A study of the application of simulation software for business processes

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Abstract:

This paper reports on the experiences of using two popular business process simulation (BPS) software packages. BPS is a technique, which assists companies in mimicking their everyday operations to find ways in which to improve and develop them in order to achieve either productivity, financial, or risk-free gains. There are many computer packages available on the market, and it is important to have an idea of the type of software that can promote these benefits further. The two software packages investigated in this study are Witness by the Lanner Group and Simul8 by the Simul8 Corporation. These packages are used by organisations as management tools to optimise their internal practices. A practical evaluation of both packages has been undertaken, using the model building of case studies in both Witness and Simul8. Comparisons were made, with a number of conclusions and recommendations, and the advantages and disadvantages of each package are given. This study is different from other investigations as it focuses on evaluating the user experience rather than a traditional comparison of the statistical output of the reference models.

Keywords: Business Process Simulation, Discrete Event Simulation, Witness, Simul8, Modelling Software, Simulation Software

Introduction:

Business Process Simulation (BPS) software has been used throughout industry in numerous formats to support change by using dynamic animation to give managers a better understanding of the flow of their business and how it operates [1]. By creating a virtual copy of the system under consideration, using computers and specifically designed software, problems are examined in detail, and various policy options are formatted to solve areas of concern within the simulated system [2].

BPS is, in our opinion, one of the most interesting techniques available. The process model to be simulated must take into account the resources used and the characteristics of the activities that make up the process itself. By specifying the system's workload, the analyst can evaluate the performance of the business process along with a number of indicators such as lead-time, use of resources, and costs [3]. Once built, the process model allows the analysis of many potential new scenarios with little extra effort, commonly known as 'what-if' analysis [4].

BPS, whether applied in the service or manufacturing industries, supplies organizations with a technique for investigating and testing its own working practices, and the results provide many benefits, such as reduced risks/costs, faster implementation of change, and improved operational efficiency [5]. All of these factors combine to show how BPS can be a beneficial process for any company or organization.

BPS has evolved and utilized the best features inherent in computer software [6]. The development of these software packages allows an analyst to watch the dynamics of a model unfold in the form of a semi-pictorial silent film [7], users can stop the running of a model and interact with it [8]. BPS has introduced effective decision-making to a new generation of management.

This paper reports on the practical experience gained from evaluating two popular BPS tools available on the market rather than on a comparison of the output statistics from the manufacturing models [9]. Due to the wide variety of software packages available, the evaluation and comparison has been limited to the two main packages available and utilized for teaching/research at Manchester Metropolitan University in the UK.

Fitness is the first of the two commercial packages to be discussed, developed by the Lanner Group [10], and promoted for it's easy to use and flexible properties. It is utilised by world-class organisations in many different industry sectors, aviation, criminal justice, defence, and oil companies, and organisations such as the US Army, the UK Ministry of Defence, Shell and Madame Tussauds have benefitted from the Witness package. The second package to be considered is Simul8, which is described as a *"Decision support simulation tool used by business professionals to facilitate the improvement of performance and service levels"* [11], and has been employed in the manufacturing sector by Hewlett Packard, healthcare and call centres, by the NHS and the British Nuclear Group, for its planning capabilities.

In order to compare the two software packages, a number of scenarios have been modelled and simulated, using discrete event simulation. The diversity of simulations supports the main aims of this study, which are:

1. To test the ease of handling of both Witness and Simul8.

2. Research the help facilities available; can each package provide the same assistance required by either experts or novices?

3. Individual specifications of each simulation program; what differences are highlighted in each business processes simulation?

4. Validity of models designed, compared to the case study provided.

5. Advantages or disadvantages of each package.

6. Does the type of process being simulated have contributing factors as to which system should be used?

BPS Methodology:

A common strategy for implementing BPS contains a number of steps from the initial plan of considering simulation, through to the results produced by this technique. If these steps are followed, the simulation will develop in a logical sequence [12]:

1. **Decide the purpose of the investigation.**

    In general terms, this will be the reason why the organisation feels the need to simulate part or all of its current systems. A type of improvement is the obvious target, but this could be either examining the logistics of change or developing methods of control for queuing.

