Expressway

Case Study

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Background

An agency of the US Government spends billions of dollars annually on responding to emergencies. It is noteworthy that planning for emergencies is difficult because the number, severity, and location of the need varies drastically from one year to the next.

In order to manage the procurement of resources needed to respond to emergencies, the agency is developing a system which we will refer to as the "Emergency Procurement System", or "EPS". This is not the actual name of the system, but a pseudonym that we use for this case study.

A key difference between an ordinary procurement system and an emergency procurement system is that actual needs are not known until an incident occurs. The driving value propositions of such a system are:

1. That advance procurement arrangements (options) will result in more favorable terms for procurement contracts, which are in effect procurement *options*
2. That elimination of paperwork might result in less manual work and possibly even lower interest costs paid to vendors as a result of payment delays.

Primary Business Concerns

The business, in this case the agency's Procurement department, had spent a great deal of time developing requirements and refining the business case for EPS. The primary concerns were:

- Costs to build the system.
- Operation and maintenance (O&M) costs.
- Return on investment, through elimination of paperwork and through a more effective and timely emergency procurement process.
- Ensuring adequate quality of equipment, potentially resulting in more effective emergency response operations.
- Ability to extend to and integrate with other areas of business.
- Redundancy with respect to similar functions in other area parts of the agency and even other agencies.
- COTS versus custom.
- Ability to handle complex and varied in-the-field needs, including physical inspection and assessment of both promised and delivered equipment.
- Transparency of business rules.
- Maintainability.
- Security.

In addition, we proposed that an important concern should be the measurement of the effectiveness of the system against all of its goals, including the impact on operational effectiveness as a result of improved equipment: to measure that, one would have to build into the system the ability to correlate equipment quality with field level performance. Addressing that concern would result in additional features in the system, and in some connected systems as well, but it would make it possible to make better decisions regarding equipment procurement – in many cases justify added purchase expenses with the expectation that overall costs would be less. This proposal was initially met with skepticism, until further discussion revealed that in fact there was ample anecdotal evidence that better equipment resulted in higher effectiveness – and possibly lower overall cost – and that field units only needed a way to prove the connection. An actual effectiveness measurement capability would provide this.

Conceptual Cause-and-Effect Model

A traditional IT financial model of the various concerns would focus mostly on cost, and would be based on a spreadsheet that tabulated the various costs. Benefits would be included if they could be quantified as some form of cost avoidance. Further, such models are typically linear in that they define a summation of benefits, without accounting for the interplay among the various elements or the statistical behavior of them over time.

In order to avoid these problems we created a stochastic model, and expressly accounted for sources of value in addition to costs. In a stochastic model one posits the kinds of possible future events, their probability distribution, and simulates to see what happens; and one estimates or models the costs or benefits that would result from each event. A simulation shows what might happen; many simulations show what will likely happen. We developed the stochastic model shown in Figure 1.

The value model has three primary sources of value or cost:

1. Building the EPS system,
2. Using and operating the EPS system, and
3. Extending or further integrating the EPS system with other systems over time.

The first of these is the traditional cost of building the system. The bubble "Build EPS" generates construction/deployment events over time, according to a statistical distribution. In this case the distribution is deterministic, since we did not model the variability of delivery, but assumed that there would be three main releases of capability over three years, each a year apart. Each time a deployment event occurs, the construction costs of that release are added to the "Total Value" bubble. Since these are costs they are negative.

The "Use EPS" bubble represents the usage and operation of the system over time. This bubble also generates events, according to a distribution, and the events represent the various ways in which the system will be used and operated. In the model we included O&M expense events, as well as license cost events.

The "Use EPS" bubble also models risks associated with usage, in particular security. As a strategic system that will be used by the public (vendors), and that contains financial and personal data, the system's security requirements are stringent. A security failure could shut the system down for months, causing the loss of its benefits for an entire season. This was modeled by defining architectural choices associated with security risk mitigation, and by using security failure metrics that were historically available for an earlier prototype of EPS.

