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Use of business process simulation: A survey of practitioners

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In order to understand the requirements of people engaged in business process simulation (BPS), a survey was conducted among potential business process simulation users. The survey had a 37% response rate and revealed a low usage of simulation in the design, modification and improvement of business processes. It confirms that BPS projects are typically short, relatively non-technical, and rely on good project management for their success. Most BPS users employ general-purpose simulation software rather than purpose-designed business process simulators. There is no evidence of a skills gap, rather a feeling that there is no net gain from employing simulation methods when simpler methods will suffice. These findings are discussed and conclusions drawn.
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Introduction

Recent years have seen much interest in the improvement of business processes. Possible reasons for this include increased competition between businesses, heightened customer expectations, and a realisation that the use of computing technologies can lead to increased effectiveness and greater efficiency. One approach to process improvement is business process modelling (BPM), in which a model is built and used to explore alternative designs. BPM includes simple process mapping techniques as well as more sophisticated approaches such as computer simulation.

This paper discusses the results of a survey of OR-type practitioners, based primarily in the UK, in an attempt to uncover the realities of business process simulation (BPS). BPS is the use of computer simulation models to mimic a business process so as to consider changes before their implementation. The survey was conducted as part of a project[1] that culminated in a component-based business process simulation tool, BPSIM++. It seemed sensible to investigate how and why BPS was being used, since this would form part of the design process for BPSIM++.

Software companies have promoted the use of their BPS tools,[2–5] and promotional books have added to the interest. However, there is little empirical evidence about the practice of BPS. Some authors[6,7] propose their own approaches that will, they claim, support the modelling process. Others[8,9] describe case studies and attempt to generalise from these so as to offer advice to their readers. There are several studies[10,11] that investigate the use of simulation in manufacturing, but little is known about the actual practice of business process simulation. One exception is Stanford and Graham,[12] who explored the practicability of BPS, but only within the context of a single software tool, Optima!®—now renamed iGrafx Process®.[2]

To remedy this, a questionnaire was mailed to a sample of 223 potential BPS practitioners. The result was a 37% response rate, which is better than that achieved for similar questionnaires. This paper discusses the survey, summarises its results, and discusses their implications.

Survey methodology

Sample frame

The purpose of the survey was to investigate how and why BPS was being used in practice. It was part of an investigation to determine the design requirements of a prototype tool (BPSIM++). To achieve this, it seemed sensible (and obvious) to target the population of practitioners engaged in modelling activities in business process improvement programmes. Indeed, they are probably the people most knowledgeable about the issues affecting the realities of modelling and simulation of business processes and, thus, the most appropriate target for the purposes of this study. This population is not made up only of simulation users, because it is important to know why people think that simulation may be not worth applying in a business process context and, at the same time, to discover what other

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techniques are used instead. The population excludes academic staff, since their views are generally disseminated in their publications. Thus, the population selected is appropriately defined for the objectives of the study.

In an ideal world, all questionnaire-based surveys would be administered to a perfect sample of the relevant population and all those surveyed would respond. However, things are rarely that simple, and such surveys are dogged by many problems, of which low response rates are the most severe since they can lead to a sample that does not properly represent the population. This survey was designed to uncover information about the current practice of BPS, mainly in the UK, and this aim, together with convenience, defined the sample frame.

The primary source of the sample frame was the alumni database of the Department of Management Science at Lancaster University. This consists of people who have been educated in the department and who, it should be expected, would be knowledgeable about OR, management science, and modelling approaches. In other words the sample was representative of people who might be expected to be familiar with and/or to use simulation in the design of business processes. For convenience, this main component of the sample was restricted to people with UK addresses. An additional 11 names were added from other contacts, some provided by individuals in the primary sample. Two of these were based outside the UK, in Denmark and the Netherlands, and are included at the suggestion of two large, UK-based consultancies. These two individuals are included in the 37% of the sample who responded to the questionnaire.

