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A dynamic modeling tool for developing and testing warranty strategies
Prepared for *The 2005 Warranty Chain Management Conference*
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Abstract

Those involved in delivering warranty services understand that the “warranty system” is much bigger than traditional thinking dictates: bigger both spatially and temporally. It is impacted by R&D decisions made months and often years previously. And warranty policies and services will have ripple effects on customer satisfaction, sales, and the bottom line for years into the future. Most organizations have sophisticated models that “dive deep” into many of the sectors mentioned above; these models are used for short- and long-term forecasting for different business units. What’s been lacking is a tool for facilitating strategy development and testing its effectiveness on the whole system.

This session will demonstrate a prototype dynamic modeling tool for building understanding of how the warranty system “really works.” You will experience a tool that can be used by policy makers to analyze the impacts of different investment strategies on product design, market share, customer satisfaction, and warranty costs. Further, you will see how the tool can be used in a workshop context with non-warranty professionals to understand their relationship to the overall warranty system.

Background

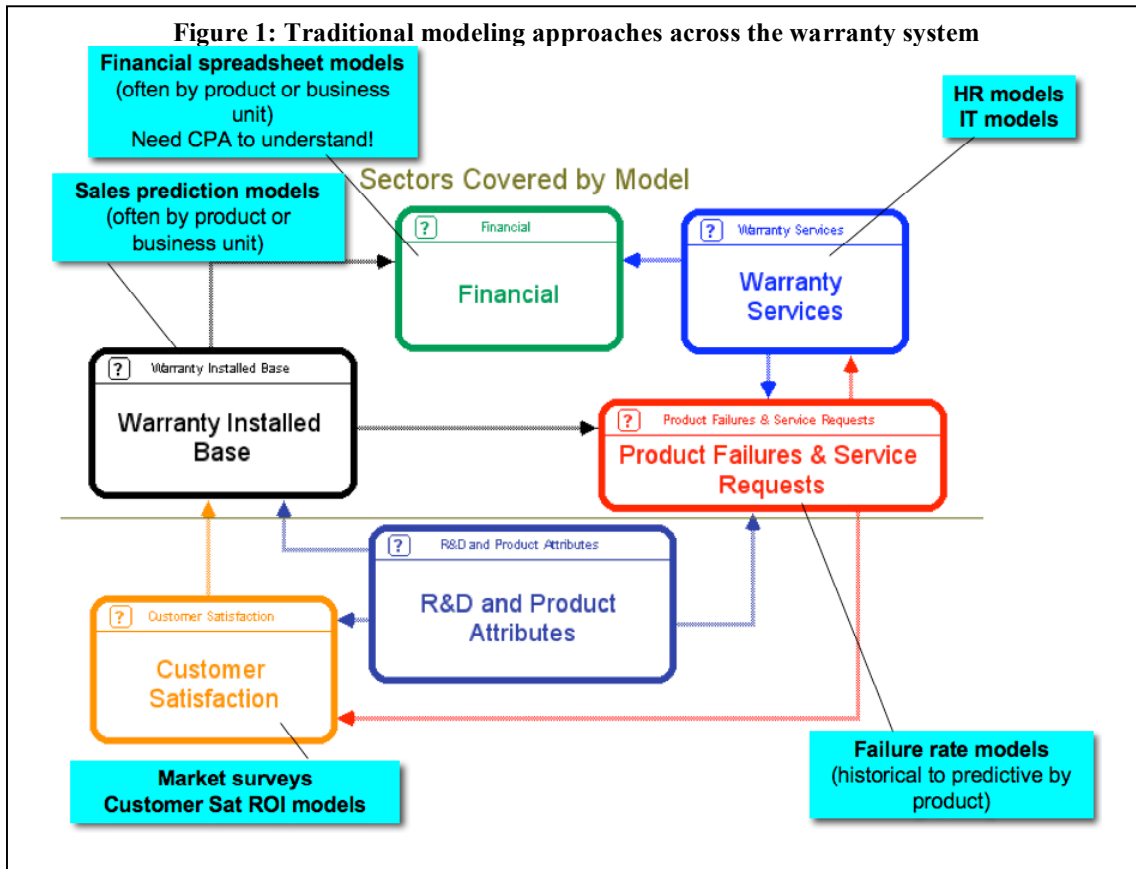
Warranty chain professionals know the commonly held view of what makes up the warranty system is not comprehensive enough to inform most organizational strategies. In many cases, the limited view could contribute to disastrous consequences on the long term viability of the organization because warranty services are not only a “necessary expense,” but are essential to customer retention and word of mouth sales. So, how can those who see the “big picture” help the organization to see the same picture? Moreover, how can they facilitate the organization developing strategies that include—even leverage—the warranty chain?

