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VOLUME 22, NUMBER 2 SUMMER 2003

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SUBSCRIPTION INFORMATION

The Journal of Business Forecasting is published quarterly by Graceway Publishing Company, Inc. Subscription rates, hard copy, $85 per year. PDF file $55 (both domestic and foreign) Student Rate: $60 per year. Foreign Subscribers, including Canada, hard copy, $110. Single issue copies are $25. SubsVisa/ Master/American Express cards accepted.

Changes of address, requests for subscription information, and other correspondence should be addressed to:

Journal of Business Forecasting
P.O. Box 670159, Flushing, N.Y. 11367-0159
516.504.7576, 800.440.0499 • Fax No. 516.498.2029
Email: ibf@ibf.org • **Web Site:** http://www.ibf.org/
Our ID No.: 11-263-2688

ISSN 0278-6087

EDITORIAL REVIEW BOARD

VOLUME 22, NUMBER 2 SUMMER 2003

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BUSINESS AND ECONOMIC OUTLOOK

FORECASTING R & D PROJECT PERFORMANCE: W. L. GORE'S JOURNEY

By Joseph DiGiacomo, Daniel Sheinberg and Richard Sonnenblick

Before assessing the performance of a given project, the framework of the forecasting system must be identified, that is, what is the ultimate goal, the best metric to track, and so on … the model used should incorporate uncertain inputs, offer transparency of data and results in simple terms, and provide scalability, i.e., it should enable quick and easy modification of the analytic elements.

Any firm that relies heavily on research and development (R&D) to generate future revenue has to make critical decisions regarding the selection of the appropriate development path for each project. Decisions to expand a project's scope, to cut back or abandon development altogether, to outsource, joint venture, or spin off a project, all involve an element of risk for the decision maker. The best way to make such a decision effectively is to thoroughly assess the project's future performance under each of the available development alternatives.

While the need for such an assessment is obvious, the task of doing it can be daunting. In general, major R&D investments represent technically challenging efforts to reach markets that are changing rapidly or to create markets that may not yet exist. Many of the underlying factors, such as how long development will take and what the competitive landscape will be at the time of product launch, are highly uncertain. In such cases, even information from expert sources will be speculative in nature. Similarly, there will be no one "right" way to conduct the analysis; the level of assessment detail will ultimately be determined by the complexity and magnitude of the opportunity being assessed. Finally, there is a question of what metrics to forecast, and what information will be of greatest value to decision makers? Is there one criterion that will suffice, or are there a number of different indicators that should be developed?

MEETING THE CHALLENGE

The keys to meeting these forecasting challenges are as follows:

1. Begin with the end result in mind. Communicate early and often with decision makers to clarify what information they will need to make project development decisions. Also, find out the metrics they should rely on and the range of development

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alternatives to be considered.

2. Build an integrated forecasting model from the ground up. Each of the driving factors of project performance should be assessed individually, and at the appropriate level of detail. Where possible, separate the overall forecast into distinct components that can be aggregated later. This will allow you to review intermediate issues such as time to market and market share, in addition to the forecast of overall project performance.
3. Apply the same methodology to generate the metrics for each project alternative. Ensure that universally applicable data (such as the firm's discount rate) is used for all forecasts, and that the same analytic assumptions are applied to each alternative. This will head off any concern about comparing different forecasts, and instill confidence that one is comparing apples with apples, and not apples with oranges.
4. Make your analysis as transparent as possible. For that reason, carefully document your analytic assumptions and data sources so that decision makers can easily review them. Furthermore, you should be proactive about assumptions or data sources that may be questioned. If possible, consult with decision makers about critical assumptions and data sources while you are compiling the forecast so that they are "in the loop."
5. Explicitly incorporate uncertainty in forecasts. When collecting predictive data, do not seek point estimates; the only thing you can be sure of about point estimates is that they will be wrong. Instead, capture the range of possible values for a particular input by using different scenarios with different probabilities. This way you will be able to generate a range in your forecast that characterizes the uncertainty surrounding the metrics of interest.

By adhering to these principles, you will develop a forecast that executive decision makers can trust. It will provide the information they require and rely on. Over time, such a process will lead to better decisions regarding project development, and at the same time will streamline the decision-making mechanism.

