Mapping tools for a sustainable building cycle

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ABSTRACT: Sustainable building principles seem to be more commonly accepted. In order to put this in practice many tools have been developed. They help us to formulate ambitions, but too often a critical evaluation of the actual implementation of sustainability is lacking. We propose an integral life cycle framework to be adopted by all people involved in all phases. The cycle consists of four phases: ambition, design, technology and building use. In order to reach a higher level of sustainability defragmentation of our actions in the sustainable building cycle is desired. Current tools don't really feed the desired flow from government and client ambition via design to sustainable use.
This paper presents a brief overview of the Dutch situation. We have 51 tools supporting sustainable construction. On the level of building and detail there are 15 tools available. We have projected these tools in the building cycle. Especially tools to support briefing and architecture are missing, as well as an evaluation mechanism to monitor sustainability performance of buildings-in-use. Ideally, from our existing knowledge base of tools we can develop a broadly accepted rating system for sustainable buildings. This rating system will monitor building performance throughout the entire building cycle, from ambition and design to use.

Keywords: sustainability, tools, life cycle, mapping

1. INTRODUCTION

Sustainable building principles seem to become commonly accepted. Building clients and (local) authorities, based on their personal considerations and stimulated by political agreements regarding sustainability, define sustainable ambitions for our built environment. Designers and other building professionals cooperate to convert these ambitions into real buildings.

In order to bridge the current knowledge gap regarding sustainable building (too) many tools have been developed. In recent years some tool inventory studies have been executed [1,2,3,4,5,6]. Every tool is developed for a different purpose and from a different viewpoint. No doubt these tools have had their contribution in increasing the level of sustainability. But, as discussed by many, also in [van den Brand 2004], they can also be an excuse to stop thinking and use your creativity to develop really sustainable solutions. Tools are applied in order to formulate good intentions, but they are no guarantee for actual implementation of sustainability in projects.

This paper describes recent developments regarding sustainable building in the Netherlands, regarding policy, design and technology. We define a sustainability cycle and propose to fit tools into this cycle. This enables a better transfer of responsibilities between building stakeholders in different phases of the building cycle. It may help to put good intentions into really implemented sustainable solutions.

2. SUSTAINABLE BUILDING CYCLE

2.1 Sustainability

First we will demonstrate our scope of sustainability. The ADE unit at Eindhoven University of Technology has developed a framework for sustainable building design, presented in figure 1. We deal with design at three essential scale levels: area, building and component. As a designer it is essential to be aware of the interrelation between these three levels and the specific issues per level. The level of performance on five key issues determines sustainability of a building: material, energy, water, indoor and outdoor environment. For these key issues building clients and design teams can define goals and measure their actual performance. The need for sustainability will result into new building concepts, for example design for lifespan, zero-energy, or autarchic design. Finally we aim for a 'broad' approach, in which ecology, economy and sociology are addressed on an equal basis (Atkinson's triple-P). We emphasize the institutional role of the government in policy-making, legislation and stimulation, but also as a large commissioner of building works.

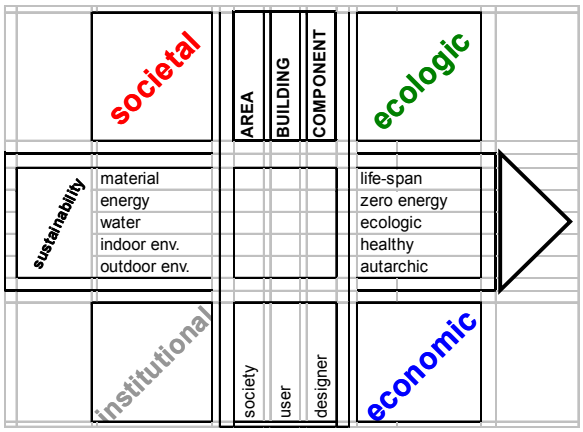

Figure 1: ADE framework for sustainable design [v.d. Brand 2003]

This framework needs to be adopted by all people involved in all phases of the building cycle. A simplified building cycle is presented in figure 2, consisting of four crucial phases: ambition, design, technology and building use/management. Real sustainability can only be achieved when this cycle is continuous. The actual building-in-use performance must be evaluated to the background of defined ambitions. This way we can build a knowledge base to learn from the past for future developments.

