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AMERICA'S BREAKTHROUGH ILLUSION

Richard Florida and Martin Kenney

Wherever one looks—in semiconductors, computers, or biotechnology—the story is the same: The United States achieves a commanding lead in basic research, develops the start-up companies that pioneer cutting edge technologies, and then somehow fails to follow through, leaving nations like Japan to mass-produce the products that the world wants. Why is the nation whose industrial output once dominated world markets so unable to follow through on its own technological breakthroughs?

The answer lies in America's "breakthrough illusion"—the naive belief held by scientists, policymakers, business officials, and average Americans that big, new scientific and technological breakthroughs will continue to lift the American economy above and beyond its major competitors. Unfortunately, the breakthrough illusion does not conform with the current global reality. As our major competitors, especially the Japanese, are proving, what matters now is the ability to harness and implement new technology—not just to in-

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vent it—to use it effectively to improve manufacturing processes and to produce better products. The root of our problems lies in the glaring separation of R&D from production and an outmoded and increasingly uncompetitive form of corporate organization that sees workers as a necessary nuisance and thus neglects the critical product and process innovations that factory workers can provide.

HOW WE LOST THE FOLLOW-THROUGH

It wasn't always this way. The secret of America's growth as an industrial power lay in its ability to follow through on new technology—frequently technology that was invented by major European competitors, Britain and Germany. They may have had science and technology, but we had the world's greatest capacity to turn that technology into mass-produced products; the world's largest and most advanced factories; a huge industrial work force of immigrant labor; the scientific management system of Frederick Taylor; and the mass production assembly line of Henry Ford. We could mass-produce anything faster and better than anyone. And then we combined all this with the industrial R&D laboratory, giving us a powerful new internal source of innovation. The industrial laboratories enabled large companies to integrate innovation with their already first-class manufacturing capabilities, propelling the U.S. economy to a position of world leadership in the earlier "high technology" industries. During the first half of the twentieth century, we were especially good at transferring these innovations into products.

But gradually, imperceptibly, the United States lost its follow-through capability. Somehow the same economic structures and institutions that once formed the heart of our advantage, could no longer deliver. A labyrinthine bureaucracy and complex managerial hierarchy grew up in the R&D lab. It was exceedingly difficult to maneuver projects through a maze of sign-offs and approvals. R&D became a focal point for power plays, information hoarding, and short-term political gain. Caught up in a Byzantine maze of corporate bureaucracy and individual turf protection, projects could go through cycles of being designated as high priority, being put on hold, and then being abandoned. R&D projects were constantly being "lost in the shuffle" of gigantic corporate bureaucracies.

Corporations responded to these problems in ways that only made them worse. New levels of managers were added, further expanding the R&D bureaucracy. Many of these new managers came straight from business school and had little expertise in or "feel" for technology or actual production. High rates of executive turnover and job-hopping made things even worse. Managers who were constantly on the move had little concern for long-term R&D projects and investments that would incur costs now but yield returns after they had moved on.

In the factory, a strict division between shop-floor workers, on one side, and managers and engineers, on the other, was created. Employees were relegated to the position of hired hands, paid to work, not to think. A growing managerial bureaucracy was called upon to coordinate internal corporate transactions, manage shop-floor labor, keep things running smoothly, and plan for the future. The very model that the United States had developed to reach new heights in productiv-

ity was predicated upon the conception that the vast majority of a firm's employees were *nothing more than hands*.

And, increasingly, corporations came to separate production from innovation as they moved their R&D facilities to suburban campuses and their factory production to low-wage regions of the Sunbelt or the Third World. This made it increasingly difficult to turn innovations into actual products.