The sample frame was chosen on convenience grounds and not on any kind of random sampling since it is impossible to identify all cases of the population and therefore non-statistical sampling was used. As a result of this, as the paper stresses, no claims are made about the statistical generalization for the total of the population. Other alternatives for creating a sample frame might include, for example, the use of business directories (eg, Dun & Bradstreet) and specialised mailing lists (eg, BPR-L). The first tactic was abandoned because it was thought that without a known contact the problem of non-response was likely to be considerable. The survey of simulation in manufacturing reported by Hollocks[10] used such a strategy and this resulted in a low response rate (9%). The use of specialised mailing lists was also rejected, since list members are often inundated by requests for cooperation in research and it was thought that, at best, this might add a couple more useful contacts. Hence, a more feasible, though no less effective, means had to be put in place.

The database of the Department of Management Science at Lancaster University includes graduates in OR who are knowledgeable of modelling approaches and work as managers, consultants, and business analysts for diverse companies around the UK. Although clearly biased, this approach is appropriate for the purposes of the investigation, which is not seeking statistical generalisation. The biased sample can be justified on pragmatic grounds, since it consists of probable users of BPS. If these people, trained in dynamic modelling and other approaches, are not using BPS, then it seems likely that use is very low. This type of survey is a useful form of enquiry especially suited for exploratory studies. The results that emerge are of particular relevance and represent key themes, which may give a feel of what is going on in the wider population.

Questionnaire design and administration

The questionnaire followed from a literature review[13] that informed the questions asked and was intended to collect data and opinions on the following:

- The use of BPS
- Reasons for using or not using BPS
- The management and conduct of BPS projects
- The use of methods other than simulation in business process design and improvement
- Issues related to the modelling of business processes
- Factors affecting success and failure.

A few questions were adapted from Stanford and Graham[12] so as to compare their findings with this survey.

Before the survey proper, the questionnaire was tested, and then refined, by administering it to two experienced practitioners, known to be active in BPS. The final questionnaire was long (eight pages) and had 21 main questions, some of which contained subquestions, spread over four sections. A copy of the questionnaire is available on request.

The questionnaire was mailed to the sample of 223 potential respondents at the end of October 1999. It was twice followed up, in November 1999, and in the following January, to increase the response rate. As part of this, respondents were offered a copy of the report and a renewed guarantee of confidentiality. The result was that 82 questionnaires were returned and, of these, just one was rejected from the analysis because of its irrelevance. Thus the response rate was around 37%.

Data analysis

The questionnaire contained open and closed questions, which meant that the analysis was both quantitative and qualitative, and Microsoft Excel® was used for the analysis. The qualitative analysis was, inevitably subjective, and was managed with a multi-pass approach, in which all individual responses were added to the spreadsheet. The common themes, categories, and clusters were identified and coded. This follows the practice adopted by others in similar work.[14] The results are discussed in the next sections.

Survey results

General information

How much use is made of BPS and who does this work? As is made clear in the later section discussing what is meant by the term 'business process', there is considerable variation in the way that the term is used. This confusion is to be found in the literature surrounding business processes,[15–17] in which a range of definitions is employed. So as not to seem too much like an academic examination paper, the survey first allowed the users to state whether or not they were users of BPS, without asking for their own definitions of those terms. Thus, the first three questions asked about the occupation, industry sector, and experience of the respondents, including whether they were current or past users of BPS. Of the 82 useable responses, only 17 (21%) were current or past users of BPS—and this in a sample composed of people who have been trained in the methods needed. As shown in Table 1, across the 82 responses, approximately 43% were employed in the service and public sectors, 18% in manufacturing and distribution, 14% operated across a range of sectors, and 25% could not be sensibly classified. Thus, the use of BPS is low and the few applications are mainly in the public and service sectors, perhaps not surprising given the proportion of UK GDP stemming from these sectors.

The majority of respondents described themselves as managers (meaning that their response covered their area of responsibility and not just themselves), followed by consultants and business analysts. More than half of the respondents had less than three years experience with BPM. BPS users were typically more experienced, around two-thirds having more than three years experience. BPS users were also more likely to be consultants, more than half being employed in external consultancies working across a range of industries. Why should this be? Melão and Pidd[13] review much of the literature surrounding BPS and it is clear that much of the impetus for business process improvement programmes has come from consulting companies. The survey thus confirms the bias that appears in the literature.

