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DEVELOPING A SIMULATION STRATEGY FOR BRITISH AIRWAYS OR

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ABSTRACT

Many organisations have seen the use of simulation evolve, often in something of a piecemeal fashion. This may lead to some deficiencies in the way that simulation is employed. Therefore, it is useful to step back and reflect upon how the application of simulation could be improved. This paper describes such a project in which a simulation strategy was devised for the British Airways Operational Research Group. The first step involved a series of interviews with the operational research analysts and their customers through which an understanding of simulation use was developed. A SWOT analysis on the findings from these interviews revealed a number of issues that needed to be resolved. Proposals for addressing these issues were developed and refined through further discussions.

1 INTRODUCTION

In many organisations the changing and hopefully increased use of simulation is likely to have occurred in an evolutionary rather than a planned fashion. This 'survival of the fittest' approach may eventually lead to the effective and efficient use of simulation, however, most organisations do not have the time to wait for this process of natural selection to occur. Therefore, there comes a point at which someone needs to intervene, reflect on the current use of simulation and develop a strategy for its continued use.

This paper describes a study in which the use of simulation by the British Airways Operational Research (BA OR) group was investigated. The aim of the study was to develop a simulation strategy. The paper starts with a description of the BA OR group and its activities, with a particular focus on its use of computer simulation. The study into BA OR's simulation strategy is then described including an outline of the problem, a description of the approach taken and a summary of the recommendations that resulted.

2 BRITISH AIRWAYS OPERATIONAL RESEARCH GROUP

The British Airways Operational Research group is the largest private sector operational research group in the UK, with over 100 members of staff. The group acts as a fee charging internal consultancy for the various divisions of British Airways (BA). It is divided into seven separate customer focused teams (key project areas are shown in brackets):

- Airports (baggage handling, passenger services and terminal control)
- Profit Development (engineering and cargo operations)
- Revenue Management (inventory management and pricing)
- Corporate (finance revenue, runway capacity, network development, corporate strategy and other central departments)
- Operations (flights and services, operations planning and delivery, and crew resources)
- Sales (world-wide sales and sales forecasting)
- Marketing (relationship marketing and product development)

Although these teams are all located at London Heathrow, they work in almost complete isolation to one another, highlighted by their disparate locations within the Heathrow site. However, staff are regularly rotated between the teams and joint meetings are held on a frequent basis, ensuring that some level of cohesion is maintained.

BA OR are involved in providing support for both tactical and strategic decisions using a variety of analysis methods including the standard operational research techniques. These techniques include both 'hard' (e.g. forecasting, optimisation and queuing theory) and 'soft' (e.g. system dynamics and cognitive mapping) approaches. Among the most commonly used techniques is discrete-event simulation.

3 THE USE OF SIMULATION WITHIN BA OR

Simulation is used by some teams more than others, with the Airports team being a particular focus of activity. Over a period of years many simulation models have been built and used. For example, a number of models have been built to investigate check-in facilities in order to determine desk and staffing requirements. Models have been developed of the baggage handling systems at Heathrow Terminal 1 and Terminal 4, as well as the transfer tunnel between the two terminals. A major project involved a simulation of the World Cargo Centre at Heathrow which was used to aid the design of the layout and methods of planning and control. Other studies have utilised models of aircraft boarding, stand planning, runways, aircraft maintenance, crew coaching and a telephone sales call centre.

These models have been built by BA OR staff and by external consultants or contractors. In some cases joint projects have been carried out with the operational research group at BAA (British Airports Authority) based at Gatwick Airport. Experimentation with the models is carried out by BA OR staff, with many of the models also being available for use by the customers within BA.

A variety of simulation packages have been employed including (in alphabetical order): Arena/Siman, AutoMod, InterStock, PCModel, SimMod, Simul8 and Witness. There has also been a joint development with Hewlett-Packard of an airport terminal simulator known as Oscar. Some simulation models have been built in Excel with Visual Basic for Applications.

Various members of BA OR have specific responsibilities for simulation. One of the authors (Stanger) acts as 'simulation champion'. His aim is to improve the use of simulation within BA OR. The 'simulation campaign team' meets regularly to discuss developments in the use of simulation within BA OR. This group is headed by the simulation champion with representation mostly from the Airports team. The more frequently used simulation packages have 'product champions' whose job is to liaise between BA OR and the software suppliers. Each team has a simulation representative with whom the campaign team and champions communicate.