Consider the case of Westinghouse. In the early years of the twentieth century the company established its original R&D lab on the site of its sprawling East Pittsburgh factory complex. As it expanded in the 1950s and 1960s, various product lines were relocated from East Pittsburgh to new factories in other parts of the world. Eventually as the East Pittsburgh site declined in share of output, it was decided in the 1960s to move R&D to a new suburban campus miles away from the old plant. The new R&D facility, being central though, was supposed to serve the entire company. Now that the East Pittsburgh facility has been shuttered, Westinghouse's R&D facility is almost completely isolated from its manufacturing operations. (In fact, there are persistent rumors that Westinghouse may move its R&D lab out of Pittsburgh in the next few years.) As a result, Westinghouse was less and less able to turn its innovations into commercial products. Although the Westinghouse lab invented the world's first advanced matrix flat panel displays, the company's various operating divisions—from consumer electronics to semiconductors—were unable to develop actual production capability. This important innovation that today is used in laptop computer screens and will potentially be used in high-definition televisions is completely dominated by Japa-

PRÉCIS

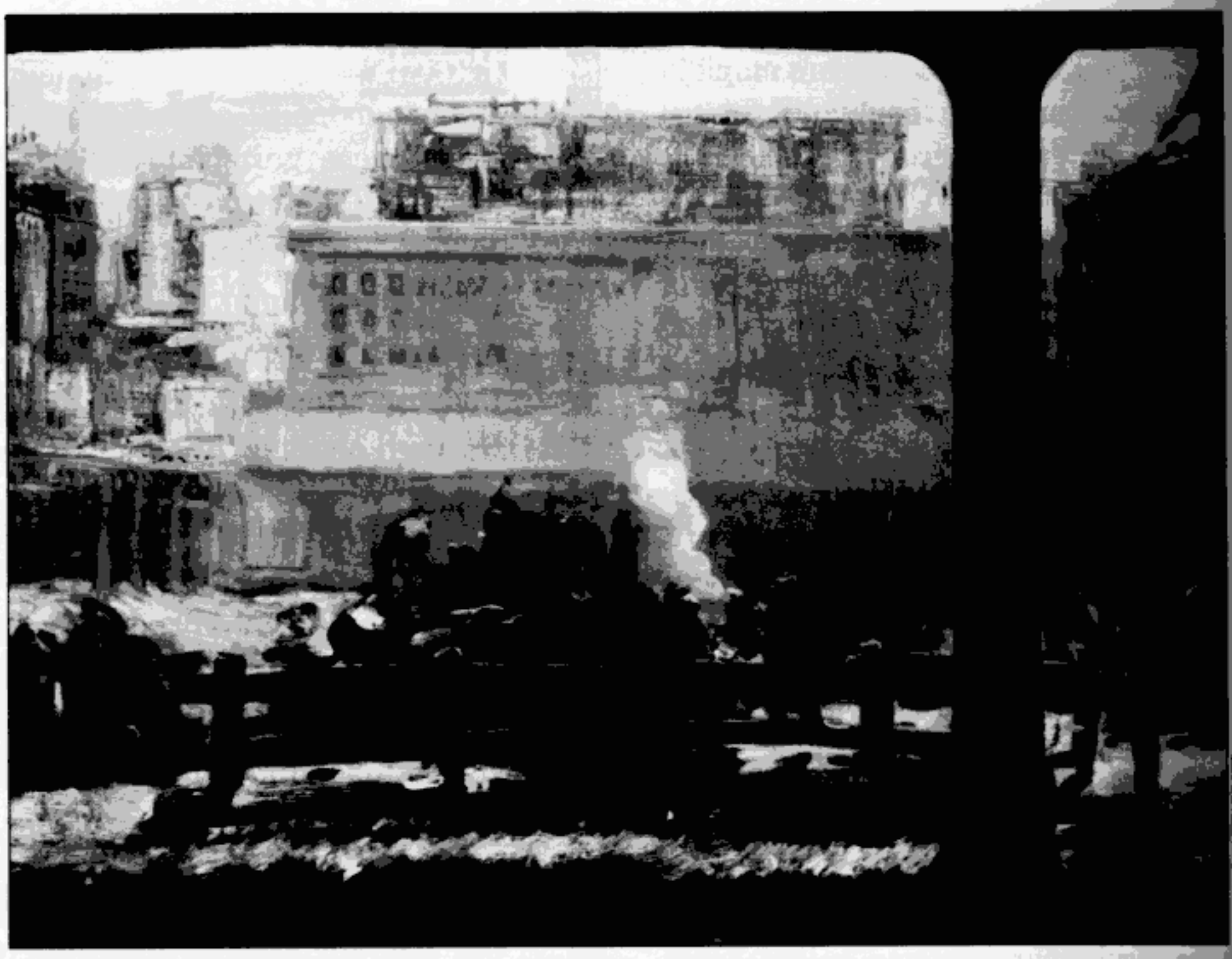
The United States continually pioneers new technology and then falls back while other nations, particularly Japan, develop and market the product, often with outstanding results. What will it take for America to regain the ability to follow through on its technological breakthroughs?

