The New Science of Retailing: How Analytics Are Transforming the Supply Chain and Improving Performance

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Chapter Seven: Technological Risk—How Retailers Should Assess and Manage Emerging Technologies

Evaluating emerging technologies accurately is hard for everyone, even seasoned technologists. Thomas J. Watson Sr., for example, is rumored to have estimated a "world market for five computers." Retailers, not being technologists, have even more difficulty, and they routinely make mistakes. That's hardly surprising. After all, most people in retailing entered the business through operations or merchandising, not the IT department. Before they were executives, they were distribution managers and buyers, not programmers.

In this chapter, we identify some typical errors in assessing and investing in new technologies and provide advice for overcoming them. Our purpose isn't to review every emerging technology in retailing. Changes come too fast for that; doing so would render this chapter obsolete the day it appeared. Rather, we want to give you a framework for analysis, a way of thinking about which technologies make sense for your company and when you should adopt them.

To make the discussion more concrete, we'll examine radio frequency identification (RFID), arguably the most innovative technology in retailing today. With RFID, a user applies a tag to a product (or to an animal or even a person) so that the product can be identified by reading the tag remotely using radio waves. RFID holds great promise—it could change retailing as radically as the cash register did. But for now, it also entails great risks: the technology and standards associated with it are still evolving, and countries haven't even agreed on which frequencies to assign to its radio transmissions.

RFID: An Emerging Technology

You've probably already used RFID without even realizing it. [1] A familiar application, with over 6 million users in the United States, is the Exxon Mobil Speedpass. Each Speedpass, contained in key fobs given to Exxon Mobil customers, contains an RFID tag that's unique to a customer. Thus that customer doesn't need to scan her credit card or pay cash when she fills her gas tank. Instead, an electronic reader located nearby identifies the customer and charges her account. Another common RFID application, introduced in the 1980s, is the system for automated toll payments in use on many major highways in the United States. If you have an E-ZPass or a FAST LANE tag, you've used RFID. You've also used an RFID application if you've run the Boston Marathon. RFID tags attached to runners' shoes track their progress along the race course.

Systems like these have three main components: RFID tags, unique serial numbers on each tag, and a software and hardware infrastructure capable of processing data collected from the tags.

The RFID tag itself consists of three simple parts: the chip that holds information about the object to which the tag is attached, the antenna that transmits to a reader using radio waves, and a case for the chip and antenna that can be attached to a physical object.

Tags come in *passive* and *active* varieties; some application authors have also used a classification called *semipassive* for a category that combines the features of both. Passive tags do not have their own batteries. Instead, electromagnetic waves emitted by the reader activate them. Consequently, they can only be read over shorter distances, usually three to seven meters. Active tags have their own batteries and can have a range of up to thirty meters. Passive tags also have limited memory capacity—about 2 kilobits (kb) of read-only memory, compared with the 32 kb or more of read/write memory in active tags. Despite these limitations, most applications have used passive tags because they're cheaper. They currently cost anywhere from 10¢ to $1 each, while active tags start at $5 and can range as high as $100. Active tags suffer from two other weaknesses. Their tag batteries can wear out or malfunction, resulting in signal loss and catastrophic failure in some applications. And because their signals travel farther, they are more likely to encounter interference. Semipassive tags have small batteries that are partially recharged every time the tag enters the electromagnetic field of the reader. They can operate with simpler batteries than active tags even though, like active tags, they have 32 kb of read/write memory.

The second component of an RFID system is the serial number within the tag. The easiest way to understand the importance of the serial number is to look at bar codes, which are precursors to the *electronic product code* (EPC) in RFID tags. The twelve-digit bar code, or Universal Product Code (UPC), is ubiquitous in consumer goods. The first eleven digits of a typical twelve-digit UPC bar code identify the company and the product. The company prefix can vary between six and ten digits. The rest of the eleven digits (i.e., those not identifying the company) identify products at the company. The twelfth digit verifies the accuracy of the read. Figure 7-1 represents a typical UPC.