4 THE PROBLEM

At the time of the study it was felt that there were opportunities to use simulation more effectively in BA OR. As a result, some of the benefits of simulation were not being achieved. The lack of co-ordination between the teams and the variety of simulation packages used presented particular problems. A strategy for the use of simulation within BA OR was required that would enable:

- greater co-ordination across the teams
- the rationalisation of simulation packages
- improved practice in, for example, project management, simulation methodology, standards and documentation, reuse of code and generic modelling
- the identification of responsibility for modelling within the teams, among the customer base and/or through the use of consultants

One of the authors (Robinson) was asked to help in the development of this strategy, with support from the simulation champion.

5 THE STUDY

The study was split into four key stages: information gathering, analysis, report back and review, and a final presentation to the OR managers.

5.1 Information Gathering

This stage consisted of a series of group discussions with members of each of the BA OR teams, as well as separate interviews with some of their customers. The aim of these discussions was to gather information on current simulation practice within BA OR and to explore how current practice could be improved.

Those members of the BA OR teams who were either currently involved in simulation work, or who had previously been involved with simulations, were gathered to discuss their experiences. The discussions were purposefully left unstructured with one of the authors (Robinson) acting as facilitator. They started with each person describing their experiences with simulation. From there, different avenues were explored depending on the issues that arose. Prior to the sessions the facilitator had determined an agenda of topics that should be covered (Table 1), and he used these to guide the discussions where necessary. This agenda was not strictly adhered to, but was simply used to ensure that all vital topics were discussed. Indeed, other topics emerged as a result of the discussions. By allowing the discussions to flow freely it

was possible to build up a 'rich picture' (Checkland 1981) of simulation practice within BA OR.

Following the group discussions, the facilitator spent some time with individual members from each team discussing in detail the work they had performed, and looking at their simulation models. This enabled a more detailed understanding of previous work to be obtained.

In a similar fashion, some discussions were held with the customers of BA OR, that is members of BA staff who had used BA OR's services. The purpose of these was to obtain an understanding of the customer's view of BA OR, and thereby develop a quality perspective - the extent to which the work performed meets the customers requirements (Crosby 1979). The discussions were also unstructured, starting with the customers describing their experiences with simulation. Again, the facilitator had an agenda of topics to be covered that was used to guide the discussions (Table 2).

Table 1: Topics for Group Discussions with BA OR Teams

The Current Situation	**Future Directions**
The Customers	*The Customers*
• Who are they?	• Is there potential for the wider use of simulation?
•	
The Providers	*The Providers*
• Who are they?	• What is the best balance between consultants, OR analysts and customers performing simulation studies?
• What skills do they have?	• What skills are required?
• How are new providers brought up to speed?	•
The Projects	*The Projects*
• What problems are tackled with simulation?	• What problems could be tackled with simulation?
• What procedures are in place for managing projects?	• What procedures are required for managing projects?
	•
The Software	*The Software*
• What software is used?	• What are the software requirements?
	•
The Environment	*The Environment*
• What level of co-ordination is there within the team?	• Does co-ordination need to improve?
• What level of co-ordination is there between the teams?	• How could co-ordination within the team be improved?
• What specific problems are encountered when performing simulation studies?	• How could co-ordination between the teams be improved?
	• How could specific problems encountered during simulation studies be overcome?

Table 2: Topics for Group Discussions with BA OR's Customers

1. Description of simulation projects in which customers have been involved.
2. An evaluation of the simulation service offered by Operational Research:
    - strengths
    - weaknesses
3. How could the use of simulation be improved in the future?
    - where could simulation be used?
    - how could the service offered by Operational Research be improved?

5.2 Analysis

Detailed notes were made of all the discussions, and these formed the basis of the analysis. The first step entailed a SWOT analysis. The points raised at the discussions were classified as strengths, weaknesses, opportunities or threats. Because a large number of points were listed, the following sub-headings were devised to add further clarity:

- Simulation Software
- Model Development
- Model Support and Maintenance
- Data
- Knowledge and Skills
- Customer Interface
- Timeliness
- OR Structure
- Future Uses for Simulation

For instance, one strength was the analytical skills of BA OR staff. This was listed under the knowledge and skills sub-heading. Examples of the SWOT analysis for two of the headings (software, and knowledge and skills) are shown in tables 3 and 4.

