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AN INQUIRY INTO THE BUILDING PERFORMANCE SIMULATION TOOLS USAGE BY ARCHITECTS IN AUSTRIA

Ardeshir Mahdavi, Silvana Feurer, Alexander Redlein, Georg Suter
Department of Building Physics and Human Ecology
Vienna University of Technology
Karlsplatz 13, A-1040 Vienna, Austria

ABSTRACT

This paper presents the results of an empirical study to establish if and to which extent professionals in design community are familiar with and use building performance simulation applications. A total of 198 architects in Austria participated in this study, answering questions regarding their familiarity and experiences with performance simulations tools, problems they have encountered, and their suggestions toward improvements of such applications. The results can help formulating strategic recommendations for the process of developing and promoting performance simulation tools for building design support.

INTRODUCTION AND BACKGROUND

To be successful, developmental efforts in building performance simulation domain must be informed by an in-depth understanding of the user needs and expectations. The actual state of affairs in terms of the spread and frequency of tool usage in practice is, however, often unknown (Lam et al. 1999). This informational deficit is problematic, as it could perpetuate a rather user-indifferent approach to the development of performance simulation tools and applications.

In this paper we present the results of an empirical study to establish if and to which extent professionals in design community are familiar with and use computational design support tools. The use frequency and pattern of building performance simulation applications was the main concern of this study. A total of 198 architects in Austria participated in this study, answering questions regarding their experiences with performance simulations tools, their attitudes toward them, problems they have encountered, and their suggestions toward improvements of such applications. Specifically, the architects' familiarity with and level of interest in performance simulation instruments (in the domains of energy, thermal comfort, building and room acoustics, daylight and electrical lighting, and fire safety) were studied. The results allow for the identification of priorities and problems as perceived by the user. This could, in turn, facilitate the formulation of strategic recommendations for the process of developing and promoting performance simulation tools for building design support. Specifically, the results of this study are expected to inform curricular revisions in the building science area in architectural schools. Hence, the survey is initially focused on architects.

In Austria, there has been no previous systematic assessment of the frequency and pattern of building performance simulation tools (BPSTs) usage by architects. General CAD (Computer-Aided Architectural Design) tools, however, are used by roughly 96% of the Austrian architects. Moreover, as Table 1 shows, such tools have been in use for quite some time.

Table 1. CAD usage in architectural offices in Austria

Use history	Percentage of users
Since 1999-2001	17
Since 1996-1998	27
Since 1992-1995	44
Since 1981-1991	11

Internationally, there have been a number of studies concerning BPSTs deployment in practice (see, for example, Goncalves 1993, Hand 1991, Lam et al. 1999, Mahdavi et al. 1993, Plokker and Soethout 1997). Goncalves 1993 identifies the informational deficits on the side of design professionals as the main reason for their difficulties in adapting simulation-based building evaluation techniques. Lam et al. 1999 analyzed some 160 questionnaires filled by architecture and engineering professionals in Singapore regarding simulation tools deployment. The results revealed a rather limited spread and low use frequency. 70% of the participants stated that conducting performance simulations is a service not required by most clients. Half the participants stated that simulation tools are expensive and not user-friendly, involve steep learning curves, and do not speed up the design process. Over half of the participants believed their staff did not possess the necessary training and skills for simulation tools employment. The authors suggested, as possible

remedial measures, introduction of performance-based regulatory systems as well as efforts towards effective integration of simulation tools within CAD applications.

Further empirical studies concerning the extent and quality of BPSTs deployment are necessary for at least two reasons. First, as with many other computational domains, the hardware and software technologies rapidly change in the BPSTs domain, creating new conditions for application of simulation tools. Second, the status and nature of the relevant professional communities can be quite different from country to country. Tool developers could benefit from reports on different deployment practices in the diverse context of target professional communities.

APPROACH

Roughly 10% (210 out of 2112) of the active registered architects in Austria were randomly selected for the present study (Table 2). A total of 198 architects actually participated in detailed telephone-based interviews (conducted in summer 2002). Typical project foci of the participants' offices included residential buildings (68%), industrial buildings (37%), large buildings such as office and hospital buildings (49%), single houses (31%), and attic apartments (22%). The random selection of the participants, coupled with the telephone-based interviews has the advantage of avoiding possibly skewed sample characteristics associated with mass-mailing of questionnaires. The response rate to such mailed questionnaires is typically rather low (only 28% in the case of Lam et al. 1999 study) and may lead to the selection of a biased sample.

