Sustainable Building Design - The Universeum Case

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1. INTRODUCTION

This paper precedes a forthcoming licentiate thesis on requirements of importance for building design processes emphasising integration of global environmental aspects into a complex local design situation. In the thesis, this integration is discussed from a design theory perspective, using empirical data from a case study of the design process for the National Science Centre building "Universeum" in Göteborg, Sweden. The thesis is to be published in August 2002 (in Swedish, with an English summary). At an early stage, this research project was reported in two conference papers, Edén (2000) and Wallin (2000).

2. THE CASE

Universeum is designed to be a major educational institution as well as a tourist attraction. It was inaugurated in June 2001, a week before the EU Summit (and was part of the localities for Summit activities). The overall aim of the Universeum project is to awaken the interest of young people - and especially girls - in technology and natural sciences, thus encouraging them towards studies and professional lives within those fields. The pedagogical efforts emphasise the importance of an environmental perspective. The building itself is designed to symbolise and exemplify this.

The building is a thrilling architectural collage astride a highslope: It has a "traditional" hands-on science centre department in a modernistic wooden structure, a glass greenhouse with a tropical rain forest, a major ocean aquarium faced with rock material from the site, and a plastic-roofed "waterway" exposition of Swedish biotopes from the alps to the west coast. The commissioner for this large investment (some 40 Million Ecu) is a foundation with four interested parties: The Gothenburg Region Association of Local Authorities (GR), the University of Göteborg, Chalmers University of Technology and the West Sweden Chamber of Commerce and Industry. The institution is operated by the company Universeum AB (Ltd).

3. THE RESEARCH PROJECT

The research project evaluates efforts of environmental adjustment in the Universeum design process with the aim of summing up and discussing experiences of the process. In accordance with the explorative approach used in the study, an open research question was put forward: What factors are important in a sustainable building design process? "Factors" were undefined but exemplified, as prerequisites, competence, knowledge, tools, design operation etc. Methods used in the case study are mainly half-structured interviews and project document studies. To a minor extent, Participative Observation was used, mainly by attending design decision meetings and meetings with the reference group, and with the Universeum Environmental Advisory Board.

The research project is financed by Universeum AB.

4. THE UNIVERSEUM DESIGN PROCESS

4.1 Two Project Concepts Merge

The building programme constitutes two main concepts: a water-based bio-zoological exhibition and an experimental, hands-on technical exhibition. These Science Centre concepts were first separately developed - each promoted by an enthusiast - but later merged on the basis of a regional political initiative. Already in the two original concepts, environmental concern was part of the agenda.

4.2 Business Plan and Financing

As part of the financing, the proprietor elaborated a business plan, describing the ideas and stating the project goals. In this plan, environmental ambitions were expressed in symbolic terms. "The ecological perspective" was considered to be a key component in the pedagogical efforts. Environmental adjustment of the building was presented as a symbol and example of project activities supporting the pedagogical aims. Limiting the environmental load of the building itself was not the primary focus. The Swedish Government added approximately ECU 5 M to the financing by founders, industry and private and public foundations. Half of this sum was an explicit support to the environmental ambitions of the project, although in practice the entire sum was regarded as such.

4.3 Architectural Competition

As the first step of architectural design, an architectural competition was held, with seven competitors. The competition program contained an appendix titled "Sustainable Architecture". This appendix was written by a Chalmers instructor and researcher, an expert in Sustainable Building. The proprietor was not highly engaged in forming these environmental guidelines. The approval of the competition programme, including the guidelines, was the responsibility of the jury. In the assessment of the competition proposals, representatives of Chalmers School of Environmental Sciences (GMV) were engaged as experts to the jury. Three proposals - one of these the winning one - out of seven were seen as having great potential for developing environmental qualities.

4.4 Environmental Reference Group

Five researchers from GMV formed an environmental reference group to support the design. The group acted as advisors to the proprietor, without any consulting responsibility, and supported the proprietor in elaborating and securing the fulfilment of the environmental aims of the project. The need for help from this group was a consequence of the governmental financial support to environmental measurements, calling for supervision of adequate use of the money. In the group, the Sustainable Building expert from Chalmers was engaged as a co-ordinator, paid by the proprietor. Resources for the other researchers were to be supplied by the universities as part of their founder responsibility. This was not regulated, though, and the researchers complained about lack of time for their project participation.

4.5 Environmental Programme and Plan

Following a model worked out by parties of the Swedish building industry, *Miljöanpassad projektering* (*Environmentally Adjusted Design*; 1997; below EAD), an environmental programme was elaborated. The environmental co-ordinator was asked to write the programme. He wrote a tentative version, which was intended to be finished by the consultants, for two reasons: They were to learn by doing their own writing, and they were to take the responsibility that a researcher, who was not a member of the design team, could not take.