In 2004, Hewlett-Packard initiated the development of a dynamic modeling tool to help address those questions. The tool is still in its infancy, but even after a few months work, there is much to learn from developing and using the tool. This paper presents the methodology used to develop a prototype system dynamic model of the warranty chain at Hewlett-Packard and includes preliminary insights generated from the process.

The Warranty System in the traditional view

The traditional approach of organizations is to develop models to analyze specific elements of the system. Spreadsheets look at the financials. Statisticians run trend analyses and use a variety of statistical techniques to create sales forecasts. Surveys are conducted to perceive customer satisfaction and used to inform R&D and warranty services decisions (staffing, training, IT capacity).

The traditional view of warranty was that it included only the organizational components responsible for delivering services. Although that is a significant portion of the warranty system, the traditional view drew boundaries that excluded many parts of the organization and the customer base that either impacted the delivery of services (directly or indirectly) or felt the impact of service delivery.



For example, assume a software company releases a new product. Decisions they make about how many features to include, how well to write the documentation, and other product attributes will determine customer satisfaction and sales. Those decisions will determine how much they gain or lose from time to market; ultimately, they will determine the amount of customer service requests generated by the customer base. Of course, how they handle these requests impacts their customer retention and word of mouth. And feedback from service requests will lead the organization to determine upgrade features and documentation changes. And *all* of these come to the bottom line! Revenue and expenses are determined by all of the above!

The value proposition for system dynamics

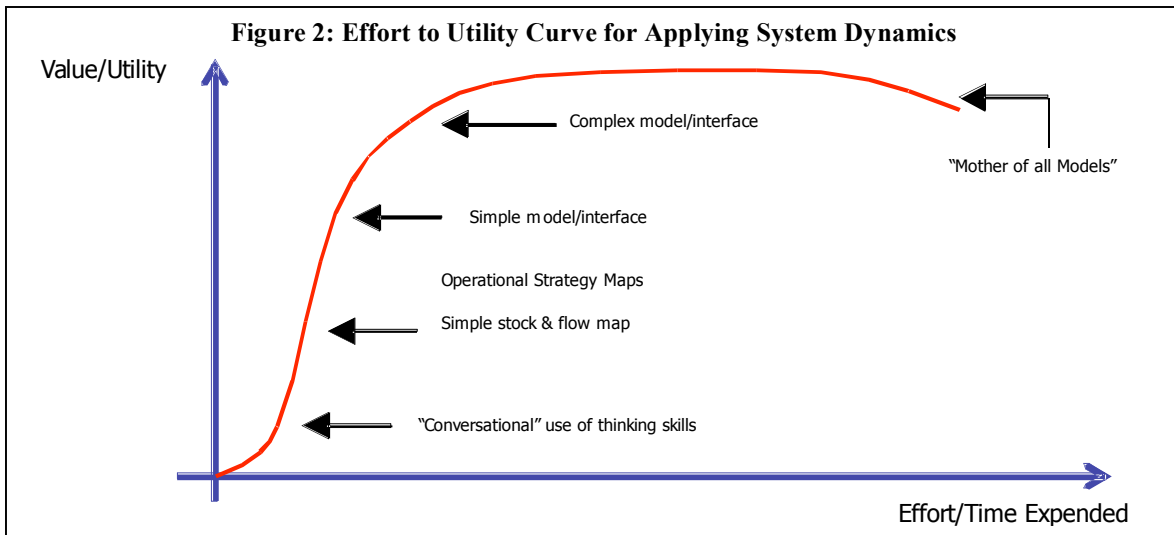
Now that's a complex system. When faced with complexity our minds often go blank and we get the MEGO syndrome (My Eyes Glaze Over). Saying something is complex may be true, but saying it's too complex to understand isn't useful—in fact, it's disempowering because it creates a sense of helplessness. The resulting inertia leads to a “status quo” approach. System dynamics provides a methodology for managing the complexity. Specifically, it provides three supporting elements:

- a *language* for building mental models that get people on the same page regarding how the system works
- a *paradigm* for making sure those mental models are realistic
- a *technology* for improving simulations of those mental models so that strategies are more likely to achieve their purpose

These elements can be applied with increasing amounts of effort to achieve the value required from their application. Conversations can benefit from applying the paradigm (using Conversational Systems Thinking to focus on trends over time, look for unintended consequences, and focus on “how the system works”). Strategy formulation often requires more effort, so the methodology can help in developing an Operational Strategy Map of the system to

facilitate strategy discussions. Strategy implementation and execution, as well as organizational development activities might require higher levels of buy-in—using flight simulators and complex simulation models may be the best way to increase the effectiveness of these activities.

Figure 2 shows an “effort to utility” curve to help determine the level of application of system dynamics to a particular set of issues. There’s a lot of value to be derived on the left end of the curve—where an organization needs to invest less effort and resources to generate a high return on value (i.e. strategic insights). The very human tendency to “get all of the details” into analysis will lead the organization to build the “mother of all models”—which at best is often overkill and takes too long to build; at worst they may never complete the model! The prototype tool developed at Hewlett-Packard included an Operational Strategy Map and simple model (activities found on the left hand side of the graph in Figure 2). I will describe how this is done, the insights achieved, and extensions along the continuum that may be undertaken to lead to further insights or strategic effectiveness.



An Operational Strategy Map of the Warranty System

The first step in developing the Operational Strategy Map is to conduct interviews among system experts, making sure to cover the space over which the system likely extends. These experts contribute their understanding of the major issues arising from the warranty system. The process (shown in Figure 3) is iterative. The first step of observing behavior and choosing the issue includes identifying major sectors of the system to study, as well as important historical trends that will later serve as “reference behavior patterns.” The reference behavior patterns can be used as a benchmark to determine if the map is adequate for understanding the issues. It’s especially useful in helping to keep the level of aggregation at the appropriate level (it’s preferable to have the least amount of detail as possible).