Table 2. Number of active architects in various states of Austria together with the corresponding number of those approached for interviews

State	Active architects	Architects approached
Burgenland	31	5
Carinthia	93	9
Lower Austria	209	21
Upper Austria	217	21
Salzburg	188	19
Styria	291	26
Tyrol	232	23
Vorarlberg	57	6
Vienna	794	80
Total	2112	210

Interviews were performed based on a questionnaire. Table 3 provides an overview of the main questions. The structure and content of the questionnaire was professionally designed and represents experiences gained from annual large-scale surveys on CAD usage in Austria, which have been conducted since 1995.

The response to the first question in Table 3 (if the respective office employed building performance simulation tools or not) decided which sub-set of the remaining question was actually put to a participant. Specifically, questions *ii* to *vii* were put to the "non-users". Questions *v* to *xvii* were put to the "users".

Table 3. Questionnaire's main items

i	Are building performance simulation tools (BPSTs) employed in your office?
ii	What BPSTs are you familiar with?
iii	What are the reasons against employing BPSTs?
iv	Would you be interested in using BPSTs in future? If yes, in which domains?
v	What is the most important criterion for purchasing BPSTs?
vi	How do you evaluate the state of architects' knowledge regarding BPSTs?
vii	How important is the role of university education of the architecture students in view of BPSTs?
viii	In which domain does your office employ BPSTs?
ix	What are the reasons for the employment of BPSTs in your office?
x	What are the main problems with the employment of BPSTs?
xi	What would be the consequences of the integration of computer-aided design (CAD) tools and BPSTs?
xii	What BPSTs are used in your office?
xiii	How long have you been using BPSTs in your office?
xiv	Who, in your office, uses BPSTs?
xv	How often are BPSTs used in your office?
xvi	In which phase of the planning are BPSTs used in your office?
xvii	How satisfied are you with BPSTs?

RESULTS

Based on the responses to the first question in Table 3, it was established that 16.7% of the sample (33 participants) use BPSTs, while 83.3% (165 participants) do not. Note that BPSTs include in the context of this study both "simple" computational tools (such as performance simulation plug-ins offered by some commercial CAD systems) and more complex simulation applications. Figures 1 to 5 show the main interview results for the "non-users". Figures 6 to 15 show the main interview results for the "users" group.

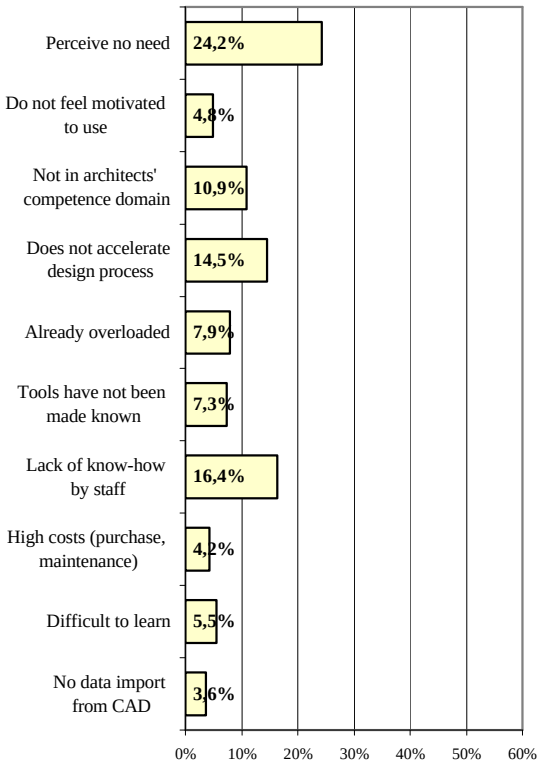

Figure 1. "What are the reasons against employing BPSTs?" (non-users group)

