DELIVERING SIMULATION TO THE PROFESSION: The Next Stage?

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ABSTRACT

Over the last fifteen years, there have been a number of UK initiatives which facilitated practitioner access to simulation programs (e.g. Clarke and Maver 1991; McElroy et al 1997). Following the success of these activities, the Scottish Energy Systems Group (SESG) was established in 1999 to assist with the further transfer of simulation into design practice.

The SESG is a joint government, industry and academic venture. Its membership comprises a spectrum of building related organisations: architectural and engineering practices, local authorities, component manufacturers, utilities, renewable energy specialists, software vendors and research bodies.

It exists to assist these organisations to gain experience with all aspects of energy and environmental modelling and to remove barriers to uptake imposed by their current work practices. The long term aim is to help companies to evolve in three important respects: improved design performance and robustness through an integrated approach; better productivity through reduced design development times; and improved competitiveness through the greater potential for inter-organisation collaboration.

In September 2000, the SESG became the Scottish affiliate of IBPSA. This paper describes IBPSA Scotland's mode of operation and elaborates on three key activities:

1. access to advanced computational support
2. support for the application of simulation
3. facilitation of future software research and development.

Where appropriate, case study material, drawn from completed projects, is introduced to elaborate the benefits or otherwise of simulation as seen from the practitioner's viewpoint.

Keywords: Building Energy Simulation, Use in Practice, Technology Transfer.

BACKGROUND

Traditionally, building designers have been reluctant to adopt a computational approach to design due to a perception that simulation is difficult to apply. The intention of IBPSA Scotland is to tackle this issue in realtion to the underlying factors: the steep learning curve, poor ease of use, fear of user error, discontinuity between program capabilities and the scale and complexity of real buildings, a demanding resource requirement, credibility of predictions, need for specialist computing equipment and, most importantly, the lack of a supportive network (Howrie 1995).

To address these factors, IBPSA Scotland employs both traditional and novel dissemination mechanisms:

- a Web site, newsletters, seminars and training courses;
- the establishment of advocacy groups to explore key issues and elaborate future actions;
- the elaboration of practical quality assurance procedures;
- the development of integrated performance benchmarks for a range of building types;
- access to advanced computational support tools;
- the provision of support for routine program use in the context of ongoing commercial activities;
- and the facilitation of future software research and development.

These devices exist to support the transfer of simulation into practice and to identify and eliminate barriers to the uptake of modelling. This paper concentrates on the last three mechanisms in the above list while the other mechanisms are reported elsewhere (McElroy and Clarke 1999)).

ACCESS TO ADVANCED COMPUTATIONAL SUPPORT

Aside from the steep learning curve associated with the software applications, and the lack of trained staff to undertake simulation work, practitioners are also faced with barriers related to the hardware. While appropriate hardware is available, companies are often reluctant to invest. IBPSA Scotland has addressed this issue by establishing a loan pool of dual boot (Linux/ Windows) computers fully configured with a range of relevant applications representing the spectrum of possibilities: simplified design tools, general purpose thermal and visualisation tools, integrated simulation tools and demand and supply side management tools. The aim is to be able to deliver a software ready system to members on demand in order to facilitate a no-risk evaluation in the context of a real project. This process is further enabled by the presence of IBPSA Scotland personnel who are trained in the application(s) being deployed. There are four key benefits to members:

- risk free access to modelling packages;
- opportunity to evaluate hardware and software prior to investment;
- reduced risk of investment in inappropriate systems;
- the presence of specialists ensures effective application.

The loan pool includes laptops and workstations, each complete with printers, and network connection capabilities to facilitate interaction with the IBPSA Scotland support team. To date, there have been several beneficiaries of the scheme: local authorities, educational establishments, consulting engineering practices and architectural practices. Where appropriate, a loaned machines can be purchased at the replacement cost.

It is recognised that while delivery of a state-of-the-art machine will not meet the needs of all, it can provide an important first step in demystifying simulation, and thereby moving the participating organisation some way towards the goal of adopting a computational approach to design. While such access reveals the myriad potentials, in most cases the participant remains on the outside looking in, able to identify the potential, but not fully appreciating what to do with the technology.

To address this barrier, IBPSA Scotland offers a Supported Technology Deployment (STD). An STD provides participating organisations with in-house training and support for program use on live projects and this is seen as an important breakthrough in the elimination of the barriers to effective technology deployment. An STD facilitates discussion and provides guidance on simulation procedures and outcome interpretation in the context of real designs and within the constraints of project deadlines.

SUPPORTED TECHNOLOGY DEPLOYMENTS

An STD delivers a fully configured computer, and an experienced operator to a design team for the duration of an appropriate part of a project and at no cost. The benefits are twofold:

- practitioners gain risk free access to simulation on live projects and within normal work practices, and are therefore better able to identify the financial and human resource barriers to routine tool deployment;
- individuals are exposed to a two way flow of information: simulation know-how is passed directly to practitioners, and specialists are exposed to real design issues.

In order to explore the potential impact on current work practices of adopting an integrated modelling approach, the process may involve more than one company.