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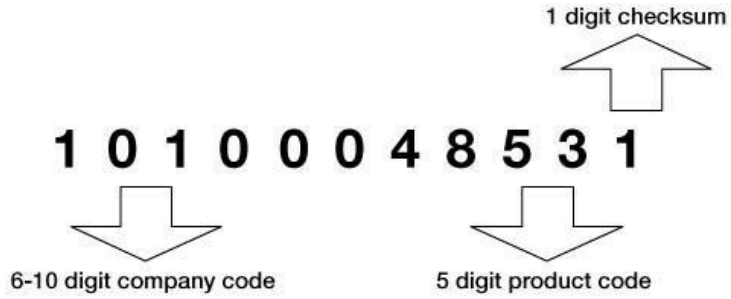

FIGURE 7-1: A twelve-digit UPC bar code

The EPC, in contrast, is large enough to identify not just the specific product but the individual unit; it can distinguish between two different units of the SKU.

The EPC scheme has four parts. The first, the *version number* , contains information on the length and structure of the code being used. The second and third parts, as in the UPC, identify the manufacturer and the product. The last one identifies the individual unit; the EPC has sufficient digits to identify roughly 60 billion individual units.

RFID tags can store and communicate more data than EPC tags can. Active tags can even transmit environmental information, such as the temperature in the area around the tag. Table 7-1 summarizes the differences between RFID/EPC and UPC tags.

Considerable infrastructure needs to exist for RFID technology to operate. Tags are useless without a network of readers, and you need a lot of readers because they have limited fields in which they can detect tags. Readers remain expensive, though manufacturers are trying to reduce the cost to less than $200 per unit. Given the high cost, companies try to reduce the number of readers needed by using additional antennas to expand the range of a reader.

Table 7-1: Differences between RFID/EPC and UPC tags

RFID/EPC	UPC (bar codes)
• Not an established technology; standards still evolving.	• Stable, open standard that has existed for 30-plus years.
• Can read several items at the same time. Does not require direct “line of sight” between reader and tag.	• Reads one item at a time. Direct line of sight between reader and code required.
• Can identify discrete items.	• Conventional bar codes can only identify SKUs.a
• Subject to interference and other problems. Read rates can be low especially near metal and water.	• High accuracy when read.
• Hard to counterfeit.	• No barrier to counterfeiting.
• Could capture data in new locations (e.g., on the door from a retailer’s back room to the selling floor) even without human actions to scan the item.	• Subject to human errors.
• Tag price is key cost driver.	• Inexpensive labels.

Source: Adapted from Eric M. Johnson, untitled slide presentation, 2005.

a. However, the new 2-D bar coding can also identify discrete items.

Widespread deployment of RFID tags will require frequency standards, which are still developing. The frequency available for passive tags in the United States is the band between 902 and 928 MHz; most passive tags operate at around 915 MHz. That frequency band is not available worldwide. In Europe, the bandwidth is between 865.7 and 867.6 MHz. Many emerging markets, which play a crucial role in the supply chains for many products, have yet to allocate frequencies. The lack of a universally available frequency poses a barrier to the widespread adoption of RFID. Companies have come together to create such a standard, and it’s called Electronic Product Code Information Services, or EPCIS. EPCIS is at its early stages, and adoption so far has been slow.

[1]The term rocket science retailing is discussed in the Introduction and is used equivalently in this book with scientific retailing. See also Marshall L. Fisher, Ananth Raman, and Anna Sheen McClelland, “Rocket Science Retailing Is Almost Here: Are You Ready?” *Harvard Business Review*, July–August 2000, 115–124, for a discussion of this concept.

RFID Applications Outside of Retailing

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RFID has its roots in World War II, when the military started to use radar to provide warnings of approaching planes. Radar could not distinguish between friend or foe—on a radar screen all planes looked the same. The British Royal Air Force figured out a way to use RFID technology to address this problem by developing an “identify friend or foe” transponder.

