Sustainable Development and the Future of Construction, a CIB W82 Project

L. Bourdeau
Centre Scientifique et Technique du Batiment, Sophia Antipolis, France
P. Huovila
VTT Building Technology, Espoo, Finland
R. Lanting
TNO Bouw, Delft, Netherlands

Abstract
This international CIB Project aimed at answering the following question *: "What will be the consequences of sustainable development on the construction industry by the year 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 followed methodology allowed to present and to take account of the specificity and orientations of more than ten countries, and to display a clear vision of what the construction sector could be in fifteen/twenty years in the framework of a sustainable development and how this goal could be reached.

The study was made of two main steps: a first step was dedicated to national efforts in order to get results at national level; a second step was dedicated to an international synthesis and the validation and dissemination of the results.

The study precisely led to :

- the identification of the issues, constraints and currently followed policies in the field of sustainable construction;
- the identification of the foreseen changes and mutations in the sector through answers given by experts on five questions dealing with : i) the kind of buildings which will be build in 2010 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.

Keywords: building, environment, sustainable development, future studies.

1. Introduction

This international CIB Project was launched in the W82 Amsterdam meeting (Spring 1995). In accordance with the scope of this Commission dealing with "Future Studies in Construction" - to supply, analyze 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 year 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 analyzed when considering sustainable development. As a matter of fact, on one side, the build environment constitutes one of the main support (infrastructures, buildings,...) of the 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. It is still an unsteadily concept, but it surely concerns the construction sector.

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 a starting point to build a more concrete definition of the concept of sustainable construction and to precise the stakes and issues of sustainable development with regards to the construction sector. More research is required to investigate the relationship between sustainable development and the future of construction (Figure 1).

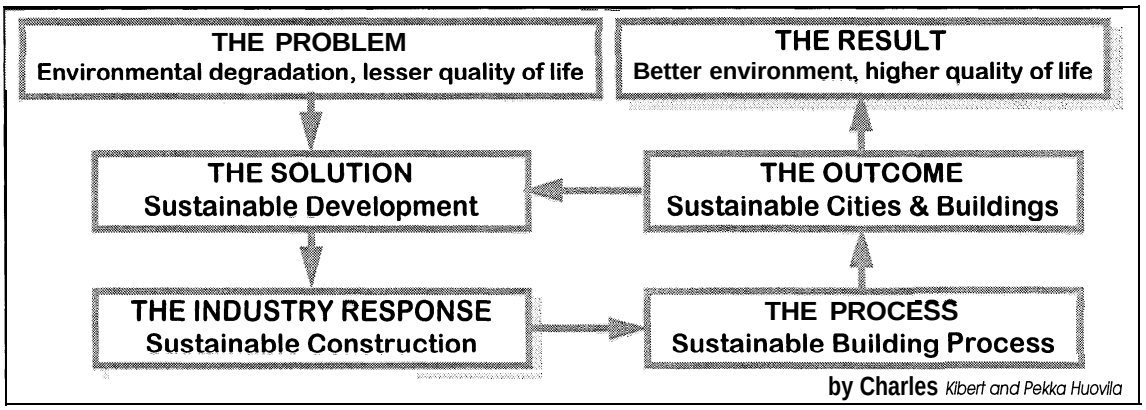

Figure 1: Sustainable Construction Road Map

2. Methodology

The study [2, 3] 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 aiming at defining a clear vision of what the construction sector could be in fifteen/twenty years in the framework of a sustainable development and how this goal could be reached; iii) it was carrying out by experts coming from organizations deeply involved in the topic at national levels.