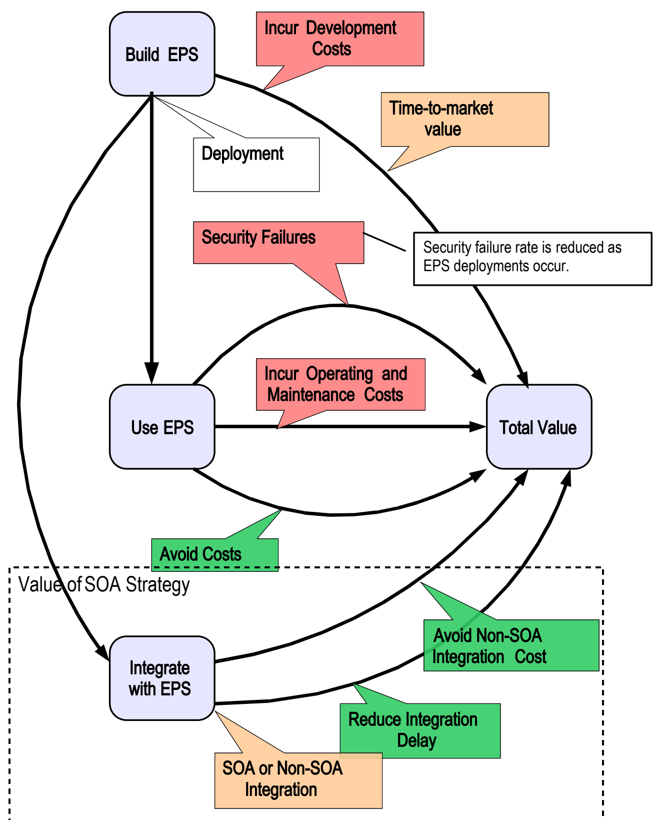

Figure 1: Value model.

The "Integrate with EPS" bubble generates events pertaining to future extensions of or integrations with the system. These are extensions or integrations that are not known in advance: if they were, they would be addressed by the "Build EPS" bubble. The "Integrate with EPS" bubble therefore models things that are possible but for which the specifics are not known. The events that are generated have direct cost associated with them, but also delay, since it takes time to perform an integration, and that is how EPS's architectural flexibility is addressed by the model: if the architecture lends itself to future integrations, then the time and cost to perform those integrations is lower.

Architectural Choices

System development cost projections varied depending on the technical architecture. In addition, the technical architecture impacts the costs and timeliness of future extensions or integrations.

The main technical architecture choices were:

1. Custom, no SOA.
2. Custom, with SOA.
3. COTS, no SOA.
4. COTS, with SOA.

Each of these choices represented a different technical architecture, and for each there was an optimal set of choices of products. Each of the four architectures represents a different technical implementation strategy that has ***business consequences***Assumptions were made (which were later debated) about the extensibility and lifecycle costs that would result from each choice.

Cost is where most financial analysis of IT projects ends. However, we wanted to go further, and assess the holistic impact for the agency.

Assigning Numbers to the Model

We worked with the procurement office to obtain whatever metrics and estimates we could in order to put tangible numbers on the various factors in our model. To estimate various IT-related parameters, we used our own analysis and judgment. As an illustration, Figure 2 lists some of the estimated costs for both a COTS and non-COTS solution strategy.

		Non COTS	COTS
Initial learn ing cu rve for devel op men t/integ ration . Initial de ve lopme nt time/ co st.			
	Year 1	$-0.5M	$-0.45M
	Year 2	$-2.3M	$-2.1M
	Year 3	$-1.6M	$-1.4M
Ong oi ng (ann ual) licen se & paid su pp ort co sts.		0	$-1M
Ong oi ng (ann ual) sta ff O&M co st.			
	Year 1	$-0.4M	$-0.2M
	Year 2 and after	$-0.5M	$-0.25M
Mean cos t/time for each futu re enhanceme nt event. Mean cos t/time for each futu re integ ration event.			
	Time-to-market delay cost	$-3M	$-6M
	Integration cost	$-0.15M	$-0.3M

Figure 2: Value factors in millions of dollars.

