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What Innovation Is

HOW COMPANIES DEVELOP OPERATING SYSTEMS FOR INNOVATION

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THE INNOVATION IMPERATIVE

There isn't a business that doesn't want to be more creative in its thinking. According to one study, 75% of CEOs of the fastest growing companies claim their strongest competitive advantage is unique products and services and the distinct business processes that power them to market—innovation by another name. In another survey, Boston Consulting Group reported that 90% of organizations believe innovation is a strategic priority for 2004 and beyond. The trend was also confirmed by research undertaken by consulting firm Strategos. Their conclusion: the importance of innovation in all sectors is growing, and growing significantly.

In today's ever-changing economic landscape, inventiveness has become a key factor influencing strategic planning. IT guru Kevin Kelly once said, "Wealth flows directly from innovation … not optimization … wealth is not gained by perfecting the known." Efficiency, while a necessary condition for business success, is insufficient to sustain growth over decades. While new levels of efficiency and productivity require inventive solutions, the goal of efficiency is not the same as the goal of innovation.

Chip Holt, inventor of the hugely successful Xerox DocuTech publishing systems, initially an obscure skunk-works effort almost killed at birth by the Xerox corporate immune system, is quoted as saying that "I characterize a lot of my efforts as the pursuit of productivity. I'm amazed at how many perspectives can be brought to bear in the pursuit of that one word. In its simplest form, productivity is the measure of the output divided by the input. The output management, which is associated with growing revenue, is an exciting one. But many times corporations get overly excited about the ease by which investment can be reduced and therefore the productivity equation increased. As an engineer and scientist, I come down squarely and strongly on the side of making investments in innovation which increase the output part of the equation."

If innovation and the balance sheet are inextricably linked, companies cannot afford to rely upon flashes of brilliance by individual inventors working alone. Hoping that what is cooking in the lab will turn up trumps is not a reasonable approach as a custodian of stockholder value. Very often, innovation is defined through the planned and deliberate recombination of ideas, people, and objects from the past that spark new technological revolutions, sought after service concepts and effective business models. Yet to stand as valuable innovations, new products and services must be sufficiently robust to progress efficiently through the end-to-end commercialization process and into the hands of customers. How does this happen?

Leading companies continuously seek out and institutionalize the insights and tools they will need if they are to stay at the leading edge and be top-rated stars in their sector. Some companies build enduring capacities for breakthrough innovation. They find ways to circumvent the years, if not decades, it can take to move from invention to commercial exploitation of a new technology. They manage the associated risks and continuously enhance their ability to solve the complex engineering and business process design problems that would otherwise place limits on their ability to envisage, and then create sustainable value from, the next generation in their industry. Far from a sporadic creative

event, leading organizations, whether product or service centric, treat innovation as a systemic and systematic process.

Economist and management consultant Peter Drucker once said, "An established company which in an age demanding innovation, is not capable of innovation, is doomed to decline and extinction." Today, many companies are taking steps to strengthen their ability to innovate—innovating to renovate the innovation process itself. In short, such companies are developing a reliable operating system for innovation, a key indicator of corporate sustainability.

Table 1: According to innovation theorists, a company should think about improving its operating system for innovation if a subset of the following applies:

You feel you are nearing the end of a long and expensive development race and your competitors are about to pass you by and win a valuable brand name and profitable chunks of the market before you are able to act.
The value in your industry is shifting from perfecting the old, towards inventing the new, in processes, products and services.
Even when you take on significant new contracts, vast amounts of new work or hundreds of new orders, your share price won't budge.
It seems that the innovation efforts in your organization are not systematic enough and are based on chance flashes of genius or ad-hoc ideas raised by individuals in skunk works projects.
You sense that your R&D staff members are sated and have settled down to middle-class complacency, and the flow of ideas is not what it was.
Your company has an excellent product that, 'if we could only solve that problem,' would conquer the world.
You are certain that reducing development time, production costs, and product price by fifteen percent would make your firm and your product a winner.
Despite of all the consultants, ISO standards and best practices you deploy, the cancer of 'it'll be okay,' and of undirected improvisation, has taken a grip on your firm, and this is something you are unwilling to accept.

A SYSTEMS FRAMEWORK FOR INNOVATION

In his landmark book, *The Fifth Discipline,* Peter Senge taught us that the most successful organizations are those that are *learning* organizations. Opening that work he wrote, "From a very early age, we are taught to break apart problems, to segment the world. This apparently makes complex tasks and subjects more manageable, but we pay a hidden price. We can no longer see the consequences of our actions; we lose our intrinsic sense of connection to a larger whole." For Senge, the answer lay in systems thinking, the antidote to reductionism.

Systems thinking helps creative individuals to see wholes, perceive relationships, uncover connections, expose root causes and master complexity. Systems thinking, Senge argued, integrates what might otherwise be separate management disciplines, preventing them being "gimmicks or the latest organization change fads." Some companies certainly took on that message. Jack Welsh, ex-CEO at most-admired company GE, once said that, "An

organization's ability to learn, and to translate that learning into action rapidly, is the ultimate competitive business advantage."

Do you believe that innovation and creativity is a learning skill; that it can be developed and improved if only one knew how? In short, does a systems thinking framework for innovation exist? Edward de Bono thinks so. Inventor of methods to foster lateral thinking and a prolific author of textbooks on creativity, his work has been taught in the boardrooms of some of the world's largest corporations and to four-year-olds in school. There is nothing more wasteful than a roomful of intelligent and highly paid people waiting for inspiration. ABB used to spend thirty days on their multinational project team discussions. Applying De Bono's "Six Thinking Hats," discussion now takes as little as two days. This experience is not unusual.

Using an applied creativity system developed by author and consultant, Min Basadur, snack foods purveyor Frito-Lay involved employees at every level in cost-improvement teams and achieved its goal of reducing costs by $500 million one year ahead of schedule. Some at the firm claim a bigger bonus: a permanent shift to a creative problem solving culture. Retired president and CEO, Jim O'Neal, is quoted as saying that, "Creativity methods provide senior management with a unique tool to tap into a massive organizational resource. Learning to leverage the creative thinking skills of every individual, regardless of their level, creates the sustainable competitive advantage every corporation is striving for."

Basadur, creator of the Simplex creativity process and who honed his methods at P&G, often tells a story about a green-striped soap bar called Irish Spring. Manufactured by Colgate and one of the most successful new product introductions in history, the soap posed a problem for P&G. After developing several unsuccessful copycat bars, P&G finally used creativity methods to shift focus from competing on market share to competing on experience. The result: P&G's new soap bar, Coast. Using blue swirls, not green stripes, Coast "out-refreshed" Colgate's customers with a new advertising concept that linked its bar design not to Irish spring water, but to the illusion of an invigorating swim in the ocean.

Whatever we feel about these apocryphal marketing stories, psychological methods of enhancing creativity, whilst effective, are unlikely in and of themselves to yield inventive companies that dominate markets. Although mankind has tried to understand the human mind over centuries, and questions about "how we get ideas" go back to antiquity, one can hardly imagine the CEO of a major corporation reassuring stockholders about company strategy on the basis of facile instructions such as "Let your mind roam free." When Peter Senge wrote about systems thinking, we can be sure he was refering to something beyond creativity tools and marketing renovations. Companies need more than creativity; they need a reliable innovation process, just as they have processes governing all other aspects of their business. Can innovation be codified? And if so, should companies make the effort? Help is at hand, but the buyer must beware.

CAVEAT EMPTOR AMID GROWING INNOVATION CHIC

To those business leaders who are sitting on the innovation fence, Gary Hamel has a dire prediction: "Out there in some garage is an entrepreneur who's forging a bullet with your company's name on it. You've got one option now—to shoot first. You've got to out-innovate the innovators. …Conventional thinking says get back to basics. Conventional wisdom says to cut costs. Conventional wisdom is doomed." Caveat Emptor. Writing in 1976, George Downs and Lawrence Mohr, observed that, "Innovation has emerged over the last decade as possibly the most fashionable of social science areas." Are we set for another round of innovation chic? Should we view Hamel's pronouncements with caution?

Innovation has become a mantra. Innovate or Die. Innovate or Die. Writing in the *Harvard Business Review,* Hamel tells us that "A company can't outgrow its competitors unless it can out-innovate them … Innovation is the fuel for growth. When a company runs out of innovation, it runs out of growth." Surely everyone knows that corporate growth—true growth, not just agglomeration—springs from innovation and that it implies more freedom for the R&D lab. How then did Southwest, Cemex and Shell Chemicals reap the benefits of innovation without spending lavishly on R&D?

According to marketing expert Sergio Zyman, many companies rely too heavily on expensive product innovation to solve their problems. Whenever a brand or business gets old and tired, the impulse is to scrap it and start over with something fresh. It sounds great, but more often than not innovation simply doesn't work. Zyman, author of *Renovate Before You Innovate*, knows this first hand—he was the chief marketing officer at Coca-Cola during the disastrous launch of New Coke. He reminds us that, "many companies mistakenly focus on innovation to drive growth. They look to create new products and lines of business instead of the more promising alternative of marketing renovation. Renovation may be a better bet because it involves doing a drastically better job of leveraging your existing assets and competencies." Convinced? Is marketing the answer to innovation doldrums?

At Coca-Cola, renovation might have been a better bet than risking the company's heritage with a new drinks formula, but surely renovation is not limited to the marketing process only? Isn't there more to marketing soap than green stripes and blue swirls? What about innovations in soap chemistry such as moisturization for an aging population, built-in deodorants, antibacterial agents and other ingredients that promote an all-over healthy skin?

Companies that wish to move beyond marketing-led renovations, quickly discover that there are as many *definitions of innovation* as there are innovation pundits. A superficial search of the Internet or Amazon.com reveals numerous sources of advice on how to generate new ideas, recognize innovation opportunities, remove mental blocks to creativity, foster creative conflict, create an innovation friendly culture and move innovations to market. Has innovation become the new knowledge management? As Thomas Davenport points out in his book *What's the Big Idea?,* "Knowledge management did have problems as a new business idea. One issue was that too many people—particularly IT vendors—conflated the use of knowledge technologies with the successful management of knowledge. Sometimes this was done in rather obvious ways.

One of us, for example, remembers speaking at a KM conference in Florida. At the beginning of the conference, each attendee's seat was graced with a new publication, *KM World*. How nice, we thought—KM now has its own little newspaper. On examination, however, we discovered that the paper was chock-full of press releases from imaging and document management technology vendors, with only a thin veneer of KM articles on the front page. Only the previous week it had been known as *Imaging World*." Is innovation suffering a similar fate? If we substituted the word 'innovation' by the word 'knowledge' in many popular books and articles that offer innovation advice, would it make any difference? In 'e-business' we found it was the business that mattered? What's the real beef in innovation?

THE MYTH OF DISRUPTIVE INNOVATIONS

A recurring meme of what some call the "innovation industry," is how business leaders get blindsided by *disruptive* innovations because they focus too closely on their most profitable customers and businesses. The idea became popular following the publication of Clayton Christensen's influential 1997 book *The Innovator's Dilemma.* Since then, the work of the Harvard Business School professor and founder of strategy consulting firm Innosight, has spawned a hundred imitations. These beguiling ideas dominate popular thinking about innovation. In the IT industry they are interpreted as the search for so-called "Killer Apps", entirely unrealistic expectations for new, holy grail, software solutions. In IT or any other industrial sector, these ideas appeal to senior managers because they speak of the potential of specific innovations in a market system, and they imply that silver bullets exist to take markets by storm. Yet by reading these theories we learn little about the process of innovation. Even when, as in Christensen's 2003 book *The Innovator's Solution,* he switches things around to show how companies get to the other side of the innovation dilemma, creating disruptions rather than being destroyed by them, we find no solution for the innovator in his analysis.

Sony releases 5,000 new products per year. A laptop's expected life is now only two years. Drug development is down from ten years to four years. Professional services firms are in a race to find ways to retain valuable customer accounts. There has never been a time when more products and services are being launched and where new technologies are being introduced to the market ever more rapidly. To cope in this environment, companies need more than big ideas about disruptive market innovations—they need new stuff, the stuff with which they can disrupt markets.

To win the next battle in the unending market wars, companies must be able to spot important trends and deliver compliant products, in soap products or anything else. Only by solving problems inherent to the current generation of a product or service, does innovation progress. Companies achieve this through the talent of their employees and the work-environment provided for them by their employers. It is creativity, inventiveness and the thoughtful application of systematic, scientific, and predicable methods that allows the innovator to move beyond the current state of the art.

When Christensen and like-minded management consultants write about "innovators" they are really referring to the mega-corporations that seek to

dominate markets. The individual inventor, scientist, engineer or problem-solver is never discussed. Their day-to-day, month-to-month and year-on-year efforts to solve the hard problems in engineering, organizational design, service-concept or process are never acknowledged. Yet it is precisely these activities that lead to new or improved products, services, processes and business models.

Management books about innovation are important in so far as they help business leaders determine if an idea has disruptive "market" potential—which competitive situations favor incumbents, which favor new entrants and which customer segments are prime to embrace new offerings—but they won't help us to be more creative or to solve the problems that innovators will inevitably face as new concepts are commercialized leading to business coming in. Management books start where innovation leaves off. They assume innovation has already taken place, and that all problems limiting commercial success, across the value chain and in all business processes, will be solved in the future. Drawn as they are from management theory, as opposed to engineering science, the ideas in such books have no impact on the number of innovations companies are able to generate or commercialize. Neither will reading such works enhance the creative and problem solving skills of employees. Management frameworks have value in screening out bad ideas before too much time and resource is invested in the wrong place, but they do not describe the sources of innovation, despite the catchy book titles. Whether developing a mass-market product or delivering intimate services one customer at a time, management frameworks won't turn dulards into innovators.