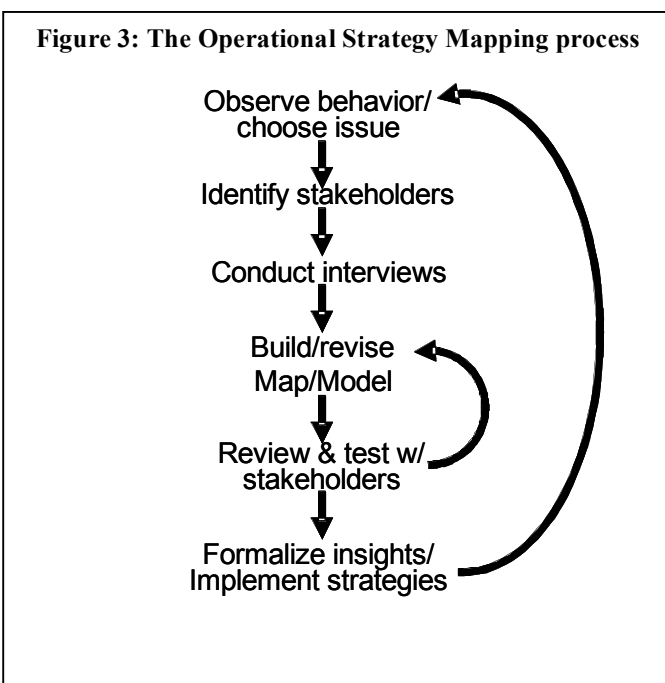
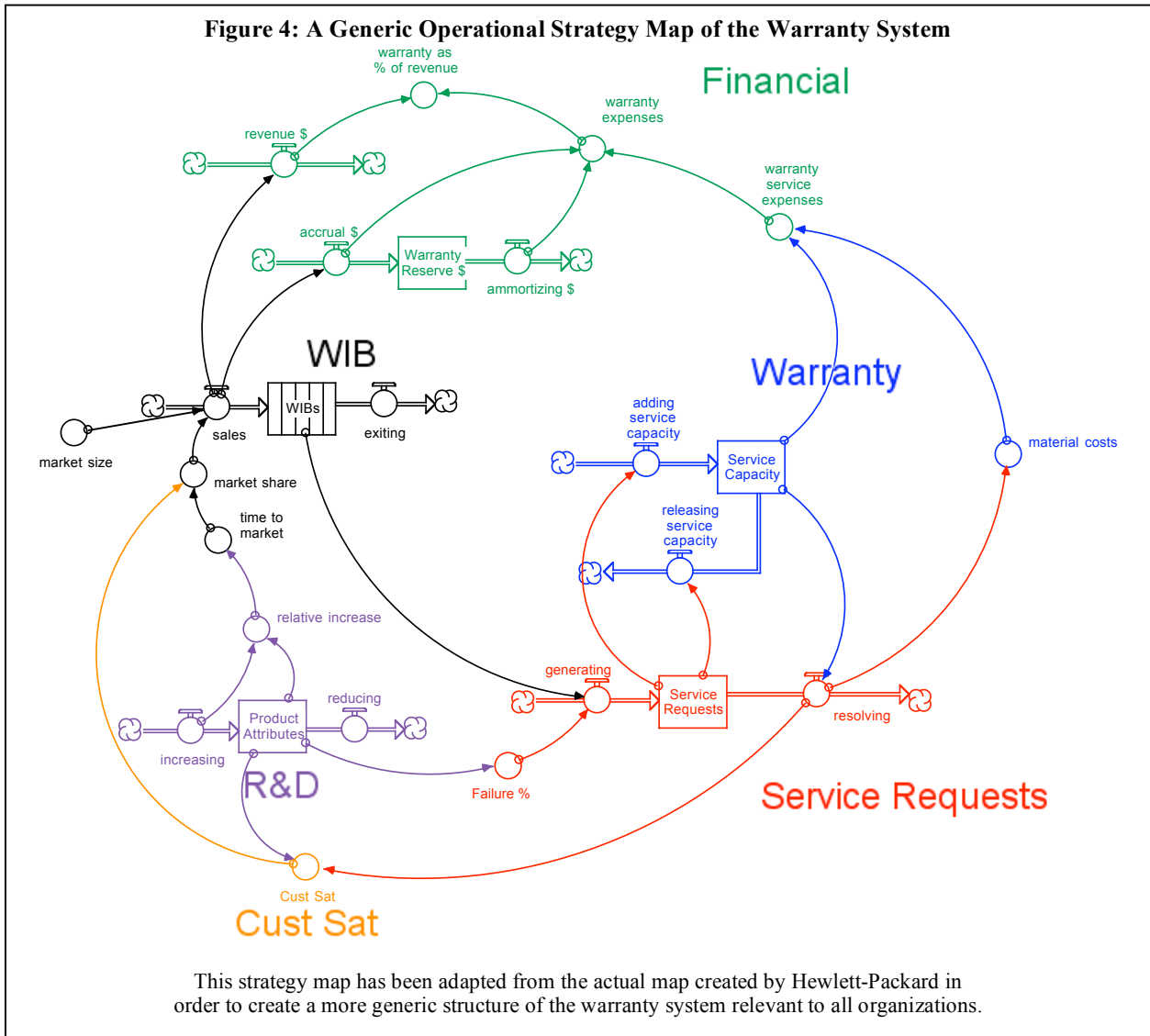


Figure 4: A Generic Operational Strategy Map of the Warranty System



Based on preliminary interviews, the map developer will construct the “strawman” strategy map. The strawman map is not the finished product! Rather it is used to facilitate conversations with those who were interviewed to check for understanding. In most cases, the owner(s) of the strategy map will convene a meeting of those interviewed, plus other important stakeholders. These sessions work best when there’s both a horizontal slice of the system (experts from different sectors) and a vertical slice (senior managers to analysts). The horizontal slice of senior managers ensures the proper 10,000 meter view of the system. The vertical slice increases buy-in required for implementation of insights at a future point.