Traditional analysis stops with direct costs, and would not include contributors related to hypothetical future projects, such as the highlighted item, which represents the value of delays in extending the system to address other parts of the organization. The theory is that such delays incur a "time-to-market" cost. For example, if extending EPS to address other future business area needs takes a year instead of six months, then the value of the extended capability is delayed by six months, and so six months of future value are lost.

Accounting for such effects are at the heart of measuring the value of business agility: agility is the ability to respond to unforeseen future opportunities, and if IT systems are inflexible, then the cost of that inflexibility is that it takes longer and more money to capture those opportunities. The cost of the lost time is usually larger than the direct costs, since if the opportunity value were not of a larger magnitude, then the organization would not even be thinking about the new extended capability.

It must be stressed that the numbers in Figure 2 are "educated guesses". After all, business is about making one's best guess about the future, since the future cannot be known. Our hope is that the discipline of documenting and analyzing the cause and effect relationships between the kinds of future events that can occur will help to increase the level of maturity of decision-making.

Many of the numbers in the model came from business stakeholders. For example, the business provided estimates of the impact of better equipment, among other things. In providing this input, they in effect become part owners of the model. Thus, building a model is not just the job of IT: it is a collaborative exercise that requires that IT work closely with the business.

Initial Results

The baseline assumption is that EPS will be built using the architecture recommended by the EPS engineering time, consisting of a customized SOA implementation. Given this assumed baseline, we simulated the model ten times, each time for a period of five simulated years. (This requires about five seconds of computing time on a MacBook.) The distribution of projected future value of the EPS system is shown in figure 3. The mean of the predicted value is is $36 million over five years. The resulting histogram is shown in Figure 3.

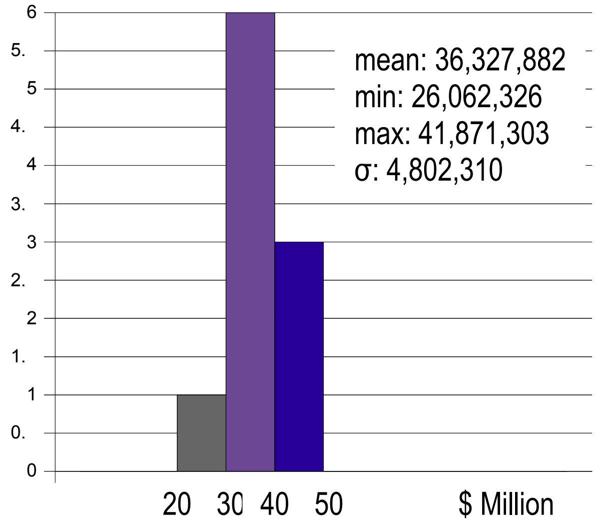

Figure 3: Projected future value histogram, for a five-year planning horizon. The vertical axis is the number of simulations that fell within each $10M range of the horizontal axis.

Note that we did not bother to simulate the model more than ten times. We could easily simulate hundreds of times – the computing cost is minimal. Simulating a large number of times results in a nicely smooth distribution instead of a choppy histogram, but it gives the illusion that this is a science rather than an art. The results should not be seen as accurate predictions. Rather, they are intelligent guesses, and the real value is not in the result but in the greater understanding that one obtains from analyzing why the result is what it is.

It should also be noted that we did not discount the value of money over time. The reasons for this are two-fold: for one, other effects overwhelm the results, so the impact of discounting is not significant. The other reason is that there is much debate about what discount rate to use[1], so we side-stepped the issue

1 The common practice of using different discount rates for different kinds of risk does not apply when performing stochastic modeling because risk is accounted for explicitly by the model. Therefore, a good argument can be made that one should use the zero-risk rate that applies for the firm.

because it has a small effect anyway.