In Christensen's latest book, *Seeing What's Next—Using The Theories Of Innovation To Predict Industry Change,* he provides a powerful synthesis of the many management frameworks he has written about over the years, including disruptive innovation theory, resources, processes and values (RPV) theory, jobs-to-be-done theory, value chain theory, schools of experience theory, emergent strategy theory and motivational/ability frameworks. Yet the truth is, many of the disruptions he is concered with do not occur, or are the results of normal business logic. Southwest grew in the airline business because they were not unionized. The company bought up cheap slots at airports when the established players were cutting back. They similarly bought cheap aircraft from Boeing when the major players could not afford them. Then they had to develop an online or telesales presense because the airlines owned the booking systems. Often, it is brutal business logic, not methodology, which drives innovation. The innovator is a problem solver and uses smarts and instinct to knock down barriers one by one that, unless overcome, would prevent the growth of their business. Yet problem solvers, and the methods they use, never even get a mention in the index to Christensen's work. Companies must look deeper to find the source of innovation and of competitive advantage.

At the MIT Emerging Technology Symposium 2003, GE CEO, Jeff Immelt, set out his beliefs about innovation, stating that, "We are all just a moment of complacency away from an abyss called commodity hell, where you compete only on price, where share goes to the least common denominator, and where you're working for your customers instead of your investors and you cannot build a business for the future." Immelt identified four factors driving companies to "commodity damnation."

First, lower growth and higher risk. There's more excess capacity today than at any time since the 1970s. There's more volatility in geopolitical risk than at any time in the last 20 years. "The toughest thing that any company has to get today is an order," he said.

Second, we're facing the strongest competitors that we've faced in our lifetime in China, India and other emerging economies. Thomas Friedman, writing in the New York Times in an article entitled "Oops. I Told the Truth", points out that, "The Chinese and the Indians are not racing us to the bottom. They are racing us to the top. Young Indian and Chinese entrepreneurs are not content just to build our designs. They aspire to design the next wave of innovations and dominate those markets. Good jobs are being outsourced to them not simply because they'll work for less, but because they are better educated in the math and science skills required for 21st-century work." Have no doubt; these societies have a strong technical foundation, and both human and material resources. Immelt told the MIT audience that, "The trick is not low cost labor; it's the fact that we can hire two to three PhDs in India for the same amount we pay one hourly worker in Louisville, and we have to compete in that world."

Third is the Internet. Re-stating GE's oft-reported belief in "digitization", Immelt stated that, "The Internet has had a profound impact on how the world works. It's primarily profound in terms of the world of perfect information. GE every year does fifteen billion dollars of purchasing online via auction, saving 20% to 30%. The ability to get value for your product is fleeting and the tendency is to go to the lowest price everywhere in the world."

Lastly, the dominant business models today are distribution oriented, consolidating channels. Companies like Wal-Mart and Dell tend to dominate the industries they're in. They take value from the manufacturers and more value has gone to distribution. His conclusion? With utter certainty he told the assembled business leaders that, "The only source of profit, the only reason to invest in companies in the future is their ability to innovate and their ability to differentiate." If innovation is so important, what is innovative about innovation today?

INNOVATION AS DESIGN PROCESS

Tom Kelley, general manager of IDEO, a leading design consultancy, describes how innovative teams immerse themselves in every possible aspect of a proposal for a new product or service. For IDEO, research from the perspective of clients, consumers and other critical audiences, is central to the innovation process. IDEO has institutionalized a process for innovation—from creating hot teams, to seeing through the customer's eyes, to unique brainstorming methods to rapid prototyping.

For cool and fast IDEO, whose mottos include "one conversation at a time," "stay focused on the topic," "encourage wild ideas," "defer judgment," and "build on the ideas of others", the innovation process is a blend of methodology, work practice, culture and infrastructure. Shadowing, behavioral mapping, consumer journey, extreme interviews, storytelling, deep dives and body storming are a few of the terms IDEO use to describe what they do. Sam Hall, vice president for mMode at AT&T Wireless Services Inc., turned to IDEO to redesign its mMode service. He was quoted in Business Week as being "Thrilled

with the results. We talked to Frog Design, Razorfish, and other design firms, and they thought this was a Web project that needed flashy graphics. IDEO knew it was about making the cell phone experience better."

In the roaring '90s, IDEO was best known for designing user-friendly computers, PDAs like the Palm V. It also designed the first no-squeeze, stand-up toothpaste tube for Procter & Gamble. Now IDEO is transferring its ability to create consumer products into designing consumer experiences in services, from shopping and banking, to healthcare and wireless communication. Is IDEO's eclectic mix of out of the box thinking, structured exploration of design alternatives and creative flair enough? Not for IDEO.

Domain experience is an essential component of innovation. The members of IDEO's creative team are far from generalists—they are scientists, engineers, artists and management theorists. Although IDEO is quick to point out they are not experts in any one field and that their core expertise lies in the *process* of design, the majority of their employees have advanced degrees in many different kinds of engineering: mechanical, electrical, biomedical, software, aerospace, and manufacturing. This background and formal training covers materials science, computer-aided design, robotics, computer science, movie special efforts, molding, industrial interaction, graphics, fashion, the automobile business, finance, communications, linguistics, sociology, ergonomics, cognitive psychology, arts, therapy, ethnology, management consulting, statistics, medicine and zoology. As a result of these qualifications and experience, the IDEO project portfolio reads like a design encyclopedia. Closer examination of individual projects reveals the power of cross-fertilization from diverse domains.

IDEO's clients have carried them far beyond the traditional high-tech product categories that might have defined the firm a decade ago, a reputation established by association with their early successes for Apple and Palm. Today, IDEO projects include an insulin delivery device, eyewear that exploits the design potential of new materials such as cellulosic plastics, the architectural design of a public learning laboratory, a new type of cap for recreational drink bottles, hospital environments and the associated processes, office furniture, luminescent bathroom tiles, aircraft interiors, the passenger train experience, novel exhibition concepts, a radio data system and a communicator for soul-mates. A quick skim through *IDEO – Masters of Innovation,* a coffee table book that describes the story and features many gorgeous images of their design work, it is easy to forget that IDEO is not just a frothy concept company whose work rarely gets further than a 3D digital mock-up or Photoshop image. Far from it: IDEO construct real prototypes of the products they design and IDEO's engineers design for manufacturability.

Manufacturing specialists are on IDEO's project teams from the earliest phases. IDEO employ materials specialists for all types of products, whether low-volume or mass-produced consumer devices. IDEO's experience extends to hardcore topics such as lean manufacturing, supply-chain, purchasing strategy, electrical, mechanical and assembly DFM, yield production, factory assessment, injection, transfer, multi-shot and many other kinds of molding as well as processes for cast, net-shape, finishing, printed-circuit and packaging.

At IDEO, as in the R&D labs of major corporations, innovation is predicated on current experience and a deep understanding of what worked in the past. And to

speed up learning, the design firm often turns to “real” experts, often end users, via an observation methodology they dub “design anthropology” and which draws from ethnographic methods. Psychologist Jane Fulton Suri, who leads IDEO’s human factors projects, has been called a “bird watcher with attitude,” except the birds she specializes in are humans. Nearly all IDEO projects now include an element of “bird watching.”

While in exotic settings one might learn how to build a canoe, weave a hammock, make rain, or deliver a baby. In the industrial workplace one gets insights into the intricacies of returning customer’s phone calls, adjusting a piece of machinery, smelling a vat of chemicals, or negotiating with co-workers about a useful strategy. IDEO anthopologists observe consumers and workers as they use, make or repair the products, services or spaces that the firm are brought in to improve. A Ford engineer once noted that, “When people look at a car in the showroom, the first thing they do is open and close the doors. They may not realize it, but if they don’t like the sound, they’ll just walk away from the car.” Knowing this, Ford and its competitors now engineer the sounds a car makes, including doors, latches, and of course engines. Design anthropology is what turns up this type of knowledge. And IDEO is smart about the way it captures design expertise from one project to provide creative design-seeds for others.

One of IDEO’s most useful creativity tools is the Tech Box, a combination library, database, website, and organizational memory of parts, mechanisms, and materials. As IDEO’s innovators discover new technologies in one industry, the Tech Box allows their knowledge to be distributed throughout the company so that it can be applied on projects in other industries. The Tech Box really is in daily use. It’s a creativity amplifier for IDEO and their customers. And IDEO has created specialized Tech Boxes for their clients as they become aware of the central role of knowledge management in innovation.

For many corporations the experience of working with IDEO is a wake-up call. The usual pattern is this: IDEO has been engaged on a specific project, senior managers hear of the results on the grapevine and a larger problem is revealed; culture. Interviewed for ABC News Nightline as part of a program in which the firm was challenged to design and manufacture a more innovative shopping trolley in just five days, David Kelley, IDEO founder and creative engineer, observed that, “If you go into a culture and there are a bunch of steps going around, I guarantee they are not likely to invent anything”.

Is IDEO inventing? Sometimes. Whoever came up with the idea for dental floss is an inventor, but the person who created the little plastic box that lets you tear off just the right amount is a designer. It’s not so easy to understand the boundary between invention and design innovation, yet a specialist at the Patent Office can, with due diligence, determine what is genuinely new in a product or process and what is just new spin. Looking across the IDEO portfolio, it is clear that the value their bring is far more than spin and marketing renovations, irrespective of whether or not individual projects create patents. What IDEO do is a significant step up on the innovation ladder, and far more than a room full of creative generalists with no domain knowledge.

Table 2: IDEO Method Cards inspire great design

Method cards are one tool IDEO uses to help explore new approaches in design. They are used to take a new view, enhance creativity, communicate among a team, avoid a roadblock or turn a corner. IDEO have hundreds of techniques they employ during their total immersion "Deep Dives". Here are four:

Card Sort

HOW: On separate cards, name possible features, functions, or design attributes. Ask people to organize the cards spatially, in ways that make sense to them. WHY: This helps to expose people's mental models of a device or system. Their organization reveals expectations and priorities about the intended functions. EXAMPLE: In a project to design a new digital phone service, a card-sorting exercise enabled potential users to influence the final menu structure and naming.

Scenarios

HOW: Illustrate a character-rich story line describing the context of use for a product or service. WHY: This process helps to communicate and test the essence of a design idea within its probable context of use. It is essentially useful for evaluation of service concepts. EXAMPLE: Designing a website, the IDEO team drew up scenarios to highlight the ways particular design ideas served different user needs.

Still-Photo Survey

HOW: Follow a planned shooting script and capture pictures of specific objects, activities, etc. WHY: The team can use this visual evidence to uncover patterns of behavior and perceptions related to a particular product or context. EXAMPLE: For a faucet design, the team documented all the situations in which people accessed water.

Character Profiles

HOW: Based on observations of real process, develop character profiles to represent archetypes and the details of their behavior or lifestyles. WHY: This is a useful way to bring a typical customer to life and to communicate the value of different concepts to various target groups. EXAMPLE: In order to understand different types of customers and how to target them, IDEO developed four characters for a pharmacy wanting to reach the male-beauty-product market.

BEYOND DESIGN

Over the past decade IDEO has steadily risen to the top of the international design consultancy prestige table, picking up over 200 clients—among them Nike, Amtrak, BMW, Canon and Pepsi. IDEO may represent the cutting edge of design innovation today, but the problem they are addressing is a century old. In 1867, German chemical giant BASF established the first industrial R&D laboratory to develop dye technology. Soon afterwards, Thomas Edison, the founder of GE and an individual who averaged filing 25 patents a year for his entire adult life, created the first organized and systematic corporate-research model for product innovation with a predictable return on investment at his Central Laboratory in Menlo Park in 1876. His work formed the prototype for corporate innovation and development in the Industrial era. For example, DuPont created one of the most successful of the first generation R&D labs. A project by chemist Wallace Carothers led to the invention of Nylon in 1939.

During the next 50 years, nylon earned the company between $20 and $25 billion in profits. These early labs were managed by scientists, yet over decades, and as the complexity of products and services grew by a thousand-fold, other disciplines, since as finance and governance, were added to the mix.

Mastery of the research and development (R&D) process remains critical to survival today whether in products or services. It involves years of patient (and impatient) investigation, punctuated by moments of inspiration. It requires uncontrollable creativity positioned side-by-side with disciplined business process. And it is, for most companies, tremendously difficult to achieve. Many top managers acknowledge that their corporations are failing at innovation, particularly at making the substantial leaps that are required to create products or service concepts that lead to market-changing breakthroughs. Some have lost confidence in the ability of their organizations to innovate effectively. No wonder then that some larger, and no doubt older, corporations are turning to external sources—firms such as Innosight, Strategos, Doblin and IDEO—for help. What is it that they are seeking? Many managers wish to understand the steps they can take to foster a genuine culture of innovation and, just as importantly, to institutionalize an ability to continuously create and shape new products and services for today's ever-changing global markets. Companies have learned that they need to manage the innovation process so as to serve the business objectives. Today, R&D is an intensely commercial activity, governed by numerous business processes, in areas such as competitive advantage analysis, risk, life-cycle aging, timing of technology in the pipeline, fit with core business strategies and the commitment of resources.

Creativity, invention, design and innovation are often confused. Innovation is a holistic process involving the entire organization of a commercial enterprise, whereas invention is a discrete event, typically performed by specialist individuals or very small teams. Innovation requires multi-disciplinary teams and is a complete lifecycle process. Creativity and design are necessary, but insufficient. In this sense, IDEO's design innovations are, like every other element in the operating system for innovation, a part of the mix. Yet in a world of product abundance, mass-customization and extraordinary high expectations when consumers interact with public or private services or business people deal with suppliers, IDEO's core competence is no doubt a vital ingredient. Their design process turns genuine inventions into useable, interesting and beautiful products and services, rendering them acceptable to commercialization. And what IDEO produces must be relevant to markets, and the timing of the release of those innovations to markets is critical, as Christensen has taught us. Yet just as we must move beyond Christensen's management frameworks if we are to understand the sources of innovation and the critical role of problem solving, so too must we move beyond IDEO's design innovation if we are to understand the full extent of what innovation is.