2. **Analyse the system structure**

    Parts, customers, workers, and machine activity need to be tracked through the system to ensure the simulation mimics the original. This phase produces flowcharts/activity cycle diagrams that capture the operational flow.

3. **Identify stochastic processes**

    All simulations have randomness within the system; a customer's inter-arrival time at a bank would be described as a random phenomenon, and this assists in setting the statistical distributions which are required as part of the simulation input.

4. **Code the simulation**

    At this stage of the procedure, the simulation package is used to convert all the information gathered into a system simulation.

5.   Preliminary runs and validation

The simulation is trialled until it is certain that it is imitating the system. This has three stages:

a)   Verify that all internal logic is correct. Activity cycle diagrams and statistical distributions are working correctly.

b)   Validate that all system outputs are similar to the real system.

c)   Analyse the stability of the system; this will show whether queues are causing bottlenecks or not.

6. Design experimentation

The importance of the simulation runs that are created in phase seven of the simulation is realised in this step by designing specific runs. Another advantage for developing the experiments at this point of the process is that the results can be compiled quicker.

7. Main Runs

This stage generates the data which is relied upon to generate the final results.

8. Analyse Results

Conclusions are now made from all the data and information gathered in each step.

With the basics of BPS methodology clarified, the paper will now continue to build on this information, with the evaluation and comparison of two widely used simulation packages

Comparison and Findings:

A series of simulation case studies were collated from Manchester Metropolitan University. The examples in question have been taken from the School of Engineering's Operational Management based courses taught at postgraduate level.

Both software packages use graphical user interfaces (GUI's) to create visually interactive models (VIMs) that represent operational logic and flow using modelling elements displayed as icons. VIMs are user-friendly and support rapid model building onscreen. Models are constructed by selecting icons that represent features of the system being simulated, and these are linked together onscreen and parameterized using property sheets.

Two case studies have been selected to give a diverse spectrum of utilisation for both software packages:

1.   Simple Queue. Typically found in retail and, for example, waiting for an elevator at a lobby call point [13].

2.   Limited Waiting Room.

Each case study is modelled and simulated in both Witness and Simul8, with findings presented below.

Case Study 1: Simple Queue:

As stated in case study 1 (Appendix 1), this example consists of a customer entering a queue, being served at a counter by a customer service officer, then leaving the system. Statistical data is included in the case study, and activity cycle diagrams are illustrated in the appendices.

Simple Queue – Witness

This is a minimal Witness model that makes use of all the designer elements that are available to build the simulation. The four elements are personalised as follows:

- Parts become customers.

- Buffers become the queue for the arriving customers.

- Machine is now a counter that serves the customer.

- Labour is the counter clerk who serves the customer at the counter.

On completion of the simulation, over a short period of time, a queue has built up (Fig 1).

Fig 1. Simple Queue – Witness Model

Whilst the simulation is running, there is no indication, other than a queue building, of how many customers have been served. However, this can be built into the Witness model by using further options in the designer elements window. It is a quick and easy process, once understood, but still requires more programming than for Simul8, as evidenced later.

After inserting a variety of performance-based display counters, the layout window (Fig. 2) now provides the analyst with reasonable feedback in a dynamic manner while the model is running.

Fig 2 Simple Queue (enhanced) – Witness Model

Simple Queue – Simul8

The same case study using Simul8 is shown in Fig. 3, with the simulation comprising the following objects:

- Work item becomes customers.

- Work entry point.

- Queue is shown as a store (identical to a bucket filling with items).

- Work centre is now a counter that serves the customer.

- Resource is the counter clerk who serves the customer at the counter.

- Work Exit Point, where customers will exit the simulation.

This simulation differs from Witness model, as all objects in the work area already have counters assigned, which has a visual advantage as the simulation runs.

Fig 3. Simple Queue (static) – Simul8 Model

However, this simulation does not show the customer as a visual element until a simulation run has started, as shown in Fig 4.