Sensitivity Analysis

We were interested in the impact of each of our assumed numeric factors on the net value prediction, and so we varied each of them, seeing the result. This enabled us to discuss the numbers and try to understand the contribution of each source of risk, cost, and value.

For example, one scenario we were particularly interested in was the impact of choosing a custom solution instead of a COTS solution. The COTS column of Figure 2 lists the numeric factors that we believe apply for a COTS solution. By substituting these into the model and simulating ten times, we obtain the projected 5-year future value distribution shown in Figure 4. This distribution has a mean of $24M – substantially lower than the mean of $36M for the non-COTS model.

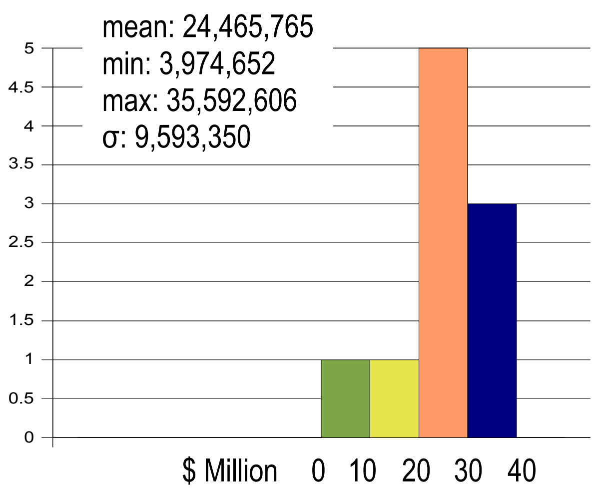

Figure 4: Projected five-year future value histogram, assuming a COTS solution.

The reason that the predicted value is lower for the COTS choice is two-fold: we assumed that a COTS solution would entail higher product license and paid support costs, and we also assumed that a COTS solution would take more time to integrate into future external systems, thereby delaying those systems somewhat. This delay has a huge impact over time on business value.

One should not accept the results of a model simulation blindly. One should examine the results and try to understand them. A model should lead to better understanding, and that is its primary value. In this case, we had the realization that an IT solution's impact on future business agility is – at least in the case of EPS – a large and perhaps primary determinant of the best technical strategy, at least with respect to COTS versus non-COTS.

Of course, further analysis might reveal that our assumptions are simplistic. For example, once we had an understanding of the primary value drivers, we started to analyze the architecture choices more closely, and indeed identified ways to mitigate the loss of flexibility of a COTS solution, e.g., by only considering COTS solutions that provided a robust and extensive SOA interface. The whole point of enterprise architecture was therefore realized: considering various technical strategies, in a manner driven by projected holistic business value.

Business Outcome

As of this writing the EPS project is proceeding using a non-COTS strategy. Since the project has high visibility – even across agencies – and many stakeholders, it is possible that its strategy might change due to external factors. However, at least now IT has a sound and deep argument that is rooted in business analysis and not only technical analysis – an argument that is worthy of presentation to the dollar-focused portfolio board.

However, as stated, there is debate about this issue.

Key Points and Conclusion

Creating a value model for IT decisions and strategies helps to clarify the issues, and allows one to assess the impact of assumptions and decisions. In the case of EPS, it raised our awareness of the monetary importance of how flexible the solution is, especially if it is expected that the system will eventually need to be extended or integrated with other systems.

Having a method for producing tangible value estimates has the benefit that discussions with business stakeholders can be in more concrete terms, and more credible as well because business stakeholders become invested in producing the estimates for the various parameters of the model.

References

For more information about the techniques used here see the author's recent book, *Value-Driven IT*, obtainable from Amazon. See also the book's website, http://ValueDrivenIT.com The simulation tool used to create and simulate the models used in this work is available for free download from the website.

For a discussion of the underlying mathematical foundation of the techniques used, an especially good paper is "Real Options Analysis: Where are the Emperor's Clothes?" by Adam Borison, Stanford University, 05/17/03. Available at http://www.realoptions.org/abstracts/abstracts03.html