Senge, De Bono, Basadur, IDEO, Christenson's Strategos and Hamel's Innosight, each supplies a distinct component of the operating system for innovation. Thinking tools, work practices, culture, market analysis, strategy, education, training and knowledge management—what's missing? What lies beneath the surface of the innovation iceberg?

HERDING AND HEARING FLOCKS OF BRAINS

According to Jonas Ridderstråle and Kjelle Nordström, researchers at the Institute of International Business at the Stockholm School of Economics, "Business success is a matter of herding flocks of brains." In their book *Funky Business—Talent Makes Capital Dance*, they observe that in a modern company, 70-80 percent of what people do is now done by way of their intellects … and the human brain is overpowering the traditional means of production. Hal Sirkin, leader of Boston Consulting Group's Operations Practice, observes that, "Most people think of innovation only in terms of R&D or new product development—but taking an idea and turning it into cash is an effort that involves almost every part of a company. The challenge is thinking about and managing this extremely broad set of interrelated activity as a unified process." To meet the challenge, some companies are turning to a concept called *idea management.*

If the phrase brings to mind the proverbial company "suggestions box," think again. Idea management focuses the creativity of employees on critical business problems and increases their participation in solving line-of-business and "big picture", market and revenue related issues. Some call it the "Innovation to Cash" process.

In the past, innovation was defined largely by creativity and the development of new ideas. Today the term encompasses coordinated projects directed toward honing these ideas and converting them into developments that boost the bottom line. When a new event, or fact, or idea emerges, and is captured, it can be evaluated, if ideas can be routed to those able to make the appropriate judgments. Does the idea embody the possibility for a new dominant design, service or platform, and can a project be constituted to manage the development of this initial "seed." Marsha McArthur, innovation manager at Bristol-Myers Squibb, one of America's largest pharmaceutical companies, used an idea management solution to help the company through a period of industry consolidation and widespread patent expiration for "blockbuster" drugs.

When a patent expires and an alternative generic drug enters the market, it is possible to lose 80% of revenue in the patented drug line within six months. In 2001, Bristol-Myers Squibb had four such drugs, each with more than US$1 billion in annual sales. Following an audit of innovation activities in late 2000 with the involvement of over 400 managers and executives, the company decided it needed to build a pipeline of revenue generating ideas to grow its pharmaceuticals and medial products businesses. Bristol-Myers Squibb deployed an idea management hub from idea innovator Imaginatik, a software application accessible on the company intranet, to capture, structure, assemble, organize, evaluate and rank suggestions collected from the field. It provided essential features such as workflow, idea reviews and security. Rather than just collecting random ideas through a traditional electronic suggestion box, the system was structured to maintain employee interest levels and participation rates, aligned to corporate innovation objectives. Workflow-based peer review weeded out bad ideas and promoted good ideas to become mature concepts. Related items were groups and expanded through further input. Project-specific review teams evaluated ideas against weighted scorecards customized to company-significant events.

The idea management application at Bristol-Myers Squibb was first offered to brand teams supporting specific products, and was subsequently used to manage ideas generated around line extensions, marketing tactics and direct-to-consumer and doctor communications. By 2003, more than 5,000 ideas had been collected. One such project, the "War on Diabetes," allowed Bristol-Myers Squibb to introduce a range of diabetes management tools that help improve the quality of life for diabetes patients, achieving one of the fastest conversion rates for a patented drug in the history of the pharmaceutical industry. Over 3,000 individuals from sales and marketing worldwide contributed to the "ideation" process, generating 400 ideas in four weeks. In 2002, sales of Glucophage XR extended-release tablets grew 29 percent to $297 million.

Sometimes referred to as the "fuzzy front end" to product development, idea management may ultimately provide the knowledge-management industry with the validation it's been seeking, says Jonathan Spira, an analyst with research firm Basex. "People have been waiting for five or six years for a reason to latch onto knowledge management," he says. "Idea management could rescue knowledge management from oblivion."

Bristol-Myers Squibb's marketing research group conducted an extensive post-ideation audit of around 1,000 ideas collected in their system to validate the quality of the concepts and the eventual business value. The "Idea-thon' study found that 10% of the ideas had significant business value, 2.5% were truly exceptional and even a single 'small" idea could pay for the entire company-wide implementation effort of the associated software. No wonder then that the idea of idea management is growing in popularity. Advocates describe different kinds of "idea-flow" as meeting the needs of different kinds of organizations. Some speak of extended "idea-chains," designed to manage the collection and development of ideas from external partners such as suppliers, customers and research partners. Such systems include additional features to manage access rights, rewards, and intellectual property rights. Idea management structures the colloration process between business partners.

Designed with sensitivity to fit the culture of an organization, idea management can help ensure that the voices of employees are properly heard within, and focused upon, important corporate objectives. The aim is the identification and evaluation of those ideas that present the most substantial benefits, allowing the development of a fruitful idea pipeline aligned to top down objectives. The byproduct may be increased buy-in to new management initiatives and positive support for the associated organizational and process changes that will inevitably result from the implementation of those ideas. A form of coordinated innovation, idea management solutions supply a starter pack of processes that act as the tipping point for a sustainable innovation program. The approach can generate a long-term corporate memory bank, a central and accessible location to organize, categorize and harvest the constant influx of ideas.

Idea management processes close the loop between employees with ideas and senior managers who have the authority, budgets and motivation to make them happen. Senior managers, business unit heads, product/service development leaders or process owners establish each campaign, and ideas generated in the field and throughout the business are directed to qualified experts in the business who can evaluate each idea. These ideas are either promoted, demoted, aggregated with related ideas and further developmed, often through

collaboration with the individual that created the seed. And idea management helps in other ways. It plays a key role in helping to ensure that time and resources are not wasted on those ideas that have been rejected in the past. Conversely, it can be used to revive ideas that were inappropriate before but now have increased relevance. In all these senses, idea management helps focus resources and further thinking on those ideas with high potential.

Typical software systems for idea management issue reminders to evaluators of upcoming deadlines and unevaluated inputs. Lacking such features, simpler electronic suggestions boxes tend to fill up with large numbers of low-quality ideas that are not focused on business goals. Without automated support, employees are unable to follow up on what happened to their thoughts and tend to become cynical, no longer sharing their insights with their employer. Yet there are limits to the value of new ideas.

The *Economist* reckons that an enterprise has to start with around 3,000 bright ideas if it is to come up with 100 worthwhile projects, which, in turn, will be winnowed down to four development programs for new products. William Miller and Langdon Morris, authors of a sweeping and insightful analysis of innovation in the knowledge economy, *Fourth Generation R&D,* draw powerful distinctions between continuous and discontinuous innovation—and between tacit and explicit knowledge. They observe that "During the 1980s, American corporations wasted billions of dollars on failed attempts to innovate, which demonstrates that just spending more money doesn't help if assumptions are incorrect and the process is flawed. … Measuring downstream, it seems that, of four projects that enter the development stage, only one becomes commercially successful."

So while it's easy to use the new tools of idea management to fish for new ideas, the real value of collaboration lies elsewhere. Perhaps idea management needs to be renamed *solution* management. Intelligent users of idea management software are doing far more than idea fishing; they are focussing the talent of employees by challenging them to solve hard problems, in engineering, in development, in operations and in marketing. Companies often underestimate the considerable costs involved in driving adoption of the new idea. The Economist's depressing statistics refer only to new product development, and this accounts for just 15%, or less, of the innovation activities a company should be doing. Reflecting on the invention of the Alto personal office computer, author, consultant and ex-Director at Xerox PARC labs, John Seely Brown observes that "as much, if not more, creativity goes into the implementation part of the innovation as into the invention itself." In this respect, Xerox, the inventor, failed as an innovator, leaving billions in profits for Apple and Microsoft.

In turbulent times it is easy to give up on innovation. The uncertainity associated with success rates for new ideas and the difficulty of commercialising any individual new idea, leaves many with the sense that innovation—the creation of new value—is mysterious, unpredictable and apparently, unmanageable. Searching for breakthroughs is expensive and time consuming, and many managers fall back on incremental improvements to existing products and services. After all, line extensions help the bottom line immediately. Some companies seek solid ground by eradicating all activities that are not requested by the customer, a focus on the consumption chain. Others make up for

innovation gaps and new product failures by pursuing parallel efforts such as increasing volume in existing markets through market share warfare, reducing costs through downsizing, process improvements, quality improvements and outsourcing, using methods and tools to enhance productivity or customer loyalty, making acquisitions or exiting marginal businesses. But as Miller and Langdon observe, "None of these strategies address the fundamental need to increase the value that is provided to customers. Only innovation is competent to do this." Where does innovation come from?

AN AGE OF TIME, TALENT AND INTANGIBLES

To keep up with all the new product launches, Procter & Gamble has more scientists on its payroll than Harvard, Berkeley and MIT combined. Physical assets and means of production, upgraded and installed last year, hardly help companies keep pace and compete in the future. Sure you need plumbing; otherwise things get very messy. But it is no longer enough. In a world of contract manufacturing and outsourcing overcapacity, "Use all the force you want. Bludgeon down walls; threaten and cajole. It won't get you anywhere if you are dealing with someone who is smarter, quicker and hungrier … the new competitive battlefield is not the engine or the air conditioner—it is the design, the warranty, the service deal, the image and the finance package," claim Ridderstråle and Nordström. In this environment, typified by General Motor's advertising slogan, "a car full of ideas," it is more accurate to talk about *provices* and *serducts* than it is to talk of products and services, as you can hardly separate the two. And this is especially true in service-based businesses.

Companies seeking new wealth need to look toward intelligence, and intangibles; and of course, people. Innovation and competence are locked in an inseparable embrace. According to Ridderstråle and Nordström, "This is the age of time and talent, where we are selling time and talent, exploiting time and talent, organizing time and talent, hiring time and talent and packaging time and talent. The most critical resource wears shoes and walks out the door around five o'clock every day." Innovative people. At design firm IDEO for example; those who have the best ideas, and little else, define what it means to be more senior.

Stanford's Paul Romer, speaking about the 300 largest multinational companies that control 25 percent of all the productive assets on earth, states that, "the ones with the best recipes will win." The individual, team, organization or economic region that excels in developing innovative concepts and ideas about how to combine and re-combine the ingredients of business will be most successful. The recipe must be unique enough to capture the attention of oversupplied and demanding customers, a recipe that adds real value and a recipe that is extremely difficult to copy. Preferably it should be protected in law. Over the next decade, dealers in and of atoms alone are in for some pretty though times. Unfortunately, atoms are easier to count.

"The financial balance sheet is probably the only 500-year-old super-model still capable of arousing a few people," observe Ridderstråle and Nordström. Yet despite its long-lasting allure, it often only manages to capture around 15-20 percent of the real value of many modern companies. Pfizer's $270 billion market cap is supported more by the patents it owns on innovative drugs such as Zoloft (depression), Zyrtec (allergies) and Norvasc (hypertension)—which have

no value on its balance sheet—than by its machinery, land and buildings, which have a book value of $20 billion.

Douglas Graham and Thomas Bachman, in their book *Ideation: The Birth and Death of Ideas,* point out that recently there has been a sea change in accounting, driven by the Financial Accounting Standards Board (FASB) with their FASB 141 and 142 Statements, as well as the Securities and Exchange Commission (SEC) with their S-X ruling. The former ruling requires companies that have acquired other companies to identify and value all the intangible assets in the acquired company. Soon this rule will extend to all intangibles, whether acquired or developed in-house. "These are not mere arcane accounting rules," claim Graham and Bachman. "The regulatory bodies are recognizing that the world has changed and most of the value of companies is tied up in their intangibles." As Alan Greenspan put it, "We are entering the era of 'Ideanomics." Yet the FASB is the first to admit that the CFO is ill eqipped to handle these new requirements. Their view: "Companies' inability to identify and inventory intangible assets may be the most significant obstacle to any comprehensive recognition of intangible assets. Managers cannot measure assets they do not, today, identify and manage as assets."

Is innovation an operating expense or an investment? Cecily Fluke and Lesley Kump, writing in *Forbes,* suggest that accounting bias penalizes earnings of companies with strong R&D efforts. So they came up with a novel approach to deal with this conundrum: adjust earning by adding back R&D expenses, arriving at what they call innovation-adjusted earnings. Chris Mallon took the idea one stage further in an article in the *Motley Fool*. Assuming R&D is an investment, why not add it back to operating cash flow, leading to what could be called innovation-adjusted-free-cash-flow. Mallon calculated how this might affect the valuation of some leading technology companies. In fiscal year 2004, Microsoft generated $14.6 billion in operating cash, had $7.8 billion in R&D expenses, and $1.1 billion in capital expenditures. Under the strict definition, free cash flow was $13.5 billion, or about $1.24 per share. Using the adjusted formula the answer would be $21.3 billion or $1.95 per share. This may be a good idea for shareholders, but it hardly counts as innovation.

Financial jiggery-pokery alone is not enough. Today, the input of ideas and human imagination make all the difference. We live and work in a competence economy. Digitization, globalization, overcapacity and deregulation are altering the balance between those who sell and those who buy on the one hand, and between capital investors and competence investors, on the other. It's a tricky balancing act. Clayton Christensen questions the status quo, stating, "Financial markets relentlessly pressure executives to grow and keep growing faster and faster. Is it possible to succeed with this mandate? Don't the innovations that can satisfy investor's demands for growth require taking risks that are unacceptable to those same investors? Is there a way out of this dilemma?"

According to the *Economist,* the new acid test for global firms is whether or not it hurts when you drop your competitive advantage on your toes, leading to the imperative to manage intellectual property (IP) and intangibles as never before. In the real-time, globally linked, surplus, society, competitors will steal your ideas in two to three weeks. "Knowledge is perishable. Treat it like milk. Date it," urge Ridderstråle and Nordström. Are they right? If so, it is hardly surprising that, alongside tired and tested business strategies such as continuous product

evolution, channel expansion, globalization and margin growth, leading firms are now placing more emphasis on the management of intangibles.