Table 1 Industry sector of practitioners

Industry sector	*Total*	*BPS*	*non-BPS*
Chemicals, const. and engineering	5 (6%)	0	5 (8%)
Energy	3 (4%)	1 (6%)	2 (3%)
Communications	3 (4%)	1 (6%)	2 (3%)
Transportation	3 (4%)	0	3 (5%)
Manufacturing and distribution	15 (18%)	3 (17%)	12 (19%)
Retail	6 (7%)	1 (6%)	5 (8%)
Financial services	11 (14%)	1 (6%)	10 (15%)
Other services	15 (18%)	1 (6%)	14 (22%)
Healthcare, government and other public service	9 (11%)	2 (12%)	7 (11%)
Across industry	11 (14%)	7 (41%)	4 (6%)
Total	81 (100%)	17 (100%)	64 (100%)

Non-users of BPS

Almost 80% of respondents claimed that they did not use simulation in designing and improving business processes. The reasons given for non-use are summarised in Table 2; the most common is the nature of the respondent's current job. These were practitioners who preferred to use other methods and some managers who were no longer actively engaged in modelling work. The second most common reasons for non-use were related to the type of processes on which the respondents worked. Some dealt with small and simple processes and stated that simulation was not needed. Other felt that their business processes were 'imprecise, people-oriented' or 'difficult to describe in ways that can be modelled'.

Looking at the same issue from the other direction, some respondents commented that BPS was too time-consuming and/or required considerable resources. Two respondents said they had yet to find a suitable application. In others words, results were needed quickly and they thought it unlikely that simulation would meet this requirement. Linked to this, some non-users stated that their organisation was not ready, including the following two quotes.

Table 2 Reasons for non-use

Reasons	*Mentions*
Nature of current job/role	
Irrelevant or inappropriate	28
Not involved in modelling	6
Nature of process/problem	
Not complex or large enough	8
Too messy or people-oriented	3
Unreliable data	3
No dynamic behaviour	1
Other	2
Limitations of BPS	
Too time/resource-consuming	4
Not found suitable application	2
Too complex	2
Difficult to justify investment	1
Not always appropriate	1
Context of the organisation	
Cultural resistance	3
No resources/expertise available	3
Company policy	1
Lack of expertise/awareness	
Lack of technical expertise	2
Unaware of benefits	1

'*. . . the use of simulation to recommend a new process would be seen as revolutionary.*'

And

'*. . . must sell them and gain political acceptance*.'

Thus, simulation use must meet the normal criteria: a net benefit should be anticipated, otherwise it will not be used, and people will not use BPS unless they feel comfortable about it.

Non-users of BPS do, however, engage in other forms of business process modelling and respondents were asked to identify what other methods they used. Alternative approaches included process mapping (12 responses), spreadsheet modelling (7), financial modelling (5), elementary statistics and arithmetic (4), and a number of other approaches such as benchmarking, enterprise resource planning (ERP), statistical process control (SPC), queuing theory and soft systems methodology (SSM). The mentions of ERP and SPC may seem strange. However, the implementation of ERP clearly requires process redesign if it is to be successful. It is likely that SPC was used as a way of monitoring business processes (eg, weekly enquiry rates from customers) and as part of wider quality improvement initiatives. Also mentioned were statistical and mathematical modelling methods such as regression, time series analysis, and mathematical (both linear and non-linear) programming.

The diversity of methods mentioned is significant and, within them, it seems that most of the respondents preferred static methods. Asked why these methods were used, the responses stressed simplicity, ease of use, quick development, and ease of communication. In addition, some tools and methods were used because they were already accepted in the organisation, sometimes as standard approaches:

'*. . . has a culture which supports the use of these techniques . . . As a result they are the best tools to . . . win hearts and minds*.'

Why and how is BPS used?

Table 3 shows why the 21% of respondents who use BPS claim to do so. The reasons given are in accordance with other studies of the use of simulation methods. Primarily, BPS is used because it supports experimentation and allows a deeper understanding of complex process interactions and other issues. A relatively high proportion claimed to use BPS because it enhanced communication and cooperation. Some mentioned the need to model dynamic effects. Others mentioned a supportive organisational context and some consultancies regard BPS as a core competence that they offer to clients. This may indicate that BPS is largely a consultancy-driven activity.