The authors contend that a large part of the problem lies in the separation of research and development from production, and a no longer useful system in our factories and plants that views workers as mindless automatons who can make no substantial contribution to efficiency beyond the narrow scope of their particular jobs.

There are a battery of other problems that explain our seeming inability to compete with the Japanese and other efficiency-minded nations. Prominent among these are the intricate mazes of corporate bureaucracy and the selfish turf battles among managers. *In addition, too often there is little* or no concern for long-term projects that will not yield results until well after the executives handling them have moved elsewhere.

To solve America's failure to follow through on its scientific and technological advances, Florida and Kenny suggest that America reinvest in manufacturing, use workers as a source of innovation, view the factory not just as a plant but as a laboratory for ideas and improvements, and provide workers with a real stake by giving them job security. These and other changes can restore U.S. competitiveness and economic leadership.

AMERICA'S BREAKTHROUGH ILLUSION



■ ***Blue Morning*, by George Wesley.**

nese companies.

Xerox and its famed Palo Alto Research Center is another case in point. Launched in the 1970s in Silicon Valley, Xerox PARC developed a whole host of innovations that stand at the heart of the "information revolution"—early versions of computer workstations and notebook computers, a user-friendly Macintosh-like operating system, new graphics technologies, Japanese language word processing software, and numerous others. But separated from the company's manufacturing units and central management, PARC was unable to turn these innovations into products. Ultimately, PARC came to function as a generic development lab for Silicon Valley, enriching entrepreneurs and venture capitalists far more than Xerox.

A NEW HIGH TECHNOLOGY SYSTEM EMERGES

A new system of innovation and production comprised of high technology companies and venture capitalists grew up in the shadows of the traditional large enterprise. Although the details vary from technology to technology and industry to industry, the basic message remains the same: Large companies failed to move into new technological openings, leaving the door open for start-up companies and venture capitalists who stepped forward to create the new organizational structures needed to capture the new industrial opportunities.

In 1957, three important companies were formed—Fairchild Semiconductor in

Silicon Valley, Digital Equipment Corporation in the Boston-Route 128 area, and Control Data Corporation in Minneapolis. The rapid success of these companies in catalyzing new technologies and whole sectors of industry quickly evidenced the power of the emerging model. These companies and others that followed overcame the organizational barriers among R&D labs, engineers, and managements in the traditional large enterprise. They did so by creating highly interactive, team-based environments in which there was intense information exchange and cross-disciplinary interaction. Venture capitalists added the risk capital and the outside expertise needed to get new businesses started. And networks of related firms and support services emerged to accelerate this process of innovation through new business creation in places like Silicon Valley and Route 128.

But this new model soon generated problems of its own. Seeking "big bucks" and dismayed by the absence of corporate loyalty, engineers and scientists were encouraged to switch jobs often. A once virtuous circle of entrepreneurial business formation gradually turned into the vicious cycle of "chronic entrepreneurship." Venture capitalists at times raided established companies to staff new ones. The entire environment came to be distinguished by a "hyper-mobility" of high tech labor—where high tech think-workers derive tremendous financial benefit by changing companies and jobs as frequently as possible. The reality of rapid breakthrough innovation, four and five year vesting schedules, and the lure of more stock from a new company make it rational for high technology think-workers to move from start-up to start-up in a constant quest to hit it big.

American companies have neglected manufacturing for the past three or four decades. The result: our manufacturing capability in both basic and high tech industries alike is antiquated.

