

# Covering the **Spread**

A standalone course  
on **spreadsheet**  
modeling teaches  
students skills they can  
use throughout the  
business curriculum —  
and on the job.

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A critical part of an MBA's education is learning how to build business models that are adaptable to real-life situations. It's particularly useful for students to learn spreadsheet modeling techniques, which allow them to make mathematical models of relatively unstructured business problems and organize them via a spreadsheet. Such models help them think through a problem and even determine what data will be most useful to solve it.

Unfortunately, many business schools do not offer in-depth instruction on the art of spreadsheet modeling. Spreadsheets are generally covered in basic accounting or finance courses, but rarely do schools devote a separate class to teaching how spreadsheet modeling can solve a wide array of business problems. Some administrators dislike modeling, remembering it as a cumbersome and difficult part of their old management sciences course; but today spreadsheet modeling can be a dynamic and vital part of any business curriculum.

At the Tuck School of Business at Dartmouth in Hanover, New Hampshire, we believe spreadsheet modeling should be a central component of MBA education. Our standalone course provides students with skills they later will use in a variety of classes—and, ultimately, in the working world.

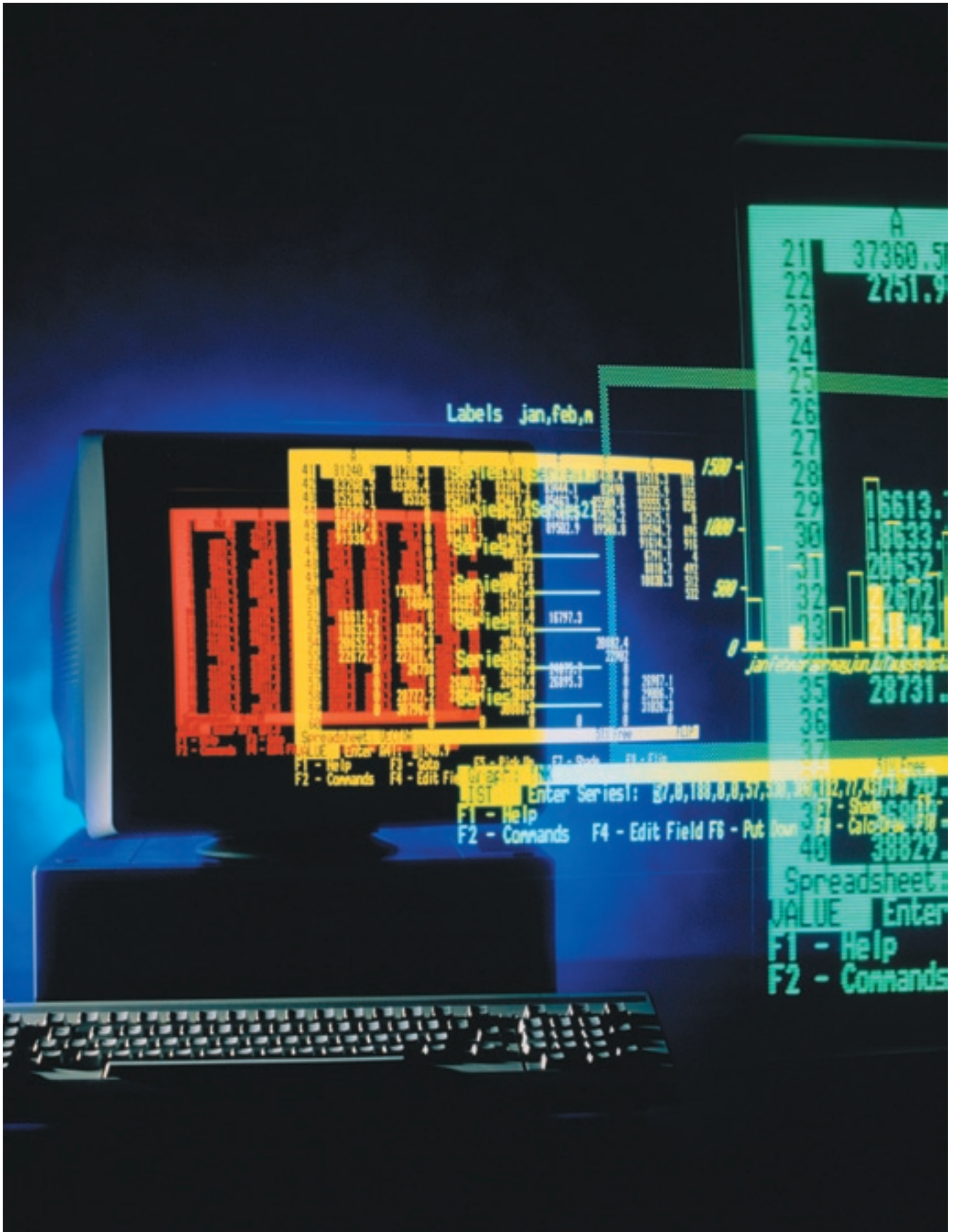
## **Spreadsheets in the Curriculum**

For schools that recognize spreadsheet modeling as an essential skill for their graduates, the challenge is to design a compelling, comprehensive course offering lessons that can be used throughout the curriculum. At the Tuck School, spreadsheet modeling skills are covered in our required decision science course, which is followed by a separate statistics class.

We tackle several fundamental questions: What is a mathematical model? What should and should not be included in a model? What is the difference between a parameter, which is something outside the manager's control, and a decision variable, which is within the manager's control?

The spreadsheet course is divided into three roughly equal parts. In turn, we focus on spreadsheet engineering, optimization, and simulation.

