

CUSTOMIZING BUSINESS SIMULATIONS: AN EXPLORATION AND A HIERARCHY

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ABSTRACT

Developing a new business simulation is a time consuming and hence costly task. A way to speed development and reduce cost is to customize an existing simulation. Here the ways an existing simulation was customized to create three new versions and three totally new business simulations are described. The case study simulations are used to propose and illustrate a customization hierarchy that consists of two parts – micro customization where a new version of the original simulation is created and macro customization where a new simulation is created. The reasons that drive the need to customize are described and the software aspects that ease and support customization are explored.

INTRODUCTION

Developing a new simulation from scratch involves deciding what decisions will be made, what results produced, designing the models that link the two, testing and calibrating the simulation (Hall, 2005). This work will take months with development time in hours per hour of simulation duration ranging from 217 to 3080 (Chadwick (2002) 300 hours/hour; de Hoog (2002) 3080 hours/hour; Brandon-Hall (2002) 750-1300 hours/hour; Summers (2003) 1200-1500 hours/hour; Chapman (2010) 217-716 hours/hour and Meyer (2009) 320-731 hours/hour). This means that the development of a simulation with an eight-hour duration will take between 11 man-months and 15 man-years. Besides duration, development time is influenced by complexity and novelty (Hall, 2009), the availability of platforms & model libraries (Hall, 2004) and whether an existing simulation can be customized (the topic of this paper). Where a simulation exists and is customizable, development times can be reduced radically

THE CASE STUDY SIMULATIONS

The original simulation modeled a total enterprise business simulation (Biggs, 1990) for use on business acumen, business appreciation and finance for non-financial management courses. With a duration of about six hours it involved making and selling two products with decisions covering price, advertising spend, sales force size, production, capacity purchases and payment terms. It allowed up to eight teams to compete directly against each other over six simulated years.

R & D simulation: Some two years after the original simulation was developed a management college won a

contract to provide a business appreciation course to the research and development management of a major chemical company and felt that a business simulation could be used at the end of the course to provide a memorable, fun, finale. The prime purpose of the simulation was to link research and development activities to commercial success with the secondary purpose to develop financial understanding. The original simulation was used as a basis but with the sales force size and payment terms decisions removed and a bank loan decision added. The impact of R & D was modeled by adding decisions that allowed R & D effort to be focused on key research activities and, other decisions made about staff development and business research. The R & D effort decisions involved deciding how to use R & D staff time to drive commercial success by improving product performance, quality, material use, manufacturing processes and basic research (that might deliver a “break-through”). As with the original simulation two products were sold but these were repositioned at opposite ends of the technology/market spectrum. One was named “LOTS” – products where performance was unimportant but price was and so reducing material and manufacturing costs would drive success. The other was named “HITS” where performance and quality was important but price relatively unimportant and where improving performance and quality would drive success. With limited R & D resources, the participants needed to consider how they focused and linked R & D effort to commercial purpose and how this impacted their commercial decisions and results. For example, a focus on LOTS would mean that material and process research would be used to reduce product costs and hence allow lower prices and larger margins. Likewise, performance and quality research would be used to increase the attractiveness of HITS, increasing sales and allowing prices to be increased. The number of decisions to be made each period increased from 9 to 15 and the size of the simulation model increased substantially. However, using an existing simulation meant that it was only required to develop, test and calibrate the R & D models. Consequentially customizing an existing simulation more than halved the time that would be needed to develop a new simulation from scratch.

Assessment Center simulation: A large engineering company was to run a series of Assessment Centers to assess whether high potentials were ready to move to the next level. One of the assessment instruments would be a business simulation where C-level Executives would observe the participants running a simulated company. The original simulation was suitable in terms of complexity, scenario and scope, but it was felt that the assessment task could be supported by providing a special set of reports to

the assessors – reports that highlighted strengths and weaknesses and thus would indicate to the assessors areas of concern and allow them to observe whether the participants also identified these and dealt with them. This customization did not involve adding decisions, report or models. Rather it involved setting up a special reporting package, separate from the reports provided to the participants. The new reporting package provided appropriate information to the assessors. Unlike the R & D simulation where the customization work took days, this customization took just over an hour.