FORECASTING PROJECT PERFORMANCE AT W. L. GORE

An example of these principles at work is the forecasting template the authors developed at W. L. Gore and Associates (Gore). Gore is a world-renowned company for fluoropolymer technology, and has a manufacturing enterprise with 45 locations worldwide and more than 6,000 employees. The firm relies heavily on its R&D capabilities in all of its product areas including textiles, high technology, and medical and healthcare.

Recognizing the significant investment being made in R&D and its importance to the future performance of the company, Gore wanted to be sure that it was investing wisely, giving promising projects their best chance to succeed while rapidly identifying those projects that should be abandoned. The company enlisted the authors to design and execute a systematic method for evaluating projects and their development alternatives.

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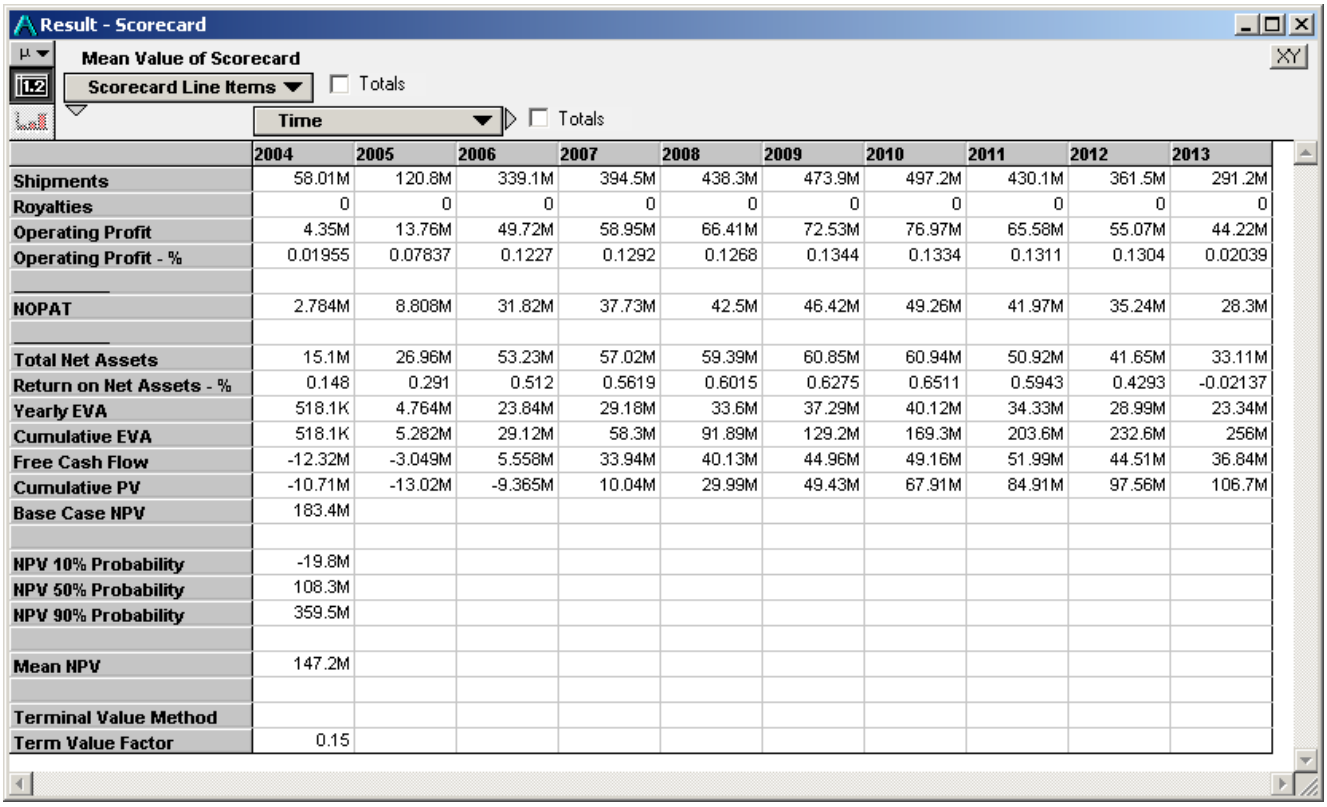
FRAMEWORK OF THE FORECASTING SYSTEM

