Clues from the crash: For electronics firms, flexibility in multiple markets is critical

The tumultuous economic events of the past two years have battered, bruised—even bankrupted—many electronics firms. While companies struggle for survival in the traditional markets, where products and services are bought and sold, they should also be cognizant of the dynamics of an often unnoticed market—the market for innovation. Learning to maintain flexibility in both the production and innovation markets can help insulate companies from the inherent volatility of the electronics industry.

By Dan Greenberg

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Big boom, big bust

During the past two years, electronics companies have endured an economic hazing of unprecedented proportions. Across almost every segment of the electronics industry, sales plunged. In 2001, spending on telecom network equipment and facilities fell nearly 14 percent and is projected to dip an additional 11 percent in 2002[1] while worldwide sales of semiconductor equipment dropped even more dramatically – a full 41 percent.[2] For 16 straight months, chipmakers' book-to-bill ratio – the ratio of orders to revenue – remained below 1.0.[3]

In stark contrast to prior years' heady growth, earnings were hit hard in 2001. Rockwell Automation announced a brutal 50 percent decline in income from continuing operations – before special charges.[4] Corning, too, could not avoid the revenue fallout, announcing a US$5.5 billion loss for 2001.[5] Even venerable Emerson Electric Company, which had grown net earnings steadily every year for more than a decade, posted a 27 percent decline.[6]

Forced to take drastic action, companies closed plants and laid off thousands of workers. Regardless of how the job cuts were tallied – by geography, industry segment or both – the totals were staggering. Of the nearly 2 million layoffs that occurred in the U.S. during 2001, 317 777 of them were from the telecom industry (nine times the amount of jobs the industry eliminated in 2000). Other segments witnessed smaller – but still substantial – reductions: 168 395 in the computer industry and 153 432 in other electronics segments.[8]

"2001 saw the worst downturn ever for the semiconductor industry and the largest decline for Intel in terms of revenue ever," — *Andy Bryant, CFO, Intel Corporation.*[7]

With demand plummeting, surplus inventory became a billion-dollar problem for many firms. When the results were in, inventory write-offs peppered the 2001 financial statements of companies across virtually every electronics segment from telecom equipment suppliers to personal computer makers.

Although overly optimistic demand forecasts started the inventory buildup, free-flowing capital also played a part by continuing to fuel irrational production levels. Even as actual end product demand began to evaporate, "supply" from the capital markets kept coming, enticing companies to continue investing in production capacity that soon proved unnecessary. With financing so readily available, even executives who saw signs of market saturation felt obligated to take advantage of once-in-a-career opportunities to expand their firms.

So what really happened to the electronics industry? Demand has wavered in the past. What turned this latest market dip into an industry-wide crash? Research at the IBM Institute for Business Value suggests that while the production and capital markets were struggling in the foreground, behind the scenes, supply in a *third* market – the market for innovation – was exceeding demand as well. It appears that concurrent declines in *all three markets* made the industry impact so widespread and severe.

The 2001 crash hit the telecom segment particularly hard. Equipment makers ramped up to supply a growing number of service providers that were building out their networks. Meanwhile, the capital markets—inspired by the idea that data communication would exceed voice—continued to finance this expansion. But, the "growth" that equipment makers began to rely on was merely a bubble—that burst as firms finished their network construction, spending slowed to normal maintenance levels and the natural monopoly traits of the telecom industry drove providers out of business before they paid equipment makers.

Even in an industry like electronics, which thrives on innovation, demand has its limits. Though many never imagined it could happen in a high-tech field like electronics, multiple innovation markets are now showing signs of saturation. Cutting-edge integrated circuits offer more computing power than most users need. The number of transistors *available* on a chip is increasing 60 percent per year, while innovative transistor *uses* are rising only 20 percent per year.[9] And, despite the massive push behind wireless technologies, market reception has been lukewarm. Continual advances in technology exacerbate the oversupply problems by making research and development organizations more productive, with each innovation potentially enabling more innovation.