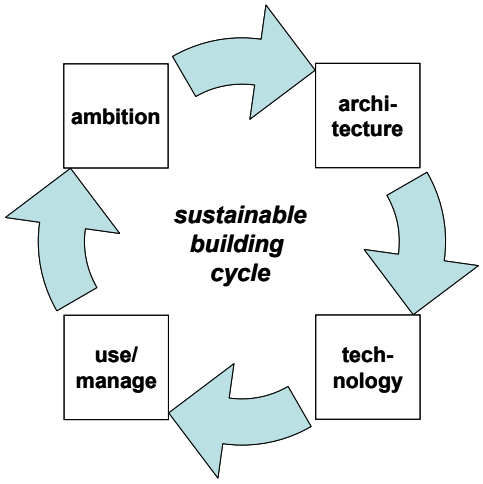

Figure 2: sustainable building cycle [v.d. Brand 2006]

2.2 Ambitions

Governments are defining targets to improve sustainability on all territorial levels. As an illustration the policy context for Eindhoven, the Netherlands can be summarised as follows:

- global (UN/Kyoto/Montréal),
- continental (EU policy),
- national (ministry of VROM),
- regional (provincie Brabant) and
- local (Eindhoven city council).

Our national government is committed to reduction of CO2-emission. This goal has been further specified for different energy consuming sectors such as mobility, industry, agriculture and building. On behalf of the government the agency SenterNovem executes several programs to contribute to this goal. For the building sector the program KOMPAS is running, aiming for a 5,5 Mton reduction of CO2 emission per year [SenterNovem 2006].

Within KOMPAS the development and implementation of energy saving technology in housing and commercial buildings have been executed. A recent development within KOMPAS is the initiation of sustainable real-estate funds. Triodos Bank is the first real estate investor to have set up such a fund [SenterNovem 2006]. Other investors have shown their interest. Using existing sustainability tools and checklists such as GreenCalc [ref 10] and GPR-gebouw [ref 11] SenterNovem has developed an assessment method to determine whether a building fits into a sustainable real estate fund. Nowadays availability of suitable sustainable office buildings seems to be an important bottle-neck to initiate these real estate funds.

About 20 large local authorities use GPR-gebouw to define sustainability ambitions. The Dutch government building agency is using GreenCalc to check the environmental performance of new office buildings.

2.3 Architecture

In the Netherlands a new wave of sustainable building design is rising. In the ’70s and ’80s there was a small wave of bio-ecologic architecture. Furtheron there were several technology-based projects to integrate energy saving solutions into housing design. These approaches were also dominantly represented in the ‘90’s government supported sustainability program. By that time we had an international leading position in the field of sustainable construction. The end of government support seemed to be the beginning of the end of this leading position.

The new wave of sustainable architecture is shaped by architects and small project developing companies –some initiated by these architects. They take their own initiatives to realise buildings that have good architectural, technical and functional quality. And at the same time they are sustainable. Examples are Paul de Ruiter, Onix and 2012 architecten [12, 13, 14]. Their approach has been called ‘performative architecture’ [Tilman 2005]. These architects don’t relate to any governmental program for sustainability, neither do they use the tools developed in these programs. They have an individual, self-aware but sensible and subtle approach towards the creation of sustainable buildings.

2.4 Technology

In order to improve our patterns of energy consumption and material use new building technologies are being developed. Currently there is a focus on technology for energy saving and exploration of renewable energy sources. Large scale projects to generate solar and wind-energy are stimulated by the government and energy companies. On building level the application of heat-cold-storage,

heat-pump technology and low temperature systems is increasing. In the Netherlands the 'Toolkit duurzame woningbouw' is selecting the most suitable combinations. This broadens the support to apply these technologies. A remaining challenge is the application of sustainable material concepts. The application of FSC certified wood is generally known. There are however more challenging strategies for sustainable material use in buildings, such as the use of renewable materials (straw, adobe and paper) and improved design for re-use. The Dutch experimental program IFD Building (industrial, flexible, demountable) has had its influence in this topic. Recent examples in practice and research are: 2012 architects – design for recycling; prof. J. Post –design for lifespan- [ref 17] and E. Durmisevic - design for (dis)assembly) [ref 18].

2.5 Use/management

The real proof of sustainability is in the use of the building. Only then the chosen climatic concept can prove to provide comfort and at the same time save natural resources. As mentioned before many ambitions unfortunately cease before an architect or a builder enters the scene. We all know how difficult it can be to persist in ambitions throughout the entire process. There are many stops along the way and many individuals that influence the decision making process. Even if we succeed to implement all sustainable measures we still depend upon the end-user to use and maintain the building in a proper way. This especially goes for new energy saving concepts, they need an intelligent user control. Users of buildings that are intentionally built for flexibility and re-use need to be aware of the value of their building when they consider adaptation or demolition.

2.6 Summary

Recent developments in sustainable building in the Netherlands that are described in this section are summarized in table 1. This presents a positive picture for sustainability. The trends in the right column have not yet all become reality, but we are clearly moving towards them.

