




Early warning

By Dan H. Elron and Steve D. Wick

You can't create business value from emerging technologies if you don't see them coming. Learn from the world's leading high-tech companies how to position yourself to catch and ride technology's biggest waves.



The waves build, one upon the other. They come from all directions; as they intersect, the impact of each successive wave seems to amplify all the others. Finally you see it on the horizon: a massive wall of water. You've managed to stay afloat so far; you've even ridden a couple of big waves. But can you get on top of this one? Or will it overwhelm you?

Welcome to the world of technology-enabled business, where each response to an emerging technology is followed by a new, more powerful wave—and then another.

Finally riding the Internet wave? That was a ripple compared to the tsunami that's coming: the cumulative effect of converging technologies, including more powerful yet less expensive computing, unlimited bandwidth, wireless capability, enriched information resources, dramatically expanded software capabilities and new human-interaction technologies.

As these technologies intersect and create new businesses, some companies, like hapless surfers adrift between waves, will be looking for competition in one direction only to be blindsided from another. The fear of being swamped is on the minds of a number of executives, including Goldman, Sachs & Co. Chairman & CEO Hank Paulson, who recently told *Forbes* magazine, "What keeps me up at night isn't what our traditional competitors are doing, but that someone we didn't foresee will use technology to emerge as a significant rival."

This needn't happen to you. Our work with businesses around the globe has shown that the most successful of today's high-tech companies—Intel Corporation, Nokia, Cisco Systems, Sony Corporation, Ericsson, Microsoft Corporation—stake their entire operating model and market capitalization

on catching the right technology waves . . . and then staying on top of them. Companies from all industries would be smart to emulate this behavior if they are to take advantage of emerging technologies.

Sure, even high-tech companies can miss key technology trends. But those that succeed share a number of critical qualities and capabilities. For example, by developing a kind of early warning system, they can see the waves while they're still at a safe distance and then take advantage of the advance warning to enhance current products and services or to create new ones—or even to enter new industries. These companies all have cultures built on experimentation, and they maintain alliances and ongoing dialogues with venture capitalists, universities and think tanks.

Above all, they have a disciplined yet flexible approach to developing solutions from emerging technologies, an approach adapted from the traditional product-development life cycle. Successful high-tech companies use this capability constantly, attuning it to their industry and focusing it on turning raw technological potential into real business value.

Our goal here is to explore these capabilities and to present concrete steps to help your company determine which technology waves make the most strategic sense to catch.

Only the beginning

When it comes to information technology, today's executives sometimes retreat behind a kind of complacency. They hear a constant drumbeat of urgent technology-related messages, yet few contain much practical advice about what should be done. This is partly the fault of technologists, who do not always speak in a clear, business-oriented language. No wonder many executives simply tune out, like

The ripple effect

Emerging information technologies, as well as many already in everyday use, can be classified under the five major categories below. As even this partial list shows, the number of applications and technologies is daunting. Yet this is only part of the challenge. Even more dramatic is the amplification or "ripple effect" that occurs when one category intersects with another. Companies must do more than deal with this resulting tidal wave—they must ride it to greater business advantage.

Computing and storage

- Embedded computing/intelligent sensors
- Smart materials and surfaces
- Robotics
- Handheld/mobile computing
- Wearable computing
- Network computing/smart appliances
- Set top boxes/gaming
- Digital television
- Storage area networks
- Processor architectures
- Micro machines/nano technology
- Biological computing
- Quantum computing
- Battery technology
- Memory technology

Communications

- Internets/intranets/extranets
- Optical communication
- Wireless communication
- Satellite communication
- Computer-TV/radio integration
- Cable
- Intelligent network services
- Home networking
- Digital subscriber line (DSL)
- Gigabit ethernet
- Communications middleware
- Peer-to-peer networking
- Location tracking/global positioning
- Virtual private networks

Software and services

- Pattern recognition/neural networks
- Digital imaging
- Workflow management agents
- Machine reasoning and learning
- Mathematical modeling and optimization
- Computer vision
- Next-generation videoconferencing
- Internet call center integration
- Electronic payments
- Internet-transactions integration
- Management of distributed environments
- Advanced operating systems
- Advanced programming languages (Java, Jini, etc.)
- Component-based software engineering
- E-groupware and e-collaboration
- Knowledge management/mining
- Unified messaging
- Tele-presence/distance learning, electronic meetings
- Adaptable contextual computing
- Streaming media