The meetings can be held in-person and using web-meeting technology. A generic version of the final map is shown in Figure 4. The sectors included in the Operational Strategy Map include: the financials, the installed base, the warranty service capacity, customer requests, customer satisfaction, product development, and sales. The rectangles are stocks and represent accumulations. In physical terms, they are like bathtubs. The flow pipes that flow into and out of the stocks cause the accumulations to increase or decrease (i.e. they fill and drain the bathtubs). Bathtub physics is pretty straightforward!

Let’s look at some of the map to develop your capacity to read the map in its entirety. The stock of Service Requests is the amount of unfilled customer requests at any point in time. The stock grows from each new request generated by a customer in the installed base (WIBs). This link is made explicit by the single line (a connector) drawn from the WIBs to the generating

flow. The outflow of resolving (caused by applying the Service Capacity, again shown through the connector arrow) reduces the backlog of Service Requests.

The stock of WIBs has vertical lines to represent a conveyor. When a sale occurs, that product becomes part of the installed base. It jumps onto the conveyor, and stays on the conveyor for the duration of the typical warranty period. And then it exits. While on the WIBs conveyor, it may generate some Service Requests.

Don't confuse a simple diagram with simple dynamics. This diagram, although it only includes a few elements, is capable of describing several complex dynamics. For example, increasing aspects of Product Attributes can have a ripple effect through the organization. In the short term, an increased time to market may reduce market share and monthly sales. That's a negative impact on the financials. Although this will also reduce the number of service requests (as new sales drop, installation-related calls will also decrease). This can lead to having overcapacity; perhaps releasing service capacity occurs. However, once the product gets to market, the increased functionality might lead to increased customer satisfaction. This can increase sales as word of mouth spreads the "good news." If the increased functionality also includes improved reliability, then failure rates might go down, as will service requests. Although a potential decrease in requests might be offset by increased calls if sales go way up! Depending on how the organization handles its service capacity will determine if it is adequate with regard to the amount of service requests. As long as the rate of resolution keeps the Service Requests backlog down, Customer Satisfaction can remain high—and so will sales. This is just one set of "systems stories" (relating to R&D in this case) the map can tell. Different stories may be told simply by picking another area of the map to start with.

Organizations use strategy maps like the one here as integral parts of their team meetings. The training staff at a Fortune 50 organization created a 4' X 6' wall map that hangs in their conference room. Whenever they discuss their training strategy and implementation, team members can point to parts of the map they think need addressing or will be impacted by someone else's strategy suggestions. The map serves to focus the conversation. It keeps people on the same page, breaking down the barriers that jargon and sub-optimal perspectives so often create.

The language has a few major benefits. First, it often surfaces the leading indicators (a term arising from the Balanced Scorecard methodology) the organization should be monitoring. Often there is a stock (perhaps undeveloped capacity) that includes a delay which people aren't aware of. Building the map causes a team to move from indicators that are too late to be useful (i.e. financials) to focusing on indicators that will determine the financials years in the future (i.e. product pipeline).

Another benefit is that it immediately brings out the leverage points. Other mapping languages are often modified arrow diagrams. It's hard to get traction when reading those maps. A stock flow map gives traction because, if you can identify the stocks you wish to improve (e.g. customer satisfaction), you can back up to flows that are activities you might undertake to create the improvement (e.g. resolving Service Requests, or better yet, reducing the amount of requests generated).

Once a strategy map has been developed and tested for usefulness, the development team may decide they've achieved the required amount of insights from the process. Or they may decide to take the map to the next stage: a computer simulation model.

A computer simulation model of the warranty system

It's relatively straightforward to transform a strategy map into a computer simulation model. In the next section, I'll describe a simulation model created from the generic strategy map just described into a simulation model (using the *ithink*[®] software by isee systems, Inc.). Please note that any data or output in this section is not specific to the Hewlett-Packard system.