These two simulations represent customization extremes – macro customization (where a totally new and different simulation is created) and micro customization (where a new version of an existing simulation is developed).

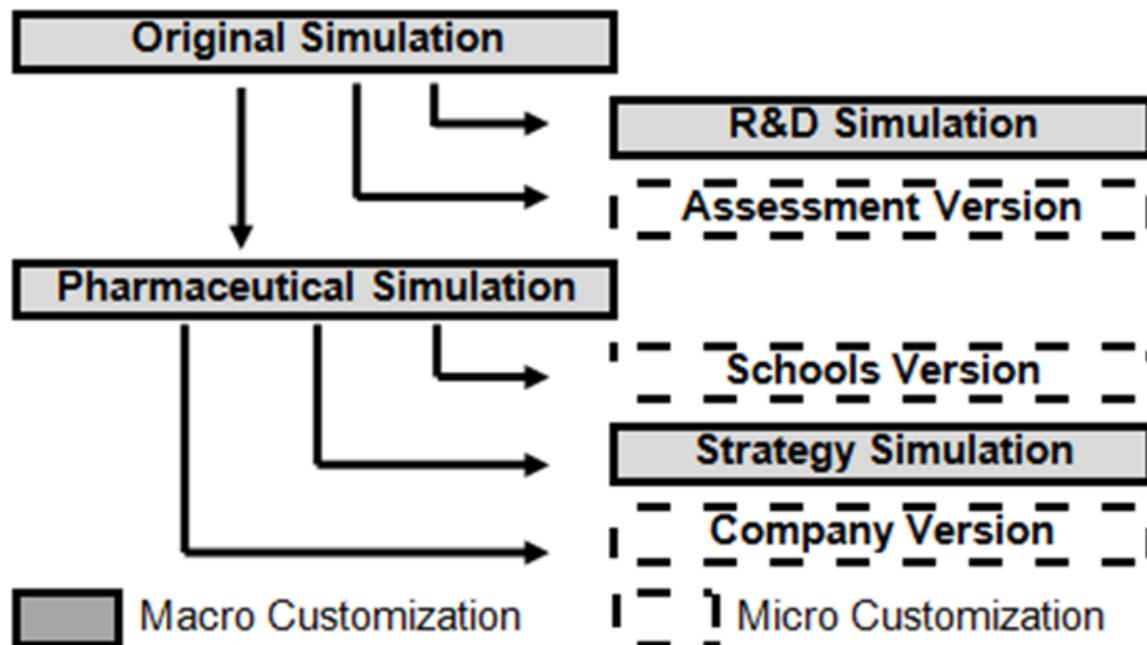
Pharmaceutical simulation: A large pharmaceutical company required a business acumen simulation but felt that the original simulation’s scenario and the issues addressed were inappropriate. This led to the development of a simulation where the number of product groups was increased from two to three (to replicate off-the-shelf pharmaceuticals, pharmaceuticals prescribed by general practitioners and pharmaceutical used by hospital consultants). Additionally, it was felt that product differentiation needed to be emphasized and so, for each, the participants could decide the *power* of the product (the amount of active ingredient). As this increase the number of decisions to limit complexity and duration, the payment terms decision was deleted. This meant that the number of decisions increased to 14 and the simulation’s duration increased from six hours to just over eight hours. In terms of customization, this simulation lies between the R & D simulation and the Assessment Center simulation and like

the R & D simulation led to a new simulation (macro customization). As the product power (performance) models had been used in another simulation, the work required was minimal (about a week and a half).