Users of BPS were then asked what simulation tools they used in their work and the responses are summarised in Table 4. Perhaps surprisingly, most people seem to use general-purpose simulation tools rather than ones designed for BPS. This may be because some respondents work across sectors and may have found that general-purpose tools are better suited to the range of applications on which they work. Again, it may be because these users are simply unaware of the special-purpose BPS tools. The general-purpose tools had often originated in manufacturing and users seemed to employ them for simulating logistics and production processes. Finally, it might be because the respondents had been trained in the use of the general-purpose packages and thus feel more comfortable in using them.

Table 3 Reasons for using BPS

Reasons	*Mentions*
Experimentation	13
Enhance communication/cooperation	6
Generate understanding	6
Cope with variability/dynamics	4
Organisational context	4
Staffing analysis	3
Other	8

Table 4 Modelling and simulation tools used

Tools	*Mentions*
General-purpose simulators	
Simul8	4
Arena	3
ProModel	3
Microsoft applications	
Excel	7
Various	1
Simulators originally designed for manufacturing	
Automod	3
Witness	3
System dynamics	
iThink	2
PowerSim	1
SD case tools	1
Analytical models	
COR	1
Markov models	1
Octave	1
Monte Carlo simulation	
Crystal ball	2
Definitive scenario	1
Bespoke programming	2
Process mapping	
Micrografx process	1
Visio	1
Special-purpose BP simulators	
Case wise	1
Cosa workflow	1

System dynamics packages were employed by some respondents needing to simulate business process situations when discrete event simulation was thought inappropriate. The other tools listed in Table 4 seem to be used to complement the simulation by providing support for data input and analysis. Users stated that they chose tools because of their ease of use or simplicity (6 users), flexibility or functionality (6), and cost or value for money (4). However, as with the use of general-purpose simulation software, system dynamics approaches may be used because of the training and background of the analysts.

Given the tools used, what modelling features were employed? It seems that more advanced features such as data/IS modelling, process mapping, hierarchical modelling, library management, multi-user and Internet links were not much used. Users seem, sensibly, to prefer those features that offer immediate added value and ignore others. They seem generally happy with the features that they do use, such as resource modelling, scenario analysis, simulation, animation, cost/statistical analysis, and activity modelling.

Just under 30% of users felt that the tools were unsuited to some of the situations that they encountered. These include weaknesses when modelling complex systems, elements that required continuous simulation, requirements for embedding geographic information, accessing large datasets, linking components models, and modelling process routings. The problem seems to be that most BPS tools are simple visual interactive modelling systems (VIMS) that lack flexibility.

How might these tools be improved? Suggestions from users were few and included improvements to input/output and extension facilities, smoother modelling of mixed discrete/continuous systems, improved statistical support, and automatic consistency checking. These suggestions are all probably related to the particular tools being used.

What is a business process?

It should be clear from the preceding sections that respondents were probably employing different implicit definitions of business processes. To check this, they were asked to provide their own definition. Examples included the following.

1. A specific part of a business's operations, which can be well-defined and looked at in isolation.
2. Performs a definite task for the business, has a process owner, involves resources, carries a cost to the company, supports the business.
3. An activity/decision that either has a duration associated with it or two or more possible outcomes.
4. Pre-defined rules and subjective human involvement implementing these rules (and coping with emergencies) together with physical machines to create a known product or achieve a known goal.
5. A collection of activities designed to work together to achieve a given objective—which may be customer-related or otherwise—and which is of direct or indirect benefit to the organisation.
6. Procedure for individuals or teams to go through or issues to consider.
7. A series of connected and reliant items, which convert inputs into outputs to feed into outcomes.
8. Any set of actions or interactions in an organisation that lead to a single or multiple outcome.
9. A series of logical and/or physical steps leading from a set of inputs to a set of outputs.

The diversity of these definitions reflects the confusion to be found in the whole literature surrounding business processes.[15–17] It may also be that some of those proposed above stein from the terminology of the software tools in use; nevertheless, there are clear commonalities amongst them. These include the notion of input/output transformations and a rather mechanistic stance (number 4 apart). This is troubling, given that there is much more to a business process than the mechanical completion of tasks—human beings are involved and much of the work is highly variable. Mechanistic views may well miss the important aspects of business processes.[13]

BPS projects

How are BPS projects conducted and what factors do users believe to be important? Several questions in the survey addressed these issues. Figures 1 and 2 summarise the typical purposes of such projects and the types of processes modelled. Staffing, queuing, cost and time analyses predominate, suggesting a focus on improving process efficiency rather than effectiveness. Projects tend to be short: nine mentioning durations of between 1 and 3 months, six of durations between 3 and 6 months.