The draft, though, was not completed, but a plan for realising it in the design, building and operation processes was worked out by the architect. The programme was published at the end of the systems design and thus applied to the detail design, although it also mirrored system design discussions. The proprietor was not highly engaged in the work, and the project manager did not use the goals as guiding and controlling instruments.

4.6. Environmental Consultant and Environmental Design Meetings

At the end of the systems design phase, an environmental consultant was attached to the design group. This was not a result of the proprietor's choice, but of a need the other consultants had, especially the architect, for environmental investigation resources. The environmental consultant led special meetings on environmental design issues, or rather environmental aspects of design issues. This meant that such aspects were partly separated from ordinary design meetings, and thereby from the main design context.

4.7. Environmental Investigations

Some design issues were chosen for special environmental analysis, for example: 1) The framework of a roof was proposed by the architect to be an advanced gluelam construction, obviously symbolising environmentally-based technical development. The project manager wanted to investigate a cheaper steel construction. The investigation showed the environmental advantages of the gluelam alternative, which was chosen by the company board. It was the most expensive solution, but architectural arguments were given priority, with supportive environmental reasons. 2) Another roof was to be covered with glass. For cost reasons, multi-welled plastic sheets substituted for glass. An environmental study showed that the thermally insulating properties were similar for the two materials. 3) Stainless steel contra recycled aluminium frames for glass structures was investigated. As the environmental load was found to be equal, the cheaper aluminium alternative was chosen.

5. RESULTS

The case illustrates the well-known gaps between practice and research: 1) Practitioners seek immediate solutions as part of the design method, researchers advocate that the first step should be to identify systems requirements ; 2) Practitioners are in need of prompt design decisions even if knowledge is insufficient or uncertain, researchers are unwilling to support insufficiently knowledge-based decisions; 3) Practitioners are in need of specific knowledge based on the local design situation, researchers produce general knowledge that must be situationally interpreted and locally adapted to be useful in practice.

The Universeum design process is a clear example of a learning process. The actors gradually understood more about environmental design as the work progressed. Obviously this applies to the proprietor, who had no prior experience in the field. But it also applies to the design professionals, the project manager and the consultants. Many environmental design steps were made on virgin soil. The architect, however, treated environmental issues as a part of his design repertoire from a symbolic, architectonic point of view.

The study shows that environmental investigations were carried out selectively, in a few cases, mainly as one of several means of settling disputes over alternative solutions, by taking into account several aspects of design. The foundations for integration of environmental aspects into the project were established in the competition proposal, assessed by the environmental experts to the jury and not put in question after that.

The building resulting from this design process is a thrilling one. The environmental performance of it, not an object for this evaluation, is however still to be investigated. Every building is more or less a unique creation - Universeum definitely more so. Therefore, bench-marking in such an investigation will be a considerable problem.

6. DISCUSSION

6.1 Integration and Separation

Environmental aspects of the design process reflect the question of dialectic relation between *integration* and *separation*. Epistemologically, this is about the notions of *part* and *system*. From a design theory perspective, the focus on environmental aspects in design could be questioned as a reductionistic scientific view, when a system theory approach might seem more appropriate. A dialectic view would take into consideration the relation of environmental and other aspects of design in an interaction between reductionist analysis and system theoretical synthesis.

Elements of the Universeum design process illustrate integration-separation relations. The *attitude of the architect* is basic. He states that environmental awareness is an integrated part of all his design. The question whether *special environmental goals* are needed is also basic. The EAD model states that environmental goals, although separately formulated, should be part of the design brief. In the Universeum competition programme, environmental guidelines are given in a *separate appendix* form. Other important appendices, like the functional programme and the floor area programme, are also given as appendices. The appendix form therefore is interpreted as strengthening rather than weakening the environmental issues in the programme context. Issues discussed in Universeum's special *environmental design meetings* should rather have been an integrated part of all design discussions.

6.2 Setting Goals as a Design Element

From a design theory perspective, setting goals can be seen not only as pointing out the result aimed at in the design process, but also as part of the definition and handling of the problem, aimed at narrowing the field of uncertainty. Setting environmental goals thus could function as *motivating*, *problem identifying*, *communicative* and *guiding* elements of design. In the Universeum process, goals were set forth in documents from three different phases: The business plan, the architectural competition programme and the environmental programme. The first document was written and embraced by the proprietor himselt, but was not very operative. The other two were expert products, to a little extent involving the consultants in the goal setting activity, and thereby not fully utilising the design potential of a common setting of goals.