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

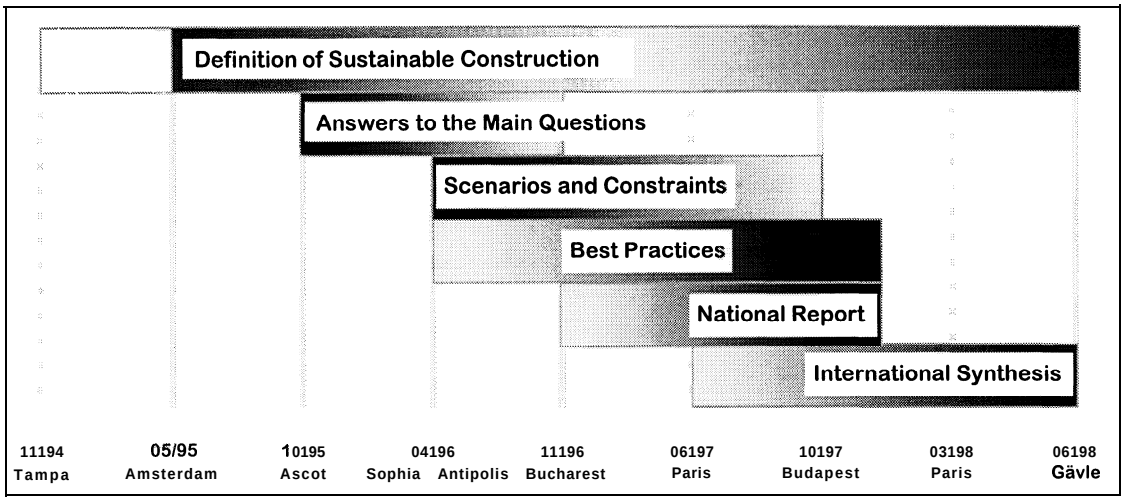

Figure 2: Main Tasks of the Project

Three different coordinators were nominated for the first three phases of the project: Sandy Halliday, for BSRIA, accepted to lead phase 1, Pekka Huovila, from VTT, led phase 2, and Caspar Richter, from sbr, led phase 3.

About fifteen countries were involved in some or all of these phases and eleven were able to produce a final National Report (Figure 3).

Countries	Organizations	Members
Belgium	CSTC	Frans Henderieckx
Finland	VTT	Pekka Huovila
France	CSTB	Luc Bourdeau
Hungary	ETE	Gyorgy Kunszt
Italy	Florence	P. Gallo & M. Sala
Japan	MIT	I Tomonari Yashiro
Netherlands	TNO	Roël Lanting
Romania	Urbanproiect	Jana Suler
Spain	UPC/UZ	P. Alavedra & J. Dominguez
United Kingdom	BSRIA	Tom Smerdon
United States	GaTech	G. Augenbroe & Saeid Sadri

Figure 3: Main Members Involved in the Project

3. Phase 1: Definition 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”.

It is why it was asked to the 10/95 Meeting participants to present papers which gather national initiatives on Sustainable Construction and to try to discuss about a definition of sustainable construction [4, 5]. 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, UK and USA) 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 identified.

Several definitions of Sustainable Construction were offered which reflected the regional diversity and differing priorities in the participating countries. They included a more precise but still concise definition of "Sustainable Construction" derived from Kibert's one, to more general and detailed views such as the French one which introduces 24 criteria [6].

4. Phase 2: Answers to 5 main questions

The questions to be answered in Phase 2 were the following:

- *What kind of buildings will be build 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 [7].

It was also decided that the precise content of the coming Phase 3 would be described in this meeting. The ideas 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 risen.

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

It was not easy 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.

Answers differed between nations, and within nations. A complete map of answers from a country (Finland) is presented in Figure 4.