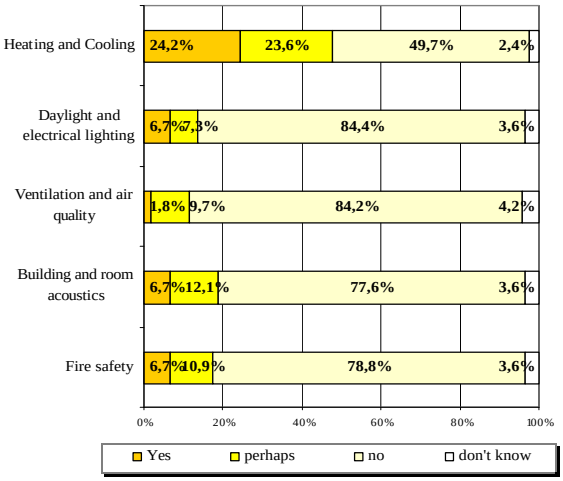

Figure 2. "Would you be interested in using BPSTs in future? If yes, in which domains?" (non-users group)

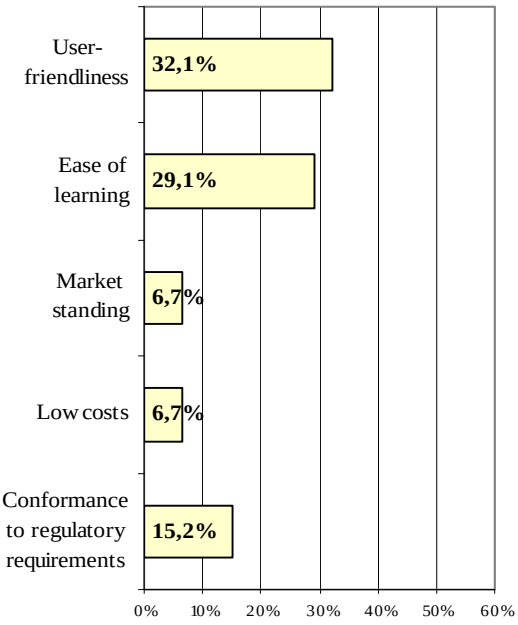

Figure 3. "What is the most important criterion for purchasing BPSTs?" (non-users group)

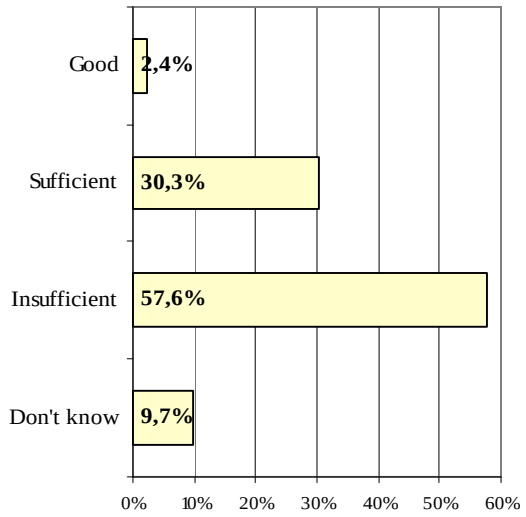

Figure 4. "How do you evaluate the state of architects' knowledge regarding BPSTs?" (non-users group)

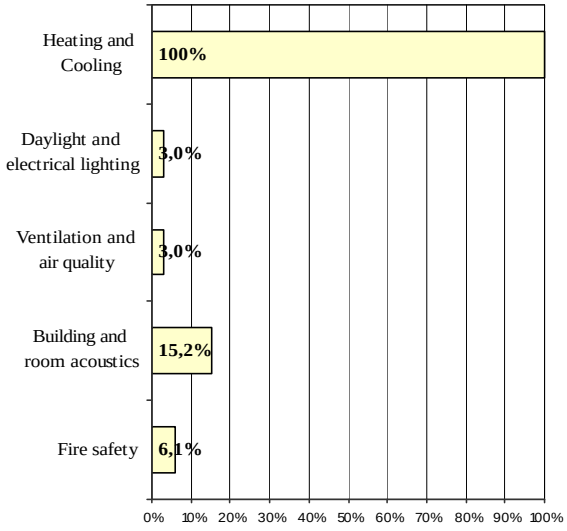

Figure 6. "In which domain does your office employ BPSTs?" (users group)

