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Technology, Enterprise, and American Economic Growth

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The success of the space shuttle and American-led advances in biotechnology, artificial intelligence, exotic materials, and other dramatic developments, have given hope to many that the United States is returning to a path of vigorous economic growth (*1*). This view reflects a misunderstanding of technology and how it contributes to a nation's economic vitality; the significant decline of American technological prowess since the 1960's, when our technological might was extolled (*2*), is beyond dispute. American industry was once the world leader in the production of consumer electronics and photographic equipment, ships, machine tools, office copiers, textile machinery, industrial chemicals, computers and semiconductor electronics, farm equipment, jet aircraft, automobiles, and steel. But today U.S. firms in these and other technology-based industries have been outpaced by or face serious challenges from foreign rivals for domestic and world markets (*3–5*).

The American descent from technological preeminence has been partially unavoidable. Our nation was technologically and economically superior to others in the decades following World War II because our allies and adversaries were recovering from massive destruction, not because we were smarter, better organized, or worked harder. What tends to be forgotten is that we were not superior to other nations in many fields before World War II. Then, for example, German chemical engineering was preeminent and European science excelled. In fact, many of the scientists who built America's postwar technology base were refugees. We are not likely to benefit from a European brain drain again. Since the end of World War II, the former combatants have rebuilt their industries, and the United States is watching other nations pass it by. The strength of the European and Japanese economies can no longer be attributed to lower wage rates or to these countries skimming the cream off our technology base. Much of it is due to greater technological vitality.

Recent explanations of this new American dilemma tend to focus on a variety of factors—too much regulation, too

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many lawyers, and too few engineers, low expenditures on research and development (R & D), shortsighted and risk-averse corporate management, insufficient capital investment, the rapid rise in energy prices. Depending on an observer's political philosophy, it is posited that reversing one or more of these factors will revitalize American industry. In this article I argue that the sources of our technological and economic strength are more fundamental than those discussions allow. I will briefly review the connection between technological advance and a nation's economic growth. Having done this, I will probe the roots of America's economic decline and suggest what the future might bring.

Summary. The weakening of technology-based economic growth in the United States may be due to inflation and to fundamental characteristics of American society and not, as is often suggested, to low expenditures on research and development, too much regulation, or risk-averse corporate management. Accordingly, renewed economic growth will require constraining inflation, as well as private initiatives and public policies that reflect the nature of technological progress and of the American people.

Technology and Economic Growth

Technology is the use of knowledge to modify the physical world (*6, 7*). Although it is common to think of technology in terms of machines or other physical tools, useful knowledge for modifying things may also be embodied in people and organizations. Thus a factory, consisting of production machinery, workers, management, and specified procedures, can be as legitimately referred to as "technology" as the machinery itself.

Economic growth consists of an increased output of goods and services. Part of this increase comes from the use of more labor, capital, and materials (collectively referred to as inputs or factors) in a nation's productive sectors, and part from a growing ability to produce more of these goods and services with fewer inputs—a process known as increasing productivity. By its nature, technological progress contributes to productivity growth. Denison (*7*, p. 23) and Kendrick (*8*) estimated that two-thirds of the growth of U.S. industrial productivity in recent years has been due to technological advance. Their findings are shown in Table 1.

Table 1. Relative contributions to business sector productivity growth in the United States.

Factor	Percent
*Total factor productivity**	
Advances in knowledge	67
Improved resource allocation	17
Scale economies	24
Other (including government regulation)	−8
	100
Real gross product per labor hour†	
Technological advance (including changes in labor education, experience)	67
Labor reallocation and capital-labor substitution	39
Volume changes (scale economies, capacity utilization)	16
Government regulation	−22
	100

*For 1948 to 1969 from Denison (*7*). †For 1960 to 1973 from Kendrick (*8*).

A society's ability to produce the great quantity and variety of goods it consumes depends on a vast number of business firms operating in the many sectors of its economy. A nation's productivity grows to the extent that the majority of firms advance their individual practices by using knowledge from all sources relevant to their needs—from fundamental scientific progress at universities to the experience of the firm's own employees. The contribution of technological progress to a nation's economic growth is thus not determined or even significantly influenced by the prowess of a few pioneering firms, by leadership in a handful of exciting technologies, or by the number of Nobel laureates in its population. Advancing knowledge makes new practical achievements possible, but does not guarantee their application throughout an industry. Because frontiers of knowledge expand continuously, a nation's economic strength is crucially dependent on the ability of most firms to change their practices to remain close to those frontiers.

Sources of Technological Knowledge

In general, technological knowledge is broadly based. While scientific advance achieved through R & D is often a significant source of useful knowledge, learning by doing is equally important. Modern computers, for example, would not exist without the great strides that have been made in semiconductor physics. Yet millions of person-years of experience with countless different component and subsystem designs and production processes have contributed greatly to advances in computer performance, reductions in manufacturing costs, and increases in system reliability.