6.3 Symbol and Effect

The two environmental perspectives of *symbol* - cultural/architectonic and pedagogic intentions, symbolising the building's mission in it's architecture and trying to influence people's minds and behaviour in the long run - and *effect* - operative intentions of affecting the building's environmental performance from the start - can be seen as environmental influence from the project in two different time perspectives. The symbolic dimension in Universeum is articulated, e. g., in the extensive use of wooden structure (renewable material), an expressive sawtooth roof carrying photovoltaics (local energy transformation) and a biological wastewater treatment demonstration plant (food chain). Effects (that can not yet be measured) are exemplified, e. g., by energy conservation, a urine separation system (nutritive salt recycling) and a biological aquatic water purifier system.

6.4 Environmental costs

In Universeum, the message of formulations in the competition programme and the governmental financial contribution is: Environmental concern costs money. For the time being, this message might be accepted. But the question that follows will be: How much? Addressing environmental factors through integrated design can entail difficulties in calculating separate environmental costs. Such costs could be calculated only as additional costs to an alternative considered to be environmentally less advantageous. The comparison will be totally dependent on which alternative is used. Moreover, integrated solutions, e. g., natural ventilation, reducing costs for technical equipment but possibly increasing building costs, makes these calculations difficult. This calls for a focus on the lifecycle costs of integrated solutions as a whole, rather than calculating specific "environmental additional costs".

7. CONCLUSIONS

Handling environmental imperatives within building design processes calls for changed routines, not only in the form of additions to traditional design process organisation, but partly as new ways of starting up the process and new skills for design actors. Environmental aspects add new prerequisites to the architect's role of functional and aesthetic co-ordinator.

The environmental impact of buildings is a consequence of a chain of requirements elaborated from the first project ideas, thus calling for early design discussions on how to implement these ideas with an appropriate limitation on environmental load. These discussions should be part of the early design phases and should integrate the whole design team. In these discussions, early educational features and joint goal setting could be design process elements of great potential. Environmental goals must be part of the proprietor's intentions, and must be continually monitored and revised when justified.

The SD imperative stresses the importance of the programme phase in the design process, which is the phase where the developer and consultants can identify and adopt, to their specific project situation, explicit environmental goals to guide the integration of these aspects. There is a need for an environmental co-ordinator, who acts as design facilitator, focusing and mediating the integration of environmental aspects into design and building processes and promoting learning about Sustainable Development for all consultants and especially for the proprietor.

A "Table of reflections" based on impressions from the case study and suggesting design process factors of environmental importance conclude this paper.

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Table of reflections: Design process factors of environmental importance	
Factor	*Substance*
Motivated proprietor	A motivated proprietor is a basic prerequisite for success in an environmentally adapted design process.
Actors-integrated design process	All actors participating from the beginning make possible common environmental goal setting in early design phases.
Aspect-integrated design process	Environmental aspects should be continually identified and studied, but in an integral way, as part of a design totality.
Organisation for environmental design	Environmental organisational support to the design should be stated in an organisation plan approved by the proprietor.
Design facilitator	An "environmental process leader" should support the design process to secure continuous environmental design ambitions.
Environmental scrutiny 1	A project's environmental load primarily results from needs, wants and "necessities" which should be early scrutinised.
Project-related environmental education	A common education granted to all design process actors should be considered as a consensus creating element.
Goal setting	All actors should participate in setting environmental goals for the project, thus internalising these goals as their own.
Compiled, monitorable environmental goals	The result of the discussion on environmental objectives should be documented, and approved by the proprietor.
Planned goal monitoring	In the design schedule, checkpoints for controlling the fulfilment of environmental goals should be planned.
Documentation of changes in goals	As quality assurance and for learning reasons, revisions of the environmental goals should be documented, including motives.
Common check lists	In checklists for environmental design, issues common to the whole design team should be identified and compiled.
Environmental scrutiny 2	Project requirements turned into building design requirements should continually include environmental impact discussions.
Lifecycle- oriented systems design	Systems design phase should be lifecycle-oriented, with a system perspective on the use and maintenance phases.
Systems thinking in decisions	The building should be planned for adaptability to future environmental features as well as part systems renewal.
Planning for monitoring	Identifying data and systems for monitoring environmental performance should be part of the systems design.
Goal awareness	Measures should be taken to maintain the awareness of all actors of environmental goals during the design process.
Pressure on suppliers	Every project implies opportunities for raising environmental market standards.
Tools	Accessible, phase-adapted tools for education, goal setting, LCC calculation and environmental assessment are scarce.