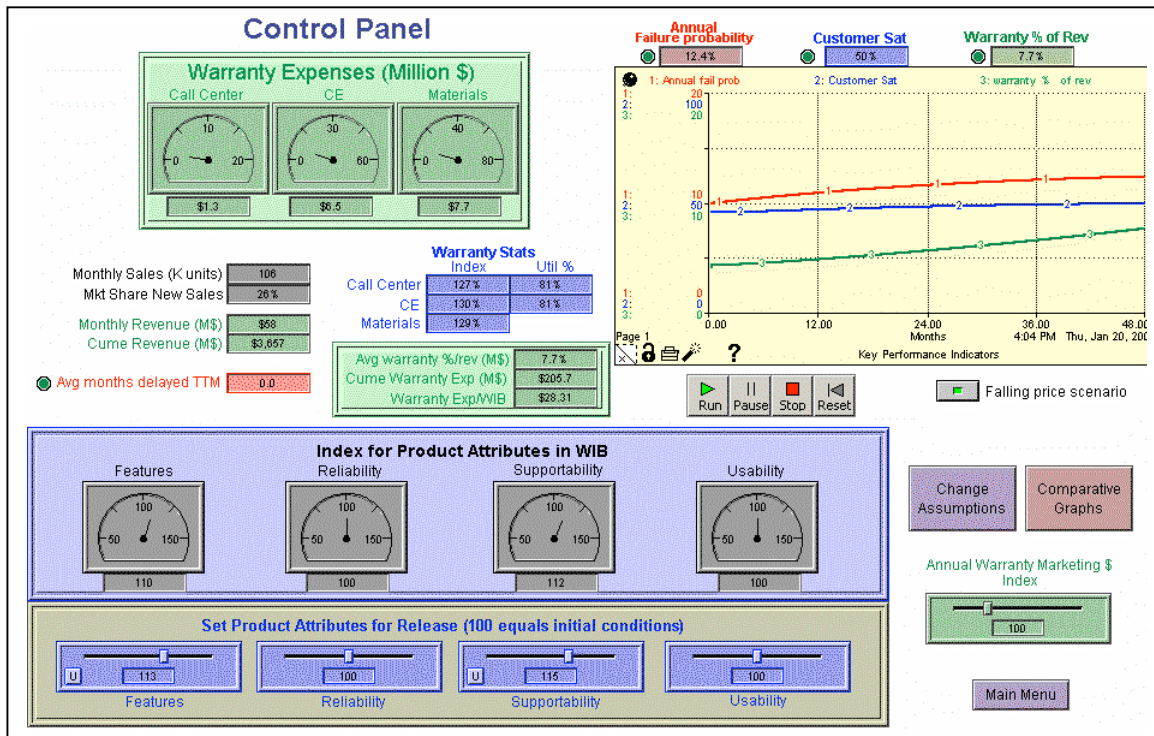
As mentioned before, one of the benefits of using the stock and flow language to create an operational strategy map is that the language is used by system dynamics software packages to create computer simulation models. This means that the assumptions about how the system works can be put into a simulation model, along with real world data, and tested for usefulness. Managers can design strategies that are effective by testing them in a virtual world. Modelers

create interfaces to allow managers to work in groups to try out strategies and discuss the outcomes in scenario planning sessions.

The process of creating a useful flight simulator takes a couple of months of modeling, data gathering, and field testing to make sure the model behaves realistically under a variety of scenarios. This process works best with a small internal team working with (or being mentored by) a modeling expert. It's very important during this stage to keep the model from becoming a "black box" model. This will occur if one modeler is responsible for adding assumptions to the model. The model needs to remain transparent to those who will use it so that assumptions will be understood and output trusted.

If the transparency advice is followed, the model will become useful for strategy and communication. What happens with many models (including those described in the beginning of this paper that are generated for different segments of the organization) is that the assumptions are a mystery to those who must make policy decisions from the model. When recommendations are generated from such models they are processed by real people who have their own "mental models" for how the system works. If the results differ from what people perceive the results should be, they are likely to distrust the model's recommendations—even if the underlying assumptions are, in fact, credible under scrutiny. The power of system dynamics modeling is that the assumptions are rigorously defined visually (i.e. the operational strategy map) and managers can understand why results may differ from their expectations. The result: recommendations are trusted and implemented!

A sample flight simulator interface is shown in Figure 5. This particular screen shot shows results from simulating a scenario where a fictional company increases the number of features in its core product, as well as builds in additional supportability. Further, there's an economic



environment assumption that competition is creating downward pressure on price (prices are falling by an annual percentage rate). The result is that the additional features are creating both increased customer satisfaction (they love the new features!) and an increased annual failure rate per product (failures more likely with increased complexity). This leads to more service requests, which drives up the service delivery capacity (to 126% of the baseline amount). However, this increase in service capacity and the simultaneous increase in supportability make it easier to resolve customer service requests; this means customer satisfaction doesn't take a hit from the increased failures. Overall, monthly sales increase to 106,000 over the baseline 100,000 (a 6% increase).