Suggestions that R & D dominates the technological component of economic growth are misleading. For example, it is frequently observed that total expenditures on R & D as a percentage of gross national product (GNP) have declined significantly in the United States since the 1960's, while they have grown significantly in Japan and Germany in the same period. It is then suggested that the United States must reverse this trend if we are to increase our economic strength. However, our R & D/GNP ratio is still above or about equal to that of our foreign competitors (*9*). Moreover, a significant portion of the R & D in most countries is government-funded, usually for purposes other than economic growth. And in spite of occasional spinoffs from government space, defense, and other R & D, there is evidence that government-funded R & D yields no net productivity gain (*10, 11*). Hence a more useful measure of a nation's R & D effort relevant to economic growth is its industrial R & D expenditures measured as a percentage of industrial output. On this basis, the United States has been and remains ahead of other nations as well, as shown in Table 2.

During the 1960's, when Japanese industry was rapidly catching up with ours, it was popularly held that the Japanese were merely exploiting American R & D results and that they could not pull ahead of the United States until their R & D expenditures exceeded ours. Today Japan excels in many industrial technologies, yet her total national and industrial R & D expenditures, total R & D/GNP, and ratio of industrial R & D to industrial output all remain well below U.S. levels (*6*, p. 12). Evidently, R & D spending levels are not the sole determinants of economic growth.

Interest in R & D as a source of economic strength derives from the recognition that modern societies have become dependent on countless synthetic materials, new alloys, and chemical compositions that form the basis of many of the goods and services we use every day. These new materials and the devices, components, products, and systems they make possible owe their existence to scientific and engineering research.

Table 2. Measures of intensity of R & D performance for selected industrial nations; from (*9*).

Measure	United States	Japan	West Germany	France	United Kingdom
Total national R & D expenditures as percent of GNP, 1979	2.25	1.94 (1976)	2.37	1.76 (1978)	2.11 (1978)
Industrial R & D expenditures as percent of industrial domestic product, 1977	1.91	1.29	1.64	1.35	1.75 (1975)
Scientists and engineers engaged in R & D per 10,000 in labor force, 1977	57.4	49.9	44.3	30.3 (1976)	31.3 (1975)

Also, economists have found a positive correlation between R & D and economic growth (*12*). But despite these links, it is evident from the previous discussion that more R & D will not necessarily accelerate economic growth. The resolution of this apparent paradox lies in the dynamics of how technological knowledge advances and is employed.

Occasionally, a major scientific breakthrough will present new opportunities for great leaps in performance and reductions in cost. But just as often many small, almost imperceptible, improvements will add up to equally great progress. These improvements occur through adjustments in operating procedures and materials, slight variations in manufacturing processes, redesign of products for easier production, or substitution of less expensive components for those used in earlier designs. The significance of these incremental advances for cost, performance, and quality improvements is virtually universal; it has been verified for products as diverse as automobiles, light bulbs, rayon, electronics, and ships (*13*).

The relative importance of research and experience as sources of technical knowledge depends on the time frame considered. This is readily understood by examining the nature of technological progress. In most research-dependent industries (this excludes craft-dependent sectors such as residential construction), there have been successive generations of technologies. In electronics, for example, vacuum tubes were replaced by transistors, which gave way to silicon chips. Each new generation is born out of long-term research and differs significantly from its predecessors in nature, cost, and performance. Each new technology, in turn, evolves as numerous modest changes are made—some from short-term R & D but most from experience with the technology—to improve and adapt it to better satisfy market requirements. Steady progress within a generation eventually depletes the reservoir of opportunities for continued advances, the costs and difficulty of progress increase, and the rate of change slows. At this stage, the technology has matured. At some point a new generation enters the picture, offering yet another breakthrough to new cost and performance levels. Initially, improvements in the breakthrough come slowly, as a firm's engineering, marketing, and production people become familiar with the new technology and adapt it. Over time, familiarity stimulates a faster rate of change until diminishing returns set in once again.

Thus longer term R & D, which is aimed at creating new technological generations, substantially expands the opportunities for economic growth. But the fruits of these long-term efforts cannot be realized unless firms are able to adapt the new technologies as they appear, and to employ knowledge from research and experience to get the most from each technological generation (*14*). From the perspective of the individual firm, long-term survival and growth require constant efforts to reach out and grasp tomorrow's technologies and markets before competitors have foreclosed the opportunities, while simultaneously working to improve today's products and production processes. These parallel long- and short-term efforts can be frustrated if management has myopic views of the future or if the firm is unable to draw fully on all available knowledge.