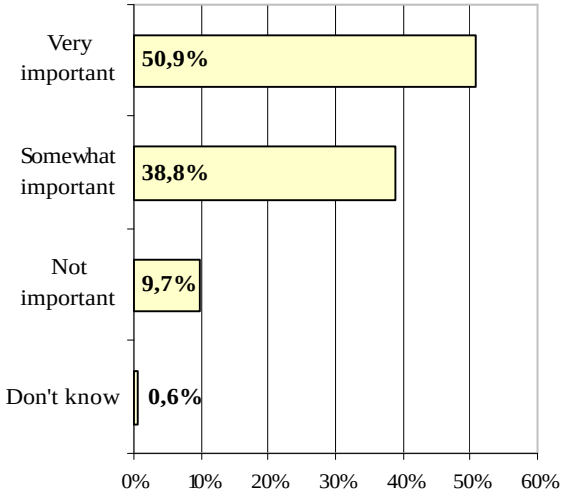

Figure 5. "How important is the role of university education of the architecture students in view of BPSTs?" (non-users group)

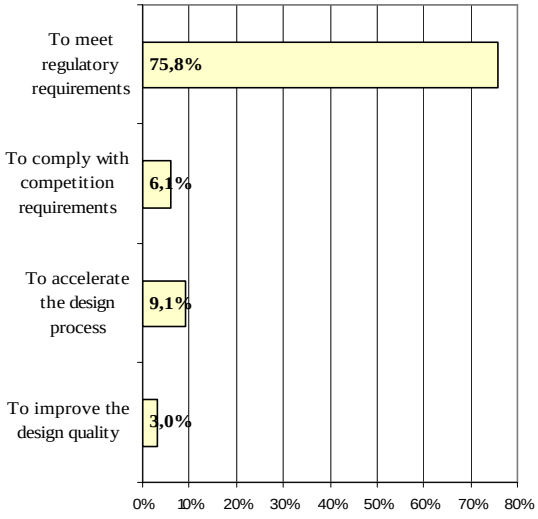

Figure 7. "What are the reasons for the employment of BPSTs in your office?" (users group)

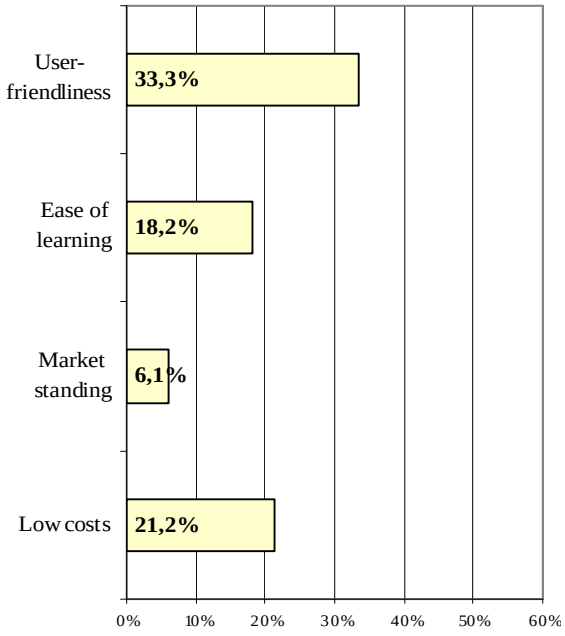

Figure 8. "What is the most important criterion for purchasing BPSTs?" (users group)