Research by academics such as Baruch Lev at the New York Stern School of Management has led some companies to note a correlation between the successful businesses that emerged from the last 100 years, the companies that hold the most patents in the last 100 years and those who have been the most innovative of the last 100 years. No wonder then that IP and other forms of intangible assets have become a major focus of U.S. businesses, with many other nations seeking to follow the U.S. lead. Germany is legislating new IP ownership laws for universities and encouraging public-private research partnerships to more closely model the U.S. model. Japanese companies are being required by government initiative to improve their intellectual property (IP) competitiveness. In the growing IP wars, the process by which companies manage IP is nothing less than a strategic market-led business process.

Bill Gates recently pointed to Microsoft's R&D as a differentiator. For fiscal year 2004, R&D spending at Microsoft represented about 17.8% of revenue. Gates noted that, according to some measures (for example, "current impact"), its patent portfolio outpaces those of Oracle, Sun, Apple and IBM. The company is on something of a patent tear, filing for 2,135 patents in fiscal year 2004 vs. 519 in fiscal year 1998. It's the same story in many other industrial sectors. Aerospace leader BAE Systems places emphasis on IP and educates employees about the danger of allowing IP to leak into the public domain. Once that happens, ideas can't be patented and can't be protected. The company believes it is never too early to start thinking about the patent filing process and they stress that an idea doesn't have to be a major technological change to warrant a patent, it can be a 'new, improved' version of an existing technology. It's a view held by the majority of CEOs who adopt the general stance that innovation, inventions and technical know-how are the lifeblood of the company and, that, to leave them unprotected and let intellectual property drain away, is reckless.

Patents are a legal proxy for innovation. A patent excludes others from making, using, offering for sale, or selling inventions. Granting a U.S. patent is a transfer of the competence of an inventor from the realm of ideas into the realm of binding property rights. And it isn't just engineering solutions that can be patented. Utility patents may be granted to anyone who invents or discovers any new and useful process, machine, article of manufacture, composition of matter, or any new useful improvement thereof.

By not patenting, companies risk losing important future technical advances and the revenue that can result from licensing. And the principle extends to process design, although legal practice in this area is far less developed. But not everyone is convinced about a sole and direct link between IP, the size of a companies' patent portfolio, and future earnings potential.

Not all companies are avid patent-filers, and many believe that the significance of patent ownership can be over-stated. It is relatively easy to point to successful firms with reliable returns to stockholders who have rarely sought legal protection for their intangibles: knowledge, competence, methodologies and processes. While patent-filing may be an indirect indicator of innovation activity for high-tech firms, the vast majority of individual patents have little commercial value, and the process of obtaining, and enforcing, patents is

complex, expensive and time consuming. Plus, there are indicators that the patent system itself is under stress.

Adam Jaffe and Josh Lerner believe that the United States patent system has become sand rather than lubricant in the wheels of American progress. Such is the premise behind their new book, *Innovation and Its Discontents: How Our Broken Patent System is Endangering Innovation and Progress, and What to Do About It.* It tells the story of how recent changes in patenting have wreaked havoc on innovators, businesses, and economic productivity. First, new laws have made it easier for businesses and inventors to secure patents on products of all kinds, and second, the laws have tilted the table to favor patent holders, no matter how tenuous their claims. Jaffe and Lerner, who have spent the past two decades studying the patent system, show how legal changes initiated in the 1980s converted the system from a stimulator of innovation to a creator of litigation and uncertainty that threatens the innovation process itself.

On the other hand, patents do provide one way to demonstrate value to the marketplace. Numerous empirical studies (e.g. Lev and Sougiannis 1996) have established an economically meaningful and statistically significant relationship between R&D outlays and subsequent benefits, in the form of increased productivity, earnings and shareholder value. In the U.S., knowledge assets account for six of every seven dollars of corporate market value. For high tech companies this ratio is larger. At the same time, the intangible assets arising from this investment are under-valued on the balance sheet. Obviously, the uncertainty about intangibles (e.g., products, services and processes under development) in respect of their future value-generating potential is substantially larger for outsiders than for corporate insiders.

Lev Barach has observed that, “Investors react to uncertainty by demanding a compensating return premium, which translates to a higher cost of capital to the company. Indeed, research shows that increased investment in knowledge assets increases both the cost of equity capital and debt of corporations.” His research points to the methods companies can use to strengthen the way in which their intangibles are presented to the market. Barach believes that, “A credible and coherent disclosure strategy can alleviate the undervaluation problem” and he urges companies to “elaborate on the major knowledge-related items relevant to investors—product pipeline, technological and commercialization capabilities—and on the effective means of disclosing them, while minimizing the potential competitive and legal harms of disclosure.”

The link between intangibles and the balance sheet leads many companies to envelop innovators with a plethora of legal, compliance and other structured procedures to maximize the downstream value of their creativity. R&D programs are structured to collect, assess and foster the development of insight. Collaborative research is dominated by the language of contracts, subcontracts, patent filing, licensing, insurances, indemnification, acquisition processes, teaming agreements, cooperative research and development agreements, memorandums of understanding, non-disclosure agreements, performance-based contracting, grants and cost reimbursement. In effect, companies are building balance-sheet amplifiers around their people as they work to think, create, invent and improve.

Companies are playing a tightrope-balancing act. In fiscally cautious times, where every line item in every budget is under intense scrutiny, organizations are subjecting nascent product and service development to rigorous screening. R&D personnel and innovators in other business units are being trained to think in business terms. The hope is that companies will be in a better position to decide whether an idea is worth pursuing in the first place. One company reported that, "Our biggest barrier to success is balancing rigorous examination of ideas while not eroding our people's motivation to keep coming up with them."

At Rohm and Haas, a company that makes specialty materials that enhance the performance of paints and coatings, computers and electronic devices, household goods, and more, IP strategy is integrated into all technology generation and subsequent commercialization. Patent attorneys sit in development teams as new technologies emerge. Under the leadership of David Bonner, who until July 2002 was the Global Director of Technology, together with Marc Adler, Chief Patent Counsel, the processes governing research and intellectual property management became a holistic business process, focused on growth markets. At the IP Summit in Japan in July 2002, Bonner explained that as a result of this approach, "Investment by Rohm and Haas in R&D has grown and stayed consistently robust for its industry. Our resolve never wavered because our senior business management had confidence in a holistic, transparent process." A properly constituted R&D program avoids swamping business units with an uncontrolled, and rapid, flow of new ideas into their commercial operation, often with little connection to the existing business strategy.

Resource constraints lead companies to structure the innovation process so as to focus limited resources on the most promising ideas. They seek to increase learning though small, low-risk proof of concept projects. Development efforts are funneled through an innovation pipeline, from ideas, to experiments, to ventures to new businesses. At one end of the pipe, projects are many and resources are few. At the other end, projects are few and resources are many. Idea management focuses creativity on the few ideas that are relevant. Product development identifies viable ideas and expands them to generate the most value. Everyone benefits in the end. By managing resources and projects against the portfolio of relevant initiatives, a company develops a capability for continued renovation. Intellectual property flows through the pipeline, from mind to market.

Companies are building the operating system for innovation, step-by-step and brick-by-brick. They are bonding the R&D process to the commercialization process. Reducing the friction is a major challenge. While it is natural to hide high-potential secrets and protect valuable insights that could be the basis of profitable future products, the widespread distribution of useful knowledge enabled by the Internet and other media can make such controls unfeasible. In the face of pressure to collaborate with partners and customers in the real-time economy, are we worrying unnecessarily?

While the key to successful innovation once lay in the controlled environment of the corporate laboratory, Eric von Hippel, author of the influential book *The Sources of Innovation,* shows us that the manufacturer-as-sole-innovator assumption is wrong. In a global economy, one in which companies focus on

core competencies—outsourcing all else and in-sourcing myriad services and competencies from numerous partners—the innovation process is predictably distributed, across users, manufacturers, suppliers and other collaborators. Yet while external ideas help create value, it takes internal R&D to claim a portion of that value (legally and with legal protection).

No innovation holds value until a viable business model successfully commercializes it. Henry Chesbrough points out that, "If you don't unlock this value, someone else will." Companies must recognize that not all the smart people work for you. Others are equally able to innovate or exploit someone else's promising ideas. Chesbrough advises companies to profit from use of their own IP, but also to buy IP from others whenever it advances their own business model. Companies, he says, should expand the role of R&D to include not only knowledge generation, but knowledge brokering as well. Other voices echo similar sentiments.

In his book *Resolving the Innovation Paradox,* George Haour encourages the "mobilization of substantial external inputs into the innovation process, requiring companies to excel as entrepreneurial architects of innovation." Quoting examples from Generics, Intel, Nokia and Samsung, his ideas about distributed innovation "help companies to raise revenue by using channels such as licensing and selling innovation projects."

Alph Bingham, former VP of R&D at Eli Lilly, was frustrated that the company was spending billions of dollars on R&D yet the rate at which it was developing drugs had not changed. In 1999 he proposed using freelancers to supplement internal resources. Lilly decided to test the idea with the creation of an external commercial enterprise, InnoCentive, founded in 2001. Today, InnoCentive is a Web-based community that matches top scientists to relevant R&D challenges facing leading companies around the globe, allowing them to reward scientific innovation through financial incentives. InnoCentive's clients include Procter & Gamble, Dow Chemical and BASF, and the research brokerage is reported to have saved Lilly millions on R&D expenses. Fifty three percent of InnoCentive's best freelance researchers are based in China and India and North American corporations have created divisions just to create and oversee InnoCentive hosted projects. One company, Dial Corpoation, avertises directly on the site and offers cash prizes for inventions that improve their bottom line. Other companies treat InnoCentive as a source of additional resources that can be targetted at well-defined fragments of internal R&D efforts.

A SHORT CUT VIA EXPERIMENTATION

Business managers that speak only of intangibles management and the protection of intellectual property may have got it wrong. Perhaps the focus should be on managing the innovators, as much as it is on managing the innovations? While it is essential to upgrade product-development systems, deploy stage-gate processes, structure judgments about risky projects, bring in collaborators and add in timely data about real and projected market demand into the commercialization process, a focus on methods is equally important.

"Rather than knowledge management, the key to increasing internal knowledge is knowledgeable management," so say Ridderstråle and Nordström. They describe the process of turning core competents into core competencies: gas is

what we have in our minds; fluid knowledge comes about when we discuss things with others, and solid knowledge is the stuff that is embodied in customer's offerings, routines and systems. "A car, a PC, a software program, an ice-cream or whatever is, in reality, nothing more and nothing less than frozen creativity. We get an idea (gas), start discussing it with others (fluid); and finally develop a customer offering (solid). We rely on our ability to develop processes that enable us to deep-freeze new pieces of knowledge faster than others—decreasing the duration of the insight-output cycle."

It was competence-based leverage, linked to an insatiable drive to experiment, that let Honda, who originally focused on engines, to nevertheless utilize its knowledge to make cars, motorcycles, watercraft, pumps, snow blowers and now … robots such as POLAR II, the most advanced pedestrian test dummy in the world. The same is true for service-centric firms. It is competence-based knowledge, honed at the customer interface, which ultimately gives rise to enduring service businesses. Competence-transference, coupled to experimentation, seems to have legs in the innovation race.

Stefan Thomke, author of *Experimentation Matters,* believes that every company's ability to innovate depends upon a process of experimentation whereby new products and services are created and existing ones improved. Citing the availability of computer simulation and modeling that promise to lift the economic barriers to being allowed to fail, Thomke reminds us that, "Never before has it been so economically feasible to ask 'what if' questions, generate preliminary answers and guide the innovation process … Put concretely, without experimentation, we might all still be living in caves and using rocks as tools."

According to Thomke, all organizations need a system of experimentation and, of course, the more rapid and efficient the system is, the quicker researchers can find solutions. Thomke urges companies to organize for rapid experimentation; fail early and often; anticipate and exploit early information; and combine new and old technologies.

When Edison noted that inventive genius is "99% perspiration and 1% inspiration," he was well aware of the importance of an organization's capability and capacity to experient. Edison designed his labs, including personnel, equipment and libraries, to allow for efficient and rapid iteration. As today's digital technologies for product, service and process modeling and simulation offer more value for less money, they provoke fundamental challenges to the innovation organizational, culture and design.

Michael Schrage, author of *Serious Play: How The World's Best Companies Simultate To Innovate*, argues that the future of modeling, simulation and prototyping is the future of innovation. Drawing on the experience of companies including Walt Disney, Boeing, Merrill Lynch, GE, Sony, IBM, IDEO, Microsoft, Royal Dutch Shell, Daimler Chrysler and American Airlines, Schrage shows us that serious play is not an oxymoron; it is the essense of innovation. The challenge and thrill of confronting uncertainty requires a healthy dose of improvisation. Whether these uncertainties are obstacles, or allies, depends on how you play. His central message: "Any tools, technologies, techniques, or toys, that let people improve how they play seriously with uncertainty is guaranteed to improve the quality of innnovation. The ability to align those

improvements cost-effectively with the needs of customers, clients, and markets dramatically boosts the odds for competitive success."

Experimentation, simulation, discovering options, evaluating alternatives and problem solving, these all lie at the heart of innovation in virtually every discipline. When a member of the IDEO creative team files a new technology in the Tech Box, they are storing knowledge about a past problem and a future creative solution option. The same idea is inherent in every legal patent. All inventions embody solutions to previously unsolved problems. Leibniz once observed that, "It pays to study the discoveries of others so that we also find a new source for inventions." Perhaps managing innovators is, in itself, not enough? Should we study the methods used by those we employ to innovate: engineers and scientists? They may be locked in a lab and cloistered by legal processes, but their experimental methods are universally applicable.