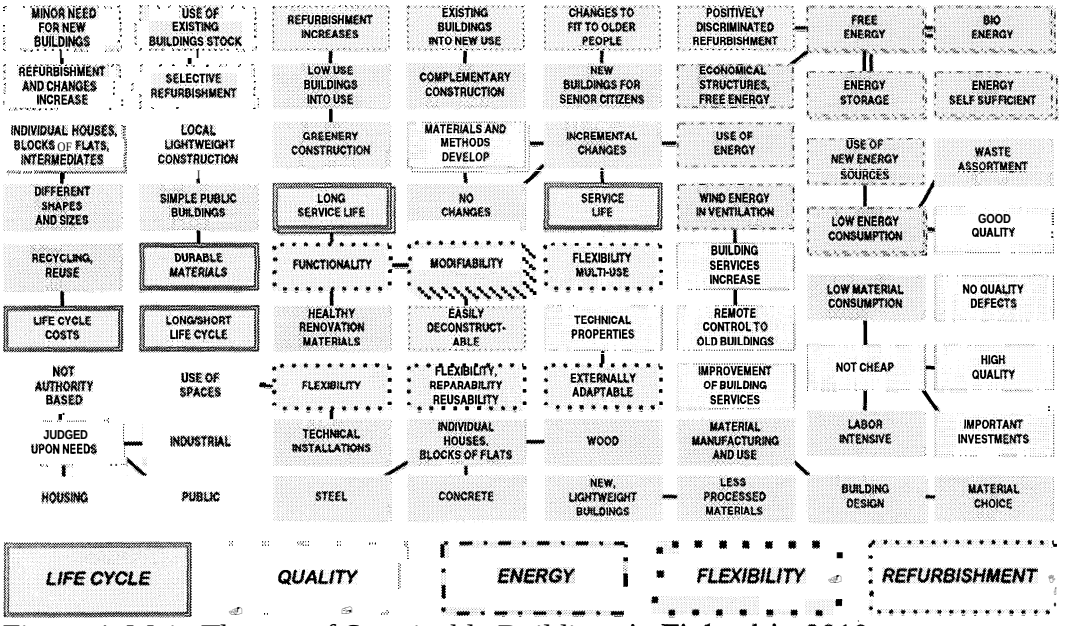

Figure 4: Main Themes of Sustainable Buildings in Finland in 2010

5. Phase 3: National Reports

First results of Phase 2 of the project rose a need for a common methodology to be applied in Phase 3 enabling later international synthesis based on national studies.

It is why a methodology to be followed was proposed in mid-96, which is based on a multi-dimension analysis of the problem (Figure 5). Three dimensions are introduced:

- Ecological principles (six principles are defined in the construction field in order to meet the three basic goals of a 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).

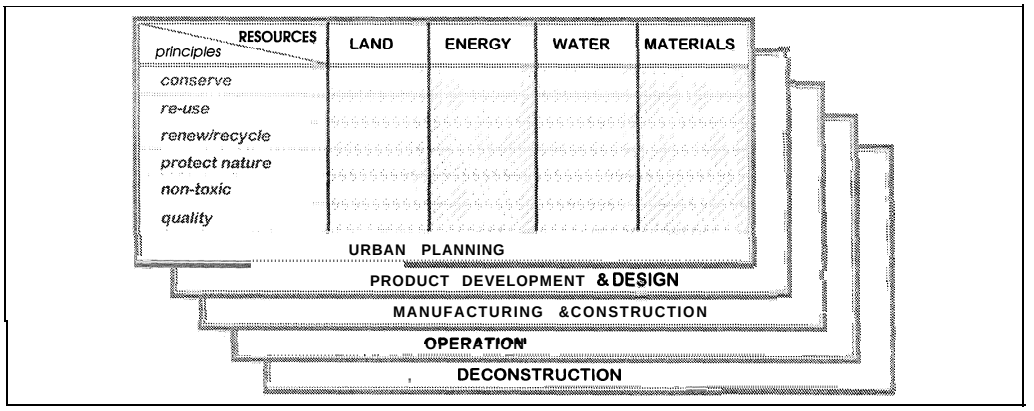

Figure 5: Proposed Format for National Reports

The idea was that for each point of this three-dimension space, it is possible to think about the consequences for the construction industry and therefore to give elements of 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 the countries. As a matter of fact, it appeared from the Ascot and Sophia Antipolis papers that the concept from some countries can be much broader than the "ecological" concept proposed here [8, 9,10].

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

It is why 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.

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

6. Phase 4: International Synthesis

The last Phase of the Project was an international synthesis of the results (Figure **6).** That work, which started in Summer 97, was based on National Reports.

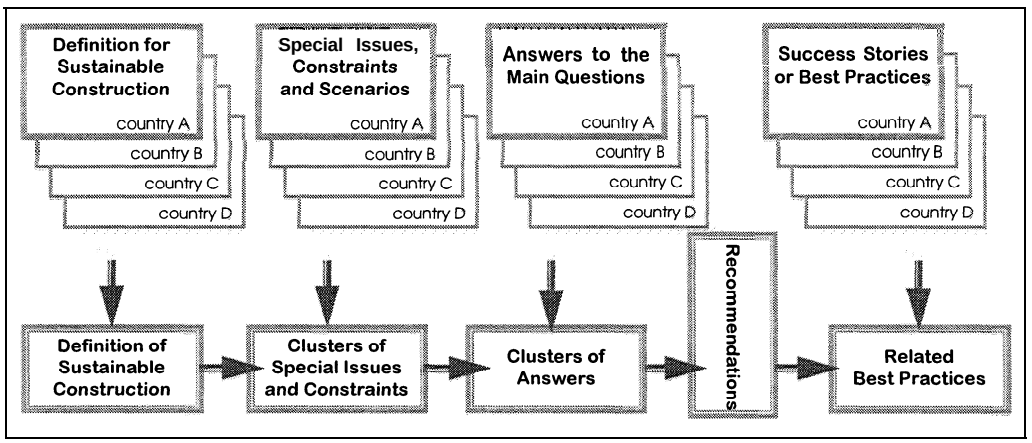

Figure 6: Methodology for the International Synthesis

The final results of the project give an international view of long term contribution by Sustainable Construction in Sustainable Development. Clusters of national differences, due to special issues and national constraints give more specific views on different levels and approaches by clusters of countries. Best practices of sustainable design are gathered. Recommendations for government, management of construction and machine industry and for research and development are also provided.