Balancing supply and demand is difficult in one market, let alone three. Complicating the picture further, each of the markets—capital, production and innovation—has a different wavelength. Although the length varies by commodity and company, production market cycles in the electronics industry typically range from three to five years. In contrast, Warren Buffett, the well-known investment expert, suggests that the U.S. capital markets move in a 34-year cycle, 17 "fat" years followed by 17 "lean" ones.[10] Though seldom discussed and more difficult to track, the innovation market appears to cycle somewhere between those two extremes. Emerging research suggests that industrial firms' interest in accelerating innovation peaks roughly every other decade—topping the priority list in 1999.[11,12,13,14]

Over time, the electronics industry could adjust to the ebb and flow of the individual cycles—the ups in one market neutralizing the effects of the downs in another—as long as the waves remained unaligned. But, when the waves of all three markets moved "in phase" with one another—each peaking some time in 2000—the triple-downdraft that followed was more than the industry could withstand, and a multiyear boom turned into a catastrophic decline (see Figure 1). Although the exact point of downward alignment occurred at different times in different segments (earlier for industrial automation, later for telecommunications equipment), the devastating pattern repeated itself across the electronics industry and propagated backward into supplier segments like semiconductors and components.

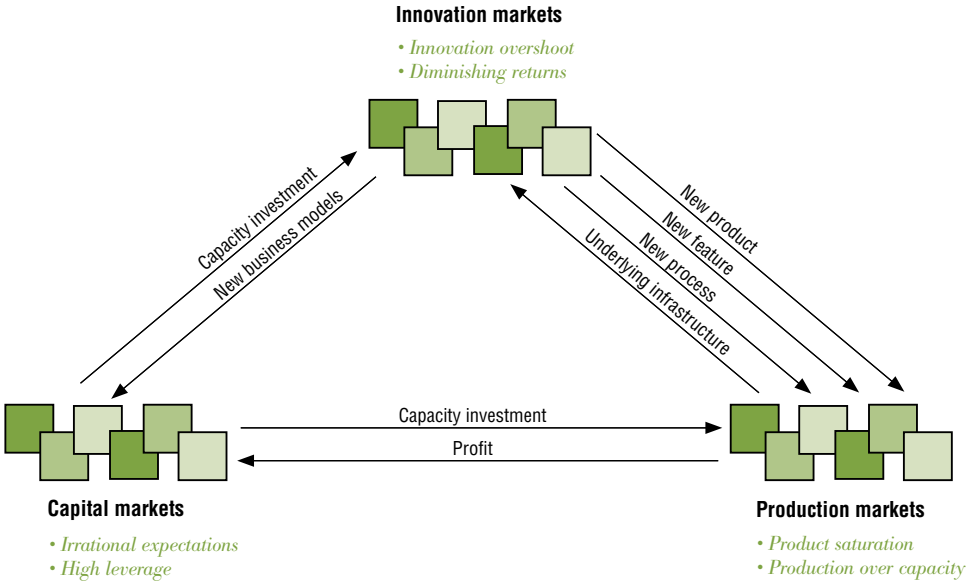

Figure 1. Cyclical downturns in all three interrelated markets synchronized, causing a more severe decline.

Source: IBM Institute for Business Value.

The market for innovation

Traditionally, the "market" has been viewed as supply and demand of products—with innovation considered primarily as a means of competitive differentiation. But, the IBM Institute for Business Value contends that the production and innovation markets are distinct and—although analogous—can be analyzed separately.

Think for a moment about water and steam. Fundamentally, they consist of the same molecules, H_2O, and yet, they are different. Water can be easily seen and measured; steam is transparent. Temperature causes them to appear distinct. In much the same way, the production and innovation markets have the same fundamental structure (based on supply and demand). However, they operate on their own timetables and, although they may have analogous measurements, the means for measuring them are necessarily different (see Figure 2).

	Production markets	Innovation markets
Commodity	Products and services	Product, feature, and process innovations and improvements
Market acceptance	One sales cycle	One product cycle – or longer
Creation time per unit	Defined period	Stochastic
Drives	Short-term customer satisfaction	Long-term brand position
Business functions involved	Production, purchasing, distribution, fulfillment, sales	Research, development, marketing, strategy
Life cycle characteristics	Has new and replacement sales cycles, with less product differentiation as market reaches saturation point	Product innovation peaks early in product life cycle followed by an upswing in process innovation
Demand drivers	Volume and style preferences of customers	Competition and unfulfilled (often latent) customer wants and needs
Demand forecast basis	Based on orders and historical analysis	Uncharted territory, may not have precedent
Forecasting timeframe	Near-term, coming weeks or months	Quarters or years into the future
Demand signal strength	Strong, although sometimes delayed	Weak, and almost always delayed
Supply reliability	Highly predictable	Less predictable, based on managing creativity
Measurement of capacity	Easy, primarily based on capital assets and labor	Difficult, often intangible
Capacity investment basis	Sales forecasts	Marketing forecasts

Figure 2. Production and innovation markets are similar, yet distinct.