A new wave of sustainable building - Overview of trends in the Netherlands	
1970-2000	**2000->**
government push	client pull
intentions – checklists and points	embedding – performance monitoring
ecologic/green	life cycle aware
one-issue	integrated
niche market	broader acceptance

Table 1: overview of changes in sustainable building approach (van den Brand, 2006)

Real sustainability needs to be supported throughout the entire building cycle. Current tools are basically oriented towards ambitions and intentions. The real sustainability performance in the phases of execution and use are hardly ever measured and evaluated. Apart from the need for tools that deal with the entire life-cycle of a building there is a need for integral responsibility of all parties involved. In stead of throwing your results over the fence one needs to assure oneself that the intentions are actually carried out into good-working sustainable solutions.

The Dutch ministry of Housing supports the debate between three groups of tool developers in order to harmonise their approaches: GPR gebouw, Toolkit duurzame woningbouw and Greencalc. GPR gebouw is suitable for definition of ambitions, the 'toolkit duurzame woningbouw' [ref 19] presents suitable technologies and GreenCalc enables a thorough sustainability assessment. In this discussion tools to support sustainable briefing and architectural design are lacking. We support this discussion introducing the sustainable building cycle. Existing tools can be positioned in this cycle and missing links can be identified.

3. INTEGRAL ANALYSIS OF SUSTAINABLE BUILDINGS

In order to reach a higher level of sustainability we need to defragment our approach into the design and delivery of buildings. At the Eindhoven University of Technology we have searched for a way to analyse sustainable projects that supports this vision and the trends described in table 1. In our view sustainability is a part of the integral quality of a building. The research has resulted in a 'sustainability matrix' (figure 3 and 4) that has been introduced in an earlier paper at PLEA 2004 [van den Brand 2004]. It has been used for four years. About 100 projects have been analysed using this matrix. Figure 4 shows the analysis of project Mikkelhorst by Onix Architecten.

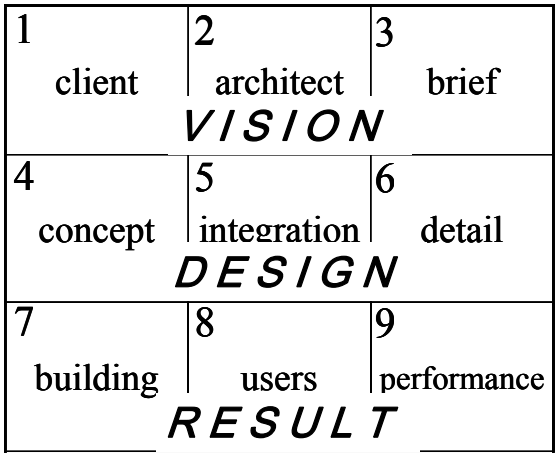

Figure 3: the TU/e-ADE **sustainability matrix** (vd Brand 2003)

The basic philosophy behind the matrix is that there must be a 'flow' in the vision of architect and client. This flow must be translated in the client's brief and the architect's concept. All consecutive project partners, such as producers, contractor and consultants need to adopt this vision. Finally the owner, the technical manager and the users of a building all must be able to use the building as it is

intended. Current tools, whether checklist or scoring methodology don't really feed this flow**.** The next chapter will present an inventory of Dutch tools projected in this matrix.

Figure 4: sustainability matrix analysis of 'Mikkelhorst', a project by Onix architecten, analysed by de Ruijter, TU/e 2004

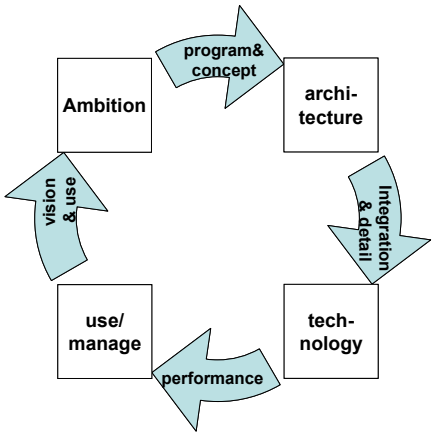

Figure 5: the sustainability matrix key elements integrated in the sustainable building cycle (vd Brand 2006)

4. TOOLS FOR SUSTAINABILITY

4.1 Tools universe

The sustainable tool universe is very wide. Recent explorations, reported by Presco, IEA, Balanced Value and (Dutch) dubo-centrum [ref 1,2,3,4,5] reveal the existence of several hundreds of tools. For example the latest Annex 31 project report (IEA, 2001) presented a considerable list of energy modelling software, environmental LCA tools for buildings and building stocks, environmental assessment frameworks and rating systems, environmental guidelines or checklists for design and management of buildings, and environmental product declarations, catalogues, reference information, certifications, and labels. In total there where found 132 environmental tools and 55 were fully accessed in this report.