Schools simulation: Soon after developing the pharmaceutical simulation two schools wanted to run a day and a half management conference to encourage their students to take up a career in the wealth generation sectors of industry. Running through the conference would be a business simulation. The pharmaceutical simulation was a possibility but there were two issues. First, it was felt students would not relate to a pharmaceutical scenario and secondly, because the students were not business majors, it need to be simplified. This led to the development of a new version of the pharmaceutical simulation with a powerboat scenario, where the three markets were boats for fishermen, family cruising and speedboats. To reduce complexity and shorten the simulation the reports produced were simplified and the students could only change the boats’ power once rather than every period. This was a micro customization that involved changing the participants’ manual, the product names and reports produced by the simulation and the timing of the power decision – work that took less than half a day.

Strategy simulation: The fifth customization was for a mid-west electrical components manufacturer, who wanted a simulation with a short duration that explored the strategic leadership of a manufacturing company. Both the original simulation and the pharmaceutical were designed to develop business acumen and not designed to develop strategic leadership where the simulation involves positioning the business in markets, developing a portfolio of products, funding growth and business research. The Power Boat version of the Pharmaceutical simulation

**Figure 1
Customization Schema**



provided a suitable scenario and basic marketing, operational and financial models. The customization involved expanding the potential product numbers from three to eight (although participants did not have to offer all eight boats), adding additional decisions and the associated models (funding, operational and promotional decisions and a range of business research). This led to a new simulation (macro customization) but even so the work only took a few weeks.

Company specific simulation: The final customization was where a special version was created for a large, international medical equipment company. It was necessary to ensure verisimilitude so as to provide *“an Exploration of How our Business Might Function Under YOUR Leadership”* (extract from the participants’ manual). It was a micro customization mainly consisting of rewriting the scenario and participants manual, changing terminology (product and market names) and minor adjustments to the parameters driving the simulation – work that took a couple of days.

Customization Hierarchy

MICRO CUSTOMIZATION

This involves developing a new *version* of the simulation. With suitable software (see later), this can be done very quickly at low cost. For the case study simulations, micro customization took between a few hours to a few days.

Changing Documentation involves changing the participants’ manual. For example, one might wish to change the currency used for the simulation (from Dollars to Euros) or, as was the case for the Company Version change the names of the products and market sectors. Changing Documentation is a cosmetic change and the simulation software is unchanged. Commonly it is enough to ensure verisimilitude as was the case for the Company Version and, occasionally, this may all that is necessary (although it may need to be done with changing terminology).

Changing Terminology involves changing the terminology embedded in and used by the simulation software. Typically, it involves changing product and market names and financial terms. This is illustrated by the

Pharmaceutical, Schools and Company simulations where a product name was changed from Product X to Boat X and PD respectively. Besides changing terminology it may be necessary to changing language. This may simply involve switching from English to American (as was necessary for the Strategy Simulation) or more radical changes (for example from English to French).

Changing Reports involves adding or removing reports. For example, the Assessment Center simulation involved adding a special group of existing reports and the Schools Version involved removing reports. Removing reports is always possible but adding reports can only be done when already data exists. That is to say that the existing simulation calculates and stores the data beyond that used by the original reports this data can be used as the basis of additional reports. For example, when designing the original simulation besides the reports necessary for a basic business acumen course, the simulation did a profit center analysis, calculated the break-even, cash flow and other financial measures. Although these were not used in the original version they helped with the calibration and design of the original simulation and were available if a version of the simulation was to used to develop more advanced financial and business knowledge.

Change Decisions involves removing decisions or changing their timing. For example, both the R & D simulation and Pharmaceutical simulation removed the payment terms decision. All that was necessary was to stop participants changing payment terms (making payment terms a constant). Illustrating timing, participants in the Schools Version could only change the product power decision in one period rather than every period (as was the situation for the Pharmaceutical and Company simulations).

MACRO CUSTOMIZATION

This involves more radical customization resulting in a new simulation. This takes time but as shown by the R & D simulation even a major customization halves development time and less radical macro customization can be done in a few weeks.