Source: IBM Institute for Business Value.

"The [semiconductor] industry would be better off if we paid more attention to the bottom line and less attention to the beauty contest of technology introduction," — *Dr. Chenming Hu, CTO, Taiwan Semiconductor Manufacturing Company.*[15]

Keeping supply and demand in sync … in both markets

For decades, electronics companies have built up an intense focus on speed. Today, product releases have brief lives — in consumer electronics, for example, often six months or less. Compounding the life span challenge, the majority of a product's profit comes in the first few months after introduction, before price pressures compress margins. It's no wonder that many electronics companies have a maniacal focus on time-to-market and time-to-volume.

To a certain extent, electronics manufacturers have created this pressure cooker environment themselves. By continually honing their product introduction and production ramp-up processes to perform faster, they have set higher and higher benchmarks for their competitors … and themselves. Over the years, practices like parallel development, product platforms and delayed customization have become commonplace, helping companies bring new products to market faster. Although firms are speeding up, there is a smaller window of opportunity to earn a return on their investments and, in turn, profitability declines.

Although it may sound like heresy, in the electronics business, speed may not be the best answer. As 2001 reminded everyone, markets can move without much warning. By focusing on being flexible — not just fast — companies can position themselves to respond more effectively (and, perhaps, even more rapidly) to production and innovation market shifts, creating more value over the long term.

Lack of flexibility can be measured in terms of lost value from *both* excess inventory and missed opportunities. As flexibility rises, supply tracks closer to demand, and companies retain more value (see Figure 3).

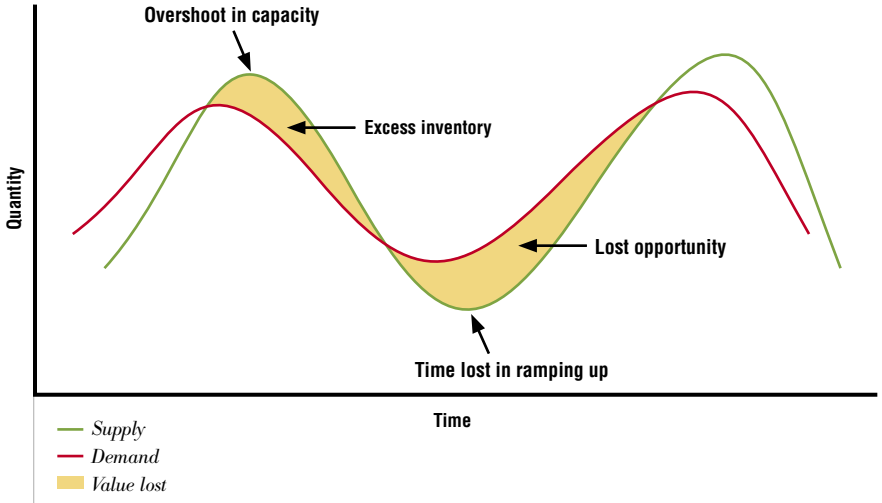

Figure 3. Flexibility helps prevent value erosion by reducing both excess inventory and lost opportunity.

Source: IBM Institute for Business Value.

In both the production and innovation markets, flexibility grows in stages:

- *Gaining control*—Before you can focus on flexibility, you need to have a good understanding of what you are managing. You must have accurate and timely data along with repeatable processes that respond in predictable ways. Flexibility without control is chaos.
- *Managing for flexibility*—Having things under control affords you the information you need to make smarter decisions and balance the inevitable trade-offs between cost and flexibility. You can begin to analyze your capabilities holistically, optimizing your overall portfolio for long-term results—not just boosting the output at one factory, or the returns on one innovation project at the expense of others. Although "hyperspecialization" might allow companies to operate at greater speeds, it can also make firms more vulnerable.
- *Stretching your flexibility envelope*—As you gain experience managing for flexibility, you start to stretch the boundaries within which you can still operate optimally. Just as the Taguchi design approach strives to create products and processes whose performance is not affected by outside conditions, you can refine your business strategies and processes so that they can operate effectively across a broader set of circumstances. As your flexibility envelope expands, your company becomes more resilient against rapid market swings.

Although the path to innovation flexibility closely parallels the path production markets are taking, progress in innovation management lags far behind. Just as the world learned to use, control and manage water well before steam, businesses are much more comfortable working in production markets where management techniques have had time to evolve and be proven effective. Production management, in effect, has had a 20-year head start on innovation management.