AND SUDDENLY THE INVENTOR APPEARED

All signficant innovations embody solutions to complex problems. While ideas sometimes take the form of a technical insight with no apparent commercial application, in most cases, a problem or opportunity inspires the insight. As Imaginatik have found through practice, there is always a reason to solve a complex problem otherwise nobody would bother. This is why the most effective idea management campaigns are those where a serious challenge is put out to employees. All who innovate are required to eradicate obstacles and find approaches that move them closer to the ideal systems they seek to build.

Opportunity recognition occurs when someone says, "This material we've invented might be of value to customers," or "If we could solve this problem, we could create value for our customers and our shareholders," or "This might produce a huge cost advantage." Every product, service and process proceeds through generations of design and evolution in its market and, at every stage, the innovator faces formidible barriers and for which inventive solutions are required. These solutions may be technological in nature or require a business innovation, such as process re-design or market alignment. For example, it's one thing to create an innovative new product or service, but it's another thing to create a process capable of maunfacturing the product or delivering the service at a price the target market will accept.

Often, a complex cocktail of problems limit a company's ability to innovate. Innovation in the product, service and process realm is connected; some innovative ideas must await process innovation before they can achieve market traction. At every stage—from conception of a new idea, through development to commercialization and eventually to marketing and business coming in—hundreds of problems must be resolved. The innovation process is littered with hurdles, both high and low, from new science to creative means of delivery to detailed product architecture, to service-concept, to business model. These problems are what innovation is, and it is up to the individual and the teams they work within to solve them.

Problem solving lies at the heart of a new methodology for innovation that, at its core, is a study of *contradiction.* A contradiction exists in a system when, in attempting to improve, say, parameter A of the system, another parameter you care about, B, deteriorates. For example, if we attempt to make a product

stronger by making it thicker, it also gets heavier. If we use better materials, the cost goes up, and so on. Stan Kaplan, engineer and applied mathematician, an expert on Quantitative Risk Assessment (QRA) and the founder of Bayesian Systems, points out that, "the typical engineering approach to dealing with such contradictions is to trade-off, in other words, to compromize." While compromize may be useful in some situations, and may itself contribute to minor improvements, compromise cannot be considered to be innovation and is unlikely to help solve further problems down the line that limit the product, service or process being successfully developed, commercialised and improved in ways that provide value to customers. By contrast, Kaplan believes that "an invention is an idea that surmounts the contradiction, moving both parameters in a favorable direction." If true, the patent literative should be littered with useful solutions and inventions must be inherent to all commercially successful products, services and organizations.

Innovators solve problems by focussing upon the parameters of a system that, if increased, would improve it substantially, but also, the harmful aspects that, if left unchecked, would lead to a contradiction. Contradictions are significant, for if eradicated or reduced, directly or indirectly, contribute to the development of a breakthrough solution. Avoiding compromize is central to innovation. Tradeoffs between strength versus weight, reliability versus cost, service-quality versus resource and output versus input, is not the same as an inventive solution that creates new value. Inventive solutions emerge by exploiting useful effects and eliminating harmful effects. The subject can even be taught as a discipline, with the effect of increasing the overall "inventiveness" of employees. Problem solving is a generic skill and can be applied across many different domains. Make someone more effective in one domain, and they will be more effective in others.

The suggestion that innovation can be taught lies uneasily with those who believe it arises from phychological factors and that great ideas come from a special place in the mind. Yet we happily teach Six Sigma to create blackbelts who are able, using reliable statistical methods, to substantically improve process reliability, even in fields where they have no domain knowledge. By applying the Six Method method, the black belt is able to identify process instances that fall outside of specification, root out the cause of process failure and suggest avenues for re-design. Is there a reliable innovation algorithm that, simply by applying it identifies contradictions and finds solutions by avoiding compromize?

Experiments are guided by science. Teams solve problems that lead to valuable innovations using systematic methodologies. Examples include the Theory of Constraints (TOC), Critical Chain, Design For Six Sigma (DFSS), Quality Function Deployment (QFD) and the Taguchi Method.

It was Design For Six Sigma that led to GE delivering record financial results in 1999, with revenue and earnings growth exceeding 25%. In that year, GE introduced seven products using Six Sigma methods with more than 20 released in 2000. Jeffrey Immelt said at the time, "These products are different—they capture customer needs better and can be brought to market faster than ever before. We will see more than two billion dollars worth of DFSS products by the end of 2000."

It was Quality Function Deployment that permitted 3M, AT&T, Boeing, DaimlerChrysler, Ford, GM, Hewlett-Packard, Hughes, Kodak, Lockheed-Martin, Pratt & Whitney, Motorola, NASA, Nokia, Raytheon, Texas Instrument, United Technologies, Visteon, Xerox and other Fortune 500 companies to reformulate products without sacrificing customer satisfaction. Their objectives were to open the path to foreign markets, to differentiate services where there was customer value, commonize elements that were invisible to the user, see opportunities in advance of market demand and develop hybrid products from two or more best selling lines.

It was the Taguchi Method (robust design) that enabled Kodak's copy machine manufacturing division to improve the reliability of its paper feeder from mean time between failures of 2500 sheets to 40,000 sheets.

But if you thought you had heard about all the best-practice acronyms and trends out there, think again. To the current plethora of strategies for adaptation and survival is now added something that may be a way of thinking, a set of tools, a methodology, a process, a theory or even possibly a deep science, but which may be gradually shaping up as 'the next big thing.' It's called TRIZ, pronounced 'trees' and is an acronym for the Russian words that translate as "The Theory of Inventive Problem Solving."

THE MESSAGE OF TRIZ: INNOVATION CAN BE CODIFIED

Remember how surprised you were when Google found the web site you needed and ranked it #1? Some TRIZ users experience a similar epiphany. Don Masingale, retired senior engineer at Boeing Corporation, will tell you that TRIZ holds the answer to just about any engineering problem you can imagine. Quoted in *PlaneTalk,* Boeing's internal newsletter, he said, "When you see something this good, you just can't walk away from it. I use TRIZ everyday in my thinking and processes. It's an innovative way of solving problems and meeting all the criteria our customers want us to have, whether commercial or military."

Practical training sowed the seeds of TRIZ at Boeing. More than 700 people attended Masingale's five-day sessions. The impact was profound. Boeing's executive engineering council set up a senior technical team to investigate the claims being made. They have since recommended increasing the visibility of TRIZ among technical and managerial ranks.

TRIZ helped Boeing solve a slow-burn issue that had been keeping a team of aeronautical engineers scratching their heads for nearly three years. Although the attendees at one of Masingale's internal training classes didn't know it at the time, the solution they developed under the guidance of TRIZ expert Zinovy Royzen would result in US$1.5 billion worth of customer orders. As reported in *Business 2.0,* Masingale credits TRIZ-inspired designs with selling Boeing's new 767 air-to-air refueling jet to the governments of Italy and Japan. For colleagues of Masingale, engineers like John Higgs, 767 Tanker Transport chief project engineer, it was a first step out of the "psychological inertia" that hampers creativity. The results, according to Higgs, "put us ahead in our race to reconfigure the 767 into a combined tanker and transport for military use."

The Tanker Transport program at Boeing presented what Higgs and Masingale refer to as a "classic engineering conflict." The 767, dubbed the world's most efficient airplane, is a two-engine airplane and, by design, has no excess hydraulic power. Yet it must be capable of pumping fuel at 900 gallons a minute at the boom-nozzle interface—while flying 300 knots at 15,000 feet altitude. No easy feat. Higgs says that, "By applying TRIZ principles, the class came up with two complete solutions and two supportive solutions that my team had never thought of. These solutions have many useful auxiliary solutions." As with many breakthroughs inspired by TRIZ, "the solutions must remain under wraps because they are highly competition sensitive", claims Higgs.

Surprising as it may sound, TRIZ pulls rabbits from hats, find needles in haystacks and generates intellectual property. Its systematic approach to innovation is the antisepsis of unreliable, hit and miss, trail and error, psychological means of lateral thinking. Its scientific, repeatable, procedural and algorithmic processes surprise all who first encounter them. Sound like magic?

After just one TRIZ workshop, engineers at National Semiconductor modified a machine that tests integrated circuits (IC) that had gobbled up $76,000 in the previous five months of trial and error. Within a week, TRIZ-based software responded with 40 directions in which to investigate a solution. The most promising idea was the replacement of frail IC contacts with an elastomer, reducing the physical impact to IC leads during insertion. The consensus among the engineers working on the problem at the time was that, without guidance from TRIZ, the project would still have been hunting for a solution. Other companies have had similar experiences.

At Rohm and Haas, and later at Cabot Corporation, David Bonner was "surprised by the impact of TRIZ on colleagues." Senior scientists became very concerned, even agitated, when the use of TRIZ, in conjunction with company domain experts, was able to solve problems that had eluded resolution for years. "Had these problems been side issues no one would have paid much attention. In fact, they centered on areas of research directly related to the company's core competence in specialty materials."

Early adopters of TRIZ in a given industry sector or market niche claim that use of the methodology can provide a strong competitive advantage. One such story relates to a major Midwestern consumer packaged-goods company who trained more than 2,000 engineers in TRIZ which led to a series of breakthrough product-innovation efforts. One of these initiatives resulted in a new product that generated $200 million in sales in its first year of introduction. The company's adoption of a structured process for innovation, a heretical belief for some more "creative" individuals, is claimed to be a major component of the company's recent 300% increase in patent production, and the fact that the company is now recognized as an innovation leader by competitors, channel partners, and Wall Street.

Stories such as these are leading some academics to examine TRIZ in detail. Vanderbilt University, in conjunction with Carnegie Mellon, is considering establishing an industry benchmark to demonstrate that a graduate equipped with modern TRIZ tools can overcome technological challenges faster than an engineer with five to ten years of experience but who lacks this knowledge.

A FATHER FOR INVENTION

TRIZ is the brainchild of Russian scientist and engineer Genrich Altshuller. Born in 1926, he made his first invention at the age of fourteen and was later educated as a mechanical engineer. While employed in the patent department of the Soviet navy, he became intrigued by the question of how an innovation happens. Was it a mysterious, capricious and random event, highly dependent on the individual in whom it occurs—a matter of luck bounded by the personal experience of the inventor—or could innovation be understood as the result of systematic patterns in the evolution of systems? Altshuller adopted an empirical approach to finding out. He began by reading patents.

Patents represent the best definition we have for what constitutes "invention." Patents necessarily contain a detailed description of a new solution to an old or new problem. If this knowledge can be tapped, great value can be unlocked. According to the World Intellectual Property Organization (WIPO), the patent base covers ninety to ninety five percent of worldwide research results; and further, making good use of the patents would reduce research time by sixty percent and research costs by forty percent.

Grounded in the patent base, but stripped of the technical subject matter, Altshuller found that the same abstract problem types appeared time and time again, together with corresponding generic solutions. After years of study he found that only a small number of engineering analogies and abstractions were necessary to explain the vast majority of inventions. He gradually became convinced that inventive problems could be classified, and solved methodologically, just like other engineering problems. Once these principles had been discovered and codified, they could be applied to any problem situation, yielding many innovative (and often patentable) ideas. Those that took an interest in his work felt that the principles he had uncovered in the patent literature were sufficiently generic that they could be written down, taught and re-applied across disparate, far-flung, fields of human endeavor. And as they worked, more and more patents were being filed. Two million patents later, Altshuller's original abstractions have grown into an impressive and useful body of work that is now being applied by leading organizations in North America, Europe and Asia. As with most technical topics, TRIZ can be self-taught, but formal training helps focus the mind.

Henry Ford once said, "I have heard it said…that we have taken skill out of work. We have not. We have put a higher skill into management, planning and tool building, and the results of that skill are enjoyed by the man who is not skilled." Before the car assembly line, labor cost to manufacture just one car was 160 hours. By 1908, that had reduced to 12 hours and by 1916 to 1.5 hours. The result, Ford's labor cost in 1916 was $52.73 per car, set against $190.87 for competitors not using the assembly-line innovation. This increase in productivity translated into lower prices for consumers. Pre-Ford, a car cost $3000. By 1908 the price had dropped to $950, and 1916 to $280. As a result, Ford's market share rose sharply, from 0% in 1907, to 56% in 1916. And, Ford's investors were very happy. Profitability rose from $0 in 1907, to $30M in 1914 and to $60M in 1916.

Ford had eradicated what TRIZ methodologists call a contradiction, in Ford's case between labor cost and productivity. Ford achieved this using an inventive

principle, the conveyor belt metaphor. It exists in TRIZ today, and can be observed in numerous innovations across many industrial sectors. TRIZ contains thousands of such insights, many of which are inherent to the modern production line and numerous other products, services and processes.

Modern versions of TRIZ are the result of decades of analysis, by hundreds of scientists and inventors, of millions of worldwide patents and related sources of knowledge, across all engineering disciplines. Hundreds of patterns of *invention* and technological *evolution* have been extracted and codified. This knowledge has been incorporated into procedures that guide innovators toward breakthrough solutions, direct the evolutionary path of development and help anticipate future limitations or roadblocks. Today, TRIZ practitioners report that dipping into this knowledge base encourages thinking and prodding at technical systems until solutions to deep-seated roadblocks are identified, problems that limit a product from developing along a desirable line of evolution in a market.

Despite the fact that there is little commercial value within the vast majority of *individually* filed patents, the rigorous criteria applied by patent officers helps ensure that the overall body of knowledge represented by the patent base continues to grow in value—at least to inventors. This feeds directly into the development of TRIZ. Since TRIZ looks across the patent base as a whole to uncover abstract principles, the lack of commercial value in any single patent does not limit the value of TRIZ. In any case, individual patents rarely represent a complete solution. Often, multiple patented inventions, often from very different disciplines, form the basis for commercially viable products and services.