**Spreadsheet engineering:** In this module, we emphasize the careful implementation of mathematical models in spreadsheets. We want students to learn to develop spreadsheets that are not only correct and useful, but also produced efficiently. Many of the course's spreadsheet engineering ideas are intuitive



and well-established in software engineering. For example, students learn they should start with a simple spreadsheet; test that component, and then expand; isolate input parameters in one section of the model; and then modularize the calculations.

We also teach methods that are less intuitive. For instance, we have students sketch the spreadsheet with a pencil and paper *before* opening Excel. Because many students have already worked with spreadsheets, the challenge is to teach them something they think they already know. However, even students who consider themselves spreadsheet experts, such as former consultants, see the benefits of acquiring a structured process for designing, building, and testing a spreadsheet.

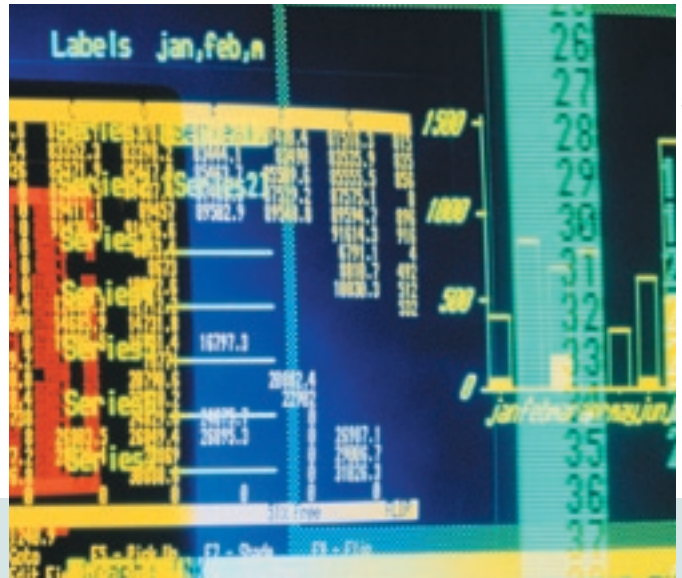
## Real-World Challenges

While stylized business scenarios learned in the classroom can help students understand problems they will encounter on the job, there often is a gap between the model and the actual situation. That's where spreadsheet modeling comes into play, as students from the Tuck School have discovered.

One of our MBA graduates recently was able to draw on her spreadsheet skills to solve a thorny problem on the job. She works for a service firm with 50 offices, each staffed by five to 200 service technicians. Local managers always have been responsible for staffing decisions—which can be very tricky. Demand for technicians in each office is unpredictable, technicians must be paid even when they are not working for clients, and there are significant penalties when capacity falls short of demand.

Corporate headquarters asked the MBA to help local managers determine the number of technicians needed for each office, balancing the costs of having too few or too many technicians. She recognized that the problem was similar to one she encountered in her first-year operations course, in which a newsvendor selling newspapers faced unpredictable demand and had to balance the costs of purchasing too few and too many papers.