Some of the most compelling emerging applications of RFID are situations in which failing to track an object can be equally catastrophic. Consider the pharmaceutical industry, where counterfeit drugs represent a problem with lethal implications. With RFID, you can track each unit of a drug from the factory floor to the pharmacy shelf. The authenticity of a bottle of aspirin can be determined by tracing its origins. This track-and-trace ability also helps in law enforcement. If a thief is caught with a drug, the contraband’s path through the supply chain can be determined, offering clues to where it was stolen from.

Potential Applications in Retailing

In retailing, too, the potential of RFID—at the pallet, case, or even item level—is huge. When fully deployed at the item level, RFID will enable retailers to track individual units even if their tags are not directly in the line of sight of a reader. Consider how checkout might change with individually tagged goods. A retailer could install readers close to a store’s exit, eliminating the need for checkout counters. Shoppers would simply walk their shopping carts, containing their RFID-tagged purchases, past a reader. It would scan all the items in the carts, and the store’s computer would tally each shopper’s bill and print out or e-mail a receipt.

Item-level tagging would also facilitate product recalls, a critical help in sectors like food, medicine, and even toys, where hazardous products can harm and even kill. Witness the 2008 outbreak of salmonella linked to Mexican jalapeño peppers, and the 2007 recall of lead-painted Thomas & Friends wooden train sets. If a batch of goods had a defect, then the manufacturer could identify all items in that batch for recall quite easily using RFID applications. Visualize, for example, what could happen if a manufacturer discovered that the items produced at a particular factory on a specific date in the past were contaminated. Without RFID or some other form of item-level tagging, the manufacturer would be unable to distinguish items from the contaminated batch, and would have to recall all previously produced items. Clearly, restricting the recall to only contaminated batches would reduce the cost and time associated with the recall. Suitable RFID applications can also enable manufacturers to locate these contaminated items; manufacturers, for example, could figure out that the batch was at store X or warehouse Y, and hence withdraw these items before they could harm people.

RFID also can help retailers streamline their handling of inventory. As noted in chapter 6, misplaced goods within stores vex many retailers and may account for as much as a quarter of stockouts at the store level. [2] Book and music superstore Borders found that consumers couldn’t find one in six books that were listed as in its stock. [3] With RFID tags on each book, a clerk could point a shopper seeking any of the close to 200,000 titles available at a typical superstore, not simply to the section where the book should sit, but to its exact location, even if someone had accidentally shelved it in the wrong section.

METRO Group, of Germany, has been experimenting with ways in which technologies like RFID can improve shoppers’ in-store experiences. [4] In September 2002, METRO created a technology-enhanced grocery in Rheinberg, Germany. There, shoppers could use small computers known as *personal shopping assistants* , which they would borrow at the store’s entrance. Akin to PDAs, these handheld devices helped them find products and provided in-depth information on goods, including such details as nutritional values and features. Information terminals scattered around the store also offered recipes, wine recommendations, and suggestions on healthy eating. Customers loved the innovations. A third of them reported using the technology, and most users called themselves highly satisfied. Just as important, the number of customers and sales at the location increased significantly. The store also provided METRO with considerable publicity. Fashion model Claudia Schiffer, a Rheinberg native, was invited to be the first customer, and METRO’s experiment garnered favorable mentions in the media.

Once standards emerge, RFID should facilitate information flow among various firms in a supply chain. Companies in a chain will be able to share information as it emerges. A supplier, for example, might use RFID to monitor when its shipments reach Wal-Mart or even to track their movement within the retailer’s stores. Thus Procter & Gamble might know whether a pallet of Tide had been forgotten in a back room or a storage area.

Similarly, RFID could enable vendors to improve promotions by ensuring that store staffers place display quantities and materials in a store promptly. According to some studies, half of all promotional displays at consumer goods retailers are either not put up or put up late. [5]

[2]This section draws from Edmund W. Schuster, Stuart J. Allen, and David L. Brock, *Global RFID: The Value of the*

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EPCglobal Network for Supply Chain Management (Berlin: Springer-Verlag, 2007).