Information and content

- Advanced information exchange/meta data (XML, PML, VRML, UML)
- Information security
- Electronic publishing and distribution
- Concept recognition/extraction
- Digital libraries
- Compression
- Multimedia indexing
- Content-based development
- Embedded databases
- Database technology
- Data warehousing
- Data mining
- Document management
- Knowledge representation
- Multimedia capture and development

Human interaction and performance technologies

- E-learning/business simulation
- Virtual reality
- Performance support
- Usability engineering
- Multi-modal interfaces
- Biometrics
- Handwriting recognition
- Information visualization
- Navigation technologies
- Natural language capability
- Voice interaction/speech recognition
- Display technology
- Authentication and directory
- Personalization
- Executive information systems
- Intelligent agents
- Avatars

the one who told us that he falls asleep whenever an expert mentions Moore's Law during the first five minutes of a presentation.

A more dangerous response might be called the "cry wolf syndrome." You've heard so many of those breathless warnings about technology that you stop listening. That is a mistake. The dramatic change of the past decade involving the Internet and e-business is only the beginning. The waves created by the convergence of emerging computing and communications are going to be huge.

There are more technologies emerging at an accelerating pace from more sources, with less time between the lab and the marketplace. One way to see tangible evidence of this heightened pace of innovation is to follow the money. Although figures for 2000 are not yet available, total private equity and venture capital investment for the year was expected to exceed even the red-hot pace of 1999, when investment grew 65 percent from 1998 to a total of \$136 billion. About 33 percent of that figure, or about \$45 billion, was in global technology investments, up from 29 percent in 1998. Some analysts predicted that venture capital investing in the United States for 2000, for example, would double the figure from 1999.

In addition, the global economy itself is being fueled by information technology. According to an IDC report, the value of the Internet economy—based on e-commerce, IT infrastructure and e-business infrastructure—is expected to reach \$2.8 trillion worldwide by 2003. Yet as the report notes, even that extraordinary economy will be only "in an embryonic state." There is much more to come. For example:

As more products become commodities, everyone will be in the software business

An increasing amount of value in the new economy comes from services and software. Thus, most company executives are asking themselves how any given product or service can become a *smart* product or service with its own annuity stream.

Because of this drive, most businesses will become software companies to one extent or another. Think, for example, of the complex software required to move from basic package delivery to full logistics services or to go from teller-based banking to the electronic delivery of a full range of financial services when and where customers want them.

Of course, this is hardly news to high-tech companies. In an interview with *The Wall Street Journal*, Nortel Networks Corporation CEO John Roth noted that "about 80 percent to 90 percent of what we do is software." Similarly, Serge Tchuruk, CEO of Alcatel, told the *Journal* that his company spends 80 percent of its research and development budget on software, compared with 25 percent just a few years ago.

Unforeseen combinations of technologies may create unforeseen competitors

It's rare for a single emerging technology to yield significant impact. Instead, the value comes from exploiting the convergence of different types of technologies—and this is where the competitive blindside can occur. For example, Microsoft's Encarta unseated venerable producers of encyclopedias, simply by delivering a traditional information format in new ways—leading to today's CD-ROM encyclopedias linked to the Internet.

The first to execute the right solution at scale gains the bigger rewards

Being the first mover is no longer enough. The real advantage in the new economy goes to those who move first *at scale*.

The Palm Pilot is a classic example. Although there were numerous competitors in the personal digital assistant market, 3Com was the first to understand not only the technologies and how to integrate them but also the needs of users, and how a PDA could best be designed to meet those needs.

As a result, the Palm Pilot became one of the fastest-selling consumer electronics products in history, with 3Com selling more than 1 million units in the first 18 months and capturing 51 percent of the PDA market within a year. Conversely, other companies that were thought to be more likely PDA makers focused too narrowly on the technology itself and missed the opportunity to dominate the market.

Harness the power

So how does a company harness the power of technology waves and create value? We have identified five actions your company can take right now.

1. Approach value creation as a specialized form of traditional product development

Creating value from emerging technologies can occur only in companies that approach this task in a deliberate and focused fashion. The disciplined, managed, yet flexible approach of the traditional product-development life cycle can serve as a model. Several aspects of the traditional life cycle take on special importance in the area of emerging technologies and enable you to envision the business potential of a new technology or application.