Recalibrating the Simulation involves changing the parameters that drive the simulation model, the starting

**Table 1
Business Simulation Summary**

Simulation	Duration	Decision Nos.	Customization Level	Customization Drivers
Original Simulation	6 hours	9	New Simulation	
R & D Simulation	12 hours	15	Macro Customization	Audience & Learning Needs
Assessment Center Version	6 hours	9	Micro Customization	Manner of Use
Pharmaceutical Simulation	8 hours	14	Macro Customization	Industry Issues
Schools Version	5 hours	14 or 15	Micro Customization	Audience
Strategy Simulation	12 hours	11 - 60	Macro Customization	Learning Needs
Company Version	8 hours	14	Micro Customization	Verisimilitude

position and how the simulation evolves as decisions are made. For example, some minor recalibration was done for the Company simulation to increase verisimilitude but because the recalibration was minor this work was negligible. However, where (for example) a cash rich business but unprofitable scenario needed to be changed to one that was profitable but cash poor, the amount of time spent recalibrating the simulation could be significant.

Add Reports involves adding additional reports to the simulation. Unlike Changing Reports (earlier) these reports incorporate data that had not been calculated by the original simulation and this means that logic (models) must be added to do these calculations.

Add Decisions involves adding additional decisions. The Pharmaceutical and R & D simulations illustrate two extremes. The Pharmaceutical simulation only involved adding pricing and promotion decisions for additional products and a power decision for all products. These additions involved changes to parameters and recalibration and simple cost and sales demand model (for the power decision). In contrast, adding decisions to the R & D simulation required a significant number of new parameters, new models and recalibration.

Add or Replace Models involves adding additional models. For the R & D simulation a significant number of models were added. But, creating the Pharmaceutical simulation only involved adding models that calculated the impact of changed power on sales demand and costs.

CUSTOMIZATION DRIVERS

As illustrated in the business simulation summary table (earlier), the reasons that drove the need to customization are:

- Learning Needs
- Audience
- Manner of Use
- Industry Issues
- Verisimilitude

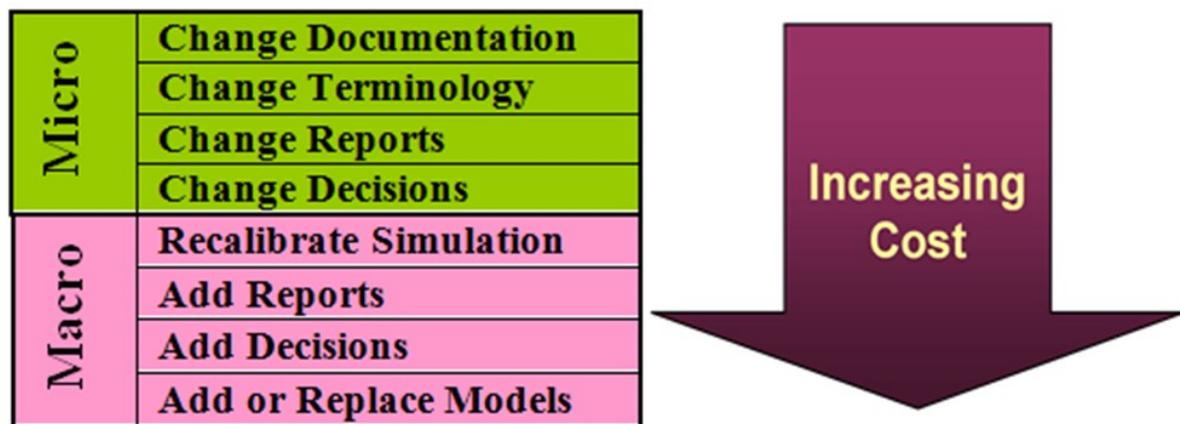
Learning Needs are the driver when the original simulation's purpose differs from what was envisaged originally but the core simulation (scenario and models) are still relevant. Example of customization to address learning needs are the R & D and Strategy simulations. Experience with these simulations and other customizations suggests that customization to meet additional learning needs involves creating a new simulation (macro customization).