[3]D. Corsten and T. Gruen, "Desperately Seeking Shelf Availability: An Examination of the Extent, the Causes, and the Efforts to Address Retail Out-of-Stocks," *International Journal of Retail & Distribution Management* 31, no. 12 (2003): 605–617.

[4]Zeynep Ton and Ananth Raman, "Borders Group, Inc.," Case 9-601-037 (Boston: Harvard Business School, 2007).

[5]Zeynep Ton, Vincent Dessain, and Monika Stachowiak-Joulain, "RFID at the METRO Group," Case 606-053 (Boston: Harvard Business School, 2005).

Pilot Studies Applying RFID in Retailing

Besides METRO, several retailers have tried to quantify the benefits of RFID. These experiments have focused on short-term benefits, not on overhauling supply chains. Mostly, they've examined the use of RFID tags on cases and pallets, though Swiss retailer Charles Vogele has tried item-level tagging.

Wal-Mart did an experiment at twenty-four stores to examine the impact of RFID on stockouts. [6] At twelve of these stores, it tagged 4,554 unique products at the case level. It equipped the test stores with RFID readers at various back-room locations, such as receiving doors, sales floor doors, and box crushers. Thanks to RFID, the test stores could track whether cases had been delivered to the store and taken to the sales floor. By combining this information with point-of-sale data, a store could generate an automatic pick list of items in the back room that needed to be taken to the sales floor. The experiment sought to identify the extent to which these automatic pick lists could reduce stockouts.

In a control group of comparable stores without RFID, pick lists had to be generated manually. An employee often had to inspect the shelves for stockouts or near stockouts and log them in to a handheld device. Alternatively, the staffer could inspect merchandise in the back room and scan items that seemed appropriate for moving to the sales floor. These methods, besides being laborious, invited errors.

In the test stores, stockouts decreased from 474 to 352 among the items studied. In other words, they went from 10.4 percent to 7.7 percent, a reduction of 2.7 percentage points, or 26 percent of the original 10.4 percent. Stockouts fell by 5 percent in the control stores. Thus, after controlling for improvements not due to RFID, you'd conclude that the technology accounted for a 21 percent reduction in stockouts. Other studies of RFID in retailing have also concluded that the technology can reduce stockouts substantially, though the estimated reductions have varied considerably among the studies.

What might be the change in sales due to stockouts declining by 2.7 percentage points? It could be smaller than 2.7 percentage points, or it could be larger. It would be smaller if consumers were willing to substitute other items when their favorite products sold out. Likewise, it could be smaller if stockouts were measured late in the day, after many customers already had shopped. (In its study, Wal-Mart scanned stockouts between 2 and 10 p.m.) Stockouts might have been lower earlier in the day, when most people were doing their shopping.

In contrast, the sales increase could be higher than 2.7 percentage points if the stockouts hit popular items with higher-than-average sales rates or if the retailer lost sales on "complimentary items" when consumers encountered stockouts. Housewares sellers, for example, often lose sales of matching pillow covers when they sell out of a particular set of sheets. Most retailers that we have consulted assume that the resulting sales increase will be a fraction, usually 25 percent to 50 percent, of the reduction in stockouts. [7] That would lead us to conclude that sales could rise by 0.675 percent to 1.35 percent (or roughly 1 percent) because of RFID adoption.

A 1 percent increase in sales at Wal-Mart would increase the company's gross margins by roughly $791 million. [8] Of course, this increase needs to be compared with the added cost associated with tags, readers, software, and training, which would also be substantial for a company as large as Wal-Mart.

In the case cited above, METRO's analysis accounted for cost savings as well as for the reduction in stockouts. It examined labor savings and found that some manual steps could be eliminated because RFID enabled the automated scanning of shipments and receipts. It also found that other processes could be streamlined.

METRO drilled down to the impact of pallet-level and case-level tagging, and quantified separately the benefits to the manufacturer and to METRO. With pallet-level tagging, all the benefits identified by METRO stemmed from labor savings. METRO estimated that its annual savings would be 15.7 €-cents (euro cents) per pallet and that the manufacturer's would

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be 50 €-cents per pallet, for a total supply chain savings of 65.7 €-cents per pallet. The average METRO store received thirty pallets per week, and the company had roughly 2,300 stores at the time of the analysis, so the total savings for the supply chain amounted to slightly more than €2 million per year, or 0.004 percent of METRO's sales. METRO's own savings amounted to roughly 0.001 percent of its sales.