Supply chain applications were the most common, which may reflect the increasing emphasis on e-business, though few mentioned attempts to assess investments in IT.

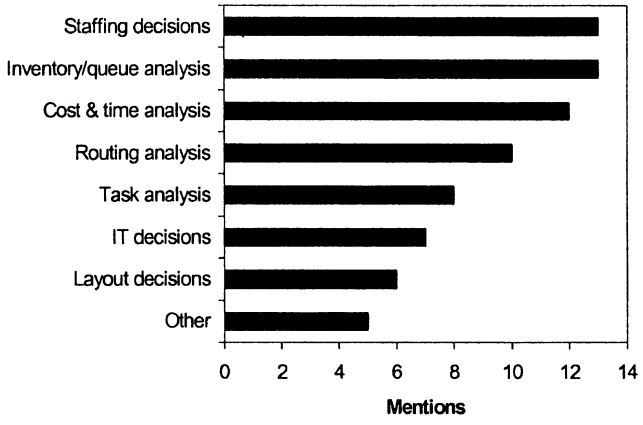

Figure 1 Typical purposes of a BPS project.

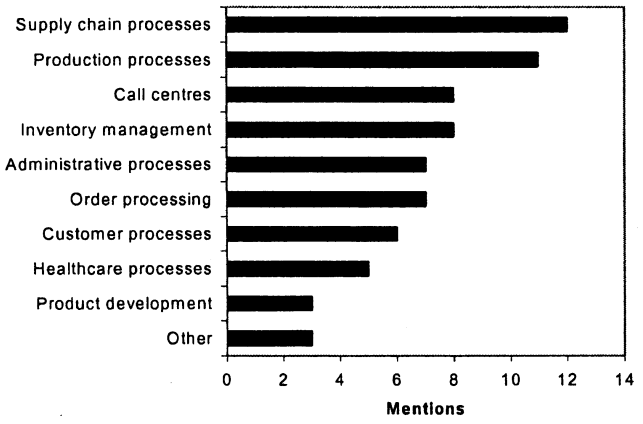

Figure 2 Types of business processes modelled.

Unexpected, to the authors at least, was the number of mentions for production processes. The authors had a neat distinction in mind between business processes and manufacturing processes, but the respondents did not. Overall, though, service-based processes dominate the responses.

What part do process experts, people who have deep knowledge of the process and its tasks, play in these projects? Over 80% of the BPS users claimed that these people were fully involved with their projects. Such involvement included participation at the start and finish of the project (11 mentions), provision of knowledge (8), and cooperation in all stages (5). Users claimed that this participation was valuable because it helped with buy-in and ownership (8 mentions), ensured the validity and utility of the results (5), and helped with sharing information (5). Users indicated that process mapping and animation tools in workshops and discussions were very useful. It seems, too, that some users applied BPS in a facilitative mode, helping their clients to think through the available options.

Do even BPS users employ other methods and approaches in their projects? The answer is yes: about 70% of users stating that they use approaches such as process mapping (6 mentions), spreadsheet models (4), and statistical analysis (3). A process map can be used in groups to provide a high level understanding of process issues and may eventually serve as a front end for building the simulation model. Spreadsheet modelling and statistical analysis are useful means for tackling simple processes or for a first approximation to the problem in hand. As one respondent put it, they 'can often provide the answers without producing in-depth model'. These are complementary methods that provide additional support during the project, most commonly in problem structuring, data analysis, and knowledge elicitation.

How successful were these interventions? All who responded as users seemed to think so, with just over 50% reporting their experience as excellent and the remainder distributed equally between good or reasonable. Whether these responses are justifiable or merely optimistic cannot be known without access to the clients of the studies. Table 5 shows the factors identified by BPS users as important for the success of a BPS project. Most seem to be related to project management rather than to technical aspects of the simulation modelling. Users stated that it was especially important to define clear project objectives and to think through the process aspects of the work.