The purpose of simulating the model isn't to make predictions (e.g. what market share will be in the year 2010); rather, it is to facilitate rigorous exploration of a collective mental model about the warranty system. That collective model was built during the strategy map formulation, and it is now simulated to see if the assumptions were reasonable, if anything is missing, and if the model suggests any counterintuitive dynamics might unfold in the future based on current strategies. If the model produces unexpected behavior that's a learning opportunity: does the model have faulty assumptions, or do our expectations of the future not "hold water" under more reasonable assumptions? In short, the tool is there to improve thinking—not take the place of it!

Future directions for the model

At present, there are several directions in which the model could be taken. These directions include:

1. Validation
2. Communication
3. Organizational Learning
4. Scenario Planning

1. Validation

The prototype model has been able to produce credible behavior at a highly aggregate level. Because it is generic, the model can be customized to particular business units or product lines. Reasons for doing this are to increase the robustness of the model by identifying weak assumptions and increase commitment to the use of the tool. Once the model is capable of replicating historical data for specific segments, a "new and improved" aggregate model can be developed that would have increased applicability to past and future organizational issues.

2. Communication

The tool can, even without further validation, begin communicating the current understanding of the warranty system to the organization at large. Stand-alone versions of the model can be made available for self-study or as part of a training program. Employees can explore the high-level strategy map to develop a broader perspective on the warranty system. Customized experiments can lead to deeper understanding of the need to take the broader perspective, which will increase commitment and buy-in to warranty strategies.

3. Organizational Learning

The mapping and modeling process shouldn't be used to create a final, static product. Rather, the map/model should be thought of as the organization's best thinking—at the moment. Times change. Markets shift. Innovations occur. A good map/model will lead warranty professionals to identify the right indicators to track so that they can be a jump ahead of the changing times. Even so, when things change, the organization should pull the map/model off the shelf and modify it based upon the newer "best thinking."

Part of the organizational learning approach might be as a component of a Balanced Scorecard methodology. The Operational Strategy Map could easily be modified to become the foundation of a Balanced Scorecard for the organization. Kaplan and Norton suggest a scorecard be the basis for facilitating organizational learning. As mentioned before, the strategy maps built by system dynamics improve the ability to identify leading indicators that will help anticipate changes in the organization or business environment that will impact the warranty chain.

4. Scenario Planning

If the organization has the desire to do scenario planning, the simulation model would serve as a foundation for that process. The generic model here already includes a scenario: downward pressure on retail price. Other scenarios could be added. Then the model could be used in a Strategic Forum™ to run an assortment of scenarios. It is likely that each scenario would dictate a different strategy mix be required to ensure maximum organization performance. By using the model to identify and test those mixes, senior leaders would have greater commitment to a strategy mix when external factors arise changing the business context.

Conclusion

The prototype tool described here is still in its infancy. Nonetheless, the system dynamics approach shows promise for helping warranty chain professionals address many challenges they face. In particular, building an Operational Strategy Map can help the organization get an understanding of the breadth of the warranty system—increased understanding will lead to greater commitment to making warranty services a higher priority in the organization's strategy. Further, simulation models will help improve the quality of the strategy by identifying unintended consequences and other challenges to implementation. All of these will combine to increase the rigor brought to bear on conversations where the warranty chain is an integral part of the system.

For Further Reading

Richmond, Barry. *Introduction to Systems Thinking* (High Performance Systems, Inc.)

Richmond, Barry. *The Thinking in Systems Thinking: Seven Essential Skills* (Pegasus Communications, 2000)

Soderquist, Chris, Facilitative Modeling, *The Systems Thinker*, Vol 14, No. 9, (Pegasus Communications, 2003)

Soderquist, Chris. *The Strategic Forum, The Change Handbook*, Holman and Devane (editors) (Berrett-Koehler, 1999) (this chapter is also available as a booklet from the publishers)

Schwarz, Roger. *The Skilled Facilitator* (Jossey-Bass, 2002)