With case-level tagging, the benefits were larger. The manufacturer saw a roughly 7 €-cents in savings per case, while METRO got roughly 8.9 €-cents per case. When all of this is taken together—and considering that each pallet has roughly seventy cases, on average—the annual savings to the supply chain totaled roughly €40 million, or 0.07 percent of sales.

Do the quantified benefits identified at Wal-Mart and METRO make a compelling case for investing in RFID? According to the metrics above, it's not even close.

Consider that METRO's projected savings from tagging cases (15.9 €-cents each) roughly matched the cost of a passive RFID tag at the time of the experiment. And this analysis does not include the expenses associated with the installation of readers and the creation of software for capturing and analyzing the data from the tags. On top of that, the costs of training and process redesign would probably exceed the cost of hardware and software combined.

Does the lack of a compelling financial return from RFID mean that retailers should shun the technology? Not necessarily. RFID's costs should fall over time, and innovative applications, giving greater benefits, should emerge. So why not wait until then to invest? As you'll see in the next section, a small early investment can enable you to learn about a technology and better understand the benefits that it might provide for your unique operations. You might view a small bet today as buying an option that will position your company to make a larger, smarter investment in the future, when the financial case becomes compelling.

[6]Brian Harris and James Tenser, "Retail Execution: The Buck Starts Here," *Progressive Grocer* , May 1, 2008.

[7]Bill C. Hardgrave, Matthew Waller, and Robert Miller, "Does RFID Reduce Out-of-Stocks? A Preliminary Analysis" (Fayetteville, AK: Information Technology Research Institute, Sam M. Walton College of Business, University of Arkansas), http://itrc.uark.edu .

[8]As an example, note that METRO (from the "RFID at the METRO Group" case) reasoned that reducing out-of-stocks by 2% would cause sales to increase by 0.5%.

Managing Emerging Technologies: Lessons from RFID and Other Technologies

How should managers evaluate and invest in new technologies such as RFID? What lessons can they derive from past examples of innovative technologies? Three major guidelines emerge from our observations of RFID and technologies such as flexible manufacturing systems (FMS) and the Internet.

1. In evaluating new technologies, understanding the key details helps a lot.
2. To derive the full benefits from a technology, you must integrate the technology with your firm's operations, which usually requires changing operations to take advantage of the technology.
3. In evaluating the economics of a new technology, managers should factor in the declining cost of the technology and the uncertainty in benefits associated with it.

Understanding the Key Details

Managers are often insufficiently aware of how emerging technologies like RFID work. Many people who talk up RFID's potential haven't even taken time to understand the different types of tags—that is, passive versus active ones—or the evolution of global standards for frequencies. Retailers often use the term *RFID* loosely, assuming that the capabilities of active tags will be available at the prices projected for passive ones.

Adopting a new technology without understanding its details usually ends in disaster. Consider managers' love-hate relationship with *optimization* . This technology, which improves decision making with computers and mathematical algorithms, can be extremely powerful. Deployed appropriately, it can dramatically improve operational performance, and thus it is widely used today in a number of applications, such as factory scheduling, airline yield management, and transportation planning. But managers often fail to understand that optimization does not apply universally. It must be customized in each operating context. Even subtle differences in assumptions and parameters can affect whether an algorithm can address a particular problem.

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During the past few decades, operating managers have periodically become enamored of optimization. Their naive enthusiasm has often led to poorly conceived attempts to buy their way into optimization without paying attention to the fit between the technology and their desired application. Not only do these attempts fail to improve decision making, they often result in operational fiascos. A European retailer recently installed a commercial software package for optimized replenishment of inventory to its stores. The software failed to take into account the fluctuating workload at stores and consequently often shipped items to stores when they did not have store labor available to receive the merchandise. Frustration resulted, and store managers pretty soon were overriding most of the system's recommendations. In many such incorrect applications, managers get disillusioned with optimization even though the problem wasn't caused by the technology itself but rather by an ill-considered and mishandled application. An appropriately designed program (that took into account workload at the store) would have likely improved the retailer's operations substantially.