And the problems multiplied. Disrupted research teams, wasted effort, and burned-out workers became the casualties of America's new high tech system. "Me-too start-ups" and copycat companies emerged to sap each other's resources and markets as entrepreneurs and venture capitalists rushed to cash in on the latest technology fads. Silicon Valley's technology companies became tangled in a growing web of law suits charging each other with copying technology or stealing employees; our leading high technology companies are increasingly turning to litigation at the expense of developing new technology and creating new products. All of this has made it increasingly difficult for established companies to benefit from and internalize the innovations they make. Rather than building stable competitive companies, we develop one-shot, breakthrough firms. We now have tens of thousands of small semiconductor, computer, software, and biotechnology companies whose efforts often do not amount to much. And these companies are not only

cut off from one another, but also from the large traditional enterprises that comprise the bulk of our economy. This severe fragmentation and splintering of our high technology capabilities makes it very difficult—perhaps impossible—to build stable companies and industries that can compete over the long haul.

PATCHWORK SOLUTIONS

For the better part of a century, the United States has shown an uncanny ability to solve many, if not most, of its technological and economic problems. But now, for the first time, we are unable to generate the kinds of solutions needed to put us back on track. In field after field, the United States seems to get a terrific head start only to have our competitors rapidly catch up when the new product is commercialized.

Perhaps the most highly touted solution for restoring U.S. competitiveness involves combining the innovative capacity of our small start-ups with the manufacturing and marketing prowess of large industrial corporations through alliances and other forms of partnership. Unfortunately, the reality of strategic alliances falls far short of the hype. Competition and conflicting objectives make it hard to build true cooperation. For small companies, alliances are only a stepping-stone, or, worse yet, a last resort when they need capital or the access to manufacturing capabilities. And large companies often want access to new technology: Once they get what they need, they have little incentive to continue the partnership. In biotechnology, for example, there has been a recurring pattern of large chemical and pharmaceutical companies abruptly canceling their joint venture agree ments after they have appropriated th start-ups' technology thereby disruptin research and at times even bankruptin the small ally. The alliance route is ofte less a marriage of true partners than a dis trustful relationship to be broken at th earliest possible convenience. The close the large firm gets to the small firm, th more the small firm is suffocated. In th end, the small firm is usually devastated while the large firm has not achieved it goals.

The case of GE and Intersil is a clas sic example of what can go wrong. I 1981, General Electric decided to reente the semiconductor industry and pur chased Intersil, a classic Silicon Valle start-up company. Though top GE execu tives vowed to leave Intersil's start-up en vironment untouched, GE's bureaucrac quickly began to assert itself. Intersil's ex ecutives were subjected to GE's maze o rules and requirements—even slides ha to be prepared according to detailed corpo rate standards. An Intersil executiv found GE accountants secretly pourin over Intersil's books on the weekend. GE took away Intersil's incentive pay pro gram because it was out of line with GE' established salary structure. The result Intersil's talented technologists and man agement cadre simply left the company In the words of one Silicon Valley execu tive: "Intersil became an empty shell. GE was like the kiss of death."

There is a final fatal flaw in the logi of those who see linkages between large and small firms as the key to a U.S. come back in high technology. The flaw is quite simply, that foreign companies can and are playing the same game. For exam ple, in biotechnology Ciba-Geigy has ab sorbed Genentech. Japanese firms have purchased dozens of smaller firms and

early all the start-ups have agreements ith foreign partners. Steve Jobs' Next rporation recently sold 16 percent of its ares to Canon Corporation for $100 mil-n. And Japanese corporations are act-g as investors in our leading venture cap-al funds to secure early access to key

chnology.

There is growing concern that foreign liances and takeovers "give away" impor-nt technologies to our competitors. But, spite all the controversy, it is difficult block foreign access to our break-rough technologies. The reason for this simple: Our high technology system pro-ces wave after wave of start-ups who ed capital to survive. The problem is es-cially acute for companies that have ed up their venture capital. Foreign mpanies are an increasingly attractive urce of the required capital. The impas-oned rhetorical attacks upon foreign com-nies developing liaisons with our small ms are understandable, but they fail to dress the root causes of these relation-ips.

STRATEGY FOR THE FUTURE

t is now time to overcome the break-through illusion. This will require breaking with outmoded ideas and old habits, adopting a new world-ew, and rebuilding many institutions from the ground up. It demands the hard work, deep public commitment, and the collective energy of workers and citizens.

There are four basic lines around which an effort to rebuild our technological and industrial capabilities should be organized.

