightened (which happened in 1998 and is again scheduled for 2000). Policy is now to introduce in 2004 an energy performance

standard for existing dwellings and office buildings built before 1985. In 2010 this will lead to a total energy saving in housing alone of 30%.

2. Recently, the Building Decree was amended to incorporate also requirements pertaining to sustainable construction. Ongoing studies look at the introduction of a performance standard for the concentration of volatile organic compounds in indoor air and a performance requirement on water saving.

3. Plans are being made to introduce in the building codes an environmental performance standard based on LCA methodology. This approach will probably rely largely on the Dutch Ecoquantum model.

4. In order to facilitate the recycling and reuse of building and demolition waste an environmental law will be introduced in 1999 giving requirements and conditions under which recycled materials and industrial waste may be applied in constructions without causing undue soil and water pollution. The requirements pertain to limit values for leaching of toxic components during the use phase. Another law with the same general objective stipulates a ban on dumping of reusable/recyclable building and demolition waste. This waste should go to recycling plants for reuse in the building cycle.

5.3.3.2 The offensive strategy - beyond compliance

This strategy introduces, for example, the development of environmentally friendly products, or going beyond compliance for competitive advantage.

In the service sector particularly, the environmental component of a product or service can be portrayed as a market benefit, adding value for its clients and customers. Typically, organisations with a market orientation are likely to respond in this area. Improved quality and customer focus are key components required to move from a “defensive” strategy to an “offensive” strategy and these are in keeping with a market orientation. In the UK, quality and customer focus are also common components for the cultural change which is being sought as a result of the Latham review published in 1994 [3]. There is thus a close relationship between the requirements on industry to deliver improved environmental performance and the need to continuously improve commercial performance.

BREEAM [4] is an example of an environmental quality standard which has proved to add value and to provide market benefits for its users. The list of organisations which sponsored BRE to develop BREEAM in 1990 were predominantly market orientated organisations. The list included: Barclays Property Holdings, BBC, Cable and Wireless Plc, Jones Lang Wootton, Lloyds Bank Plc, Nat West Bank Plc, Prudential, Stanhope Properties Plc and DOE Property Holdings.

The quality standards required to achieve BREEAM ratings are above those required by law but achievable by designers and constructors. It complies perfectly with the approach which we could expect market-orientated organisations to take.

An interesting observation on BREEAM developments is that BREEAM is now specified for all new buildings commissioned by the UK Government and a growing number of local authorities. This has come about due to the increased political profile of environmental issues but also because the benefits of BREEAM certificated buildings are better known and more quantifiable.

The US Green Building Council have recently introduced a new American commercial building assessment method called Leadership in Energy and Environmental Design (LEED) This method rates the environmental aspects of a building and the behaviour of its occupants to arrive at a final score rated at Platinum, gold, silver or bronze.

Interestingly, the motivation for developing this scheme has also come from organisations throughout the buildings supply chain with a market perspective.

Two further examples from the USA of schemes which rate the environmental quality of products based on the eco-efficiency of operations are the National Fenestration Rating Council and the Smartwood Program of the Forestry Stewardship Council (FSC) both of which relate to the sustainability and quality of timber products.

Three further examples of assessment tools, developed by CSTB, come from France. INIES and EQuity are two complementary tools for assessing the environmental quality of buildings products and ESCALE is a method for assessing the environmental quality of buildings.

5.3.3.3 Eco-efficiency strategy

This strategy tries to identify win-win solutions by reducing environmental impacts and costs; it includes concepts such as total quality environmental management and industrial ecology.

This strategy goes one step beyond the offensive strategy and builds in a win-win outcome for supplier and client. There are examples of this response where supplier and customer collaborate to provide mutual benefit over and above the normally accepted contractual provision. However, to succeed, this strategy requires understanding and change on both the supply and demand sides.

“An important aspect of eco-efficiency strategy is its service provision” [2].

“Value enhancement must be sought through focusing on providing the service connected to their products to customers instead of selling as much product as possible” [2].