Fig 4. Simple Queue (dynamic) – Simul8 Model

An additional point to highlight within the same model (Fig 4) is the store. This object is automatically input into the initial model as an image displaying a bucket filling with six items. This obviously does not represent a queue of people correctly. However, straightforward changes can be made to display a queue of customers waiting in line at the counter. Once the queue display style is highlighted, the simple queue model updates and shows the customers queuing, as in Fig 5.
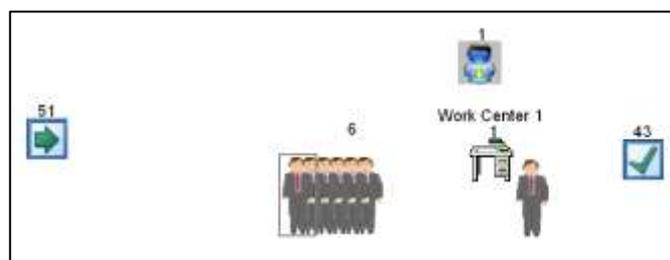

Fig 5. Simple Queue – Simul8 Model

Simple Queue – Findings

Even with a simple model, the differences between Witness and Simul8 start to appear. Nevertheless, actions can be taken to influence either simulation to correct these deficiencies. Tallies similar to Simul8 can be implemented in the Witness model; therefore, a tally is kept of the number of entities which have passed through each point of the simulation.

Evidently, the customers are arriving at the location at a faster rate than the Server can handle. This highlights the need for an organisation to test whether they require a further resource to handle the additional capacity of customers flowing through the system, or whether, perhaps, quicker service procedures need to be implemented at the counter. Testing can be done on all aspects of this model.

Reports are automatically compiled in the Witness software, whilst Simul8 needs specific commands to compile the reports. Results can be examined for each object by opening the properties window (Fig 6) and selecting the results icon.
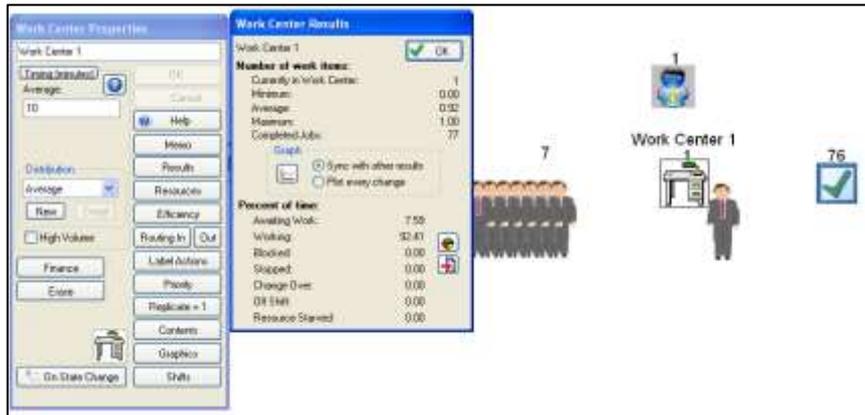

Fig 6. Simple Queue – Compiling Reports in Simul8

Case Study 2: Limited Waiting Room:

Limitations in a waiting area or a queue are commonplace in industry. This example has been taken from a rear combination lamp assembly cell in the automotive industry. It shows that by simulating the problem, it can be seen more clearly, and experimentation can be carried out on the virtual process. This is far more cost-effective than having to alter the actual system.

Presented with the problem in case study 2 (Appendix 2), it is immediately obvious that, having only the capacity of two parts that can queue from Job A to Job B, Job B will become blocked very quickly, creating a blockage in job A, holding the backlog of work. From a simulation package point of view, how will each tool demonstrate the blockage issue?

Limited Waiting Room – Witness

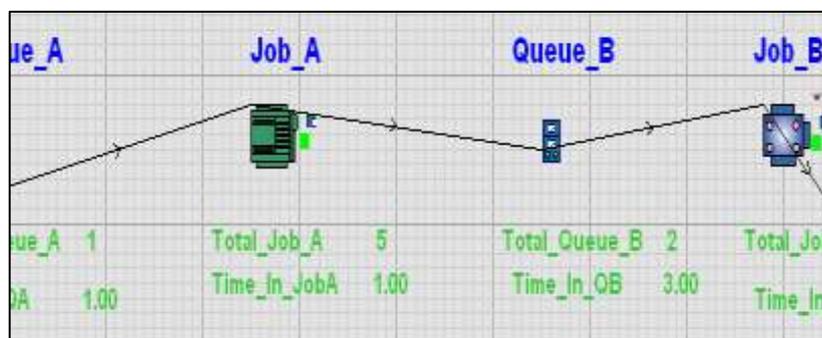The completed model is displayed in Fig 7.