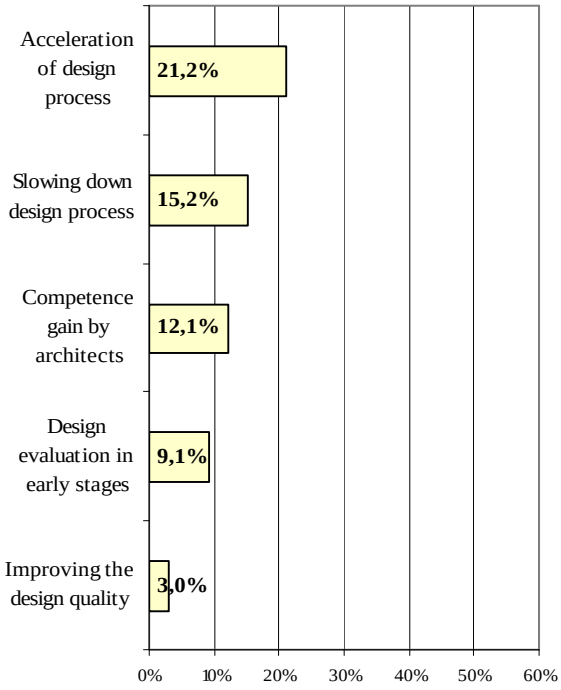

Figure 10. "What would be the consequences of the integration of computer-aided design (CAD) tools and BPSTs?" (users group)

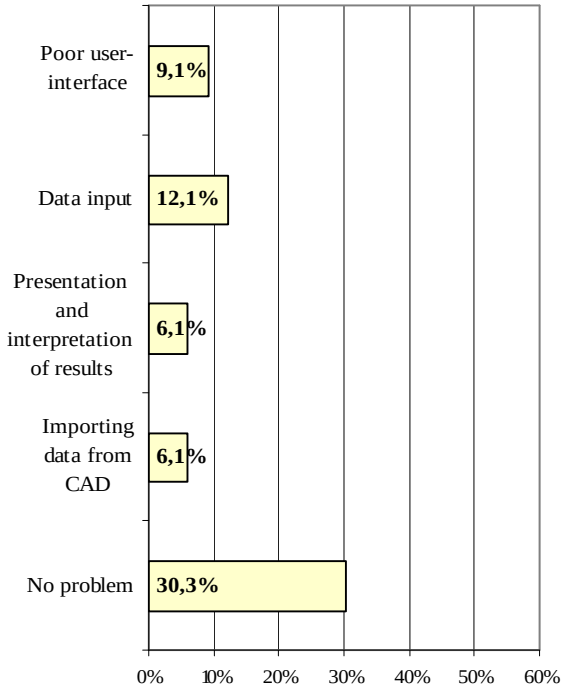

Figure 9. "What are the main problems by the employment of BPSTs?" (users group)

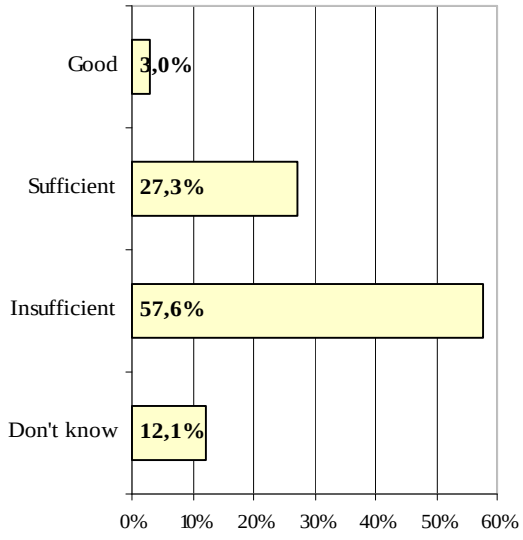

Figure 11. "How do you evaluate the state of architects' knowledge regarding BPSTs?" (users group)

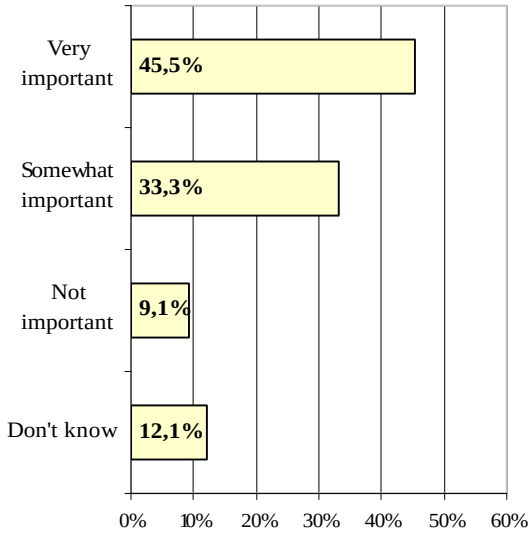

Figure 12. "How important is the role of university education of the architecture students in view of BPSTs?" (users group)