TRIZ has been around since the late 1940s, but the computer revolution has made the method practical, taking the grunt work out of exploring numerous trees of alternatives solutions. Software programs to support TRIZ are available from several companies. Some are little more than e-books that guide engineers in the use of TRIZ. Others could be dubbed computer-aided innovation (CAI) and embody problem formulators and/or links to extensive patent databases. Research Group AMR has reported that innovation software is in use by many commercial firms and can reduce the idea-to-concept time from two months to two hours.

A word processing application will not teach you how to write a novel, just as a shovel will not dig a hole. However, both tools will help you achieve your goals faster and more efficiently; assuming that the basis upon which the tool works is sound. Where inventors and inventions are concerned, beware. Quacks abound, and, no doubt, charlatans exist who peddle beguiling ideas for simplistic software that, if only you buy it now, will make you rich beyond your dreams. Naïve individuals can be led to believe that finding an invention semi-automatically and then filing it as a patent will create lucrative future licensing options. Scientists know life is not so simple. Nevertheless, software tools will no doubt play an increased role in innovation in the near future. Dr. Elena Averboukh, a professor at Germany's University of Kassel IMAT-Institute for Measuring and Automation Technologies, is positive about the use of computer tools to support innovation. Quoted in *The Manufacturer,* Averboukh claims that, "Tools based training allows one to master the TRIZ methodology in a shorter time and to use it efficiently across diverse problem-solving in marketing, business development, product design, and business process

improvement." Perhaps this is why MIT, renowned for its commitment to innovation and technological advances, has made innovation software widely available to students, licencing Goldfire Innovator from Invention Machine.

The MIT software provides pre-configured and customizable workflows that guide students through proven, easy-to-follow innovation processes such as root-cause analysis, problem determination, patent analysis and semantic knowledge retrieval providing fast, pinpoint, access to relevant scientific and engineering content. Via this program, MIT students also have access to over 15 million patents from worldwide patent collections, and access to more than 9,000 scientific effects and 2,000 scientific websites. Other packages of software to support innovation are available, for example, the Creax Innovation Suite.

To maximize the value of software tools the best software engine working with the most complete TRIZ knowledge base is needed. Unfortunately, the innovation community is fragmented and somewhat split into competing camps. The best software does not necessarily include the latest methodological developments. Conversely, the best methodologists are not the best software developers. Nevertheless, over time, better software will become available.

Table 3: Altshuller defined five levels of invention by studying the patent base

1. Apparent or Conventional solutions: 32%
2. Small Invention Inside Paradigm: 45% Improvement of an existing system, usually with some compromise
3. Substantial Invention Inside Technology Platform: 18% Essential improvement of existing system
4. Invention Outside Technology Platform: 4% New generation of design using science, not technology
5. Discovery: 1% Major discovery and new science, basis for new technology platforms

CREATIVITY CAN BE TAUGHT

Some companies that have tried TRIZ have been disappointed by the results achieved. There could be several reasons for this. Lack of training is one. Companies believe, incorrectly, that books will help. They won't. Professional training is required, preferably, by applying TRIZ to a practical problem at hand. In TRIZ, learning on the job is a good thing, not a shortcut. TRIZ cannot be studied in any meaningful way unless it is applied to solving problems. Yet few firms enlist a professional coach during initial projects. And not all firms offering TRIZ training are equally versed in TRIZ or have access to modern TRIZ methods and software.

There are other factors that can lead firms to dismiss TRIZ. The methodology comes in different varients, some more powerful than others. Companies who look no further than "classical TRIZ" are certain to develop a jaded view. Unfortunately, the vast majority of published information describes TRIZ at an early stage in its development. Well known TRIZ tools, such as the classical "contradiction matrix," a simple table that lets an inventor look up potential solutions that bypass the need for compromise (enhancing one product feature would degrade another etc.) are simplistic, and controversial. Can the table ever be complete? Are the generic solutions the table describes so abstract that

mapping them back to specifics is either impossible or unreliable? How large does the table have to be to guarantee a solution? Are the solutions only relevant in engineering?

If you are tempted to dip into TRIZ looking for simple answers to complex problems, think again. Yet for those that go further, and who learn the basis for how TRIZ works, a quick look under the hood at a comprehensive modern version of TRIZ will leave many stunned by its depth, applicability, and potential.

If you have read the works of Eliyahu Goldratt, originator of the theory of constraints (TOC), you may already have an intuitive understanding of how TRIZ works. In the business novel, *The Goal,* Goldratt tells the story of Alex Rogo, a harried plant manager working ever more desperately to improve performance. His factory is rapidly heading for disaster. So is his marriage. He has ninety days to save his plant or it will be closed by corporate HQ—with hundreds of job losses. It takes a chance meeting with a colleague from student days—Jonah—to help him break out of conventional ways of thinking to see what needs to be done. Like a chain with its weakest link, in any complex system at any point in time, there is most often only one aspect of that system that is limiting its ability to achieve more of its goal. For that system to attain any significant improvement the constraint must be identified and the whole system must be managed with it in mind.

During their first meeting, Jonah asks Alex a simple question: "Just between us: Was your plant able to ship even one more product per day as a result of what happened in the department where you installed the robots?" Alex, unable to respond with convincing figures, pushes Jonah to explain. "Check your figures if you like … but if your inventories haven't gone down … and your employee expense was not reduced …and if your company isn't selling more products—which obviously it can't, if you've not shipping more of them—then you can't tell me these robots increased your plant's productivity." Over the course of the novel, Jonah teaches Alex how to redefine his goals, see the whole problem and eradicate constraints. Through Jonah, Alex learns how to remove obstacles that block the organization from working together as an integrated system. The result is significant and sustainable improvement in each and every problem area.

The theory of constraints (TOC) is used by thousands of companies. It is taught in hundreds of colleges, universities and business schools. TOC allowed SeaGate Technology and AGI to bring the first '15,000 revolutions per minute' disc to customers ahead of the market, causing all other companies to pull out. Lockheed Martin and the Boeing Corporation used TOC to build the most sophisticated jet fighter in the world. Lucent Technologies' Fiber Optic Cable Division used TOC to reduce its product introduction cycle by 50%, improve on-time delivery and increase the organization's capacity to develop products. Balfour Beatty plans civil engineering projects using TOC. The US Air Force Healthcare System (USAF) used TOC to deal with downsizing and cost cutting without compromising on quality of service and meeting patient's needs.

To get a sense of TRIZ, think of the theory of constraints but taken to the extreme. Visteon, a spin-off of the Ford Motor Company and a tier one supplier in the automobile industry, had a simple objective: develop at least three new and innovative concepts, each with the potential of generating $150 million in

revenue. Visteon turned to TRIZ experts, Ideation International, for help. Ten subject matter experts from varying automotive disciplines worked with Ideation scientists to develop new concepts, roadmaps and business plans for automotive security and convenience systems. Three months of work resulted in 194 new ideas, 60 new concepts, 27 scenarios for product evolution and the filing of several patents.

TRIZ allowed a car manufacturer to reduce the weight of the car door while preserving the lateral protection it provides to passengers during impact. TRIZ allowed a manufacturer of jet engines to reduce the weight of a particularly heavy engine part by over 30 percent, and thus increase the engine efficiency and decrease the energy loss of the aircraft. TRIZ has been applied in the solution of thousands of such problems, from improving truck fenders at Ford to optimal planning of complex production lines and processes in the oil and fuel industry at AMOCO. TRIZ helped Johnson and Johnson develop an innovation in feminine personal hygiene. It is even possible that the world's most famous invention, the incandescent bulb, may have occurred earlier had TRIZ existed at the time.

Electric current passing through metal filaments produced light as early as 1801, but the filaments burned themselves out too quickly to be of use. For TRIZ experts this is a contradiction: The filaments must burn hot enough to produce light but not so hot as to consume themselves. It was not until the late 1870s that Sir Joseph Wilson Swan and Thomas Alva Edison resolved the problem. Placing the filaments in a vacuum allowed them to produce light without burning themselves out too quickly. TRIZ solves these types of engineering contradictions with ease. For example, there is the principle of dynamicity, where the characteristic of a system must be altered to provide optimal performance at each stage of an operation. It's desirable for an umbrella to be broad so that it will shield you from rain and also for it be compact so that it is portable. Applying the principle of dynamicity makes an umbrella that's broad when it's raining, but folds into a compact shape when it's not.

MUMBO JUMBO?

Many household name Fortune 500 firms use TRIZ today, but the methodology is far from a household name. Engineers at Dow Chemical are developing new polymers with TRIZ. Otis Elevator used TRIZ to prevent escalator belts from wearing. TRIZ solved automotive transmission problems at Peugeot. Allied Signal used TRIZ to reduce the weight of containment rings for aircraft engines reducing the associated costs of FAA tests. LG Electronics, the third largest company in Korea, eradicated noise problems in air conditioners using TRIZ. Samsung, a major Korean company, recently flew four Altshuller disciples to South Korea to teach its scientists about TRIZ as part of a program to strengthen its innovation capabilities. The global director of innovation at Procter and Gamble is reported to be skilled in TRIZ. Using TRIZ, companies are teaching their core competents how to invent.

Perhaps because of the secrecy that surrounds individual TRIZ projects, stories that should otherwise attract attention to the methodology, the vast majority of people in business have never heard of it. Yet TRIZ may be about to go mainstream. Will it take its place along side more widely known and practiced

methods such as Six Sigma, QFD and Taguchi. Some claim that's already happened. Subir Chowdhury, executive vice president at the American Supplier Institute, a consulting and training firm on Six Sigma and robust engineering, cites TRIZ in his book *Design For Six Sigma.*

Chowdhury, previously a quality consultant to GM, claims that, "Innovation can be made more manageable through TRIZ. Systematic innovation may seem an oxymoron, like jumbo shrimp, but with TRIZ, individuals can generate amazingly creative solutions without threatening the stability of the company." Chowdhury views TRIZ as part of Design For Six Sigma and makes reference to the acronym "DFSS-TRIZ." He claims that the reason DFSS-TRIZ works so effectively is, "The simple fact that over 90 per cent of the underlying generic problems product and process designers face today at a given company have already been solved at another company or even in a completely different industry—perhaps even for entirely unrelated situations."

For the close-knit community of TRIZ masters, Russian intellectuals like Boris Zlotin and Alla Zusman who worked with Altshuller until his death in 1998, TRIZ is the study of the evolution of artificial systems: products, services, processes, organizations, society. At Ideation International, these scientists see themselves as furthering the development of a new discipline, and providing practical tools, applications and processes around the ever-deepening TRIZ theoretic. Are these people just ultra-bright and, by bringing rigor to a problem situation, illuminate solution options that others cannot see because they are paradigm bound within their own experience? How much is due to TRIZ and how much to their intellect? Has the striking nature of the problems they have demonstrably solved, led some observers to imbue TRIZ with almost mythical qualities? Or is it the case, as some academics are beginning to conclude, that modern TRIZ represents, if not "the truth," perhaps the most complete approach we have for studying the evolution of technical systems and solving problems limiting their development.

The bottom line is that no one really knows if TRIZ is mumbo-jumbo, pseudo-science or a foundational breakthrough. While case studies, and the personal stories of advocates, speak of the effectiveness of TRIZ, and while there are numerous academic papers that attempt to explain how TRIZ works in specific instances, the method has not been studied academically. Whatever TRIZ is, it is impressive. Examination of its databases and processes reveal deep insight by those who developed them. And echoes of TRIZ can be found in many age-old business stories.

Without realizing it, engineer and social scientist Andrew Hargadon has published research that gives credence to the claims of those who advocate TRIZ. Did you know that Henry Ford's revolutionary car assembly line came from an unlikely blend of observations from Singer sewing machines, meatpacking and Campbell's Soup? Or that the engineering innovation firm Design Continuum pulled together ideas from various medical devices to develop the Reebok Pump shoe? That's how TRIZ works. In his book, *How Breakthroughs Happen,* Hargadon cites past innovations and demonstrates that many are the result of synthesizing, or "bridging," ideas from different fields. Innovation, he argues, is the result of simultaneous thinking in multiple boxes, not of the oft-prescribed "thinking outside of the box." Why do IDEO bring domain experts from different fields together in every project? Cross-

fertilization. Writing in the foreword to Hargadon's book, Kathleen Eisenhardt observes that the concept of "bridging" can be counter-intuitive, "Whereas it may be appealing [to innovators] to focus on the future, break-through innovation depends on exploiting the past. Often, combining well-known insights from diverse settings creates novel ideas that can, in turn, evolve into innovations. This kind of evolutionary approach is how biology works … organizing structure can dominate individual creativity."

Table 4: Companies known to be using TRIZ to varying degrees

Allied Signal, Amoco, BAE Systems, Boeing Corporation, Brunswick-Life Fitness, Cabot Corporation, Chrysler, Daimler Chrysler, Dana, Dow Chemical, Dura Automotive, Eastman Chemical, Ford, GM, Hewlett-Packard, Hitachi, Honeywell, IBM, Johnson & Johnson, LG Electronics, Lockheed Martin, Motorola, Kimberly-Clark, Kodak, McDonnell Douglas, NASA, National Semiconductor, Navistar Nortel, Otis Elevator Panasonic, Parsons, Peugeot, Procter & Gamble (P&G), Samsung, Rockwell, Shell, Rohm and Haas, Rolls Royce, Teck Cominco, Toyota, TRW, UNISYS, United Technologies, Visteon, Xerox

THE DEVELOPING TRIZ

Methodologies develop over years and decades. For example, Six Sigma has evolved from reducing product defects toward reducing variation around business goal accomplishment. Likewise, TRIZ is expanding and, while its newest applications are far from common, their impact is beginning to be felt.