- *Experimentation.* Here the concern is with developing ideas into business-opportunity concepts and experimenting with them to determine their viability. Creating a risk-taking culture can be easier if experimentation is explicitly identified as a key capability. Experimentation requires processes that allow you to

Screening emerging technologies for business value

Each company must filter and screen emerging technologies according to the unique needs and interests of its business and industry. The list below is a representative sampling of a screening performed by Accenture to determine what kinds of emerging technologies would have the most strategic impact and would be relevant to most companies.

Types of technologies	Description
Embedded computing <i>(sensors, smart tags, smart materials)</i>	<ul style="list-style-type: none"> • Allows intelligence to be embedded in everyday things • Declining price points enable smart things to be disposable (packing material, boxes, etc.)
Wireless/mobile capability and optical communication <i>(wireless communication, device-to-device communication, optical communication)</i>	<ul style="list-style-type: none"> • Enables anytime, anywhere access and exchange of information between devices and/or people • Provides higher mobile bandwidth to increase the richness and value in mobile software and services • Optical communication redefines both the amount of information to transport and the speed of transmission (for example, 2 trillion pages per second). Allows competition leveraging richness and reach of information
Enriched information exchange <i>(structured information standards such as Extensible Markup Language; data mining)</i>	<ul style="list-style-type: none"> • Standardizes communication across networks, opening access of value chains and business models across all industries • Provides the ability to manage vast amounts of information and to exchange information across industries and specific functions of a company • Several examples of structured information standards are maturing: <ol style="list-style-type: none"> 1. Virtual Reality Modeling Language (VRML) allows the navigation of three-dimensional objects and environments on the Web (for example, gaming, shopping, interactive chat spaces) 2. Extensible Markup Language (XML) facilitates information exchange across humans and applications by making it easier to author and describe complex documents/information 3. Physical Markup Language (PML) provides the ability to describe and represent physical objects in electronic media
Component-based development software with sense-and-respond capability <i>(software engineering with advanced language; advanced software architecture engineered to automatically sense and respond)</i>	<ul style="list-style-type: none"> • Enables modular software design and engineering to improve reuse and increase flexibility of software, keeping pace with global business change (think of Legos for software) • Provides the core software object technologies for writing applications and services in a highly distributed and heterogeneous environment • Enables network-centric intelligence to respond to smart things • Sense-and-respond software integrates with embedded computing and wireless capability to reinvent all aspects of the supply chain and business functions
Advanced human interaction and performance <i>(voice recognition, intelligent agents, business simulation and e-learning)</i>	<ul style="list-style-type: none"> • Enables humans to navigate, interact and learn to sustain the complexity of advanced technologies • Compresses time to learn while increasing effectiveness of learning (flight simulator technology applied to learning business capabilities) • Delivers augmented intelligence at time of need

catch problems early and to extract value from failure—for example, by reusing assets developed as part of products that failed.

- *Establish effective teams.* The ability to create a successful team (including business developers, technologists and marketers) at the experimentation stage is also vital. When the primary goal is to identify opportunities, the team is small. With experimentation, on the other hand, a company must not only enlarge its internal team. It must also, based on an assessment of its core competence, determine what alliances or partners will be needed to transform an idea into reality. In the e-economy, assembling the right mix of partners quickly will become a core competence itself.
- *Iteration.* At the actual development stage, iteration becomes increasingly important and will pass through three phases: developing the solution and supporting operations; conducting market tests; and constantly revising, sometimes radically, the business case.

With the assembled team, a company completes early field trials of prototypes. The business case is continually updated; contingency planning is particularly important because at this point the technology is a moving target, evolving and maturing as the iterations are occurring. At the end of each phase, if the company decides to proceed, adjustments are made; if not, the project is shut down. One key message about iteration: If you're going to fail, fail early.

Finally, at this stage of the value-creation life cycle, companies need to get involved in developing standards and driving them toward the point at which they support rather than inhibit the commercialization of the technology.

2. Develop an early warning system

Obviously, if you don't see an emerging technology coming, you can't respond to it effectively, let alone envision its potential. The ability to detect threats and opportunities through a radarlike system requires dedicated resources within a company that are charged with identifying and evaluating emerging technologies. Moreover, given the rapid pace of innovation in today's marketplace, these dedicated resources must work constantly, not just during an annual or quarterly planning cycle.