"The management of innovation today is where the Quality Movement was 20 years ago…" — *Clayton Christensen.*[16]

Looking specifically at production management, most electronics companies are nearing the midpoint on the flexibility continuum. Advanced management techniques and sophisticated systems help firms keep individual processes—and factories—under control. At an enterprise level, firms are integrating systems and using the pooled information for improved visibility and decisions. Knowledge is growing deeper with access to details at a factory level as well as a view of the enterprise as a whole; executives understand their total capacity and the overall set of operational constraints. Proactive firms are also broadening their knowledge and flexibility by sharing information with partners up and down the supply chain; they are beginning to work toward strong collaborative networks that allow them to see two steps back (to their suppliers' suppliers) and two steps forward (to their customers' customers).

With such complex and interconnected supply chains, it's important to remember that a company can only be as flexible as its least-flexible partner. Improving flexibility may mean helping a supply chain partner become more flexible. With realtime production and supply chain information at their disposal, businesses can then begin to manage the other side of the equation, stimulating demand as needed to keep everything in balance.

"We have to innovate our way out of this economy."— *Craig Barrett, Intel CEO.*[17]

Few companies today would claim to have innovation "under control." Most have not even thought about measuring innovation flexibility—much less managing it. The first steps toward innovation control are just now becoming visible as companies implement knowledge management systems and establish product life-cycle management programs. But, for most companies, managing for flexibility is much farther down the road. Thinking back twenty years, manufacturing executives felt ill-equipped to tackle the complexities of managing production, wondering how they could ever achieve complete control. Now, production control is a well-defined science, with most factories running at very low levels of variability. Although the innovation market and innovation "management" seem more intangible and less defined than their production counterparts, the progress made—and the setbacks encountered—in manufacturing over the past two decades can provide clues as to what is in store for innovation markets. And, thanks to these early lessons, the science of innovation management may actually evolve faster than manufacturing management.

The manufacture of innovation: Applying what you already know

The electronics industry has spent years perfecting production processes and inventing new management techniques to optimize returns. Many of these same processes and practices can be applied to innovation management as well. Individual innovators may even be practicing a few of these techniques, albeit outside of an overall innovation management strategy. Although the following list is far from exhaustive, it may cause you to start thinking differently about managing innovation:

- *Modularity*—Snap-together components allow companies to assemble products more quickly. In a similar fashion, modular product and process designs facilitate quicker development and higher degrees of reuse. By considering modularity at the beginning of an innovation project, teams may be able to work on a variety of research aspects in parallel, trimming time from schedules. Plus, products can be recreated over time by reinventing individual modules or adding new features, rather than reworking the whole innovation at once.
- *Platforms*—By establishing a platform for their basic product and then—at assembly—"snapping on" different combinations of optional features and functions, manufacturers can create a broad set of "products" from a single production line. Shrinking product life cycles demand that manufacturers introduce new versions rapidly and regularly, causing manufacturers to use the same platform principle in new product design. Depending primarily on "big bang" innovation is risky; innovation "around the edges" is more predictable. Innovation projects that can be divided into platform and releases offer opportunities for parallel work, near-term successes and more potential end uses of the innovation. At the same time, new innovation platforms can be developed more effectively, allowing a balance of risk and returns from the portfolio of innovation projects.
- *Delayed customization*—When creating production processes, manufacturers look for ways to load high-value, distinguishing features into the product at the last minute. In a classic case, The United Colors of Benetton sweaters are mass-produced in white and dyed the season's colors after assembly. The same holds true for innovation. Imagine the flexibility of creating a multiuse base that can be spun off in many different directions as applications for the innovation are envisioned. Rather than basing invention on clear, up-front requirements, broad innovation processes can take advantage of, and even welcome, feedback obtained late in the development cycle.