An example of synthesis of the answers given to the 5 main questions in the various national reports is reported on Figure 7.

Resources	Main issues	Consequences for cities and city planners
Land	Efficient use of land	Restricted suburbanisation
		Adaptation and regeneration of the existing built environment taking account of future needs
		Remediation of brownfield sites
		New soil cleaning technologies
		Land reclamation for industrial use
		More low density building
	Intensive use of land	High density building, underground building; double use of land
		Underground drilling techniques
		Building in nuisance zones
	Conservation of open space and green areas	Combined transport corridors (roads, rail, cables, ducts)
		Creating new space by underground construction
		No fragmentation, no ribbon building

Resources	Main issues	Consequences for buildings and designers
Land	Efficient use of land	Multi-functional buildings
		Temporary or transportable buildings
	Intensive use of land	Double use of land (above and underground)
		Flat roofs for recreational purposes
	Longevity of buildings	Design for flexibility/adaptability
		Support/infill modularity
		Design for life cycle performance
		Introduce standards for longevity in building codes
		High quality building
		Life cycle costing tools
		Understand needs and requirements of future users
	Greater use of existing buildings	Redestination of non-functioning buildings
		More refurbishment and retrofit activities
		Refurbishment techniques (vertical/horizontal extensions; lightweight constructions)
		Performance standards for regenerating existing building stock
		Better condition assessment methods
		Decision support tools demolition/ renewal

Figure 7: Example of Main Issues for the Resource “Land” and Consequences for City Planners and Designers

7. Conclusion

Sustainable construction should be an important component of creating a sustainable development. However, no clear consensus on the exact meaning of such a sentence 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 ten or so National Reports and an International Synthesis, most probably gathered in a CIB Publication, which contain:

- the identification of the issues, constraints and currently followed policies in the field of sustainable construction;

- the identification of the foreseen changes and mutations in the sector 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 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.

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.

8. Acknowledgments

The authors of this paper would like to thank, on one side, all the authors of the national reports and, on another side, Sandy Halliday and Cas Richter who coordinated Phase 1 and Phase 3 of the Project respectively.

9. References

1. Kibert, C. (1111994) *Proceedings of the First International Conference on Sustainable Construction,* Tampa.
2. Bourdeau, L., Halliday, S., Huovila, P., Richter, C. (9-12/6/1997) Sustainable development and the future of construction. *2nd International Conference on Buildings and the Environment.* CSTB-CIB, Paris.
3. Huovila, P., Richter, C. (19-21/8/1997) Life cycle building design in 2010. *International Conference on Engineering Design,* ICED, Tampere.
4. BSRIA (1111995) *Report on the CIB W82 Commission Ascot Meeting.* BSRIA 79 150, Bracknell.
5. CSTB (3/1996) *Appendix to CIB W82 Commission Ascot Meeting: contributions.* CSTB, Sophia Antipolis.
6. Angioletti, R., Gobin, C., Weckstein, M., Durand, E. (9-12/6/1997) 24 criteria for designing and constructing buildings with a sustainable development approach. *2nd International Conference on Buildings and the Environment.* CSTB-CIB, Paris.
7. CSTB (18-19/4/1996) *Sustainable development and the future of construction - Phase II - Sophia Antipolis Meeting,* CSTB, Sophia Antipolis.
8. CSTB (18-20/11/1996) *Sustainable development and the future of construction - Phase IIIa - Bucharest Meeting,* CSTB, Sophia Antipolis.
9. CSTB (5-6/5/1997) *Sustainable development and the future of construction - Phase IIIb - Brussels Meeting,* CSTB, Sophia Antipolis.
10. CSTB (7-9/10/1997) *Sustainable development and the future of construction - Phases IIIc & IV - Budapest Meeting,* CSTB, Sophia Antipolis.