Initially, through meetings with Gore's decision makers, the framework for the forecasting system was developed. The ultimate goal was to maximize shareholder value, and it was agreed that the best metric to track for this purpose was net present value (NPV). The purpose of using NPV as the decision-making criteria was twofold. First, it encapsulated many aspects of shareholder value in a single metric, and second, it was clear, understandable, and relatively simple to communicate to others. The NPV was reported in a scorecard (Figure 1) that contained other important sales and cash flow metrics.

The decision makers also identified a number of issues the forecasting system should address if its recommendations were to be valued. The breakdown of these concerns were:

1. Basic technical, market, and business conditions should be well understood. For example, does the project draw on core competencies or will it require additional expertise and staff? Does it address a mature market, or a market with a significant growth potential? What does the competitive landscape look like?
2. Technical, market, and strategic business alternatives should be clearly identified. For example, is outsourcing development a viable option? Is there an appropriate partner to co-market with? Does the project fit in with current corporate objectives?
3. Assessments of each alternative should be complete, honest, and cognizant of the risks involved. The appropriate sources should be consulted and their information should be recorded

FIGURE 1
SCORECARD



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Shipments	58.01M	120.8M	339.1M	394.5M	438.3M	473.9M	497.2M	430.1M	361.5M	291.2M
Royalties	0	0	0	0	0	0	0	0	0	0
Operating Profit	4.35M	13.76M	49.72M	58.95M	66.41M	72.53M	76.97M	65.58M	55.07M	44.22M
Operating Profit - %	0.01955	0.07837	0.1227	0.1292	0.1268	0.1344	0.1334	0.1311	0.1304	0.02039
NOPAT	2.784M	8.808M	31.82M	37.73M	42.5M	46.42M	49.26M	41.97M	35.24M	28.3M
Total Net Assets	15.1M	26.96M	53.23M	57.02M	59.39M	60.85M	60.94M	50.92M	41.65M	33.11M
Return on Net Assets - %	0.148	0.291	0.512	0.5619	0.6015	0.6275	0.6511	0.5943	0.4293	-0.02137
Yearly EVA	518.1K	4.764M	23.84M	29.18M	33.6M	37.29M	40.12M	34.33M	28.99M	23.34M
Cumulative EVA	518.1K	5.282M	29.12M	58.3M	91.89M	129.2M	169.3M	203.6M	232.6M	256M
Free Cash Flow	-12.32M	-3.049M	5.558M	33.94M	40.13M	44.96M	49.16M	51.99M	44.51M	36.84M
Cumulative PV	-10.71M	-13.02M	-9.365M	10.04M	29.99M	49.43M	67.91M	84.91M	97.56M	106.7M
Base Case NPV	183.4M									
NPV 10% Probability	-19.8M									
NPV 50% Probability	108.3M									
NPV 90% Probability	359.5M									
Mean NPV	147.2M									
Terminal Value Method										
Term Value Factor	0.15									

Note: **All data provided in this and successive figures are for illustrative purpose only, and not indicative of any actual project at W. L. Gore and Associates.**

accurately. If the information is uncertain, the range of uncertainty should be identified so that it can be incorporated into the analysis.

4. Alternatives should be compared across both quantitative metrics such as NPV, revenue, and funding requirement; and qualitative metrics such as competitive position, strategic fit, and technology leverage.

ANALYTIC MODELING

With a clear vision of the forecasting system's requirements, an analytic template was developed which was flexible enough to evaluate alternatives within Gore's many different R&D projects, yet structured enough to ensure that the evaluations would be consistent and comparable. The template's basic design is captured in Figure 2.

The diagram shows that uncertain forecasts are required for such variables as *Technical Success* — whether internal development of the product will succeed or fail at each stage; *Development Time* — *how* long it will take to do the job in each stage of internal development; and *Development Cost* — the costs incurred during development of a product. The arrows indicate that the range of possible development costs will depend on the technical success and development time of the project. Also, it shows that the forecast for market share will vary depending on when Gore's product reaches the market relative to any competitive products.