Table 5 Perceived success factors of BPS projects

Factors	*Mentions*
Project management	
Management involvement	14
Clear project objectives/scope	7
Good communication	4
Project duration	3
Good project management	2
Process experts cooperation/involvement	2
Cross discipline team	1
Management of expectations	1
Open mind about improvements	1
Proven methodology	1
Content	
Clear definition/understanding of problem	5
Clear model objectives/scope	3
Quality/accuracy of data	3
Experiment selection	1
Right tools	1

Some reflections on the survey findings

Although the number of responses from people claiming to use BPS was low, there are still some interesting findings from the survey. The generalisations cannot be said to be statistically valid; nevertheless, they do provide a reference point against which researchers, practitioners, and software specialists can compare their own experience.

Few people use business process simulation

The most obvious finding is that the number of users appears to be low, even within a group whose training and background might be expected to make them favourably disposed to BPS. Process mapping and spreadsheet modelling seem much more popular when faced with the need to design, modify, or improve a business process. It should be noted that some of the responses were from people responding on behalf of a group, but there seems no reason to suppose that the group : individual response ratio differs in the user and non-user populations. It seems that the enclaves in which BPS is used tend to be groups of internal and external consultancies who have mastered the approach and for whom BPS is a saleable competence.

However, it must be recalled that other studies of simulation application areas have also revealed low usage. About ten years ago, Hollocks[10] reported on simulation usage in UK manufacturing and found that only 9% of organisations

were users. His sample was different from the one used here, making no attempt to focus on people who might, *a priori*, be expected to be simulation users. It is to be expected that a sample frame comparable to that of the Hollocks study would produce a rate of usage of well below 21%, and probably well below the figure of 9%.

Why should usage be so low? The most obvious reason is that BPS is simply not suited to all applications or to all circumstances. One respondent commented,

> '*...some of the business processes are so loosely defined that BPM is a pointless undertaking*.'

Given that most respondents seem to regard BPS as at the technical end of BPM, such statements indicate that the people concerned do not feel BPS to be appropriate in their circumstances. In effect, they say that BPS is likely to be unproductive if the processes are as ill-defined as they feel theirs to be. Instead, these people use simple static methods for process mapping and may use spreadsheets to size things up. Whether this is sensible, given the amount of variation in most human processes, is another question altogether. Hollocks argued that lack of trained people was one reason for the low use of simulation in manufacturing. However, this reason did not figure when people responded about why they did not use BPS. Of course, this may be due to the sample frame used here, which consisted of people who have already received at least a basic education in computer simulation methods.

Even fewer people use BP simulators

For some years there have been dedicated tools to support the simulation of business processes,[2–5] but BPS users seem to prefer more general-purpose simulation software. This may be because their groups have existing investments in the general-purpose software and that enough people are trained in its use to make it unattractive to switch. Or it might be because the existing BPS VIMS are not up to the job. Although there were few complaints about existing simulation software, it is possible that some of the BPS VIMS are not flexible enough to meet the demands of business process simulation, given the comments above about the ill-defined nature of many business processes. Asked what features needed improvement, the few users who responded listed aspects such as the modelling of activities, resources, storage areas, and routing of workflows. In addition, respondents occasionally indicated that existing tools were not ideal for modelling human processes, which are, after all, at the core of many business processes.

Some might argue that this extremely low use is because many BPS VIMS are simply cut-down versions of more general-purpose VIMS. This may have been true in the first years of the development of BPS VIMS. However, as the software vendors obtained feedback from clients, the tools evolved. There are now tools with some degree of sophistication, supporting the mapping, simulation, automation, and monitoring of business processes (eg, Aris Toolset®). The simulation engine may be the same as mainstream products, but the GUI and the functionality can be different. Despite this, their reported use is very low.

BPS projects have short durations and are often facilitative

As indicated earlier, BPS projects almost never last more than six months, which was what was reported by Cochran *et al*[11] in their survey of industrial simulation projects. BPS projects typically focus on staffing and inventory, stressing process efficiency rather than effectiveness, which mirrors the findings of Stanford and Graham[12] for users of Optima!® and of Cochran *et al.*[11] There seemed little concern with novel approaches nor any wish to use the latest software; instead there was a recognition that BPS could be applied in a facilitative mode. In other words, process experts were part of project teams and the models were used as part of an approach that invited people to collaborate in developing and evaluating ideas.