Fig 7. Limited Waiting Room – Witness Model

The limited waiting room model is developed as in the previous case study in Witness. The queue for Job B needs a capacity of two inserted into the properties window. Counters and timings take additional time to set up with visual counters, but this can be taken one step further. Fig 8 shows how the visual display can be enhanced by having a key that represents the state of the machine at any time in the simulation run.

The machine state key enters the layout window and, with its easy to follow colour state key, it is easily seen that Job A machine has become blocked due to the limited waiting room at Job B and the queue forming at all elements prior to it (Fig 8).
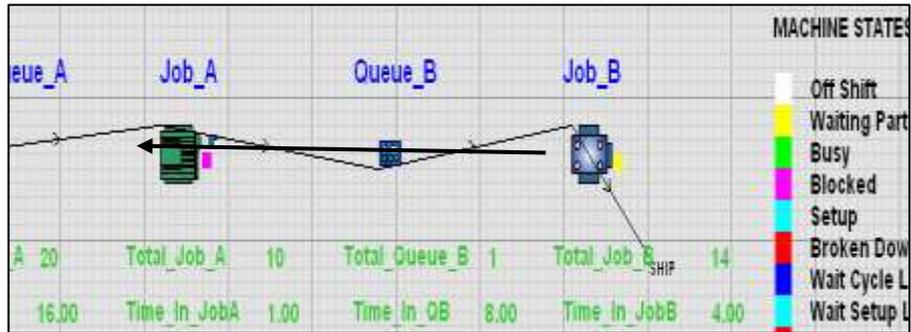

Fig 8. Limited Waiting Room (with key)– Witness Model

Limited Waiting Room – Simul8

The same model was built in the Simul8 package, but the machine status type of feedback is unavailable when the model is running. However, is it needed? From Fig 9, it is obvious that a queue is building prior to Job A due to the limited waiting area for Job B.
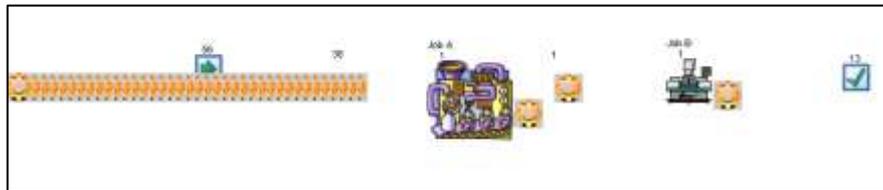

Fig 9. Limited Waiting Room – Simul8 Model

Limited waiting Room – Findings

At this point of the evaluation, it seems that the two packages are offering exactly the same function, which is to simulate business processes in order to encourage improvements within the system that is being modelled. However, the detail which can be included is phenomenal, and at what point is this detail too much?

Results:

The differences found within the modelled and simulated case studies are now discussed in detail.

Simple Queue

The most notable difference between Witness and Simul8 is the visual dynamics of both packages. For Simul8, when building the Simple Queue, it automatically includes counters to allow the analyst to look at the amount of work or items that are passing through each entrance, activity, queue or exit point. Having the identical information implemented within the Witness screen takes some further work, but nothing that would add a huge difference onto the model building timescale. However, the additional information that can be shown

whilst the simulation is running is beneficial to the analyst. Colored status blocks in the form of a key (Fig 10) give the analyst immediate warnings as to the areas of concern.
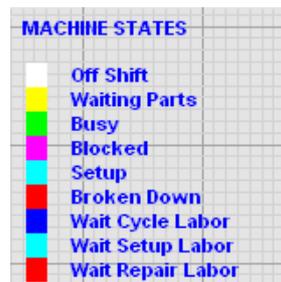

Fig 10. Machine States

Once stopped, Simul8 can be looked into for all of the above states, but this means waiting until the full simulation has run its course and then conducting further investigation.