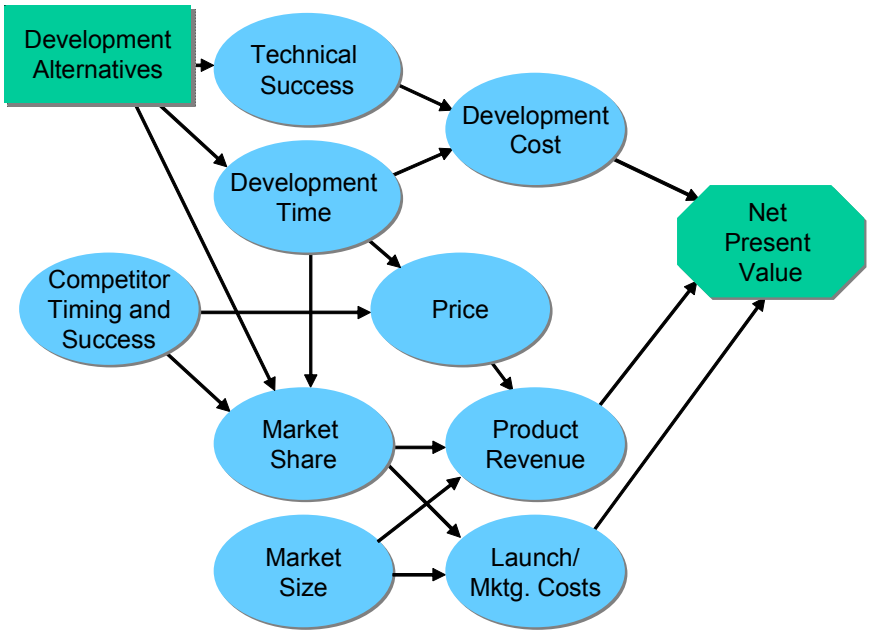
A critical element of the template, which is not apparent from the figure, is its capability for progressive refinement. Because the system is used at a variety of stage gates in the development process, it was desirable to allow for varying degrees of analytic detail in using the model. For example, a concept stage project might require minimal investment to continue R&D, and therefore would not require more than a basic, high-level analysis of the potential market. By contrast, to evaluate whether to proceed with a late stage development project that would require a significant capital investment, the market analysis should be thoroughly detailed. This type of flexibility is built into the model so that as a project progresses through the development stages, the assessment data increases in detail and the resulting forecast is correspondingly refined.

To accommodate this underlying structure, the forecasting template was built with analytical modeling capability (Analytica software from Lumina Decision Systems). Using the model, Gore was able to capture and display the effect of uncertainty on multiple outputs related to

the project's assessment. Specifically, the model offers the following benefits:

1. It incorporates uncertain inputs. Monte Carlo simulation capability inherent in the template enables the assessment of uncertainties, sensitivities, and scenarios.
2. It offers transparency by providing a visual interface, well-documented model structure, and direct use of business structures (regions, markets, months and quarters, etc.) Furthermore, it facilitates the discussion of inputs and results with individuals who are unfamiliar with the model.
3. It provides scalability. The modular and flexible nature of the model enables additions or modifications in the analytic elements quickly and easily, which can "grow without growing out of control."

FIGURE 2
DECISION DIAGRAM



Note: Here a rectangular node indicates a decision, an oval node indicates an uncertain factor that must be forecast, and an octagonal node indicates a calculated variable of interest. An arrow between nodes indicates that the value of the child node may be affected by the value of the parent node.