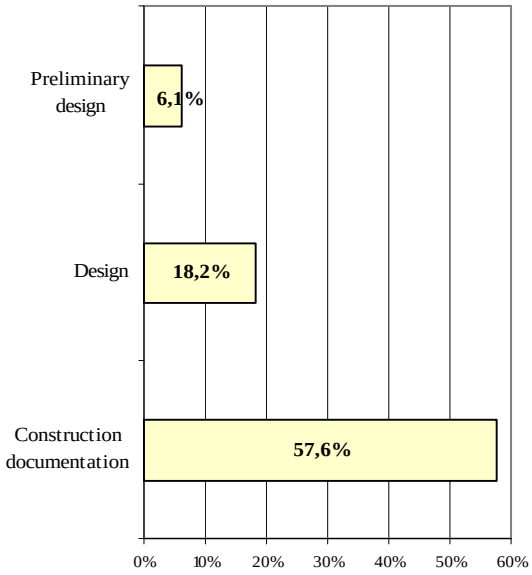

Figure 14. "In which phase of the planning are BPSTs used in your office?" (users group)

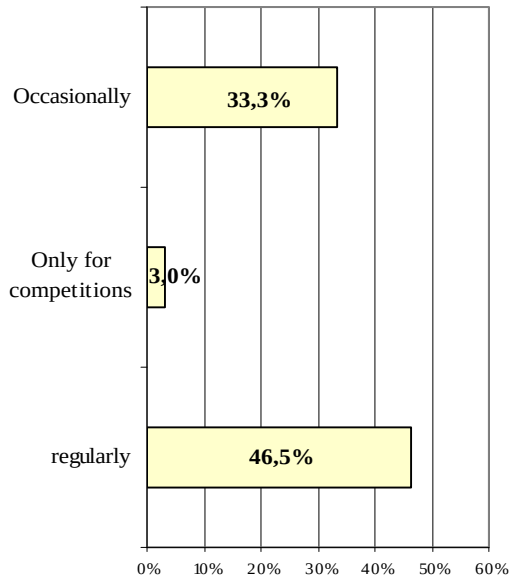

Figure 13. "How often are BPSTs used in your office?" (users group)

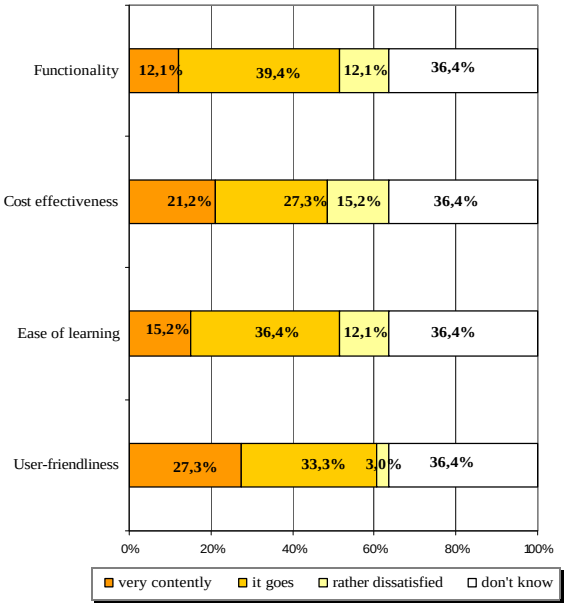

Figure 15. "How satisfied are you with BPSTs?" (users group)

DISCUSSION

The review of the responses of the interviewed architects leads to a number of (in part sobering) observations:

i While general CAD tools are used by the overwhelming majority of architects in Austria (96%), BPSTs are not (17%). Moreover, the architects' use of BPSTs is almost entirely limited to the energy simulation (heating, cooling) domain.

ii Less than half of the users (47%) deploy BPSTs on a regular basis. The dominant reason for BPSTs use is conformance to regulatory requirements (76%). Design improvement is de facto absent (3%) as a motivation. Consequently, BPSTs are often used in the design documentation phase (58%), rarely in the preliminary design stage (6%).

iii Stated reasons for not using BPSTs are rarely specific tools attributes, but imply either a skeptical attitude toward the usefulness of tools in general (tools are not deemed necessary or effective) or cite existing professional shortcomings (overloaded and ill-informed staff). Only few specific tool-centric reasons (cost, learning curve, data exchange with CAD) are mentioned for not using BPSTs.