- *Inventory management*—Some great ideas never make it to the market. They may not suit the market, or the market may just not be ready. When the laser was initially invented, no one knew what to do with it, the proverbial solution looking for a problem. Now, lasers are everywhere—from operating rooms to CD-ROM drives. Clearly, innovation produces an inventory that must be managed. In production markets, although some manufacturers are moving toward build-to-order processes, many are still using build-to-stock approaches because of long production cycles or shaky market-forecasting abilities. In innovation markets, too, the philosophy is likely to remain build-to-stock for some time due to weak demand signals and the uncertainty of development timetables. Therefore, careful inventory tracking and continuous improvement of forecasting techniques are important approaches for reducing the number of "orphan technologies."
- *Capital investment*—In manufacturing, the division between cost of goods sold and capital is clear-cut. Decisions on how to classify a particular investment in production capacity require little thought: Is it a cost of producing this singular product, or does it relate to my overall production capacity? In innovation, no clear lines of demarcation exist. Because research and development (R&D) is typically managed as a collection of projects, managers associate costs with individual innovations. Other than a few isolated investments in facilities or tools, there's no visible capital: everything is simply a cost of creating an innovation. True? Maybe not. Consider a familiar situation: A discovery team develops a new feature for an existing product in half the time that it took to create the preceding feature. Why? The innovation "capital" created during prior endeavors—experience, acquaintances, reusable concepts or materials—made the team more productive. Taking this productivity argument a step farther implies that not all innovation investment goes into "cost of goods sold"; some portion of the projects' budget creates "capital" that makes the innovation factory run more effectively. This capital, although intangible, should be evaluated in the same way as manufacturing capital: is the investment offset by a corresponding benefit from increased productivity?
- *Productivity and capacity*—Combining this "capital" with a labor force devoted to innovation implies a certain "capacity" for creating innovation. Most companies, however, don't know how to measure productivity or capital in the innovation organization. Manufacturing managers *know* what their plants are currently producing—just as innovation mangers know what their scientists and designers are working on—but manufacturing managers also know what their factories are *capable* of producing and whether increased capital investment is appropriate. Innovation managers often have no idea what their total capacity is—or whether they are operating at under- or over-capacity.

- *Planning and execution control* – Materials resource planning (MRP), Theory of Constraints,[18] manufacturing execution systems (MES)… the list goes on and on. Managing a factory is a science, with a bevy of automated tools that help executives view their entire production portfolio and optimize overall output, based on a clear view of the whole. For innovation, planning and execution control is still a process, not a system, but many of the same basic concepts can help executives gain more control over innovation. The first step is to think about your research and development organization not as a series of individual projects and teams, but as a whole portfolio that's better managed collectively. Think of it like the move from teams of individual craftsmen and apprentices that created unique pieces one at a time, to mass production on an assembly line where individual steps are optimized and bottlenecks are identified and eliminated. With a broader perspective, you gain insight into your overall innovation capacity as well as your key constraints.

How far can you flex?

How far can your business bend before it breaks? Although it is uncertain whether even the most flexible electronics firm could have escaped 2001 unscathed, flexibility can help smooth the inevitable highs and lows, allowing companies to produce greater value over the long term. As you think through the following questions, consider whether your answers place you closer to the agile or the brittle end of the business flexibility spectrum:

- Do you currently measure business flexibility during both up and down market cycles? How?
- Are you pursuing increased external collaboration primarily to gain speed or to improve flexibility?
- Which parts of your supply chain are the least flexible? Why? What steps are you taking with supply chain partners to increase your collective flexibility?
- What actions are you taking to increase the breadth of market variation over which your production remains economical?
- Do you measure innovation success on a project-by-project basis or grade yourself on the health of your overall portfolio?

- How much of every innovation project goes into creation of "capital" versus "cost of goods sold?" In the innovation arena, what is your capital versus labor trade-off?
- How do you measure innovation productivity? Do you know what each innovation investment dollar produces in terms of innovation output?
- When downsizing the innovation organization, how do you account for the loss in intangible capital? Note that innovation capacity is not totally labor-based; the capacity loss will be greater than the percentage of employees leaving the firm.
- Across your innovation project portfolio, how many initiatives are creating platforms from which to launch a series of future innovations?
- How do you know whether you have exactly enough (not too little and not too much) innovation capacity? Clue: "enough" is not defined as a percent of current sales.
- Do you actively measure and manage risk across your innovation portfolio?

Improving your flexibility

Like steam, the innovation market can easily go unnoticed—even when its impacts are clearly visible. But, just as learning to control and use steam pushed the Industrial Revolution, discovering how to manage innovation effectively may, in fact, spur another.

At IBM, we understand—from firsthand experience—the volatility of the electronics industry. We also know that creating long-term business value is more critical than results in a single market cycle. Managing for flexibility in both the production and innovation markets improves the odds of sustained success. To discuss your company's strategies for becoming more flexible, we invite you to contact us at *bva@us.ibm.com*. To browse through other resources for business executives, please visit our Web site at:

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