An additional benefit of Witness is that the tallies can then be added onto the layout screen of the simulation, they can be adapted for any result, whether it be a number, a time stamp, timed activity or financial feedback, without stopping the simulation.

Limited Waiting Room

As a queuing theory scenario, this is a vital case study to look at for simulation purposes, but for comparison purposes, the beneficial factor is that Witness allows each element to be named on the simulation screen, whereas Simul8 does not. Queues within Simul8 originally input on the screen as buckets of work items that fill and empty, but it is not made factually clear which queue it is. On large simulations, this can become confusing when deciding which queue, a certain item is from or where it is bound. Witness allows every element on the screen to be named.

Discussions:

Throughout the model building, simulation, and analysis of the two case studies, some initial findings have been made, with differences highlighted. Amalgamating the differences between the two simulation packages will be basis for the outcomes of this evaluation study.

When either Witness or Simul8 is applied to a case-study, there are some differences that become immediately apparent:

Simulation Plan: Witness requires an initial investigation into the system to be simulated in the form of a flowchart, whereas Simul8 introduces system state and activity cycle diagrams from the beginning of the simulation process.

Names of Specific Elements: Whilst Simul8 creates its own language, which distances itself from the generic language of simulation, Witness uses standard terminology, with glossaries provided if a more technical version is used. For example, the performance & service version of Witness describes the element of interest that flows through the system as an 'entity', but the manufacturing version describes this as a 'part.' Simul8 complicates matters by having its own personalized terminology, for example, an entity can be a work item or resource depending on the entities used.

Ease of Handling: Immediately on opening the Simul8 package, assistance is offered, with the use of templates and examples to consider when designing and creating a personalised simulation. Examples are available with the Witness package; however, these are not as obviously demonstrated as in Simul8.

Simulation packages do offer an extensive scope of areas to consider when creating a simulation, but can anyone use them immediately?

Using Witness has shown that some training is needed even for simple simulations, but this is no different from Simul8. Although Simul8 is a simple and straightforward package when dealing with a simulation with one work item, anything more in-depth needs some form of training. However, after working with both packages for many hours, it becomes a logical process that can be experimented with.

Both software packages offer help commands and searches, but continuous simulation problems require the use of tanks and pipes, and Simlu8 has little explanation on how to approach these. The help section offered by Witness is comprehensive and detailed compared to the more simplistic approach of Simul8 software. This highlights that further support is required after purchasing Simul8, whereas most problems with Witness can be researched through the help application provided.

Conclusions:

After reflection on the discussions, the following conclusions have been identified:

Advantages of Witness as a Simulation Package

- This program allows greater diversity for input of distributions.

- First arrival times can be stated.

- Cloning of elements can speed up simulation input.

- Layout screen can include feedback on the simulation whilst model is running, e.g. in the dynamic model, for example, financial data or timing of activities.

- Machine status key allows the analyst to visualise where the blockages or delays are occurring without stopping the simulation.

- The graphical content available for each industry is comprehensive.

- Numerous entities can be simulated to progress through the system, making it more realistic.

- Authentic elements are available, for example tanks and pipes, rather than just using parts and activities.

- Help available as part of the program is extensive, and works through "how to…" scenarios in detail.

- A strong format to present to employees and management, without having to explain the mathematical processes behind the system itself.

Disadvantages of Witness as a Simulation Package

- This package is marketed as easy to use; however, the practicalities of getting it right, rather than experimenting with analytical tools, is not highlighted.

- The limited use of pre-modelling planning may mean that the modelled system and the real system could have major differences.

Advantages of Simul8 as a Simulation Package

- Examples and templates are offered immediately, with many guides to simple systems.

- No further work is required to allow the work area to highlight numbers of entities served, etc., as the simulation runs.

- Similar terminology used as Microsoft Windows, which offers familiarity with the Simul8 program immediately. For example, 'copy,' 'paste,' etc.

- Additional routing options are available, making Simul8 more versatile.

- Results can be trialled giving more versatility

Disadvantages of Simul8 as a Simulation Package

- Simul8 assumes information without actual input by the analyst. Timings of work centres and time to travel between objects, requires amendment immediately. In addition, routing is often assumed by the software rather than allowing an analyst to program the software themselves.