PROCESS AND ROLES

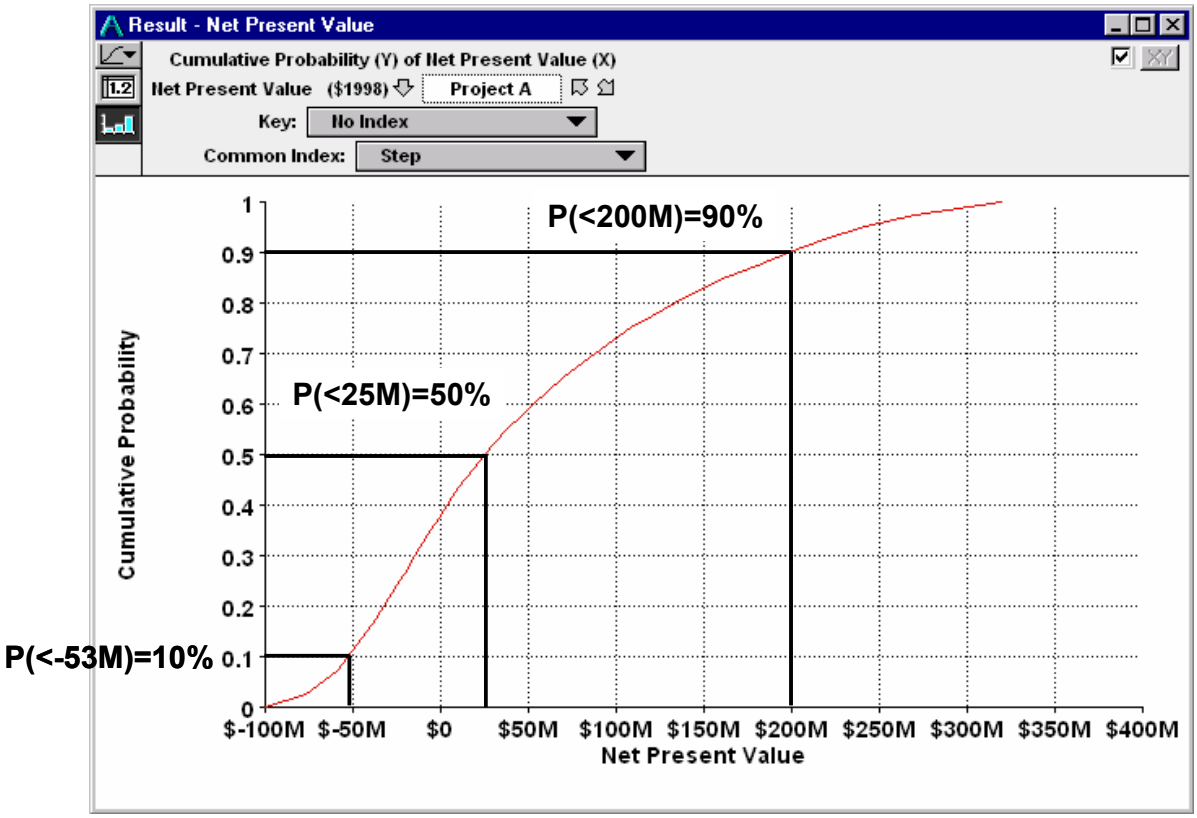
Of course, forecasting is more than just a model itself. To effectively implement a forecasting system such as Gore's, there is a clear need for a champion of the project assessment process. This individual (or team of individuals) must be expert not only in quantitative modeling, but also in guiding the conversation that informs the model. At Gore, each project has an analyst/forecaster (known as the Facilitator) who works with the project's interdisciplinary Core Team, which consists of associates committed to the project in assessing project alternatives and project value. Together, the Facilitator and the Core Team are responsible not just for gathering data, but also for understanding the context of the project and generating the development alternatives for consideration. These are ongoing responsibilities that are discussed at the time of initiation of the forecasting process, which are revisited as needed. For example, as the 'keeper of the process,' it is the Facilitator's responsibility to update inputs when uncertainties are mitigated or refined, and as additional information becomes available.

The Facilitator is the point person for completing and validating all of the inputs in the assessment model. This is done directly through research when the data can be located in the literature, or through expert consultations when the required information is project-specific. In the latter case, the Facilitator, with the help of the Core Team or the R&D leadership, identifies the appropriate expert to consult (whether from within or outside of the organization). It is the Facilitator's task to elicit a forecast that accurately represents the expert's knowledge. The dialogue between the Facilitator and the expert is critical to this elicitation, as the Facilitator encourages the expert to consider the context of the project while formulating the forecast. If, for example, the expert is being consulted about market share, the Facilitator might draw attention to the timing of product launch relative to the competition, or to the likely operating profile of Gore's product. Besides encouraging the expert to draw on all available information when making a forecast, the Facilitator also ensures an accurate elicitation by using probabilities to capture the expert's range of uncertainty. This makes it possible to incorporate not only the expert's opinions, but also his or her level of confidence in those opinions. As a routine matter, all such consultations are carefully documented (as are direct sources) to provide an audit trail for future reference.

