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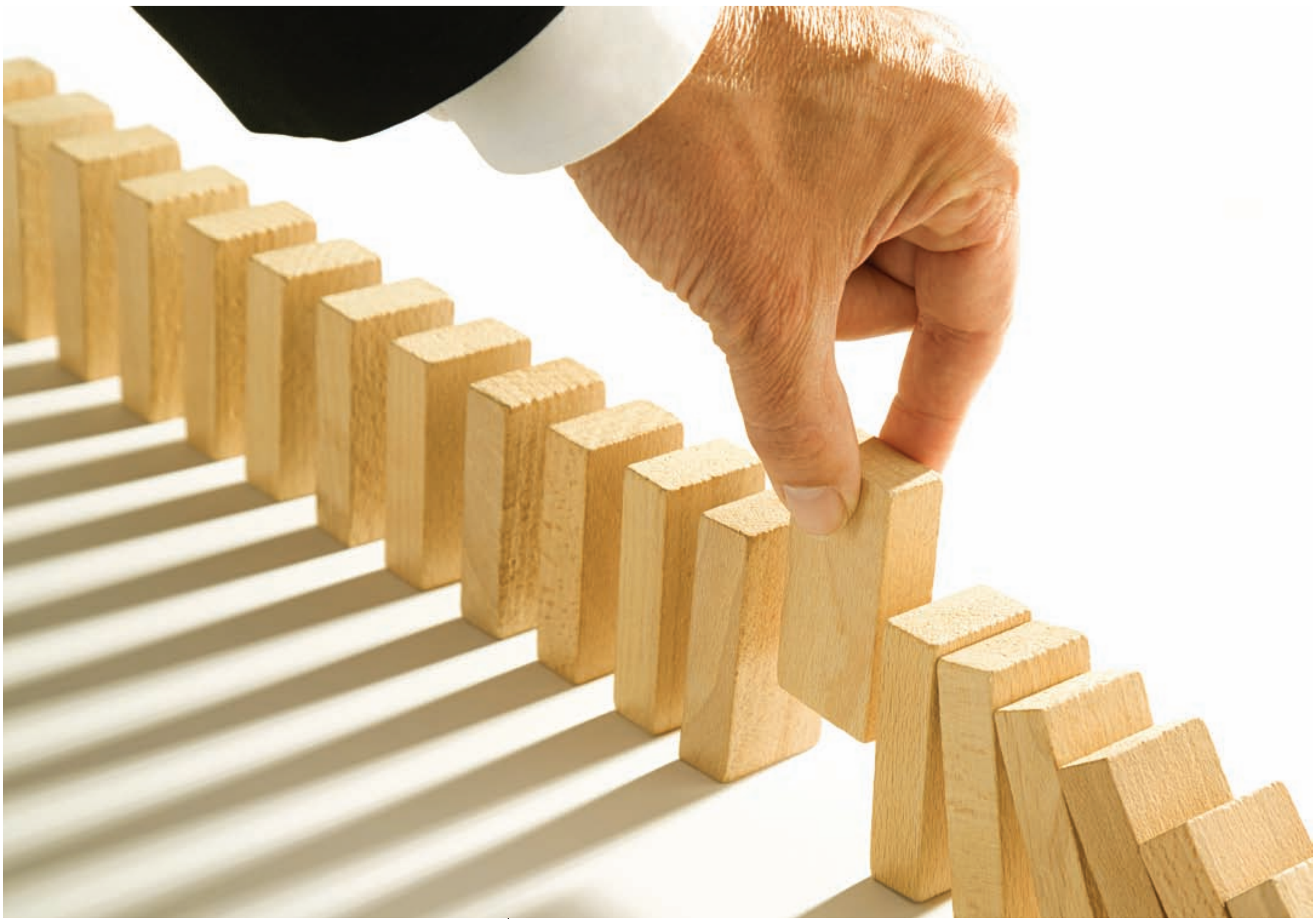
Put to the Test

Executive-level business decisions include a broad range of interconnected variables leading to an extensive array of options. In the supply chain arena, this often plays out as a tradeoff between operating costs, working capital (mostly inventory), asset utilization and customer service levels. The challenge for executives – and it's a significant one – is to reach a decision that will have positive outcomes regardless of the various scenarios. To accomplish this goal, it is critical to run models that encompass a variety of possibilities for when the future turns out to be not exactly as planned.

