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Tools and methods used by architects for solar design

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ABSTRACT

Architects have a key role to play when it comes to the design of future low-energy (solar) buildings. Proper design tools and working methods could help architects in the design process. In order to identify barriers of existing tools and methods for solar design, needs of architects for improved tools, and to gain an insight into architects' methods of working during the design process, an international survey was carried out within the framework of IEA-SHC Task 41-Solar Energy and Architecture, combined with semi-structured interviews. This paper presents an overview of main results of this study.

Both the survey and interviews strongly indicate the need for further development of design tools for solar architecture, focusing on a user-friendly, visual tool that is easily interoperable within current modelling software packages, and which generates clear and meaningful results that are compatible with the existing work flow of the architect. Furthermore, the survey and interviews also indicated a strong awareness about solar aspects among respondents. However, this was combined with a limited use and knowledge of solar energy technologies, suggesting the need for further skill development amongst architects and tool development to accelerate the implementation of these technologies in future buildings and urban fabric.

1. Introduction

Our future built environment needs to be low-energy consuming in order to be resilient to future developments in energy resources and distribution. In several countries, legislation is pushing towards nearly zero energy buildings within a decade or two. In Europe, the recast of the EPBD directive [1] is an example of this legislation. These nearly zero energy buildings will not only need to be energy efficient, they will also need to produce their own energy by the integration of, for instance, passive and active solar energy systems.

Architects have a key role to play in future (solar) low-energy buildings, since passive design is related to architectural decisions already made in the early design phase (EDP). This question was addressed in a recent IEA-SHC programme project titled Solar Energy and Architecture [2]. In the context of Subtasks A and B of this task, an international survey was carried out which was separated in two parts. The Subtask-A survey concerned the integration of solar energy systems in architecture, while the Subtask-B survey was about the adequacy of existing tools and methods for solar design, with emphasis on the early design phase. In this article, only results of the subtask B survey are discussed. More detailed results of the Subtask-B survey can be found in the IEA-SHC Task 41 report T41.B2 [3]. In addition to the survey, semi-structured interviews were conducted with architects and urban planners who designed solar integrated buildings or urban plans. These results are discussed in the second part of this article.

The objectives of the Subtask-B survey and the interviews were:

1. To identify barriers of existing digital tools and design methods for solar design;
2. To identify the needs of architects for better or improved tools and methods;
3. To gain an in-depth insight into architects' methods of working with design tools and building performance simulation (BPS) programs during the design process.

The design process and the role of BPS tools have been the subject of several studies. In an overview of widely used BPS tools, Crawley et al. [4] noticed that there is no common language on describing what the tools do. This leads to the fact that architects do not necessarily know which tool would fit their working method best.

Likely, Lam et al. [5] showed with a survey amongst building professionals in Singapore that architects did not see the use of simulation tools as a part of their design responsibilities. In parallel, in a survey performed by de Wilde and Voorden [6], the

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majority of responding architects indicated that they did not use specific tools to support energy related aspects in their design process. With the increasingly high demands placed on energy performances of buildings, evidence-based design by validating different design alternatives and choosing the most suitable options from all points of view [7] becomes more important for all actors in the design process, especially in the EDP.

BPS tools can be of great help when validating these different design alternatives. In an article describing a new, prototypical tool, Schlueter and Thesseling [8] noticed that there is a lack of current BPS tools supporting the EDP, and numerous authors agree with this [5,9,10]. Current BPS tools are found not to be 'architect friendly' [9] because they are not compatible with architects' working methods and needs, as well as it is difficult to exchange information between different tools without losing information [11]. It might explain why rules of thumb are still widely used by architects in the EDP because they provide quick and rough estimates on solar energy.

The lack of appropriate tools has been regarded as an opportunity by many researchers to develop new BPS tools which would fit the needs of architects better. Some examples of these are described by Ellis and Matthew [12], Schlueter and Thesseling [8], Yezioro [13], Chlela et al. [14], Peter and Svendsen [15], and Garde et al. [16]. All of them share the common goal of reduced complexity in input, reduced simulation time, while providing a graphical interface rather than a numerical one, which makes it easier to validate competing design alternatives.

Besides the lack of architect-friendly BPS tools, another complicating factor is the communication between the designers, and other actors, such as engineers, and clients. It is important for a client to understand the outcome of such BPS tools and the implications on the architecture of buildings [6], but many clients still do not see the need for paying consultant fees for performing energy simulations [17,18] even though it might save them money in the long run.

2. Method

In order to identify the barriers of existing tools and methods, the needs for improved tools, and to gain insight into architects' methods, the IEA-SHC Task 41 performed a survey amongst building professionals in 14 participating countries, and interviews were conducted with 23 architects in Scandinavia.

2.1. Survey

The survey was designed by the international Task 41 expert team and then programmed into Questionform [19], an online survey creator. Then, in each participating country, one national coordinator involved in Task 41 distributed the survey to building professionals in his/her own country. These coordinators used a variety of methods to reach practitioners: by publishing links for surveys through national associations of architects, through professional newsletters and magazines, through custom mailing lists developed from yellow pages or the like. A total of 627 responses were received from 14 countries (Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Norway, Portugal, South-Korea, Spain, Sweden, and Switzerland). Of these, 350 were considered in the analysis. Many surveys were not analysed because they contained less than 75% of completion. Unfortunately, it was impossible to calculate a precise response rate due to the different distribution methods in every country. Table 1 gives an overview of the amount of respondents reached in the participating countries. In Table 1 can be seen that, in the most pessimistic scenario, a direct response rate of 5.9% was calculated.

2.2. Interviews

The survey was chosen as a research method in order to reach a large population of building professionals in many countries. In addition, 23 semi-structured interviews were conducted in Denmark, Norway, and Sweden in order to explore ideas and responses in greater depth, and to be able to study a design process. Similar research carried out earlier within the field of architecture, focussing on the design process, also made use of this method [20–27]. The research method of observations was also considered but found inappropriate since it implied following the design process from the beginning to the end, which would have been a problem since many of the selected buildings were already built. It also required presence of the researcher at many critical times in the process which would be hard to achieve due to the geographical distribution of the projects.

Table 1
Amount of respondents reached by direct e-mails or indirectly through links on websites, complete, incomplete questionnaires (missing few questions) and empty questionnaires by participating country.

Country		Indirect contact (i.e. website)	Direct e-mail	Complete	Missing few quest.	Empty	Total	Resp. rate (indirect) %	Resp. rate (direct) %
Australia		est. 9 000	0	78	6	49	133	0.9	n/a
Austria		90	180	17	1	13	31	20.0	10.0
Belgium		n/a	179	16	5	9	30	n/a	11.7
Canada	Eng.			20	9	15	44		
	Fr.			11	3	13	27		
	Total	n/a	1050	31	12	28	71	n/a	4.1
Denmark		n/a	265	2	0	2	4	n/a	0.8
France		est. 29 000	0	8	0	1	9	0.0	n/a
Germany		n/a	776	8	10	28	46	n/a	2.3
Italy		est. 60 000	100	13	13	34	60	0.0	26.0
Norway		unknown	244	10	12	17	39	n/a	9.0
Portugal		n/a	59	6	0	19	25	n/a	10.2
S. Korea		n/a	286	33	3	34	60	n/a	26.0
Spain		n/a	n/a	7	4	8	19		
Sweden		est. 7 000	1775	27	11	25	63	0.5	2.1
Switzerland	Fr.			1	0	1	2		
	Ger.			7	4	8	19		
	It.			8	0	9	17		
	Total	n/a	920	16	1	27	44	n/a	1.8
Total			5 834	272	78	277	627	0.5	5.9