Many managers have difficulty understanding the subtleties of tailoring technology to the complexities of a particular enterprise. Technology specialists often understand technical details but not the nuances of a firm's business. Operating managers, in contrast, see their business and operational needs but misunderstand the requirements and capabilities of the technology. One chief information officer told us that his chief challenge was finding people within his company who understood both. He's right. Indentifying these folks and assigning them to the evaluation and management of new technologies might be the most important task for a company that's evaluating a new technology.

Integrating the Technology with Operations

The importance of changing operations to best exploit technology is shown by the adoption in the United States of new kinds of manufacturing technologies in the 1980s. [9] This was a period when U.S. companies faced strong new competition from foreign firms, especially those in Japan. As a result, many U.S. manufacturers were rushing to increase their efficiency by embracing such new technologies as computer-aided design and engineering, flexible manufacturing systems, and robotics. As is often the case with new approaches, proponents promised "to improve everything: cost, quality, flexibility, delivery, speed, design—everything." [10] But many managers had difficulty reaping these advantages because they had not tailored their processes to the new technologies.

When talk turns to new technology, people typically imagine computers and software. But a more tangible technology, like a helicopter, better illustrates the promise and perils that new approaches can bring.

If you buy a helicopter and merely use it instead of your car in your daily commute to work, then maybe you can turn a thirty-minute commute into a twenty-minute commute. And you might not see any time savings, given that a helicopter is a tad harder to park than a car. But a helicopter can facilitate major changes in your lifestyle. You can live in some remote place, visit faraway clients more easily, and get a new perspective on the lay of the land. If you don't do these things—or don't find some other beneficial uses for your machine—you've wasted the small fortune you've paid for the copter and your pilot. "In short, you shouldn't buy a helicopter unless you're committed to getting the most out of it. You have to organize for it." [11]

Or let's go back even farther in history, to the early twentieth century, when trucks began to replace horse-drawn buggies. An advertisement for the International Commercial Truck, circa 1910, on display at Maine's Owls Head Transportation Museum provides this warning:

That the motor truck is an excellent substitute for the horse has been proven in every instance where business men have given it a fair trial. But the man who uses his motor truck simply as a substitute for horses neglects to make the most of his opportunities. The horse is not a machine—five to six hours actual work— fifteen to twenty miles—is its maximum day's work. A motor truck can be used twenty-four hours a day if necessary, and it will travel the last hour and the hundredth mile just as fast as the first.

Business men who are using the motor truck in place of horse and wagon equipment with the greatest success are men who have given this problem careful study. In most instances, it was necessary to change the plan of routing—delays which were necessary to give the horses rest were eliminated—plans were laid to keep the truck busy the entire day with as few delays as possible. [12]

New technologies, whether trucks a hundred years ago or RFID tags today, require leaders with an "integrative imagination." These managers can identify the most effective ways to employ a technology within their firms and can modify their operations to take maximum advantage of the technology.

When considering the adoption of a new technology, you must also understand that it often takes years before that technology gets fully integrated with operations. Often, the technology goes through three phases: substitution, scale, and

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structure. Initially, it substitutes for an existing way of operating. Eventually, it reaches scale. And finally, as the technology matures, the firm makes structural changes to accommodate it. [13]

The evolution of business-to-business (B2B) e-commerce demonstrates this evolution. In its early days, B2B replaced old ways of making orders and processing payments, like the phone and the fax machine. At this stage, the Internet offered limited advantages, mainly lower transaction costs.

During the scale-up stage, the Internet enabled firms to reach out to many more buyers and sellers and to cut out brokers with whom they'd previously had to share their revenue. Thus, for example, traditional travel agents began to disappear, as they lost their usefulness due to airline Web sites and online travel bookers such as Travelocity and Expedia. Today, most of us search for flights online and buy our airline tickets there. Airlines accordingly have reduced travel agents' commissions over time.