Audience – those who will participate in the simulation impacts the need to customize. For instance a basic business acumen simulation would not be relevant for the R & D managers and this necessitated creating the R & D simulation. Likewise the lack of the participants' prior knowledge and experience impacted the Schools Version requiring customization. Experience with these simulations and other customizations suggests that depending on the audience, it may be necessary to produce a new version (micro customization) or to produce a new simulation (macro customization).

Manner of Use defines how the simulation is to be used. The original simulation was developed for use as a stand-alone activity or as a course finale and when used on an assessment center that meant that new reports were required. If the simulation was used as a course theme there might be a need to have the reports produced and the decisions made evolve as the simulation progressed and link to the content sessions. Experience with these simulations and other customizations suggests that often, customizing for manner of use results in a new version (micro customization) rather than a new simulation (macro customization).

Industry Issues impact the decisions made, the markets, product offering, the economy etc. For example, it was felt that the Pharmaceutical simulation needed a product design (performance) dimension and this involved adding a product "power" decision and associated parameters and model. Although this was a macro customization, the pre-existence of a product performance model minimized work. Another customization might involve recalibrating a simulation to reduce profitability levels or reduce liquidity (because these are characteristic

Figure 2
Customization Hierarchy



of the participants' industry). Experience with these simulations and other customizations suggests customization to match industry issues involves creating a new simulation (macro customization of the original simulation).

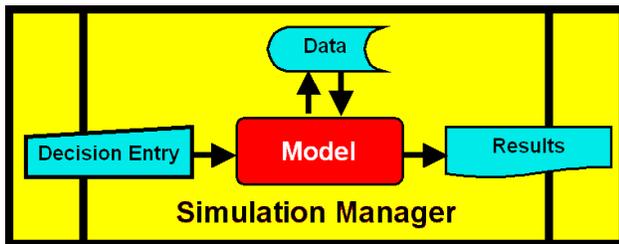
Verisimilitude “*the ability of the model to give the appearance of reality*” (Barton, 1980) is a key driver of engagement as it is vital for the adult learner to see the relevance of learning (Knowles et al, 1980) and this is ensured if the scenario, issues, decisions and results reflect the participants' industry. This was especially true for the Company Version but to some extent for all the other customizations. Often it is possible to address verisimilitude needs by cosmetic changes (changing documentation and terminology). For example, a service industry simulation was customized for a sports body by changing the market sectors from services to leagues and resources from people to teams. Experience with these simulations and other customizations suggests that customizing to increase verisimilitude involves a micro customization (or minor macro customization) – creating a new version.

SOFTWARE ASPECTS

The design of simulation software (simulator) impacts the ease of customization. As shown below the basic simulation process involves entering decisions, using the model to simulate a period. In turn the simulation model uses data (parameters and team data) and updates this. Finally, results are produced. Customization can be aided if the software treats the model algorithms, data and decision/results as separate entities and each version of a simulation is configured using a control file.

A **Simulation Manager** consists of the software that is common to a particular type of simulation. For example, a single simulation manager would be used for all Total Enterprise simulations (such as the simulations described

Figure 3
Basic Simulation Process



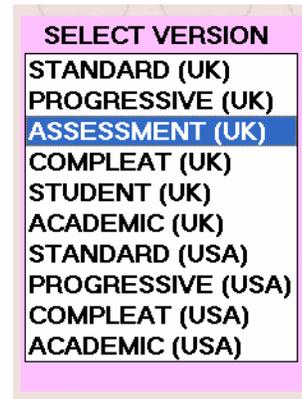
here) where several teams interact in the same marketplaces.) Using Simulation Managers reduces new simulation design times substantially but has minimal impact on customization times

A **Control File** defines all the files used by an individual version of a simulation together with data that controls the way the simulation progresses and is used by the simulation manager. Each version of a simulation will have its own control file. For example, changing the original version to the Assessment Version involved

creating a separate control file that, besides the normal participant reporting pack, defined the assessors reporting pack. As illustrated to the right, when the simulation is run the Simulation Manager displays a list of versions for the user to select the version that they wish to use. Here the menu shows versions in ascending complexity (standard, progressive and compleat), for education and in two languages.