In the second stage of the analysis one of the authors (Robinson) devised an initial simulation strategy for BA OR. The aim of this initial strategy was not to dictate future directions but to act as a catalyst for further discussion. For each of the sub-headings described above an objective and set of plans were proposed. For instance, the following objective was proposed for the simulation software at BA OR:

> *Appropriate simulation software is to be maintained in-house for all levels of model that are directly supported by BA OR.*

Table 3: Example of SWOT Analysis for BA OR: Simulation Software

Strengths	**Weaknesses**
Wide selection of software available	Lack of involvement in choice of software Difficult to enhance specialist airline software
Opportunities	**Threats**
Virtual Reality could provide a new use for simulation Obtaining a process mapping/modelling tool Obtaining networked software Identifying a simple simulation tool for 'quick and dirty' modelling	Limitations of some packages and difficulties of continued development Cost of software licences Slow run-speed of simulations Continued diversification into unsupported software

Table 4: Example of SWOT Analysis for BA OR: Knowledge and Skills

Strengths	**Weaknesses**
Analytical skills Strong customer focus develops expertise in customer areas	Knowledge lost through high level of internal staff moves Limited knowledge of simulation software and simulation developments Shortage of simulation modelling expertise Teams adopt solution approaches aligned only to their skills
Opportunities	**Threats**
Formal training in simulation software and methodology for new staff Develop simulation experts that support projects Share expertise through special interest groups	None identified

Table 5: Tentative Suggestions for Simulation Software Choice at BA OR

	Types of problem		
Levels of model	**General simulation**	**Materials handling**	**High Level**
Quick and dirty	Simul8	Simul8	Stella/iThink
		Witness	
	Witness		
		AutoMod	ProSim
Moderate			
Complex	ModSim III		

This required some rationalisation of the software that was being used. It was proposed that between three and five packages should suffice for the majority of BA OR's needs. These were identified by considering the level of models that are built and the types of problem that are modelled. The matrix shown in Table 5 was devised, with initial suggestions for the appropriate software. These suggestions were made in part on the basis of BA OR's current software investments and skills. However, a number of alternative packages were identified that could fulfil these roles. What Table 5 shows is that for general simulation problems a package such as Simul8 would suffice for very simple models, however, once more complex models need to be developed a package such as Witness would be necessary. At the extreme end of complexity a specialist simulation language such as ModSim III may be required. For materials handling problems, whilst the general simulation packages may be able to model relatively simple problems, a specialist materials handling package, such as AutoMod, would eventually be required. For high level models, the System Dynamics approach (Wolstenholme 1990) may be appropriate using software such as Stella/iThink. Beyond this, a specialist process mapping/discrete-event simulation tool, such as ProSim (which links to Witness) (Thompson 1995), may be beneficial.

BA OR also uses a number of specialist airline simulation tools. It was suggested that these should continue to be used, although some rationalisation would be beneficial. It was also recommended that networked software should be considered as a means for reducing licence fees and increasing flexibility. This, however, would require the implementation of an in-house network, spread across the various locations of the BA OR teams.

In terms of knowledge and skills the initial objective set out was:

A hierarchy of readily available skills from basic simulation package use to simulation and modelling expertise.

Since BA OR is currently customer focused this encourages a good knowledge of the situations to be modelled. What it has not encouraged is expertise in simulation and modelling, and whereas knowledge of the customers' business may be important for lower level modelling, more complex models require a greater emphasis on modelling skills. As a result, it was suggested that the following specific simulation roles should be established:

- *A Simulation Modelling Expert*: who should be proactive in ensuring that simulation is used, specifying projects, ensuring the right software is selected and ensuring simulation is used properly.
- *Simulation Software Experts*: who should develop expertise in a specific simulation package and be available to support its use.

The time these experts spend on any project should be chargeable to those projects.

A major difficulty is BA OR's approach to career development, which is one of regularly moving staff between teams. While this serves to develop a broad knowledge of analysis methods and the customers' business, it discourages the development of specific modelling skills. Being a simulation expert has to be seen as a means of career development, and even if these experts move between teams their skills should not be lost to the rest of BA OR. Indeed, becoming an expert has to be seen as a long-term role due to the costs of training and experience required.