Using the mathematical formula from the newsvendor model as a template, the MBA constructed a spreadsheet to determine the optimal staffing for each office. Of course, she faced more complications than the newsvendor did, so she had to build a customized spreadsheet



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that took other factors into account. For example, technicians typically are hired for long periods of time, while newspapers are purchased daily. Similarly, technicians sometimes are shared between offices, while newsvendors operate independently. The costs associated with insufficient goods are different as well. In the classroom model, the "cost of underage" is simply the profit the vendor loses by having to turn a customer away. In an actual office, it's much more difficult to determine what a business loses if it is understaffed during a busy period.

Keeping those differences in mind, the MBA created a spreadsheet that allowed her to take into account the specific details of her situation. The spreadsheet also enabled her to test how changes in the cost of underage—the most uncertain parameter—affected the solution. While the newsvendor model provided a useful starting point, the MBA needed the skills to adapt it to her situation. When she successfully completed the spreadsheet, it was used throughout the firm to reduce costs and improve productivity.

Another true story demonstrates how spreadsheet modeling can help students think through a basic problem. As an intern at a major media and publishing company, one of our marketing MBAs was asked to forecast sales for a new consumer product. The new offering would be sold in book and music stores, card and gift stores, and mass merchandise outlets. The product had been marketed before but would be substantially redesigned for this sales effort. It

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Our course also stresses the use of spreadsheet models for interpretation and experimentation. By exploring how the model responds to changes in parameters, the students can develop intuitions about the real world. For example, a model might show that a project has a negative net present value at a discount rate of 10 percent, but breaks even at a discount rate of 8.2 percent.

In addition, we encourage students to document effectively. We believe models should be designed with usage and communication in mind. In industry, many spreadsheets outlive their creators, and managers who inherit spreadsheets from their predecessors on the job are often confronted with arcane notation and spaghetti logic. Our students practice building self-explanatory spreadsheet

would be expected to sell particularly well during certain holiday seasons.

Compared to the challenge faced by our first student, this problem was relatively unstructured. The intern could have approached the problem using the forecasting models he learned in his statistics class, but it didn't fit into any of the standard categories like regression or time series analysis. Before he collected data—a process that can be costly in terms of both time and effort—he wanted to know which data would be most useful. So he first created a spreadsheet model that linked inputs, such as product availability and advertising, with outputs, such as sales.

Simply creating a structured model helped him gain insights into the problem, and building the model helped him to recognize and refine his own assumptions. Sensitivity analysis allowed him to determine which data would be useful to collect and analyze. In particular, experiments with the model helped specify which parameters could be assigned rough estimates and which parameters should be given precise values based on data analysis. After creating a structured, logical model, he was able to communicate his findings to his supervisors in a clear fashion.

Classroom exercises introduce students to the types of situations they're likely to encounter on the job. Spreadsheet modeling skills help them turn theoretical knowledge into practical solutions, allowing them to solve real-world problems.

models that have a clear structure, complete documentation, and output that is easily interpreted.

**Optimization:** In the second major module, students learn about making the best decisions, such as maximizing profits or minimizing costs. This is actually quite a sophisticated mathematical subject, but spreadsheet modeling brings it within the capabilities of a motivated MBA student. In the classroom, students use optimization tools to analyze problems such as how to allocate a sales force for a pharmaceutical manufacturer across seven product lines and five geographical areas.

**Simulation:** The final module covers Monte Carlo simulation, in which the spreadsheet model forecasts the probabilities of certain outcomes, such as the chance that a business will be profitable. Constructing spreadsheet models for simulations teaches students to recognize the uncertainty in their assumptions and, therefore, the uncertainty in their forecasts. Using this tool, students analyze a problem involving an insurance decision for an oil refinery. They also apply it to the problem a toy company faces as it decides how many units to produce for the holiday season.

### Curriculum Integration

Information learned in the decision science course is widely integrated into other courses in the MBA program. For instance, the same tools students have learned in the optimization module will help them in their capital markets course as they solve problems such as portfolio optimization—choosing how much to invest in a set of assets to maximize the mean return with acceptable risk.