The biggest changes occur in the structural stage. This is where entirely new business processes emerge to suit the technology. In the airline industry, for example, companies can offer unsold seats to consumers at a discount just days, even hours, before a flight is scheduled to depart. Similarly, Amazon provides customer reviews of products that would have been too expensive to pull off without the Internet.

Factoring In Cost and Benefits

The price of RFID tags and readers has dropped over time and should continue to fall over the next few years. This, in the minds of many analysts, is the simplest way to justify investing in RFID. In other words, the benefits of adoption eventually will exceed the costs as the technology becomes cheaper. It is tough to argue with the logic. Analysts, after all, are projecting a five-cent price for passive tags.

Despite the likelihood that costs will drop, considerable uncertainty remains about how precisely RFID will evolve—about such topics as how companies will integrate the technology into their operations and which applications will work best. Managers must accept this uncertainty.

At times, operating managers, especially those unaccustomed to making decisions facing considerable uncertainty, attempt to eliminate the uncertainty through better forecasting, or simply ignore it. They'd be better served if instead they would "prepare for, and adapt to, what the organization does not know, so as to benefit from the desired possibilities that can arise." [14]

Metrics used in the capital-budgeting process to evaluate new technological investments can compound the management bias against longer-range and higher-risk research programs. [15] Managers thus need to consider carefully the appropriate metric to evaluate different types of projects.

R&D programs in large companies differ substantially in associated uncertainty and the attendant level of investment. At one extreme, "knowledge building" moves involve considerable uncertainty but require little cash. The appropriate approach—and one followed by many managers—is to view these as a cost of doing business. At the other end of the spectrum, are "business investments," where the uncertainty is low but the dollars large. Return on investment (ROI) or some other capital-budgeting approach makes sense in evaluating such projects.

In between these extremes lies the category of R&D projects that require a hefty financial bet but also carry a lot of uncertainty. This category encompasses applied research, exploratory development, and, at times, feasibility demonstration. With these projects, neither the ROI nor the "cost of doing business" approach works.

Managers considering these sorts of projects must understand that what they're doing, in effect, is working toward the creation of an option. As with a call option in finance, you commit relatively modest resources today to provide an opportunity to make a profitable investment at a later date.

In practice, this means that you'll be staging your investment. You'll follow your current investment (call it X) with a bigger investment (Y) at a later time, but by then, the uncertainty surrounding the new technology will have diminished. If you decide not to make the second investment (Y), you'll lose only your first investment (X), which is analogous to the exercise price on a call option. Managers often mistakenly assume that once they begin the process, they must invest Y and lose all of the money in both investment rounds if the technology does not pan out.

We can illustrate the difference between treating RFID as an investment or as a call option by revisiting the METRO market example, described earlier in the chapter. Imagine that METRO is assessing whether it should invest in RFID at the case level. As of the moment that METRO is making its decision, the benefits from implementing RFID at the case level

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barely exceed the cost of the tags. To achieve a positive ROI, METRO would have to identify new benefits, or the cost of tags, readers, and related technology would have to drop substantially.

Without the call-option approach, a manager at METRO might not recommend case-level RFID. After all, the projected benefits are low, the risk is high, and several years might pass before METRO realized benefits.

But a manager taking a strategic-option approach might view this differently. She might ask herself what relatively small investments METRO could make today to help it learn more about the technology so it can make informed decisions in the future. Just as important, she'd consider ways in which the company might structure its activities so that it could identify new opportunities for applying RFID as they emerged. Using the call-option approach, the manager would recognize the value of creating several projects to explore various aspects of the technology, as opposed to placing a single big bet on just one application.

A temptation for any manager when faced with significant cost and uncertainty is to simply wait. You know this line of thinking. It says that waiting will allow time for the technology to improve and for its costs to fall. Then you can adopt it later without any of the difficulties associated with experimentation. To put this in terms of the call option, the manager might wonder whether she really needs to buy an option today to be able to make an investment tomorrow. Can't she count on some other retailer to make the required investment?