Typically, a suitable modelling package is identified and an application specialist is located by IBPSA Scotland and arrangements made for this individual to join the design team as a technical adviser. Their role is essentially twofold: to confirm that appraisal requests made by the design team are feasible, and to ensure that each appraisal is appropriately executed and completed in the timescale required by the programme. In this way, the design team is given access to a powerful new resource while being protected from the problems associated with inexperience and the vagaries of new technology.

IBPSA Scotland monitors and documents the process, identifying barriers and bottlenecks in order to assist in the development of strategies for the use of simulation in real-time design. This information is then reported back to the industry at large. A key issue is that the technical advisor will not interfere with the design process or offer design advice.

The following brief case studies outline the STD experiences of three very different practices:

CASE STUDIES

1. Adoption of simulation in a small engineering practice

Over the last two years, through IBPSA Scotland, the integration of advanced modelling into a small environmental engineering company has been achieved through the STD mechanism. The first stage involves the company agreeing to send two staff members to a training courses on the simulation packages identified as best meeting the company's needs. Following on from this, the STD centred on a specific project with support being delivered in-house.

To date, the use of simulation within the practice has been limited to less conventional projects where strategies such as natural ventilation have been used. Simulation is seen as essential in developing the design on these projects, representing the only available means of analysis that allows the practice to meet client needs and deliver leading edge design solutions.

The ultimate intention is to integrate the use of simulation in order that it can be offered as a primary design tool to every client. The appropriateness of this will depend on project type and time constraints, and the company recognises that this route will not always be applicable.

Experience to date has assisted the company to identify the following as being of critical importance in integrating simulation within a small practice, to ensure that simulation does not adversely affect either the design process or the economics adversely:

- In order to avoid being side-tracked by the power of the simulation tool, the objectives of the exercise must be clearly defined, and the input parameters agreed.

- A novice user must accept their limitations and allow expertise to develop. Support is vital at the initial stages to ensure that an analysis is well planned and executed.

- Quality assurance procedures are crucial to ensure that the novice modeller can be confident about the results. These procedures also ensure that the building performance is analysed according to appropriate criteria.

- Ongoing support and advice to ensure a successful deployment is essential and associated staff training ensures that skills develop apace.

The experience of this small practice not only acknowledges the need for appropriate training and subsequent support in deploying simulation, but also recognises the fact that if support is available, reliable results can be obtained quicker and better than by using traditional methods, thus saving the company money through reduced design development. The continuing development of simulation skills will allow the practice to offer clients access to leading edge technology to analyse innovative designs effectively.

The practice is serious about this change to work practices as it is now free to explore technical aspects that it could only guess at before. But for other small practices offers the following cautionary note.
The move should not be taken lightly, the main cost in undertaking this commitment is not hardware or software, but staff training. For a small practice, the initial start-up cost in terms of staff time is estimated at around £25,000 based on formal training and time lost in moving from the old to the new methods. Without support (e.g. from IBPSA Scotland) this cost would double.

2. Adoption of simulation in a large architectural practice

A member company has recently taken the decision to adopt building performance modelling as part of the everyday design process. The company, a large architectural practice with offices throughout the UK has decided to make this commitment nationwide, in order that the company can in future draw on the necessary skills from its offices across the country.

The aim is to become one of only a few architectural practices that include thermal, lighting, structural and cost analysis methods as an integral part of the design process. In order to achieve this goal, the practice has launched a two year programme with the aim of developing an in-house simulation capability (Morbitzer et al 2001). The company recognises that many barriers will have to be overcome (financial, training times, personnel issues etc) and these are being assessed.

With support from IBPSA Scotland, the practice has invested in a new member of staff to facilitate the rapid adoption of a formal modelling approach. The company is IT literate and a key factor is seen as the need for the development of unhindered transfer mechanisms for CAD based design modifications to simulation tools.

The practice is also aware of the risk of error associated with adopting default engineering values in cases of uncertainty and has taken two key steps to eliminating the risk of trainee modeller error. First, the company is identifying and adopting recommended engineering assumptions for use in all cases of uncertainty (CIBSE 1998). Second, in order to facilitate the unrestricted use of simulation throughout the practice, the medium term goal is to develop a custom built interface that will further reduce risks by assisting with the selection of appropriate defaults.

Initially, the practice did not have a full in-house capability or resource to undertake the modelling it desired, and assistance was sought from IBPSA Scotland. This offered an opportunity to address thermal modelling and visual comfort aspects on a live project using the skills of the new member of staff working with IBPSA Scotland personnel. The outcome improved confidence in the integrated modelling approach and gave rise to the decision to adopt the approach.

As with the previous case study, this decision was not taken lightly. Although operating with a large staff and a higher turnover, there are still high costs and potentially greater insurance risks in terms of retaining control and overseeing the new work practices. The practice is addressing these issues through the development of quality assurance procedures and the tailored interfaces. It is now proceeding to build up an in-house simulation capability as a matter of course. The practice sees this as an essential capability that will be increasingly demanded by clients.