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Many leading high-tech companies assign so-called executive watchers to monitor particular trends. For example, a number of executive watchers in the computing industry are assigned to study trends in biotechnology, in part because they know that biotech developments have the potential to ignite the invention of the next generation of computing, rendering existing silicon-based technology obsolete.

But few companies can scan and screen emerging technologies effectively on their own. A key feature of the technology environment today is the multiple intersection points between technologies—the manner in which their value is amplified as they interact (see chart, page 59).

Most companies will not have a field of view large enough to see these intersections without being part of a greater community of thought and practice. Therefore, it's critical to col-

laborate with companies that have technology R&D capabilities, to make alliances with research consortia and leading university programs focused on emerging technologies, and to work with vendors and venture capitalists to consider new combinations of technology and business opportunities. For the most successful high-tech companies, these relationships and links are long-term.

3. Tune the early warning system according to the unique frequencies or value levers of your company

Exactly how a system is tuned will vary from company to company, depending on the industry and the competitive environment. Getting this tuning right is crucial.

For example, a company like Sony will look at different things in emerging technologies than a company like FedEx. But there will be overlap. Both would look at smart devices, ubiquitous computing, new kinds of software, GPS (global positioning system) and wireless technologies.

But Sony might be watching for new video-display technology that could make its products easier to use and its games more vivid. FedEx, with its own kinds of labor challenges, more intense customer service needs and different value chains, would have different concerns. It would be especially interested in developments that affect learning or technologies that would bring greater value to its customers, such as micro radio tags on packages.

Another way to look at tuning your radar is creating a screen, or filter, that considers how emerging technologies affect each key aspect of your company, including those not directly related to technology. Our firm, for example, went through one such filtering exercise to come up with a list of key

technologies that we feel will have a broad impact on most companies (see page 61). Every company needs to go through this sort of exercise, altering the filter according to what's most relevant to its industry operating model and value chain.

For example, voice-recognition technologies and wireless capability have great potential to alter both the consumer products and industrial products industries. As more and more inanimate objects become intelligent and connected "information appliances," consumer and industrial products will need to adapt. Remaining competitive will most likely require the ability to reach network-based software and services for maintenance and/or extensions of new product capability.

But the filter that works for consumer products does not necessarily work if applied to a chemical company or a utility. Companies need to be attuned to these differences.

4. Exercise "deconstructive leadership"

One of the important points in Joseph L. Bower and Clayton M. Christensen's now-famous 1995 *Harvard Business Review* article about "disruptive technologies" is that most companies have processes and incentives in place for their current customers that blind management to opportunities in emerging technologies. Deconstructive leadership takes this lesson to heart by asking executives to envision a different future.

Some leading CEOs have been willing to exercise the "creative destructiveness" represented by the Internet. General Electric Company's Jack Welch once referred to his Internet business units as "destroy-your-business.com." The leaders in the world of emerging technologies are those who constantly encourage their manage-

ment teams to think about how existing organization structures and ways of doing things might be undone, or "deconstructed," in the name of new opportunity.

5. Establish new methods of accountability

In the e-economy, effective governance requires an increased capacity to anticipate and deal with the multiple consequences of a decision. There needs to be a governance model in place to ensure that there is a set of processes, rules, roles and responsibilities not only for effective decision making but also for effective follow-through on decisions and accountability for them. (See "Governance at eSpeed," *Outlook* Special Edition, September 2000.)

For instance, many leading companies are taking new approaches to traditional boards of directors, augmenting them with additional "growth boards" or "technology advisory boards" to ensure that fresh thinking is baked into the company.

Executive accountability will also need to be different. Today it must include responsibility for catching the emerging technology waves, as well as for providing incentives so that various and diverse departments, such as marketing, engineering and customer service, understand the waves as well as the costs and time required to build capabilities, products or services to ride them.

Creating new kinds of business value from emerging technologies involves seeing the wave in advance, understanding its potential and having the right skills to ride it. It can be a rough ride, to be sure. It requires the ability to do a number of things simultaneously rather than sequentially. There will be a fair amount of failure—what surfers call wipeouts. Indeed, in the realm of emerging

technologies, failures often outnumber successes. Yet the payoff for the waves caught early and ridden successfully is huge. Just ask Microsoft, Intel, Cisco or Yahoo!

Or ask a professional surfer. The key to success, one of them said recently, is "taking the wave seriously—shooting with everyone I can and never letting a sunny day go by without using the opportunity to work." ■

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