But waiting carries risks of its own. As we have pointed out before, tailoring new technologies to *your* operations requires customization of hardware and software and some changes to your processes. These sorts of changes take time. By making early experimental investments, you gain a head start over competitors. What's more, retailers that make early investments often have a chance to influence the development of a technology and the evolution of its standards. With RFID, for example, early adopters like Wal-Mart and METRO may be able to influence the allocations of frequencies. Finally, consumers and even investors at times identify an early experimenter as a technological leader. This phenomenon is best illustrated in the battle among the big book retailers—Borders, Barnes & Noble, and Amazon. [16] Borders was historically a pioneer among retailers in the application of technology. As early as the 1990s, Borders' CEO Robert DiRomualdo, in Borders' annual report, had discussed distributing computer floppy disks that customers could use to order books from home. However, during the Internet boom in the late 1990s, Borders was slow to capitalize on Web-based commerce and allowed Amazon and Barnes & Noble to set up and publicize Web sites before it did. The company argued that it was unclear how the technology would evolve and how it could sell books profitably on the Internet. Consumers and even investors perceived Borders as a laggard and penalized its stock. (Borders' stock price fell from over $30 on January 1, 1998, to roughly $16 two years later. By comparison, the Dow Jones Index rose roughly 50 percent during the period, the NASDAQ index rose by roughly 150 percent, and Amazon saw its stock price go from roughly $5 to over $70.) Once Borders did launch its Web site, it had difficulty attracting consumers relative to its speedier rivals. Equally important, investors—who had rallied behind Amazon and Barnes & Noble—were not enthusiastic about Borders' foray into Internet retailing, even when the company belatedly launched the Internet site.

[9]Based on 23% gross margins and annual sales of $344 billion.

[10]Robert Hayes and Ramachandran Jaikumar, "Manufacturing's Crisis: New Technologies, Obsolete Organizations," *Harvard Business Review* , September 1988.

[11]Ibid.

[12]Ibid.

[13]Advertisement for International Commercial Truck, circa 1910, on display in Maine's Owl's Head Transportation Museum.

[14]Hau Lee, "Peering Through a Glass Darkly," *ECR Journal: International Commerce Review* , Spring 2007, articulated this phenomenon first.

[15]Alan MacCormack, "Managing Innovation in an Uncertain World: Module 1: Innovation and Uncertainty," Module Note 5-606-125 (Boston: Harvard Business School, 2006).

[16]Graham R. Mitchell and William F. Hamilton, " Managing R&D as a Strategic Option, " *Research-Technology Management* (May–June 1988), reprinted March–April 2007.

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Conclusion

Rocket science retailing relies crucially on information technology. [17]

IT will continue its pace of rapid evolution in the next few decades, and cutting-edge retailers will have to stay abreast of these changes and find ways to evaluate emerging technologies like RFID and apply them to their operations.

RFID, in particular, will alter the nature of retailing as surely as the cash register and desktop computers did. As of this writing, it's expensive, and its applications are limited. The current benefits don't seem to justify the costs, when viewed on a strict ROI basis.

Regardless, retailers should continue to invest in it. It will get cheaper, and its benefits will grow. Thus managers evaluating investments in RFID should frame the expense in terms of a call option on the technology. Think of your RFID investments as tickets purchased today to play a game that will happen tomorrow. When the game begins, you may not be able to play effectively unless you've already bought a ticket.

RFID is the rare sort of technology to which the overused term *revolutionary* applies. Typically, in its early stages, this kind of technology suffers from poorly defined standards, unreliable performance, uncertain benefits, and high costs. Managers are understandably reluctant to invest. But they should heed the lesson of Borders' late entry into e-commerce. Sometimes, a series of staged early investments offer critical opportunities to learn and to tweak a technology for your needs. The failure to seize that opportunity can handicap you over the longer term.

[17]Zeynep Ton and Ananth Raman, "Borders Group, Inc."

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