Sustainable development is built upon three pillars: economic growth, ecological balance, and social progress. Authors such as Dodds [1], Lovins [5] propose that industry’s contribution to sustainable development come through “eco-efficiency”. Getting more from less. Dodds [1] goes on to identify three components which are necessary for this strategy to succeed:

- eco-efficiency (systems and processes),
- leadership - which he describes as having vision, being proactive, transforming organisations and people,
- effective and innovative use of technology.

ISO 14000 - environmental management systems provide the basis of a management system which enables organisations to improve their environmental performance.

There are several examples of management systems that enhance the eco-efficiency of buildings and operations in the Operation section of Better Practices. Examples include:

- Barcelona - Glories commercial centre has installed a control and management system
- Facilities Management and Information System developed by CSIR in South Africa.

Successful “eco-efficiency” demands more than good environmental systems and processes. Successful “eco-efficiency” requires change management skills and new working practices, examples of which are emerging in the USA and UK construction industries as Partnering.

Partnering is a term which describes an approach to construction procurement which can (and often does) eliminate competitive tendering as part of the process. A partnership is built between customer and supplier(s) which can be strategic, i.e. set up with a long time horizon, or project-based (where the partnership is established for the duration of the project alone). Inevitably there is a process of comparison, often at the very outset of the process where clients make a selection of potential partners from a proposal or submission. However, selection criteria are a combination of cost, quality, approach, style and skill in partnering. There are three key elements which define “partnering”:

- mutual objectives - shared by the partners on both customer and supply sides;
- problem resolution - where a process of conflict resolution is agreed at the outset of the partnership;
- continuous improvement - where partnership aims to learn and build its capabilities from one experience to the next. This element includes the process of evaluation, feedback and review.

Collectively, these three elements describe an approach to construction procurement which was encouraged by Latham in the UK and is being taken forward by the UK construction industry’s Construction Industry Board (CIB).

QUEST (Quality Utilizing Employee Suggestions and Teamwork) is another approach to partnering and change management which has been developed by Interface Inc. in the USA. Here the company has launched an initiative to eliminate waste across the enterprise by harnessing the interest, skills and ideas of every employee. Waste is broadly defined by the Interface CEO, Ray Anderson, as anything that goes into end products that does not come out as value to the customer.

SKJ Companies of Finland have developed their business to include 1.4 million tonnes of by-products from the Finnish steel industry. SKJ Companies have activities in the fields of by-product treatment, product development and technology know-how which it exports to many countries including Russia and Eastern European countries.

The third component of successful eco-efficiency is the effective use of innovation and technology. This requires, not only technological advances, but an understanding of how the technologies relate to the needs and requirements of the users, their ability to use and maintain them and the pressures which these new technologies will bring to their normal modes of operation. The construction industry has experienced many failures which appear to be failures of technology. An interesting example is the “failure” of systems building in the UK during the 1960’s, resulting in obsolete buildings and massive maintenance and repair costs. It could be argued that the technology was not at fault but that it was a lack of the skills and training for those who constructed the buildings which resulted in poor quality and faulty installations.

“Important improvements will result by matching an available technology with the appropriate application” - USA National report. A good example is reported in DOE study on a “Cool Communities” strategy applied in hot climates, e.g. in southen California. The implementation of lighter coloured re-roofs and resurfaced pavements and shade tress has been conducted. It was found that these measures can directly lower annual air conditioning bills in Los Angeles by $200M, cool the basin by 3degrees C, save indirectly $160M more in air conditioning and reduce smog by 10%, worth another $360M.

There are many examples from national reports that exemplify the use of new and innovative technologies. Many are being integrated into existing buildings and many are providing completely new possibilities of performance and control.

A typical example is the:

Thermal Photo voltaic building, Pompeu Library, Mataro, Barcelona - has been designed to reach an optimal balance between energy saving, comfort, lighting, aesthetic and economy. The building incorporates semi-transparent, multi functional, photovoltaic modules formed out of policrystalline silicon cells installed in the facade. The building gives and receives energy from the electricity supply network. Another aspect of solar power is the use of hot air obtained from the chamber formed between the solar modules and the transparent glazed wall. This thermal system allows a power saving of 30% on preheating the air in the conventional heating system.