- Only one work item is deemed as compulsory, which brings in the factor of Labels, a function that can be confusing rather than a helpful addition.

Observation

After careful consideration of the simulations, it is the conclusion of this study that, whilst the use of graphics has developed, the process, planning, and investigation are still only as good as the data implemented into the model.

This paper also provides interesting insights into the usability and relevance of component technology for simulation modelling. It demonstrates that a component-based approach can be usefully exploited to construct simulation environments that are able to address the compromise between ease-of-use and flexibility.

On a more critical note, it dismisses the claims of scientific literature that component technology is a cure for simulation modelling. The technology alone is not enough for a successful outcome, but component-based simulation still requires careful attention to design principles. Hence, this paper contributes to the emerging discussion investigating the potential of BPS software technology for discrete event simulation.

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Appendix 1

Case Study 1 - Simple Queue:

This example consists of a customer entering a queue, being served at a counter, which is manned by a resource (Worker) on a first come first served basis. A representative activity cycle diagram is shown in Fig 11.

| Simple Queue: Simulation Specific Information		
Type	**Detail of Type**	**Distribution or Additional Notes**
Temporary Entity	Customer or Part	Inter Arrival Time – Poisson (7) minutes
Permanent Entity	Work Centre/Activity – Service Desk (Includes Resource/Labour)	Fixed Serving Time of 10 minutes.
Assumptions:	After service, all customer types leave the simulation system.	
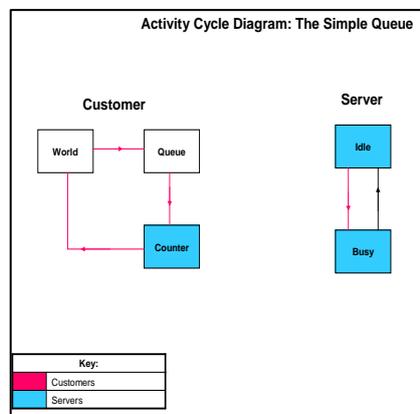
Fig 11. Activity Cycle Diagram of the Simple Queue Model

Appendix 2

Case Study 2 - Limited Waiting Room

This case study is an extract from an investigation into limited storage capacity for a third-party automotive supplier. The process is the assembly cell of a rear combination lamp (RCL) that comprises multiple jobs at different stations. For reasons of confidentiality, job details are removed and generalised as Job A and Job B.

This case study introduces additional limitations within the queue. Capacity is an issue which is frequently raised; a queue or store cannot have a limitless capacity. Therefore, this case study introduces a queue with a constraint on the number allowed to enter. Fig 12 illustrates the activity cycle diagram of the Limited Waiting Room.

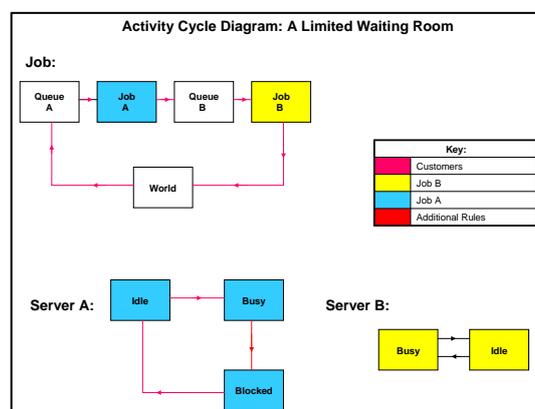| Limited Waiting Room: Simulation Specific Information		
Type	**Detail of Type**	**Distribution or Additional Notes**
Temporary Entity	Part	Inter Arrival Time - Exponential (1) minutes
Queue/Store	Queue for Job A Parts	Queue for Temp Entity – Capacity (100)
Permanent Entity	Work Centre/Activity - Job A	Fixed Service Time (1) minutes
Queue/Store	Low Priority Queue	Queue for Temp Entity – Capacity (2)
Permanent Entity	Work Centre/Activity - Job B	Fixed Service Time (4) minutes
Assumptions:	After parts have been processed in both Job A and Job B, the completed work leaves the simulation.	

Fig 12. Activity Cycle Diagram of the Limited Waiting Room Model