Process Modeling and Simulation

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A business process is the set of activities and decision rules required to accomplish an operational objective. Examples include fulfilling an order, manufacturing a product, fielding a technical support phone call, or even launching a rocket. A *process model* provides an analytical framework for describing the activities and their relationships in detail. It extends the concept of business process reengineering by providing a quantitative predictive capability. A process model codifies the process and provides a common understanding of how a current or future system behaves. The steps of a process model can be illustrated with a flowchart (see Figure 1 below), however, it also contains additional information including business logic, sequencing rules, flow rates, and any statistical equations that describe the role of uncertainty in the process.

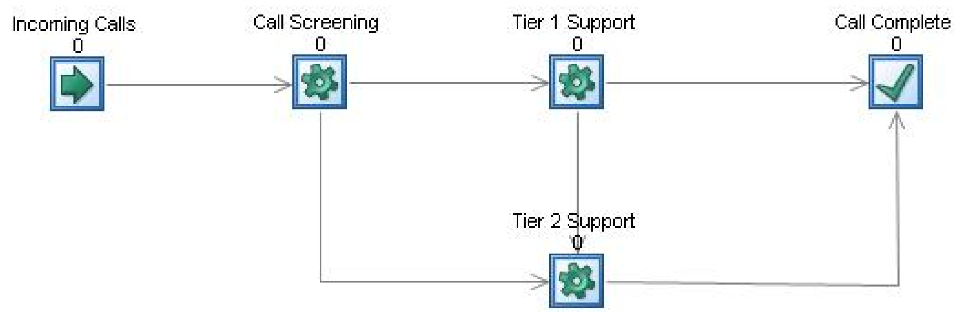

Figure 1. Flowchart of a Simple Call Center Business Process

Process models are an enabling technology for business process improvement. A typical business process improvement project will involve the steps shown below:

1. Define performance metrics
2. Capture the “as-is” process
3. Measure process performance according to the desired metrics
4. Identify process improvements (the “to-be” process)
5. Implement improvements
6. Measure process performance
7. Repeat steps 4-6 as necessary

By comparing the performance of “as-is” and “to-be” systems we can measure the degree of change, and thereby, the value of the improvements. In the case where the process does not yet exist, we can compare alternative “to-be” systems, skipping steps (2) and (3).

One potential problem with all of this is that changing an *actual* system can be costly and disruptive. We often don't have the time, resources, or ability to implement multiple "to-be" systems and try each of them out. Pilot programs might be one exception, but their use is necessarily limited for the same reasons. And what if the changes do not produce the desired results? Process simulation provides a solution to this. A simulation can be developed for both the "as-is" process and one or more alternative "to-be" simulations. (In the case where the processes do not yet exist we can go straight to the "to-be" simulation.) By running the simulation models of the alternative processes we can compare their performance ahead of making any changes to the actual business process. This reduces project risk and cost by helping to identify flaws or misconceptions in the design of the proposed process. As described in Michael Schrage's book, ***Serious Play: How the World's Best Companies Simulate to Innovate***, the simulation approach to rapid prototyping of business processes has significant cost advantages.

A second advantage to using simulation in process modeling is its ability to quantify uncertainty. There are very few business activities that always take a fixed time to complete, where the steps followed are all known in advance, and where the outcome is always known with certainty. A simulation can capture variable and uncertain behavior in the form of statistical equations known as probability distributions. Figure 2 illustrates a probability distribution – the horizontal axis represents the possible numerical outcomes, while the vertical axis represents the relative likelihoods of the outcomes. The effect of the probability distributions in the simulation is variations in the process performance metrics from one "run" of the simulation to another. By running the simulation many times, we can build up a profile of the different possible outcomes and establish confidence intervals on the results. For example, if Figure 2 was the output distribution of some metric measured by the simulation, we could say that the estimated average value was "μ", but there was a 95% chance the value could range anywhere between μ-2σ to μ+2σ. It is unrealistic to rely on point estimates alone – but simulation provides a solution.