Other examples include:

- PLEIADE - low energy house - demonstration project - Belgium
- “Internet” Office and Eco-house, Lough Derg - Ireland
- The active intelligent window - Italy
- The OM Solar House - Japan
- The Barn, Kuthumba Nature Reserve - South Africa
- The Oxford photovoltaïc House - UK

Key components required to move from the offensive to the eco-efficient strategy include: the valuing and costing of environmental impacts; and identifying and valuing the full cost of development, over time, for all stakeholders.

An excellent example of an eco-efficient approach was a carpet manufacturer in the USA who contracted to provide a “carpeted area” throughout a building for an agreed period of time and to take back the carpet at the end of its useful life, when it would be recycled.

The key step towards environmental improvement in this case was the provision of a service, rather than sale of product. Benefits included:

- for the client - quality products appropriate to location, elimination of waste materials, maintenance free provision, free replacement in heavily trafficked areas leading to consistent image and condition;
- for the supplier - long term contract, reduced waste, reduced manufacturing costs using recovered carpet material, improved environmental management performance.

5.3.3.4 Sustainability strategy

This strategy focuses on new and emerging partnerships between business and other stakeholders. This is the most advanced strategy, requiring an understanding and tolerance of complexity. It is likely that this strategic response will be achieved through decision-makers adopting new values that reflect the aims, objectives and aspirations of sustainable development. For businesses used to short time horizons with defined, discreet client groups and markets, the risk of including and responding to the range of stakeholders and potential "clients" may be too high. What shape might the sustainable business take? What shape might the sustainable business opportunity take? From a range of policy research projects, there are indications that sustainable business will be more holistic, systemic and integrated [6]. Core values are likely to include [2]:

- "Wholeness" - understanding and accepting the system relationships between industry behaviour and its impact (usually known as the externalities in economic theory). This means taking responsibility for the impact of the business, so recognising that businesses do not operate in isolation to their surrounding environment. This approach leads to a shared responsibility and unity between the business and its community.
- "Care for future generations" - where a "future generation" representative may be included in the boardrooms of industry to challenge their time horizon for decision making, requiring more emphasis on whole life costing and long term impacts. The business takes responsibility for the impacts of its process but extends this over time.
- "Smallness" - utilising small work teams, defining responsibility at the lowest level possible, requiring an ability to attend to detail "at the coal face", with increased ability to respond flexibly and innovatively.

The change from eco-efficient to sustainability strategy poses, perhaps, the greatest challenge to construction businesses. However, there is evidence to suggest that changes are taking place at community level in terms of long-term, multi-faceted integrated planning and within the industry itself in terms of new approaches to value management, partnerships, shared ownership, shared risks and benefits.

At community level there are many examples from the national reports which document initiatives considering the long term environmental and community impacts of commercial developments:

- Ecological criteria for experimental construction - Finland
- Le Clos des Vignes - France
- Urban planning, Saline - Italy
- Environmental symbiosis and NEXT 21 projects, Osaka - Japan
- Leidse Rijn, development of a new medium sized town - Netherlands
- Holy Island Retreat - UK
- Planned unit Developments - USA
- Traditional Neighborhood Development - USA

The South African report reminds us of the indigenous knowledge which exists in many communities and how these communities have lived in harmony with their environment for generations. The report also reminds us that Indigenous knowledge, whilst systematically devalued and suppressed, can offer valuable insight and guidance on drought resistant crops, new medicines and designing more sustainable settlement patterns which incorporate the use of appropriate technologies. The concept of - *umunta wabantu ababantu* - literally translates to “a person is a person because of other people”.

Within the construction industry there are developments taking place to increase the time horizon of decision-makers and include wider criteria for consideration.

Two procurement protocols emerging in the UK which provide the framework for long term relationships between client and supplier are Design Build Finance and Operate (DBFO) and Private Finance Initiatives (PFI). Both of these practices are employed, in the UK construction industry, to give better value to customers and ensure that their requirements are accurately represented. Whilst commercial benefit is the main motive for using these approaches the results are a higher level of client satisfaction, less conflict between the client and the supplier and a better product which requires less maintenance and repair through faulty workmanship and inappropriate specification. They are providing opportunities for a more socially responsive and eco-efficient approach to development.