Daimler Chrysler looked into the future of steering column technology using a modern TRIZ process called Directed Evolution (DE). The same idea was used at American Northern Telecom for studying the future of voice recognition. Similar projects are being conducted today for the petrochemical industry and in the field of wireless communication. Another TRIZ process, anticipatory failure determination (AFD), has been used to analyze mechanical failure in helicopter rotors. AFD was also used to anticipate and determine ways in which terrorists could use information overload as a potential "weapon of the weak" in future information warfare. At a high level, TRIZ is even being used to map the possible future of entire industries. Take the automotive industry as an example.

With the advent of global warning and the worsening of urban air pollution, many in the auto industry believe that electric or hybrid cars are inevitable and are working on discontinuous innovations to make them a reality. For automotive systems, examples of useful functions include transportation with information, style, entertainment, climate control, comfort, speed, tow or carrying capacity, movement over deep snow or off-road, etc. Examples of harmful functions include pollution or poor exterior air quality, poor interior air quality, safety and crash concerns, operating cost, use of fuel and energy, quality issues (especially items associated with vehicle dependability), vehicle concerns with reliability and robustness over time, dependability concerns, and recyclability/reuse of materials/parts at vehicle end-of-life. The problem was analyzed using TRIZ Directed Evolution. The insights gained went further than requiring a new type of fuel cell, and suggested that the next generation in the auto industry would require a transition, from making vehicles less harmful to the environment to making vehicles that, when driven and upgraded, positively improve the environment. The more cars, the better!

The analysis coincided with the ideas of William McDonough and Michael Braungart as set out in their book *Cradle to Cradle.* A key idea that emerged from the TRIZ analysis was a new concept in manufacturing: the disassembly line. In this futuristic manufacturing scenario, vehicles are modularly designed for rapid disassembly and replacement/refurbishment of key components. The transportation provider owns the vehicle and takes responsibility for maintenance, repair, recycling, refurbishment, and freshening of style, features, performance, and function. The consumer enters into contracts for vehicle use and reuse, with options to upgrade features on demand.

THE URGENT NEED TO EXPAND INTELLECTUAL PROPERTY

Given the effectiveness of TRIZ to generate new solutions, it is perhaps not surprising that the methodology has become thoroughly mixed up with the debate over the value of intellectual property and patents. While TRIZ is primarily used to solve complex problems that limit the future development of systems such as products, services, processes and organizations, could it be used to help structure the search for IP itself?

At Rohm and Haas and at Cabot Corporation, the same type of event occurred. Venture business was doing well, but a major competitor blocked growth in certain sectors. TRIZ Directed Evolution was employed to understand how to leapfrog competition in the industry. The analysis yielded future product scenarios that allowed for the prophetic filing of provisional patents, a term used to refer to a patent that describes a concept that has not yet been reduced to practice. Early stage patents were filed on the basis of the TRIZ results. In consequence, R&D investments could, with increased certainty, be focused on the new areas uncovered with the aim of subsequently reducing them to practice. Final (true) patents were filed a year or more later.

What these companies had achieved using TRIZ Directed Evolution was a patent wall that afforded them legal protection and a strong position from which to capture growth during the next phase of development of the technology. In effect, competitors were frozen out of the market. “We achieved substantial incremental market share”, claims David Bonner who, as a result of these positive experiences, decided to leave the world of corporate America to join TRIZ startup, Ideation International. Whilst rare, Bonner’s experience is echoed by others.

Some advocates position TRIZ as ‘high speed R&D”, generating ideas at least 20 times faster than normal R&D groups. Can all the ideas generated be patented? Clearly not, but no doubt some companies will try. Patent fences will not be published as a trap for competitors. Broader ideas, meanwhile, on which the published concepts depend, could be pushed through the patent process. One TRIZ user quipped, “even if we don’t get market share, we’re going to pick up on royalties.” Technology forecasting can help organizations control the competition.

Intellectual Property Business International, a spin off of Ideation International, specializes in providing asset growth solutions to Intellectual Property Management departments. Their services include the application of proprietary, and patented, computer-assisted processes for the evaluation, opinion formation, and forecasting of inventions and patents. They believe their methods can have a

major impact on increasing the value of an IP portfolio. Using TRIZ Directed Evolution (DE) and Anticipatory Failure Analysis (AFD), IPBI predicts the likely evolutionary development of technologies, quantifies strengths and weaknesses in patents through proprietary deconstruction techniques, and formulates strategies to assure optimum value from IP. The company claims to be able to quantitatively assess the logical correctness of patents, discover additional innovations that lie dormant in technologies taught by patents, and, provide highly credible expectations of the future evolution of patented technologies.

The claims of IPBI and other TRIZ advocates are ambitious. No amount of dispassionate desk-bound study is likely to uncover the extent of the power of TRIZ. TRIZ requires full-on engagement applied to a concrete problem area if skeptics are to gain insight as to its validity. If TRIZ can be used to expand intellectual property and do so comprehensively, cost-effectively and in commerce-time, it can safely be predicted that Altshuller's legacy, and its modern variants, will be adopted as a permanent feature of corporate innovation practice.

CREATIVITY REALLY MAY GROW ON TRIZ

There is a commonly held, but fundamentally flawed, view of research and development: that innovation is just a matter of engineering improvements in products and the application of a new technology—nuts and bolts. Invention and creativity have never been the sole preserve of scientists and engineers. On the other hand, if the experience of IDEO's domain experts, insiders at the R&D labs of major corporations and the TRIZ community are anything to go by, it may be that it is the PhD qualified scientists and engineers, and not the business generalists and management consultants, who have opened the innovation-kimono, so that all can now learn to innovate.

Can systematic and scientific methods of innovation, such as TRIZ, be applied more widely and within typical business processes? According to David Levy, whose portfolio includes work on the functional layout of the Apple PowerBook, "TRIZ is tremendous." Although he does not use TRIZ formally, Levy was quoted in *Salon.com* as saying that his practices "naturally echo those found in the discipline." "The most exciting part about TRIZ is, it's not limited to how to make a widget," says Levy. Illustrating how TRIZ can be used at many levels, from daily thinking to deep engineering, he observes correctly that, "It's how to approach problem solving, it's how to approach relationships, and it's how to approach societal problems. It's really how to be creative and to observe the world and solve problems."

Many observe an extreme degree of generality in TRIZ. Perhaps this is not so surprising. The worldwide patent base now covers far more than engineering solutions and some believe its content, including the scientific and engineering content, to be a broad reflection of the commercial activity that generated the economic need to file for legal protection. So while TRIZ originated in engineering, the TRIZ knowledge base is expanding, and with it, the applications of TRIZ.

David Bonner tells a story of how TRIZ was used to entirely re-design his technical research and development organization and the processes by which it

interacted with other business functions. Using TRIZ he resolved a fundamental contradiction in the R&D process itself: senior management want enhanced innovation and new product generation, yet business units are rarely willing to pay for it. It's a common problem, plaguing even those companies with excellent innovation credentials. At the MIT Emerging Technologies Symposium in 2003, Jeff Immelt was quoted as saying that, "If I were to give you a chapter of my business book, it would be called, 'Two Million Dollars from Greatness.' I can't tell you how many GE leaders give me the excuse, 'I could fund new innovations but I can't afford it. I can't fit it into my budget.' These are from leaders that have a billion dollar base cost budget."

TRIZ has also been inserted into other business processes. It has been used to enhance stage-gate processes, which aim to reduce expenditure on unviable product concepts, for example, to anticipate consumer safety issues in advance. Due to the prerequisite cross-organizational decision-making, detailed investigations and coordination with external regulators and advisors, the required procedures are typically cumbersome and slow. Bonner claims that TRIZ has proved useful at several points in the stage-gate by de-bottlenecking decision making. A benchmark at Rohm and Haas, taken across 12 projects, demonstrated a cycle time reduction of 30% to commercialization and a vastly increased idea flow. Process re-design, using codified inventive methods, may be the next frontier for the corporate world.

Table 5: Nine factors point to a belief in TRIZ as an effective and transformational methodology

1. TRIZ is general purpose.
2. TRIZ generates exhaustive and comprehensive solution scenarios.
3. TRIZ is grounded in a reliable body of knowledge, the growing patent base.
4. TRIZ generated scenarios bypass both the psychological inertia of team members and their paradigm bound experiences.
5. TRIZ can be inserted into other processes.
6. TRIZ reduces the resources required to generate a solution set.
7. TRIZ is rapid, relative to other methods.
8. TRIZ can be taught, and applied, at any level of education, from school children, to management consultants, to PhD scientists.
9. TRIZ helps people migrate their problem-solving skills from one domain to another, even into areas that would otherwise require them to study for years in order to gain expertise.

THE BROADENING AGENDA TO RENOVATE INNOVATION

The potential for a reliable and general-purpose innovation methodology has never been greater. Erkki Liikanen, EU Commissioner for enterprise and the information society, wrote recently that, "Innovation is … a multi-dimensional concept, which goes beyond technological innovation to encompass … new means of distribution, marketing or design. Innovation is thus not only limited to high tech sectors of the economy, but is rather an omnipresent driver for

growth." Recognizing this, companies will not define innovation as owned by one part of the organization or applying only to those working in leading edge R&D. Rather, they will pursue innovation as a broad business-led approach furthering commercial goals.

Every aspect of how an organization operates is subject to innovation—administrative innovations, marketing innovations, financial innovations, design innovations, manufacturing innovations, service concept innovations and human resource management innovations. These *process innovations* are nothing less than the reengineering mantra of the early 90s. Today, those creative process re-design concepts have been given new life and a new path to execution in the form of business process management (BPM) systems, IT tools that bring work processes to life in the enterprise.

In the 1960s, manufacturing and distribution were the dominant activities in many large firms. Marketing and management, product and business development, research and systems development, together accounted for just 30% of the firm's activities. Over the following three decades, the percentage of those knowledge-based activities, increased. Today, the percentage is approximately 75% of what a firm does. That is to say, 75% of us work with processes or in processes, directly or indirectly, and knowledge worker costs are more than 50% of all corporate costs.

Knowledge workers spend a sizable proporation of each working day using electronic tools, including email, word processing, spreadsheets, and databases. But the process tools available to most knowledge workers go lacking. It's obvious to even the casual observer that there is a glaring need for process tools if companies are to take the next step in productivity. For many firms, particularly in the service sectors, professional services and in industries in which complex products require a high-touch interface with the customer, such as aerospace and IT solutions, process improvement is an inherent part of the innovation program.

Customers ask companies to innovate, create, design, deliver, integrate, maintain, optimize and improve. Yet to do these things, the knowledge worker has manage processes back inside the company: coordinating negotiating, collaborateing, planning, delegating, monitoring, approving and evaluating—all forms of process-related work that involves many participants. The customer asked for 25% of our work, and only expects to pay for 25% of it. That is, they want to pay for the innovative products or services, not the 75% who do the underlying process-related work. For many firms, the eradication of the underlying non-value-adding tasks associated with customer-facing processes is where investment in innovation is crucial. For example, a European financial services firm used process tools from Action Technologies to increase the productivity of relationship managers serving high-net-worth individuals, while simultaneously reducing the number of staff in the business unit, allowing them to be re-assigned to other departments and to new products and services. A total of 1,720 staff were re-assigned. Before the process innovation, there were 1,800 relationship managers, 1,000 assistants and 350 mid-office experts. After the innovation there were 1,150 relationship managers (doing twice as much work by maintaining relationships with twice the number of customers), zero assistants (most administrative tasks were automated) and 280 mid-office experts.

It has been said about processes that they are, "What works around here." Processes are unique in any organization, and process improvement managers seek unique solutions to very specific business issues they face. Examples include reductions in elapsed cycle time, higher productivity per person, improved quality, reduced errors, higher employee satisfaction, coordination across departments/geographies, automation of administrative tasks, reduced cost per transactions, enabling external users access to internal processes, improved regulatory/legal compliance, flexibility/business agility or customization at the customer interface.

Processes come in all shapes and sizes, and process tools provide business people with computer-assisted support for the processes they manage or fulfill. Process tools can automate, inform, accelerate, sequence, track, distribute, parallel up, analyze, integrate, capture, disseminate, instruct, compute, process, correlate, direct, sense, respond, monitor, predict, secure, delegate, record, expose, measure, agree, follow up, promote and illuminate. Such tools are Swiss Army Knifes for process improvements, and, as well as their value applied to processes such as human resources, procurement, logistics, operations, sales, marketing and service, can be applied to define and execute processes in the operating system for innovation. Examples might be: new idea assessment, research and collaboration, patent filing, project execution, new product development/introduction, stage-gate, licensing and contract life cycle. These processes are fragments of the overarching objective, new revenues. Bill Welty, CEO of Action Technologies, says, "Turning ideas into new profits requires the management of end-to-end processes. Specific innovation processes can stand alone, but when people's work within the whole chain is coordinated, speed, productivity and quality all dramatically improve."

While process improvement efforts go under many names—industrial engineering, ISO certification, Six Sigma, Sarbanes Oxley, enterprise business architecture (EBA), business process re-engineering (BPR), Audit and Compliance, Rummler-Brache, Integrated Definition Function Modeling (IDFM) and Lean Thinking, to name a few—it's all process work underneath. Thus, multi-purpose process tools are desirable, for all process work is connected. Process tools now available can unleash the creative improvement potential in everyone.

Table 6: Unique processes, subject to improvement

Handling of insurance claims in cases of disaster; Maintanence of health records as individuals interact with myriad health services; Finding lost parcels across a logistics supply chain; Tracking the support process using trouble tickets; Managing the goals associated with projects; Organizing emergency response during a severe incident; Clarifying, negotiating, agreeing to and tracking work associated with service requests; Processing procurement orders in complex industries; Initiating and progressing a management-led initiative; Implementing farm animal certification and the associated tags; Equiping customers to provision and configure their own services; Employee on-boarding; Publishing books on demand; Managing change, and change requests, across a multi-tier supplier network; Executing a public health campaign; Sharing information to create a case file in criminal investigations; Issuance of land permits in high-growth rate cities.