The closer the large firm gets to the small firm, the more the small firm is suffocated.

Reinvest in manufacturing. Held hostage by quarterly reporting requirements and captivated by the myth that breakthroughs would drive us forward, American companies have neglected manufacturing for the past three or four decades. The result: Our manufacturing capability in both basic and high tech industries alike is antiquated. It will take massive investments to rebuild this capability.

State-of-the-art semiconductor fabrication lines currently cost between $200-400 million, and by the mid-1990s are expected to exceed $1 billion; automobile assembly plants range from $500 million to $1 billion or more; an integrated steel mill might cost $5 billion or more. We desperately need such investments to rebuild our capacity to follow through on the innovations we make.

Many in America say such investments just cannot be made in a financial climate that prizes short-term returns. But, the Japanese "transplant" firms are making massive investments in U.S. manufacturing—building new plants in the old industrial heartland of the Rustbelt

■ ***From the Garden of the Château*, by Charles Demuth.**

that American manufacturers wrote off decades ago. Our forthcoming book on transplant firms in heavy industry documents that Japanese companies have already opened more than four hundred state-of-the-art automobile assembly, automotive parts, steel, and rubber transplant factories in the United States, investing more than $20 billion. Now, Japanese companies are making major investments in high technology production. Japan's leading electronics companies operate semicon-

ductor fabs, telecommunications factories, and high tech television plants across the United States. In a telling irony, Sony is building a state-of-the-art television factory outside Pittsburgh—on a site which Chrysler initially developed but never opened, and where Volkswagen failed.

What is required is nothing less than a revolutionary transformation of American industry and management.

Workers as a source of innovation. Investment in manufacturing must be coupled with a fundamental organizational transformation of American industry. The key to success lies in constantly improving and upgrading the manufacturing process to churn out state-of-the-art products. To do this requires harnessing workers' knowledge of production and the ideas and innovations that flow from it. In a growing number of world-class factories, workers use their intelligence to actually improve production processes and work in groups to solve manufacturing problems. R&D scientists and engineers work alongside production workers on the factory floor. Konosuke Matsushita, the founder of Matsushita Electronics, suggests that the essence of Japan's advantage over the United States "depends upon the continued mobilization of every ounce of intelligence." This is not the "passive" involvement of the labor-management committees and American quality circle movement of the 1970s and 1980s. This is a new kind of direct involvement in which workers' intelligence and ideas are mobilized on a day-to-day basis as a source of new innovations and improvements in the manufacturing process.

Most American corporations fail to recognize the crucial fact that innovation is a constant, continuous process that goes on both inside the laboratory *and* outside on the shop-floor. They disregard the incremental advances in product design, quality, and manufacturing that come from shop-floor workers. Cynics say that this new model, which harnesses workers intelligence as well as their physical dexterity, could never take root in the United States. How wrong they are. At Honda's huge automotive assembly complex in central Ohio, engineers and managers are told that they must always listen to shop-floor workers who have the hands-on knowledge and the ideas required to improve the production process. In some cases, factory workers actually supervise engineers.

Xerox is an example of how an American company can begin to turn itself around by harnessing the intelligence and innovative capabilities of its entire work force. Buffeted by Japanese competition in the 1970s and early 1980s, Xerox put in motion a sweeping turnaround strategy. It began by getting back to the basics—improving quality, manufacturing, and working with its suppliers to make them more effective. Now it is striving to harness the intelligence and creativ-

ity of its work force. Xerox is forming workers into self-managing teams which it calls "productive communities," empowering them to design and redesign their own work units, deemphasizing hierarchy, decentralizing authority to the shop-floor, and attempting to gain the benefits of what its top executive Paul Allaire refers to as the "group social mind."

Companies like Xerox and Honda of America recognize the crucial fact that the mobilization of the collective intelligence of the entire work force can provide an innovative capability that is far more powerful than individual genius.

The factory as laboratory. The factory is no longer just sweat, muscle, and grease. It is undergoing a sweeping transformation from being a center of mechanically powered machines and physical labor to a center of brainpower and continuous, ongoing innovation. The new factory is a source of ideas, innovation, and intellectual labor—a computer-driven steel mill, a semiconductor clean room, a pharmaceutical production process. In this new reality, the shop-floor must become an extension of the R&D lab, and the R&D lab an extension of the shop-floor.