ANALYSIS

Once the model inputs are complete, the Facilitator runs the analytics to "crunch the numbers." The metrics of interest are generated for each alternative, and risk analyses are conducted. The probabilistic nature of the model makes it possible to perform meaningful uncertainty analysis, including the identification of project risks and opportunities. Two of the techniques most often used at Gore are uncertainty characterization and sensitivity analysis. Uncertainty characterization enables an

FIGURE 3
UNCERTAINTY RANGE OF NPV CUMULATIVE PROBABILITY DISTRIBUTION



understanding of the overall risk of a project, while sensitivity analysis clarifies which uncertain inputs are of greatest concern.

Uncertainty characterization encompasses a number of methods for communicating the overall risk of a project. Rather than simply examining the average (or mean) value of a metric such as NPV, it can be extremely important to understand the range of possible values and their associated likelihood. One of the most informative ways to communicate this uncertainty is the cumulative probability distribution. An example is shown in Figure 3. For any value of NPV on the horizontal axis, the curve shows the likelihood that the actual NPV will be less than that value. The cumulative probability distribution enables one to see, for example, that there is a 50% chance the project NPV will be less than $25M, and an 80% chance the project NPV will be between $53M and $200M. This type of analysis is frequently employed to decide between different alternatives, and even between different projects, with an understanding of all the possible outcomes, rather than simply basing the decision on a single average value for each alternative or project.

Sensitivity analysis reveals how different factors contribute to the uncertainty in the metric of interest. While holding all other inputs constant at their base values, one input at a time is varied between its high and low forecast, and the difference generated in the metric of interest is recorded. Figure 4 shows a tornado diagram that graphically represents this information, with NPV as the metric of interest. (The diagram is called a 'tornado' because it visually represents a tornado with the inputs sorted from most sensitive at the top to least sensitive at the bottom.) Figure 4 suggests that the NPV of the project is very sensitive to the uncertainty in the forecast of *Market Capture Rate*. To see this, note that when all inputs are at their base values, the NPV of the project is approximately $183M. If the *Market Capture Rate* is at the high end of its forecast, the NPV soars to $250M, and if it is at the low end of its forecast, the NPV sinks to just $22M. Conversely, uncertainty in the forecast of *G&A Expenses* seems to have relatively little impact on project NPV. Varying it from its high to low forecast only results in a $4M difference in NPV. This type of sensitivity analysis is extremely informative when considering where to invest resources to gather more information. In this example, it is clear that to improve the forecast it would help greatly to develop a more informed forecast of *Market Capture Rate*, while it would be a wasted effort to focus further attention on *G&A Expenses*. In this manner, the tornado