INNOVATION FUSES METHODOLOGY VALIDATED AT THE CUSTOMER INTERFACE

Historically, innovation has been embedded in organizational structure as the responsibility of the R&D department, focused almost exclusively on the development of technology in supply-driven markets. What is now required, however, is a business process focused on innovation, rather than a business structure focused on R&D. Critical to success is the selection of appropriate targets in which to innovate.

Recognizing that innovation touches many processes, innovation strategy firm Doblin, have mapped the business domains in which they believe the greatest benefits lie, across sectors, in business model, value network, enabling and core processes, product performance, systems and service, channel, brand and customer experience.

Doblin draw inspiration from a Pareto analysis that recognizes that less then two percent of innovation projects generate more than ninety percent of the value. Using metrics that cut across industry innovation patterns, organizational capability analysis, partner links and corporate performance assessments, Doblin claim that they are able to measure the impact of innovation in different areas of the business. Exploiting data gathered from leading firms in different vertical industries, Doblin show where companies have innovated in the past, which helps guide decisions for future innovation investment emphasis. For example, in passenger air travel over the period 1988 to 1998, innovation has been consistently focused on enabling processes, customer service and channel distribution. In pharmaceuticals, by contrast, investment concentrated upon enhancing product performance, but may soon shift to other areas. Corporate innovation practice is quickly moving to integrate this kind of analysis.

Using best practices, such as the *Fourth Generation R&D* model of William Miller and Langdon Morris, companies like 3M develop a definition of the next generation of their technology platforms. These platforms, once realized and reduced to practice, form the springboard for the reliable development of numerous new products and services. They represent a description of the architecture of the industry, markets, competitors, products, services and processes: the context within which innovation can occur.

Failure to develop such a platform description, which applies equally to service firms dependent on infrastructure, as it does to product firms dependent on technology patents, often leads to a largescale failure. One such failure occurred at GM at the end of the 1980s when a new investment of $500 million worth of rigid robots had to be scrapped because their design was inadequate to compete with the more flexible manufacturing systems of the Japanese. As William Miller and Langdon Morris observe, “nearly every field has some form of architecture at its highest level of abstraction, including law, medicine, physics, engineering, and business … Defining an architecture requires study and observation, for inevitably some parts of the system are readily evident, whereas others remain hidden from all but the most studious.”

It is now commonplace for companies to draw detailed maps of the past generations of their products and services in terms of the constituent technologies and processes. For example, 3M’s “Non-wovens” map, covering the period 1950 to 2000, shows the complexity and richness evident within the

myriad products they sell today under the broad categories of Tape Backings, Low Density Abrasives, Medical Products, Insulations and Filters. The map illustrates the evolution of 3M's current product portfolio from its roots in the Decorative Ribbons and Scotch Brite Pads of the 1950s.

The success or otherwise of a new technology platform, the springboard for all new products and services, depends upon an understanding of the markets within which the platform will compete. Herein lies the value of modern TRIZ. By positioning a technology platform on, literally, hundreds of lines of technological evolution, many paths to future value can be foreseen and evaluated. Although a minor example, a global consumer products company used this technique to evaluate TRIZ. In a matter of weeks they identified numerous candidate designs for a new range of cleaning products. Once such future possibilities are revealed, the strategy frameworks of management consultants such as Christensen or Doblin can be used to evaluate market impact.

Techniques that fuse industry maps, TRIZ and market analysis may represent the next frontier in corporate innovation, but few firms will rely only on models and some may never attempt such an analysis. There are also other, less theoetical methods, available to innovators. By identifying stakeholder requirements throughout the current and future anticipated value chains, innovation can be targetted. Mutually dependent learning involving all relevant groups, including R&D, suppliers, and customers, plus distribution partners and other internal functional departments such as marketing, manufacturing and finance, can be very effective.

Many companies work with *lead users*, believing that the customer will guide them to towards those innovations that customers will value most. In some industries, 50 percent of all innovations are sparked by customer need, and the lead customer is pivotal to providing a solution. The idea that only employees of the producer can solve innovation problems is defunct. While the producer has core competence in the technology, the technology itself is often not the driver of value, rather, how the technology is used.

Clearly, no single department, including R&D, has the full knowledge needed to carry out the responsibility for innovation. Internal and external stakeholders learn together through iteration in design and testing. Each gains the understanding of capabilities that will satisfy existing needs and many believe that the approach stands the best chance of uncovering latent, unmet needs among existing and potential customers and in markets that do not presently exist. Fumio Kodama, author of *Analyzing Japanese High Technologies: The Techno-Paradigm Shift,* calls this form of innovation forecasting, "demand articulation."

THE INNOVATOR IS AN OBSESSIVE PROBLEM SOLVER

As globalization advances and companies see fewer opportunities for growth, the clamor for invention and innovation—proxies for "economic value"—will inexorably rise. Innovation poster-child GE redid a twenty three year old slogan called, "We bring good things to life," and replaced it with a slogan called, "Imagination at work." The firm includes a creative drawing tool on its Web home page. By contrast, FedEx is almost dull. Its core competence in logistics

implies supply-chain efficiency and reliability. Those qualities define the FedEx 'identity' business process.

Is FedEx less innovative than GE? Not necessarily. What do GE and FedEx have in common? Both are obsessive problem solvers.

Companies do more than perfect the known and optimize for efficiency. Glib use of the terms 'creativity' or 'innovation' mean little if relevant problems are not being solved. Innovative firms develop an ability to solve problems that remove barriers to greater economic value. Whether an engineer is figuring out why an industrial process won't start, or a call centre operator is re-designing support processes to avoid answering similar problems over and over again, both are solving problems and each requires methodology and in-context expertise. At the macro level, numerous elements are involved: a learning environment, creative thinking tools, design flair, engineering skill, scientific method, enabling work practices, an amenable culture, specific organizational structures, supportive management frameworks, numerous business processes, information systems, market strategy, inventive and predictive algorithms. At the micro level is comes down to the individual employees, their talent, qualifications and knowledge.

Being talent-limited, every company finds innovation hard to do, but not because employees don't have bright ideas, or that new concepts are impossible to develop. The world is awash with creativity and technological breakthroughs. Rather, in the idea-to-cash process, there are myriad obstables that hinder the innovator, right across the value chain and covering every conceivable business and technical discipline.

No organization can be world-class in everything. Companies focus on their customers and allow specialists to contribute. In innovation, as in procurement, companies have a duty to shareholders to take steps to strengthen their capabilities. Paradoxical as it may seem, the success of IDEO demonstrates that innovation can be sourced, like other raw materials. Every supplier or business partner should innovate in its offerings. Yet while external experts can solve many problems in its core competence, problem solving is everyone's problem.

It is no longer appropriate to speak of discontinuous (radical, disruptive) innovation and continuous (incremental) innovation. To do so implies than one comes out of thin-air and the other has less value. Disruptive innovation is an oxymoron. Innovation is always continuous, a never endless sequence of problems to be solved. Unless the individual, team or company is solving problems, they are not innovative and they are not innovating. The solution, not the invention, is what allows all processes to progress. Innovation is a systematic and systemic search, supported by predictable and scientific methods, to reach solutions beyond the current state-of-the-art in an industry. Along the way, the solutions reached or the inventions discovered are the *activities* that generate value for customers.

As Altshuller has demonstrated, solutions to contradictions exist at five levels. Some are apparent or conventional. Some are small inventions inside an existing paradigm. Others are substantial inventions, within the current technology platform, or based on new science. Some are new discoveries. Like the modern production line, to stand as a valuable innovation, any new product or service must be sufficiently robust, in terms of their constituent inventions, to progress

efficiently through the end-to-end commercialization process and into the hands of customers. Innovation is the aggregate of problems solved in any situation.

The idea-to-cash process is complex, so complex in fact that it requires the contribution of all employees and those of suppliers, partners and distributors across all of the business processes required, to be successful. Just as the ambitious CEO gathers an able CxO team, organizations seek relationships with smart, problem-solving partners. The extent of the value generated by innovation, and the value placed on the solutions a business partner is able to provide, depend only upon whether the innovator is solving inventive problems that, in aggregate, create product/service improvements (incremental or new generation) aligned to the customer's customer needs. In this endeavour, the most effective innovators will employ methods that lie beyond the conventional and apparent, and will no doubt look towards numerous systematic methods for help, including TRIZ.

John Hamilton of Computer Sciences Corporation observes that, "The very brightest employees can always solve problems. Yet the majority of employees are often out of their depth given the complexity of today's business environment. Rather than enabling the brightest to shine even more brightly, can we enhance the problem solving capabilities of the majority? If so, we can unleash the value that those who are not used to innovating can contribute."

Can innovation be taught? GE believes so. The Six Sigma leader is a leading advocate of Design for Six Sigma, which often includes TRIZ. Campus-based development courses for upcoming leaders include specific innovation training. GE also recognizes the central role of domain experience. Over the past few years the firm has made engineers and scientists more important. GE had 175 "officers" of the company in 2003, a number that had been flat for roughly ten years. In 2000, of the top officers, only seven were engineering leaders. Over three years, GE tripled the number of technology leaders who became officers of the company.

If a problem solver comes to you and says, "Hey, I can help you innovate," do not ask them whether they know about your industry, rather, ask them whether they have problem solving methods that can be transferred to your industry. Then ask them to demonstrate the efficiency of those solutions in the business processes across your value-network, from concept inception, through development, commercialization and to business coming in as a result.

Perhaps it is no longer appropriate to speak about mature companies and commoditized markets, only tired ones full of inertia; organizations that have given up on solving problems. By focusing upon the specifics of innovation, and avoiding the seductive trap of a belief in empty innovation chic or marketing-led renovations, companies will be able to turn stale, risk obsessed cultures into proactive idea and dream factories that can compete on imagination, inspiration, ingenuity and initiative. The race is on to find the path of least resistance to new value.

Systematic methods are no silver bullet, and advocates must avoid adopting a cultish view of them as The Solution, but as TRIZ founder Genrich Altshuller once said, "We have to teach creativity, and that requires science."

POSTSCRIPT: INNOVATION AND THE CIO ORGANIZATION

Some CIOs today may feel that they are being side lined in corporate innovation. While they are being asked to do little more than reduce IT costs and focus on network security risks, there is evidence that the CIO has no less a role in core innovation than any other member of the CxO team. The CIO can significantly contribute to the operating system for innovation. They can contribute, beyond their role in managing the IT infrastructure, by deploying software applications that support idea management, inventive problem solving and the automation of systematic innovation processes. However, such ideas do not capture the full role of the CIO in in respect of innovation.

Craig Barrett, CEO at Intel, says that, "economies today are measured in terms of the intellectual content embedded in the products and services they sell." IT is integral to projects and services and to the value chain processes that create them and deliver them to customers. The use of IT in business process is not only mandatory in many industries, it both reduces the resources required and the time involved to discover, design, deploy, operate, analyze and optimize processes. Products and services are the by-products of processes. In some industries the process is the product or service. IT has become the primary means of enabling process innovations. Hence, the field of Business Process Management (BPM) and its associated methods and tools are powerful enablers of process innovations.

David Moschella, global research director for CSC's Research & Advisory Services, in a report entitled "The Future Role of the CIO: Commodity IT Officer or Career In Overdrive", observes that, "In addition to IT's traditional functional role, the skills possessed by IT people add value to an organization beyond just implementing new technologies. IT people excel at abstract systems thinking as well as thinking through key business processes. IT's opinion in organizational decisions is meaningfull as IT is credible due to its neutrality in many internal debates. Also, because IT is so embedded in linking and supporting functions within an organization, it providers a critical bridge between functions." And it is often the case that IT understand the end-to-end business processes of an organization in greater depth and clarity than many in the business functions, simply because they are required to implement those processes in support systems.

George Lieberman, the former head of Technology Strategy and Planning for Merrill Lynch is quoted in Optimize Magazine as saying that "I wish TRIZ had been available when I was trying to make technology-related IT decisions. Most of the problems we now solve using the TRIZ methodology involve complex engineering systems, where a system's fundamental problem is often masked by symptomatic factors." Lieberman learnt about TRIZ during a brief spell as CEO at innovation consulting firm, Gen3 Partners.

FOR MORE INFORMATION

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APPENDIX A: INNOVATION RESOURCES

Action Technologies, www.actiontech.com, Process improvement tools

American Supplier Institute, www.asiusa.com, Design for Six Sigma and The Taguchi Method

Baruch Lev, pages.stern.nyu.edu/~blev/, Intangibles, Intellectual Property & Patents: Management, Measurement and Reporting

Creax, www.creax.com, Innovation Software

Doblin, www.doblin.com, Innovation Strategy Consulting

Edward De Bono, www.edwdebono.com, Lateral Thinking Methods

Eliyahu Goldratt, www.goldratt.com, Theory of Constraints and Critical Chain Methods, author of the business novels *The Goal* and *Critical Chain*

Ideation International, www.ideationtriz.com, Modern TRIZ and its applications, Inventive Problem Solving, Directed Evolution and Anticipatory Failure Determination

IDEO, www.ideo.com, Design Innovation, Domain Expertise

Imaginatik, www.imaginatik.com, Idea Management Processes and Solutions, founder Mark Turrell

InnoCentive, www.innocentive.com, R&D Freelancer Community and Brokerage

Innosight, www.innosight.com, Market Strategy and Innovation Consulting, founded by Clayton Christensen, author of *The Innovator's Dilemma*, *The Innovator's Solution* and *Seeing What's Next*

Invention Machine, www.invention-machine.com, Innovation Software

Intellectual Property Business International, www.ipbizint.com, Patent Analysis, Deconstruction and Evolution, IP Portfolio Analysis, Litigation Support

Quality Function Deployment Institute, www.qfdi.org

Min Basadur, www.basadur.com, Creativity Method

Strategos, www.strategos.com, Innovation and Strategy Consulting, founded by Gary Hamel, author of *Leading The Revolution*

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