Unsurprisingly, respondents stressed that the management of BPS projects is crucial to their success. This mirrors the findings of Hlupic[18] on simulation software and of Robinson and Pidd[19] on provider and customer expectations in simulation projects. Respondents cited the need for management support, clear project objectives, clear understanding of the problem being addressed, good communications, and high quality data. None of these is surprising, though some may worry about the lack of mention for detailed simulation expertise. Perhaps this is taken for granted?

BPS may have negative connotations

Although the survey did not ask specific questions about the BPS phenomenon itself, users could express freely their opinion in the spaces provided for open-ended questions. One practitioner who was using BPS on an experimental basis wrote:

> '*many of the issues that arise can be determined by common sense and a little*[bit] *of thought*',

and goes on even further to say,

> '*most of the business people I have dealt with regard the topic and the tools as* [an]*academic nicety*'.

[Bracketed words added by the authors to clarify the meaning of the quotations.]

These are severe statements, revealing a view, possibly widespread, that BPS projects add little to conventional wisdom, and that BPS is of limited practical use. This may indicate that, like its 'cousin' BPR, BPS has negative connotations with damaging effects on its practice, which is unsurprising given the hype of software vendors and a lack of serious research.

Concluding remarks

What can be concluded from this study, other than that the use of simulation in the design, modification, and improvement of business processes is rather limited in practice? Certainly, some of the drive for business process simulation came from the software vendors wishing to extend their markets beyond manufacturing simulation. However, it seems unlikely that things are entirely that simple. Others[15–17] have discussed the rise to prominence of business process concepts in an attempt to move away from the fragmented organisation of tasks in many organisations. Others[20,21] have discussed, too, whether the notions of integrated business processes are dependent on computer technology, are driven by computer technology, or are related to computer technology. What is clear is that customers demand rapid responses and that integrated business processes offer a way to achieve this.

The drive for manufacturing simulators in the 1980s and 1990s seems to have been driven by two factors. The first was the scale of investment being made in highly automated manufacturing systems that could not be designed on a 'suck it and see' basis. Simulation offered a way to understand how alternative designs and configurations would perform. However, this need was only one part of the equation and manufacturing simulation would not have become popular (if under-used) had not computer technology provided easy-to-use VIMS that freed the modeller from detailed programming. Perhaps the difference with business processes (as against automated manufacturing systems) is that they depend much more on human performance? This might explain the desire, from some respondents, for simulation software to be better at modelling human behaviour, whatever that may mean.

This desire could mean at least three things. The first is that it is may be difficult to use simulation to model unstructured, messy situations. Soft approaches might be of help, but they were little cited by users. The second is that human behaviour may be regarded as so unpredictable and tacit that it is very difficult to model. The third possible meaning is that the BPS tools are so simple that they are unable adequately to create logic resulting from complex human interactions (this is the meaning that is suggested in the paper). The combination of both soft and hard approaches to address both technical and social issues may be a useful implication for further research. Earlier experiences show that this may be time-consuming and complex and there is a need for a practical framework to achieve this.

The results of the survey have implications for four groups of people, as follows.

- *Practitioners*: Although only a small proportion of those surveyed reported that they were users of BPS, of those that did it is significant that they regarded project management as important and also that working in a facilitative mode was common. This may suggest that practitioners should regard the simulation of business processes as a way of working closely with their clients rather than as a way of unarguably demonstrating proposals for change.
- *Software developers*: These people will probably find the survey results very frustrating. After all their efforts in developing and promoting their packages for the simulation of business processes, use is low and very few people seem to use VIMS that are solely aimed at BPS. It may be that this group is caught in a bind—they promote their software on the basis of its ease of use (as well as value for money), but potential users know that important aspects of business processes are subtle and may not be modelled easily.
- *Educators*: If use of BPS is to increase then it will be necessary for educators to ensure that their examples and assignments relate to simulation applications of the type encountered in business process improvement. It will, though, also be necessary for this group to infuse their teaching with a concern for good project management and cooperative working with client groups. Being familiar with the technical aspects of simulation may not be enough.
- *Researchers*: Given that the small number of users do not seem to make much use of dedicated BPS VIMS, it may be better for researchers to turn their attention to other things. One such might be the development of component-based software that can be extended to fit particular markets. Another might be to develop more understanding of how people use simulation software, going several steps beyond what was possible in this survey.

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