I/N Tek, a joint venture between Inland Steel and Nippon Steel in Indiana, illustrates the tremendous power of factory as laboratory. The company has transformed the process of cold rolling steel into a continuous process that takes roughly ten minutes from start to finish; a tremendous advance over the old way that could take as many as 12 days.

How did they do it? They did it by unleashing the collective intelligence of the work force. The company began by mobilizing factory workers, engineers, and R&D scientists, back in Japan, to combine the various batch processes one at a time. Then, they added sophisticated compute controls that the workers themselves mo itor, modify, and program. Now worker engineers, and computer specialists a working together to connect the cold rol ing process to the electro-galvanizing pr cess, which coats steel, making it corr sion resistant for use in automobile bod parts. These innovations are not the pro uct of an R&D center, but were born o the factory floor. In the words of Georg Landsly, an I/N Tek executive, the factor itself is "a living lab with bright capabl people. The key is to use their brain Those are resources, your technician your lab [scientists], but they're out ther on the operating floor. … Constant im provement means constant change. Yo can't get constant change if you've got th status quo. You get it by doing thing you've never done before."

Provide workers with a real stake American workers will resist, are resis ing, and have every right to resist corp rate efforts to tap into their "brains" they are not given real guarantees tha their jobs are safe. Invariably the mo competitive firms and the most compet tive nations provide the employment sec rity it takes to ensure that workers ar both smart and committed. Workers re quire a real stake in the company if the are to be true innovators. Companie must treat workers as full citizens, em power them, and provide guarantees tha their jobs are safe. Only then can worker give their full intelligence and ideas.

A company doing this is LS-Electr galvanizing (LSE)—a joint venture be tween LTV Steel and Sumitomo Metal– which produces high-quality electro-galva nized steel in LTV's century old Cleve land steel complex. A revolutionary agree ment between the company and the Unit

ed Steelworkers Union has traded job security for a sweeping reorganization of the workplace. LSE does not pay hourly wages but has put all workers on a monthly salary. Workers receive raises as they learn new skills and progress through a "pay-for-knowledge" system. Most of all the company has put real responsibility and authority in workers' hands. Workers virtually run the plant, scheduling and monitoring the entire process, with support, but not interference, from "white-collar" managers and engineers. Workers' committees have taken over the gamut of what are traditionally thought of as exclusive management prerogatives—hiring, pay and progression, training, gain sharing, safety, process control, and virtually all management functions. The result: a powerful new source innovation that can only come from dedicated and committed workers.

Still, most of our leading corporations—from Big Three automakers to the cutting edge entrepreneurial firms of Silicon Valley—continue to treat workers like lowly "cogs in the machine." Believing that breakthroughs are the answer, they separate innovation from actual factory production, placing scientists and engineers in gleaming R&D campuses far removed from grimy factories. Even many of the most progressive U.S. companies continue to organize factory work along the rigid lines of Frederick Taylor and Henry Ford—they do not allow workers to contribute their ideas or intelligence.

This outmoded management mentality is proving hard to change. A few years ago, Chrysler chief Lee Iacocca commissioned a study of the world's state-of-the-art management practices to help prepare Chrysler for a potential restructuring. When the report came in suggesting that the company be more egalitarian and empower its workers, Iacocca balked: "They wanted us to eat in the cafeteria and go through the rain in the parking lot like everybody else—we don't go for that."

To do nothing may well result in our economy going the way of England, or worse yet, becoming "Brazil-ized" with declining industries, huge debt, falling living standards, and dependence upon foreign investment.

Government alone cannot solve these problems. Decades of industrial protection for the steel and automobile industries and defense department subsidies for our electronics and semiconductor industries have done little to shelter them from a swelling competitive challenge. What is required is nothing less than a revolutionary transformation of the American model of industry, organization, and management.

The world has changed. American industry is running out of time and excuses. To do nothing may well result in our economy going the way of England, or worse yet, becoming "Brazil-ized" with declining industries, huge debt, falling living standards, and dependence upon foreign investment. We know what needs to be done to reverse our economic slide. What we need is the willingness to do it.■