This activity involves data crunching. It is designed to achieve the best balance of operating costs, inventory, asset utilization and customer service while lowering the risk of unsustainable costs. Macro models and design of experiments (DOE) are under-utilized approaches that can help business leaders understand value and risk at the highest level and lead to better strategic decisions.

It would be ideal if companies could test every possible business and supply chain decision against all business conditions. However, because there are so many variables – such as fuel prices, customer demands, supplier costs, manufacturing costs, distribution costs, etc. – it is not feasible to run thousands of scenarios. A good option is to use DOE, which is a well-established technique applicable to



science and engineering. It offers reasonable predictions of performance over a wide range of scenarios by explicitly testing a small but carefully selected subset of scenarios. This method, which has yielded excellent research and design, is well-suited for business decision-making despite its less-than-widespread use.

Consider this scenario: Many companies that closed warehouses or manufacturing facilities at the start of the economic downturn have found they are not well-positioned to respond to a pick-up in demand in the most cost-effective manner. Other short-sighted decisions have been made by firms that terminated supplier and transportation contracts in response to a short-term drop in sales, which is clearly an incorrect call because long-term costs of resourcing those needs is higher than anticipated. Instead, a more strategic approach for all these cases is in order – a strategy designed to perform well under a variety of market conditions.

A BETTER CHOICE

DOE supplants one-at-a time experimentation and intuition as the preferred choice for exploring options and their relation to performance. DOE often uncovers the interactions between design factors that cannot be discovered with one-at-a-time methods where a single factor varies in each round of experiment.

In addition to improved effectiveness, DOE delivers efficiency improvements by selecting from designs that uncover as much information as possible in the least number of model or experiment runs. A hypothetical experiment here – a model of an organization's future supply chain – provides insight into the process. Known elements as well as possible added facilities – warehouses, plants, cross-docks – are modeled. Another model will recommend locations for the facilities.

Desirability of these locations depends on factors such as unknown future demand, fuel prices and, perhaps, supplier locations. However, instead of relying on arbitrary model runs, the DOE approach lays out a sequence of runs that would reveal the importance of each of the factors in an unambiguous way.

Consider the method by looking at the most common designs in use – factorial experiments. Begin by selecting factors of interest and setting up different levels of each factor. Although factor levels are typically numerical, they can also be yes/no type choices. In the so-called orthogonal designs, every factor is exposed to the same levels of the other factors and that makes it simple to isolate the effects of the individual factors.

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In a full factorial experiment where factors have been restricted to two levels, such as low and high demand, the number of runs of a model grows as 2n – where n is the number of factors in the experiment. If you have 10 factors of interest, 1,024 runs are needed to explore all the possibilities. In reality, many fewer runs are needed. The full 1,024 runs would allow you to estimate interaction effects of every order; for instance, a highly unlikely interaction between nine of the factors.

SIMPLIFY THE PROCESS

To pare things down to something more reasonable, a small fraction of these runs is selected that gives up the ability to estimate the effect of very unlikely interactions. The fractional experiment restricts itself to estimating the effect of the main factors and reasonable interactions such as those among pairs or triplets of factors. So in the 10-factor experiment, you could estimate all those main effects and get some useful information on two-way interactions with just 32 runs. This usually points the direction for a few more runs that crystallize the results.

If an objection is raised that the levels of the factors are hard to select or there are more than 10 factors, DOE offers additional support. Screening experiments can be used to identify factors that should be considered more closely. These are low-resolution experiments – because they cannot uncover interactions – that hunt for single factors with large importance. It is generally true that unless a factor has a significant effect on its own, it is unlikely to be important in an interaction.

When it is difficult to pin down factor levels, a sequence of designs can be run that looks for gradient information such as directions of improvement. These show the direction for future runs and, when appropriate, can lead to designs that find the optimum result.

Fortunately, in the typical case, reasonable factor levels are given, such as a demand increase of 10 to 50 percent over the next five years. Furthermore, only a small set of factors and controllable decisions are really of interest.

Inexpensive software is available to assist in creating a design and interpreting the results of the experiment. It is always important to have skilled people who can run experiments and designs and interpret the results correctly. Fortunately, in recent years, the bar has been lowered considerably in terms of what it takes to get this done.

The rapid changes occurring in today's business world require a robust and effective plan that is viable for good times and bad. Understanding how to achieve and increase business profitability in an uncertain future requires the best choices now. Tried and true success strategies from the fields of design and engineering applied to business makes those best decisions possible.

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