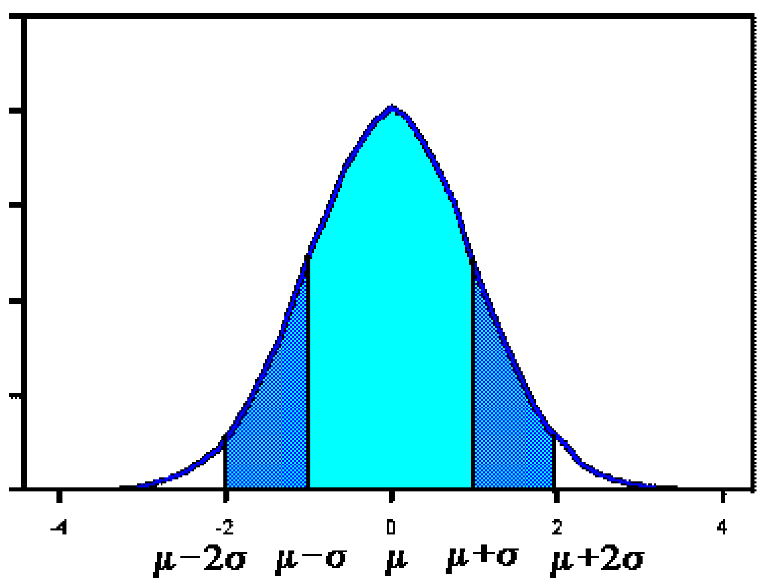

Figure 2. Uncertainty Expressed as a Probability Distribution

Variability in individual activities can also change the entire dynamic of a process. For example, a system might be designed whose capacity will easily handle a given long term average throughput rate (parts, orders, documents, calls, etc.). However, a series of higher than average processing times at a single bottleneck activity could cause “upstream” effects where processing is delayed or blocked, and “downstream” effects where processing is “starved” for work. This wasted capacity would prevent the process from ever achieving its designed throughput rate. Similarly, short term surges in inputs or processing times could overwhelm a process and cause unacceptable backlogs or waiting lines. (These dynamics are effectively and humorously described in Eliyahu Goldratt’s excellent book, ***The Goal***.) In supply chain analysis, a related phenomenon known as the “whiplash effect” results when unusually large demands occur at the retail end of the chain, belated overreactions in the form of excessive backorders are generated, and the effects compound upstream as organizations attempt to maintain desired stock levels. The result is over/under stocking and poor service levels. This dynamic can be captured and identified in a process simulation, but not a spreadsheet. A simulation model that correctly captures variability can help determine the likelihood of these system-wide effects, measure their impact, and assess the effectiveness of corrective changes.

A third and more recent advantage of process simulation is the ability to link the simulation with an ***optimizer***. A simulation optimizer automates the process of finding the right combination of constrained input values to maximize or minimize some performance metric. For example, Systems View has used simulation optimization to find the combination of repair labor categories that will maximize system uptime, subject to a constraint on total labor cost. Figure 3 is a sample plot of the progress of the optimizer as a function of the number of trial attempts. Attempting to do this manually via trial and error, even with statistical experimental design techniques, could take days, weeks, or even longer depending on the problem size.

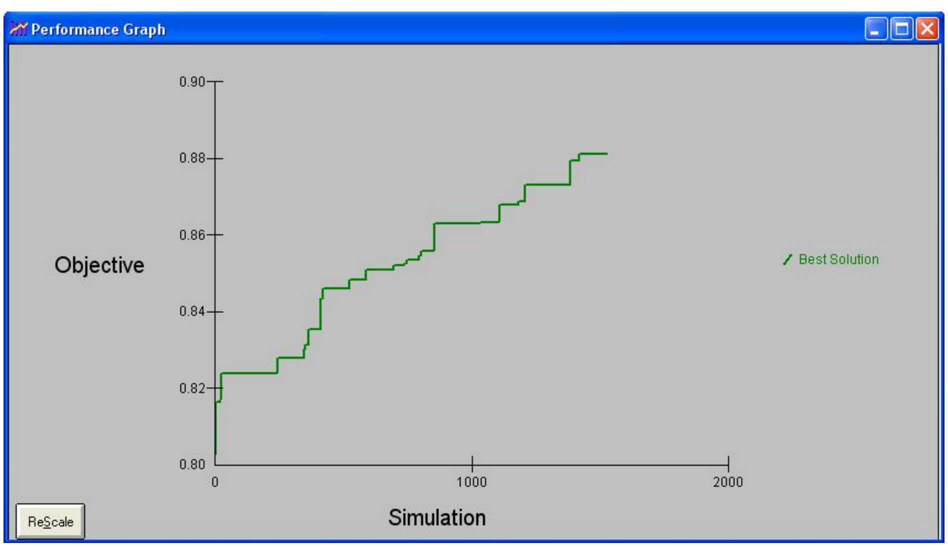

Figure 3. A Simulation Optimization Performance Graph

There are literally dozens of simulation software packages available at prices ranging from about $1,000 to $25,000. These packages provide the infrastructure and tools for building and running your process simulation. At Systems View, we have found that ProcessModel (www.processmodel.com) and Simul8 (www.simul8.com) provide a good value, are easy to use, and have lots of features, including optimization. Both provide a straightforward graphical interface for building models and pass my basic requirement that a user be able to build a simple one or two step process model in a matter of minutes without training or having to read extensive documentation (some of the most expensive packages fail this test!) For simpler modeling situations, ProcessModel is relatively inexpensive (~ $4K), yet still very capable. We especially like its hierarchical modeling feature. For more complex systems, Simul8 (~ $5K) is a great tool. Its extensive scripting language allows you model virtually any type of business or scenario logic into the simulation. It also easily interfaces with Excel through VBA.

Process modeling is as much art as science. While sophisticated computer-based analysis tools make the job faster, it requires experience and judgment to translate a real-world system into a compact yet unambiguous process model description. The trick is to capture just the right amount of detail so that the generated performance measures provide a reasonable approximation to real-world behavior. Only in this way can you be assured that your processes will be truly improved.