Models are used unchanged when developing a new version (micro customization) but, generally, a new simulation (macro customization) requires additional models. Where the added models exist in a library of

Figure 4
Control File Selection Menu



models (as was the situation for the Pharmaceutical simulation product power models), the existing model can be imported and used with minor modifications. But in other circumstances such as the R & D simulation, new models must be created.

Data consisted of the parameters that drive the simulation model and data that defines decisions and results structures and timing.

Parameters drive the simulation model and developing a new version or simulation generally involves modifying these. For example, creating the Schools version from the Pharmaceutical simulation just involved changing the product names (from Product to Boat). Separate data files speed terminology changes substantially and speed recalibration to some extent.

Decision/Results Structures such as report name, its parameters and layout are held in a data file. Then as illustrated below, results are generated by the software taking a record from the result/decision format file and using this to create a template that is then populated with data (from the parameter file).

Similarly, decision entry templates can be created using format data and the decisions entered into the template before simulation. This approach means that where reports and decisions are changed all that is necessary is to edit the report/decision format file. Both the Schools and Assessment simulations involved adding formats to the format data file.

CONCLUSIONS

Customization of an existing simulation when coupled with suitable software reduces the time and cost to create a new version or simulation substantially.

But, more important is that customization allows one to match learning needs, the audience and manner of use while exploring relevant issues in an environment that the learners can relate to (verisimilitude). This is illustrated by the longevity of use - for example, the Pharmaceutical simulation has been dozens of times; Schools simulation was used for some ten years and the Company simulation was used fourteen times around the world with some 320 senior managers. With the Director of People & Organisational Development stating "it was very pleasing to see the programme deliver all that was expected and more".

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APPENDIX: CASE STUDY DECISIONS

The following show the decision forms used by the original simulation and the customized simulations.

Original & Assessment Center Simulation Decisions (all periods)

	Product A	Product B	Total
Price			
Advertising			
Production			
	Decision		Cost
Sales Force		x 25 =	
New Capacity		x 20 =	
Accounts Receivable Days		÷ 365 =	Fraction

R & D Simulation Decisions (all periods)

	LOTS	HITS	Total
Price			
Promotion			
Production			
Other Decisions			
New Capacity			
New Term Loans			
Staff Development			
R & D Decisions			
Performance Engineers			
Quality Engineers			
Materials Engineers			
Processes Engineers			
Basic Research Engineers			
Research			
Performance Research (Y/N)			
Quality Research (Y/N)			

Pharmaceutical Simulation Decisions (all periods)

	Product X	Product Y	Product Z	Total
Price				
Power				
Promotion				
Production				
	Decision		Cost	
Sales Force		x 25 =		
New Capacity		x 20 =		

Schools Simulation Decisions (periods 1 to 4)

	Boat X	Boat Y	Boat Z	Total
Price				
Promotion				
Production				

	Decision		Cost
Sales Force		x 25 =	
New Capacity		x 20 =	

Strategy Simulation (eventual decisions)

Boat	A	B	C	D	E	F	G	H
Price								
Advertising								
Production								
Power								

Other Decisions
Sales Force
New Capacity
Hull Capacity
Agreed Debt
Receivable Days
New Equity
New Term Debt
Race Boats (Yes or No)
Sponsor Fishing (Yes or No)
Outdoors Show (Yes or No)
Boat & Yacht Show (Yes or No)
Scheduling System (Yes or No)
Power Unit Tuning (Yes or No)
Perceptions Research (Yes or No)
Awareness Research (Yes or No)
Special Research Cost

	Test 1	Test 2	Test 3
Test Market Research			
Test Boat			
Test Power			
Test Price			
Test Advertising			

Company Simulation Decisions (all periods)

	PD	HD	RIC	Total
Price				
Features				
Sales Teams				
Production				

	Decision
Promotion	
New Capacity	