FIGURE 4
TORNADO DIAGRAM
SENSITIVITY OF NPV TO ASSESSMENT MODEL INPUTS

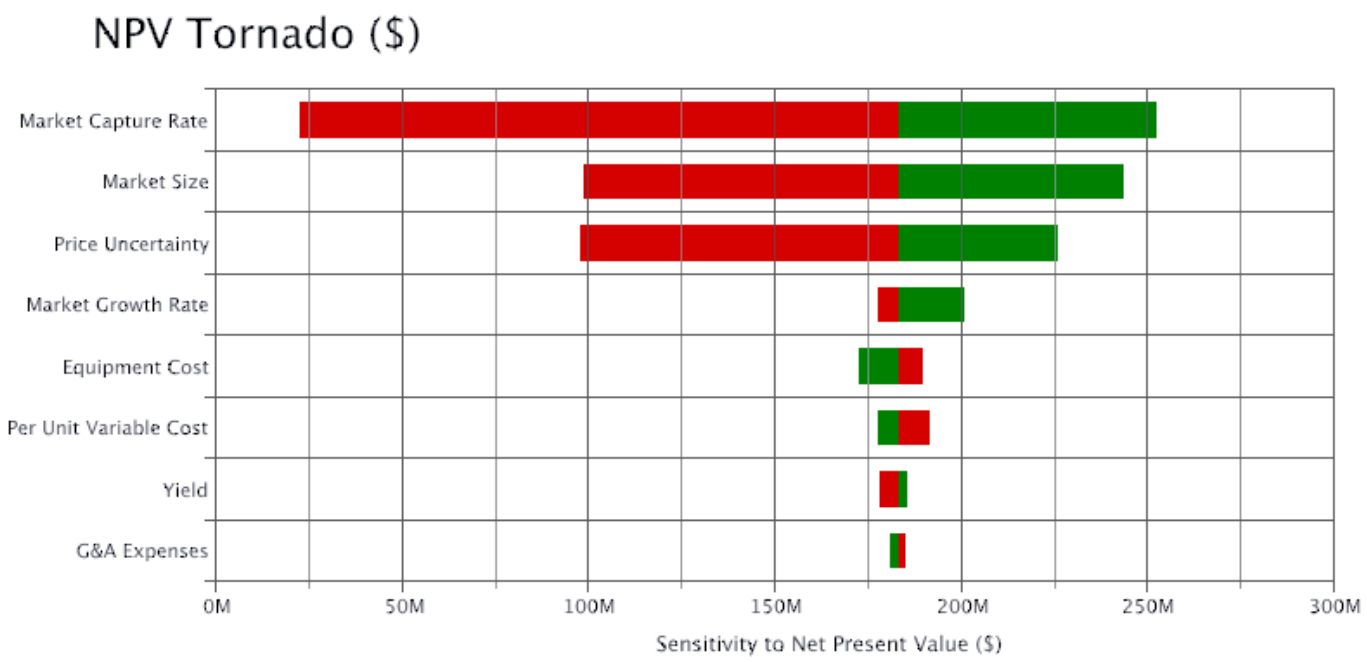


diagram helps to separate "what is countable" from "what counts."

DECISIONS AND ACTION

After analyzing the project forecast, the Facilitator reviews the results with the Core Team to get feedback and develop recommendations for presentation to the R&D leadership. Any concerns or suggestions brought up by the team members may lead to additional information gathering and further analysis. Often it is at this stage that the most promising alternatives are generated, as the Core Team has the opportunity to see why some development strategies are superior to others, and they are able to come up with hybrid, or sometimes revolutionary, strategies that create even more value. Once the iterative process of reviewing results and conducting further analyses is complete and the team is comfortable with both the process and the recommendations, the results are brought to the attention of decision makers for a review.

During the executive review, the Facilitator and members of the Core Team jointly present their findings, and field questions. Because the underlying analytic model has already been tested and approved, time is not wasted on challenging the methodology during these meetings. Instead, the R&D leadership critically examines the results of the analysis and then focuses on the differences between alternatives. If there are questions about the validity of a result, the Facilitator quickly refers back to the data entered so that executives can review the underlying assumptions and their sources. The end result is that review meetings are generally efficient and productive; either a product development alternative is selected, or the Facilitator and Core Team are asked to revisit the data and assumptions used in the business model.

The benefits of the forecasting system at Gore have been recognized by all of the parties involved. The Facilitators appreciate the established analytic framework. It allows them to focus their efforts on gathering the best available information and generating insight into the drivers of value, which then allows them to develop better recommendations. The Core Teams appreciate their active role in informing the strategic development decisions that guide their efforts, and feel they gain insight not only into the forecasting process, but also into their project. R&D leaders are more confident that they have quality information to base their decisions on, and appreciate the streamlined process that eliminates wasted time and effort.

CONCLUSION

Forecasting R&D project performance is a challenging task, which is fundamental to the overall performance of many organizations. The principles discussed here provide an outline for a forecasting framework that enables rigorous evaluation of strategic development alternatives. As demonstrated by the forecasting system now in use at W. L. Gore and Associates, implementing such a framework provides tangible benefits to an organization, both through better decision-making and more efficient use of resources. ■