A recent example in the UK is where a Joint Venture project team bidding for a privately financed school project has included a provision for environmental management and the development of teaching materials which can be integrated into the curriculum of the school. Thereby following the principle of adding-value for the client by utilising good environmental management practices and the innovative use of skills and knowledge to provide an educational resource for the community.

Whilst the examples presented here are based on UK practice there is every evidence to suggest that this approach will be an important mechanism for development and redevelopment in many market and transitional economies. The principles can be widely applied.

The management technique called Value management provides the basis of an approach that is applicable to many decision making levels in sustainable development.

Value Management focuses on producing a better definition of the client’s requirements. Value management should not be confused with value engineering which can be described as the provision of function at least cost. Value management requires that a careful analysis of "need" be carried out. Here all possible requirements of a client are considered prior to commencing the normal procurement process (i.e. design, pricing, detailed design, construction). The benefit of this is that the full range of skills can be applied to finding solutions for the client. Priorities are defined - in terms of value and importance - and then design, procurement and construction solutions are applied to deliver those priorities throughout the development process. The structure allows for review and the introduction of changing priorities occurring during the process. Value Management is particularly applied to projects with high value and high strategic risk.

The key stage in Value Management is the beginning where, usually in a facilitated workshop environment, the customer and supplier teams combine to:

- share aims and aspirations,
- share values and identify priorities,
- identify shared and individual benefits,
- define decision making protocols,
- set and agree strategic objectives,
- set and agree means of measurement of success, and establish the partnership.

5.4 Conclusion - mechanisms for achieving change in future construction markets

Whilst the demand for construction will continue the broadening of societal values and interests challenge the motives and values which have previously driven growth and development and which have previously defined industrial success.

Therefore sustainable development, from a construction industry perspective, undoubtedly means change. For an industry which is inherently defensive the prospect of, and opportunity for, positive change is not always apparent, particularly in the context of the complexities of sustainability.

Whilst for many construction businesses, eco-efficient and sustainable strategies may well appear to be impracticable and too far from their current trading reality, there is evidence from the UK and USA construction industries that procurement strategies such as Design Build Finance and Operate, Private Finance Initiatives, Partnering and Value Management are providing a platform for the development of working practices which go some way towards achieving these strategies. In Holland where a higher level of community responsibility is acceptable in business the response has been to issue standards of sustainable construction to which the whole industry can respond. In South Africa the opportunity is there to create sustainable developments from scratch, using the indigenous knowledge of sustainable communities. In transitional economies such as Romania there is the demand for new and previously unavailable goods.

The industry will have to adapt to these new and emerging construction markets which have environmental and social dimensions. Construction businesses will be expected to integrate into, and consider more fully, the issues valued by others at national, regional and community level where the driving forces will be a mixture of political, social and market forces, requiring products which respond to genuine need and concerns.

5.5 References

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6. CONCLUSION

Sustainable construction should be an important component of creating a sustainable development. However, no clear consensus on the exact meaning of such a concept seems to be agreed today. This W82 Project aimed at contributing to reaching such an agreed clear vision of the future of construction within a sustainable development assumption.

At the moment, the Project led to a set of fourteen national reports and an international synthesis, gathered in this CIB Publication, which contain:

- the identification of the issues, constraints and currently followed policies in the involved countries in the field of sustainable construction;
- the identification of the foreseen changes and mutations for the construction sector in these countries through answers given by experts on five main questions;
- the analyses of the consequences of sustainable development for the phases of the construction process;
- the identification of main strategic recommendations to be given in these countries to the main driving actors of the construction sector;
- an illustration of best practices through some case studies, design methods, buildings or building products.

The main goal of the present international synthesis was to extract main issues from the national reports, to detect the common ones and to stress the main differences (in scenarios, consequences, recommendations to actors...).

The next step should be to reach a more consensus vision through a global common model (with of course eventually items specific to regions or countries) and to set up indicators and policies to translate this vision into reality.