What is described above is two examples of the SWOT analysis and the initial strategy. In a similar fashion a SWOT analysis and initial recommendations in terms of objectives and plans were made for each of the other seven sub-headings.

5.3 Report Back and Review

Following the analysis, the findings were presented and discussed at a one day meeting of the simulation campaign team. The purpose of this meeting was to further develop the strategy through a process of consultation. The morning was spent discussing the SWOT analysis, ensuring that all members of the campaign team understood and agreed with the findings. From this discussion some items were added to the analysis. The afternoon was spent discussing the strategy. The initial simulation strategy was presented, after which the team discussed the extent to which the strategy should be adopted. Some parts of the strategy did not fit with the organisation of BA OR. The team held some additional meetings to discuss how to adapt the recommendations particularly on structure and roles.

The proposed structure was ideal in terms of the practical side of providing simulation services across seven separate teams. However, it did not fit in with the way these teams charged for their services. Each team reports to a different department which holds the budget for resources, software etc. and charges productive time to its customers. There is no provision within BA OR for holding a central budget for simulation. The campaign team came up with three alternative options on structure, ranging from part-time experts within individual teams, to a single full-time roving expert.

The roles proposed in the strategy were designed to fit in with the centralised simulation team. These roles had to be revised to take account of the alternative structure options.

5.4 Final Presentation to the OR Managers

On the completion of these discussions the simulation champion presented the strategy to the managers of the seven OR teams. This presentation covered:

- *SWOT Analysis*: an overview of the SWOT analysis to provide the background and context to the strategy.
- *Proposals*: an outline of the proposals covering the software, customer interface, and model development, support and maintenance. These proposals were presented for information only and were all accepted.
- *Structure and Roles Options*: the options for structure and roles were described and discussed. It was decided that the Airports OR team (the biggest user of simulation) would look to recruit a simulation expert along the lines of the simulation modelling expert described in section 5.2. This person would provide simulation project management and modelling skills to the Airports team, and support to the other teams.

6 THE RECOMMENDATIONS

The recommendations from this study can be broken down into three sections: recommendations that can be implemented immediately, tasks that need to be implemented, and longer-term aims. These are summarised in Table 6.

It should be noted that BA OR have decided not to adopt a strict approach to software selection. Instead, the recommendations outlined in Table 5 (section 5.2) will be used as a guide, rather than a set of constraints.

The study also came up with recommendations on the use of data within BA OR. There are many common data requirements across the seven OR teams, for example, schedule data, passenger numbers and activity timings. Historically each team has collected its own data, often from different data sources, with no knowledge of the data held by the other teams. The study recommended the development of a central OR database to improve data accuracy and consistency, and to reduce the amount of time spent on data collection.

7 CONCLUSION

This paper describes the development of a simulation strategy for BA OR. The development of this strategy, however, is only the first step; there is still a great deal of work to be done in the implementation of the recommendations. In particular, a lot of effort is required to improve the co-ordination across the teams, and the use of outsourcing and internal experts needs to be closely monitored. It is worth noting that many of the recommendations could also be applied to other techniques used by BA OR, for instance, the use of networked licences, outsourcing larger projects and developing guidelines and procedures.

Obviously the recommendations presented here are very specific to BA OR. They should in no way be transferred directly to another organisation. Many organisations may, however, be in a similar position to BA OR; having seen the use of simulation evolve in the past few years, or even decades, it may now be time for them to step back and reflect on the way that simulation is being used.

Table 6: Simulation Strategy Recommendations

Heading	Immediate implementation	Tasks to be implemented	Longer-term aims
Software		Investigate the potential for networked licences Introduce Simul8 or similar package to the OR teams Promote the use of 'quick and dirty' modelling	
Model development, support and maintenance	Outsource larger project to companies (rather than individuals) Develop generic models where possible	Find preferred simulation modelling suppliers Develop a standard approach to generic modelling Develop guidelines and procedures for maintaining, validating and documenting models	
Roles and structure			Recruit people with simulation skills Develop the simulation role as a means for career development
Customer interface			Be more proactive with simulation

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