3. Simulation support in a modelling based practice

The third case study relates to support given to a relatively experienced simulation-based consulting practice that sought to diversify its core competencies in order to attract a range of project types. This move is being supported by IBPSA Scotland who are providing technical advisors to assist with the integration of the new simulation capabilities as required.

The practice began with an initial focus on one suite of software, but as it began to take on a variety of work, additional simulation tools were gradually adopted. Thus, the practice actively sought to attract, train and retain staff with a range of skills. Experience indicated that two broad categories of skills and experience were required - those with domain skills and an intuitive grasp of how to approach complex tasks and graduates who are able to quickly acquire skills and adapt to non-traditional work practices and project demands.

It became clear to the practice that simulation-based consulting is typified by a mix of active, pending and dormant projects. It is exceptional for staff to be working on a single project. Senior staff may be called upon to advise on aspects of a score of projects. Clearly, the designers of simulation tools can no longer expect the undivided attention of users. The difficulties of deploying staff and computational resources in such a state of flux is complicated by the resource required to switch between projects.

In addition, clients often respond to successful "what if" explorations with further curiosity (which may or may not have been anticipated in initial work proposals). To respond by rushing to the keyboard is rarely a successful strategy. There is a "dark side" to simulation tools which can seduce the unwary to extremes of complexity or over-simplification. This particular practice has found that initial planning, ongoing supervision and quality assurance were crucial in constraining the complexity of simulation models as well as enhancing their clarity.

This collaboration allowed IBPSA Scotland to identify key issues that will emerge as more of its members advance down the simulation route. In adopting a unilateral approach to simulation in a company, it is essential that:

- an individual is identified who has responsibility for overall strategic decisions in order to ensure that the aims of the company remain clearly in sight;
- someone must be responsible for the overall simulation strategy;
- to cope with an increasing simulation-based project workload, at varying design stages, simulation tools may require improved documentation, archiving and retrieval procedures in order to minimise time required to "get up to speed" as they switch between projects;
- initial planning, ongoing supervision and ongoing supervision quality assurance are crucial to a successful outcome.

As a simulation-based enterprise adopting new tools, this company faced the need for intensive retraining and the risk of lost income during the changeover. Moreover, they ran the risk of having to reduce workload (while developing new skills) at a time when they were naturally expanding. By observing their work practices and developing an achievable training programme assisted by the availability of emergency support from IBPSA Scotland, potential bottlenecks and barriers have been addressed and the dilemma avoided.

Summary

In summary the STD mechanism has proven itself to be a powerful technology transfer device, largely because training is an integral part of a familiar process and is undertaken in the real time, real scale context of design practice. Following on from a successful STD, it is not unusual for a company to acquire the featured modelling package and send staff on related training courses. This is a key point: a serious investment in software and training is only made after the benefits of a program have been demonstrated in a commercial setting. In this way, companies are able to evaluate the appropriateness of alternative programs before making a decision to invest.

The case study practices have made a commitment because they see simulation as the only way of addressing the design challenges with which they are now faced. They believe that if they do not accept this challenge now, they will be overtaken by their competitors.

A key message from all three is that while machine deployment and in-house training will ease the way, they nevertheless face a transition phase, between old and new practices while still meeting day to day programme requirements and deadlines. It is difficult to maintain a balance that does not adversely affect productivity. This may explain why up until now, most of the associated activity has been in larger practices.

FACILITATING SOFTWARE RESEARCH AND DEVELOPMENT

IBPSA Scotland, in association with third party organisations, is facilitating software reasearch and development by providing access to its membership to assist with the β testing of new versions of software.

For example, a recent project mobilised the membership to help with developments on the LT Method (Baker N V), to expand the tool's use from the UK to Europe. IBPSA Scotland hosted three workshops, initially to demonstrate the tool to potential users and subsequently to support its testing on live projects.

Through these activities, the tool designer was provided with access to consultants who were able to test proposed refinements in terms of interface friendliness and technical capability. As the users are experienced designers, they were able to compare the test results with accepted industry benchmarks for the same building types. This activity is being repeated for other tool/user combinations.

CONCLUSIONS

From the mechanisms discussed in this paper and those highlighted in previous publications (McElroy and Clarke 1999), (e.g. quality assurance, advocacy groups, benchmarking), the following conclusions are drawn.

- Contemporary modelling systems can be cost-effectively deployed where appropriate support is available.
- The largest portion of the cost relates to staff training, not to the acquisition of hardware and software.
- A change in work practices is needed if the profession is to move to a new best practice based on a computational model of design.
- Barriers and bottlenecks can be minimised through training support and by setting achievable goals.

In addition.

- All STD recipients have reported that they anticipate no impact on their professional indemnity insurance due to the uptake of simulation.
- Interestingly, project fees are likely to remain the same despite the value added to their service. This is because access to modelling engenders the confidence to implement innovative solutions which would otherwise not be possible by conventional methods.

Finally, the use of a forum that provides tool designers with access to a mixed audience of practitioners through which evolving design tools can be evaluated has been proven.

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