An understanding of this problem is at the very core of the capital markets course, and spreadsheet modeling makes it possible for students both to understand the theory better and to solve real instances of the problem. In fact, in our course, the famous “efficient frontier” is nothing but a routine sensitivity analysis.

Similarly, an understanding of Monte Carlo simulation is essential in corporate valuation and option pricing. It's also employed in operations electives to analyze inventory problems, in marketing electives to study survey responses, and in economics courses to study how the uncertainty of the exchange rate affects the decisions of international firms. While studying spreadsheets, students learn to build a price segregation model, an option pricing model, and an airline yield management model—all of which become useful tools in the functional areas of marketing, finance, and service operations, respectively.

Members of the decision science department act as

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ambassadors to our fellow faculty, helping them develop content to utilize the tools we introduce. The managerial accounting course at Tuck uses the optimization tool to teach students about the impact of alternative overhead allocation schemes. The corporate valuation course uses simulation to estimate the risks of an IPO.

This high degree of integration provides many advantages. Because our course includes applications from a variety of fields, all students are likely to find examples that fit their backgrounds and goals. Students are also likely to see the immediate value of the material and apply it right away in their jobs.

### Selling the Course

At most schools, the MBA curriculum is already crowded with required courses and electives, and not everyone will immediately see the value of adding a standalone spreadsheet modeling course. Three constituencies must be persuaded: students, faculty, and administrators.

Students might be the easiest to convince. Most of them realize that Excel is important on the job, and they'll work hard at any course that enhances their Excel skills. They'll work even harder if they learn how graduates of the program have drawn on these skills to be successful. It's important to realize that some students will resist because they're phobic about math. In those cases, it's necessary to downplay the mathematical aspects of the course, concentrating instead on the Excel equivalents. But gradually even those students will come to believe they can master spreadsheet modeling.

Some faculty, on the other hand, object to adding a spreadsheet modeling course because they're worried that it will displace something else in the curriculum. The best answer is that this course can benefit so many other courses that its impact will be multiplied many times over. For instance, if optimization is used in the cost accounting and operations courses, and simulation is used in the marketing and finance courses, it makes sense to teach both of those techniques in one class. Usually it becomes clear that the spreadsheet modeling course almost pays for itself.

Many administrators, especially those who received their MBAs 20 or 30 years ago, oppose the addition of a spreadsheet modeling course. They remember the old management science or quantitative methods course as highly theoretical, unpopular with students, and useless in the real world. While the spreadsheet modeling course can be viewed as a new version of the old management science course, it's been completely revitalized. This time, it's built on a practical computing platform that makes the methods understandable to moti-

vated students—and eminently applicable on the job. That's a winning combination that should appeal to administrators.

### Measuring Success


To judge the success of our spreadsheet modeling course, we've considered three measures: how similar courses have been used at other schools, how our course has affected our curriculum, and how our course has improved on-the-job performance of our graduates.

We know of several other schools that have redesigned a moribund management science course as a practical, dynamic spreadsheet modeling course. These schools have all adapted a basic spreadsheet modeling course to the specific demands of their programs. Not only does their success strengthen our belief in the value of such a course, but it also provides a vital community of like-minded teachers.

Within the Tuck MBA program, we can see that spreadsheets have become an accepted and widely used tool across the curriculum, at least in part because of our course. Because students have developed strong spreadsheet skills, more faculty are willing to use spreadsheets in their courses. Faculty use spreadsheets to present their own ideas, and they expect students to use them to solve problems.

Of course, the ultimate test is how well our students perform at work. Every year we poll returning second-year students to find out how they used the tools of the course on their summer jobs. In their responses, students have gone so far as to attribute their permanent job offers to their spreadsheet and analytic skills. This feedback convinces us we are having a positive impact.

Like most faculties, we hear regularly from recent alumni, who often ask job-related questions—many of them focused on spreadsheet modeling. Some want recommendations on purchasing spreadsheet software. Some request assistance in formulating a particularly challenging model. Others simply want to check in and let us know they are using the tools we taught them.

Such feedback reinforces our belief that spreadsheet modeling is an essential tool for any business student to learn. While it is rooted in traditional quantitative coursework, spreadsheet modeling can be viewed as an innovation in the MBA curriculum, one that touches a host of functional areas and helps prepare students for a wide range of business challenges. 

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