Most of the tools have been developed and implemented by (local) authorities and sustainability councils. They often commission specialised consultants to do the job. A problem for building clients and designers –mainly non-specialists in sustainability- is to select the right tool for their purposes. Further on it's difficult to value the outcome of the different tools. The possible differentiation of outcome of different tools is illustrated by [Kawazu 2005]. The author compared the outcome of four green labelling tools BREAM, LEED, CASBEE and GB Tool. Though the trend is similar the outcome differs, based on different assumptions within these tools. The Dutch LCA based tool GreenCalc is promoting their tool using the slogan 'One number says it all'. But what is the number's value if it only expresses intentions and it can easily be manipulated, as we see this happening in the use of the Dutch Energy Performance standard (energieprestatienorm-EPN NEN 2916 and NEN 5128).

4.2 Dutch tools and the sustainable cycle

The Dutch tools for sustainable building have been inventoried and categorised by SenterNovem/Dubo-centrum (figure 6). We have 51 tools supporting sustainable building. Most of these tools -27 in number- operate on the level of area and city. On the level of building and detail, which we are discussing in this conference, there are –only- 15 tools available. Unfortunately we can conclude that there is only one tool available to support renovation.

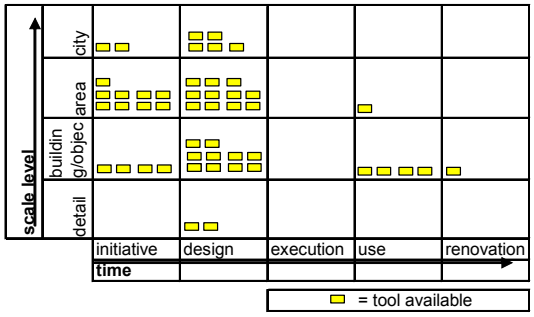

Figure 6: Tool's universe for supporting a sustainable building process (Dubo-centrum, 2006)

Additional research at the tools available at building level focussed on their objectives an methodology. We have assessed in what phase of the sustainable building cycle (fig 2) the tools can play a role. If a tool is used in at least two out of the four phases of the sustainable building cycle a more detailed study is needed to determine its applicability. A tool scoring on three phases or more is considered to be suitable. No tools were found to cover all four phases, and only one tool was partly dealing with architectural aspects.

overview of sustainability tools in the netherlands (dubocentrum 2006)						
name of tool	**type of tool**	**building cycle**				**suitable**
		amb	**arc**	**tec**	**use**	
Groene Hypotheek	checklist				x	
NP Beheer	checklist				x	
NP Nieuwbouw	checklist	x				
Toetslijst gezond en veilig wonen	checklist	x				
EPC en kosten	ambition&communication	x				
Leefstijlen en woonbeleving	ambition&communication	x				
Menukaart Duurzaam Inkopen	ambition&communication					
Menukaart Milieumanagement	ambition&communication					
Toolkit duurzame woningbouw	ambition&communication	x		x	x	yes
DCBA-methode	ambition&communication	x	x	x		yes
DuBes: Duurzaam Beslissen	ambition&communication	x				
EPA: Energie Prestatie Advies	ambition&communication				x	
Dubo op maat	performance monitoring	x		x		perhaps
Eco-Quantum	performance monitoring	x		x		perhaps
GPR-gebouw	performance monitoring	x		x		perhaps
Greencalc+	performance monitoring	x		x		perhaps

Table 2: Dutch tools vs the sustainable building cycle (van den Brand, 2006)

In the Netherlands many tools for sustainability have been developed in the period of 1990-2000. Only the 'toolkit duurzame woningbouw' is a relatively new tool. Some other tools, such as Greencalc and GPR Gebouw have been regularly updated and they found a broad application. All tools serve their own specific objective and there is no real interrelation. This may be a reason why there is still no broadly accepted sustainable building rating system in the Netherlands, comparable to BREEAM in the UK, LEED in the US and CASBEE in Japan. Last year the Dutch ministry of Housing took the initiative to select three tools (GPR, Greencalc and Toolkit) that may possibly be harmonised and integrated. This eventually my lead to a generally accepted sustainable building rating system. Ideally this system will monitor the entire building cycle, from ambition to design and real sustainability performance as presented in this paper.

5. CONCLUSION

An abundance of tools to support sustainable development is available, but their effect on real sustainability seems to be fragmented. A real breakthrough demands an integral life-cycle approach, and tools that fit in this cycle. The Dutch case presented in this paper demonstrates how this may work. A brief analysis of Dutch tools shows the desired combination of tools is not yet available. Especially tools to support briefing and architecture are missing, as well as an evaluation mechanism to monitor real sustainability performance. Ideally, from our existing knowledge base we can develop a generally accepted rating system for sustainable buildings. The TU/e sustainability matrix (figures 3 and 4), the building cycle (figure 2) and analysis of trends and tools presented in this paper can contribute to this development.

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