iv Both users and non-users seem to agree as to criteria important for purchasing BPSTs: *a)* user-friendliness, *b)* ease of learning, *c)* conformance to regulatory requirements, *d)* cost. (Note that the user group does not mention item *c* above explicitly as a purchase criterion. We suspect the users take this attribute for granted: they consider conformance to regulatory requirements as by far the most important reason for using BPSTs in the first place.)

v Users' evaluation of the potential benefits of integrating BPSTs with CAD is inconclusive. Some believe such integration to improve the efficiency of the design process (21%). Others think the opposite (15%): they anticipate that integration would lead to an increase in the frequency and density of data exchange, thus slowing down the design process.

vi The majority of the participants believe architects' knowledge of BPSTs is insufficient. Moreover, they believe the academic education of architecture students regarding BPSTs to be quite important. Interestingly, non-users share these opinions, even though they do not seem to consider performance simulation integral to the "core business" of the architectural profession.

CONCLUSION

An essential potential of building performance simulation tools, namely the timely support of architects toward better designs remains unexploited (at least in the context of the population considered in the present study). Architects rarely use such tools, and if they use them, it is mostly for conformance to (predominantly prescriptive) regulatory requirements. This circumstance is not likely to be addressed with simple measures. The following comments aim at highlighting the main dimensions of the problem and its potential remedies.

Perception and education. A considerable fraction of architects do not consider building physics and performance assessment as integral to their professional role. As with the structural analysis, they seem to believe that such tasks should be "out-sourced" (i.e., performed by building physics "experts"). However, this view is problematic, not only because it sanctions a further loss of professional competence on the side of architects, but also because it leaves the preliminary stage of design (with its importance for the performance) without the benefit of timely performance analysis feed back. Should one succumb (as many seem to have done) to the assessment that, as far as building physics and performance analysis is concerned, architects represent a lost cause, then only the early involvement of experts in multi-disciplinary project design teams could ensure that such early design stage performance feed back is in fact provided. Realistically, though, such teams may be feasible only in case of large projects and large design firms. Thus, efforts to popularize building performance assessment (and the respective tools) in the design development phase should not be abandoned. There may still be hope, as the majority of the architects interviewed do believe they should know more about building performance and its evaluation methods. Likewise, most architects consider the current level of building physics emphasis in architectural education insufficient.

Tools. It should not come as a surprise that potential users ask for better and more affordable tools with more user-friendly interfaces, with shorter learning curves, and with more effective data exchange possibilities. Progress in these areas must, of course, be high on the agenda of tool developers, even though incremental tool improvements, on their own, may not bring about pervasive tool usage. In fact, one could argue that there already exist performance simulation applications at least as user-friendly as many CAD tools frequently used by architects. Apparently, it is the perception of relevance for the design profession's core business that can motivate the users to mobilize the necessary time, effort, and

resources toward integrating tools in their processes. Not surprisingly, the idea of integrating simulation routines within CAD applications has been with the performance simulation community for quite some time. As compared with the performance simulation research community, architects seem to perceive this integration as less important. It is not clear at this point if and to which extent integration (if understood as interoperability in exchange of design documents) would contribute to the popularization of simulation-based building performance assessment in the design development phase.

Process. Improving building designs is not just an issue for the designers and tool developers. Building performance is relevant for sustainability (energy conservation, environmental protection) and habitability (health, comfort, satisfaction, and productivity of the occupants) of the built environment and affects as such the whole society. Regulatory measures are thus in order and possibly effective, as meeting regulatory requirements is currently the main reason for architects to deploy simulation tools in the first place. It has been argued frequently that, in comparison to prescriptive regulations, performance-based codes and standards would be in a better position to ensure design quality. It may sound paradoxical, but perhaps performance-based codes need to be prescriptive regarding simulation tool deployment. At a more general level, the overall social standing of the building delivery process and its implications for the quality of the built environment needs to be revisited. Many design professionals complain about being overloaded and underpaid. Perhaps additional dedicated social investments in measures and tools toward better performing buildings should be considered.

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