The Firm: Time Horizons

It is widely recognized that the "push" of new technology yields the greatest rewards when it is guided by the "pull" of the marketplace. Since long-term developments must frequently aim at latent demands and market segments that have yet to emerge, marketing foresight and creativity are critical ingredients of success over the long term. It is thus noteworthy that respected observers of business performance and even the chief executives of major corporations have observed that the marketing function in most U.S. firms is shortsighted and unimaginative; marketing means no more than systematic selling. Foreign firms are regarded as more likely to think in terms of longer-run trends, identify market niches and opportunities that others have overlooked, and develop their products and businesses with future markets in mind (*15*).

The consequences of short time horizons are clearly visible in the competitive behavior of American firms. Over the past decade, for example, a commitment to longer term R & D has helped the major German chemical firms grow faster and larger than their American rivals in world markets. During this period, the German firms' spending for R & D as a percent of sales has remained constant, while that of their American counterparts has steadily declined. Commenting on long-term R & D, DuPont's board chairman observed that "in today's world you can't afford to take chances anymore" (*16*). The view of a German chemical executive is equally illuminating: "American corporations have to show they can make more and more profits from quarter to quarter. We are not using that yardstick" (*14*). The automobile industry provides another example. For decades General Motors has used investment criteria requiring paybacks within 5 years. This has forced it to change its production systems by tinkering with old plants, thus missing opportunities for large-scale technological change. The average life of General Motors' U.S. assembly plants is 39 years, compared with 14 years for its Japanese competitors (*17*).

A comparison of the U.S. and Japanese consumer electronics industries further illuminates the nature and value of a long-term perspective on markets and technologies. Abernathy and Rosenbloom (*5*) noted that "during the 1960's, while Zenith, G.E. and RCA treated consumer electronics as a mature business with few opportunities for significant advance, Sony, Matsushita and JVC did the opposite. In radio and then in monochrome and color television [and video recording], they sought to apply advanced technology to enhance product value for the consumer. The Japanese foresaw consumer applications of video recording 15 years before the market could actually be tapped, and persisted in their commitment to develop the basic technology even [in the face of repeated failure]. The Betamax, for example, was the fourth videorecorder generation demonstrated by Sony as a consumer product." It was the first to succeed. In 1955, the U.S. output in consumer electronics was $1.5 billion, while Japanese firms produced only $70 million. Today, Japanese sales in consumer electronics are more than twice those of the United States (*5*).

American executives have, since the 1960's, developed a penchant for business growth through acquisitions, frequently in markets and technologies unfamiliar to the top-level managers. This strategy has the apparent advantage of acquiring current earnings while spreading business risks. But it actually inhibits growth because, in a diversified enterprise, the range of issues requiring top management attention and judgment easily exceeds an individual's experience and grasp. Under these circumstances, executives tend to select growth opportunities by using elegant planning and decision-making techniques that favor analytic precision and detachment over insight and judgment based on experience (*18*).

The use of quantitative decision-making procedures limits a firm's ability to act on necessarily qualitative speculations about future markets and technologies. In the late 1960's, for example, General Electric used quantitative techniques to consider growth opportunities in computers, nuclear power, and semiconductor electronics. At the time, markets and technologies for the first two options were presumably closer at hand and thus easier to quantify than the third. General Electric proceeded to drop semiconductor electronics and invest heavily in computers and nuclear reactors. Since then the company has left the computer business, nuclear power sales have tumbled, and semiconductor electronics has become a major growth industry.

Some observers contend that business schools are at least partially responsible for the shortsightedness of American corporate behavior, because the schools developed the analytic decision-making techniques being used by the firms. But this begs the question of whether adoption of the techniques made the firms risk-averse, or whether the firms were already risk-averse and employed the techniques because they met internal corporate needs. It is possible, for example, that the risk aversion of American business is due to forces in the American social and economic environment that are well beyond the influence of the business schools.

The Firm: Management Style

The large number of incremental advances that characterize product and process improvement within a technological generation are crucially dependent on the willingness of employees to work together as a team, contributing knowledge gained from experience on the shop floor and in the field and introducing new ideas without fear of rebuke and regardless of the employee's formal position in the hierarchy. This open attitude is equally important if the firm is to take advantage of new technologies and markets rather than be overtaken by more innovative newcomers. Otherwise, as a technology matures, the growing need for specialization within the firm will cause people to shift from collaborating to working on separate, generally narrower problems. The temptation to reject new concepts grows, rigidity sets in, and change is resisted because it threatens the hierarchy of power and prestige on which the firm's system of control is built.

The participative management style described above has long been appreciated by scholars of innovation, but rejected by most American executives as being irrelevant or impossible to achieve. More than two decades ago, Argyris, McGregor, Likert, and others were reporting the benefits of drawing on workers' minds as well as their bodies to improve productivity (*19, 20*). The evidence for this is drawn from industries as diverse as electronics production in Britain and coal mining in Wyoming (*20, 21*). In the latter case, the U.S. General Accounting Office (GAO) studied 20 similar coal mines in the same region, all of which were producing the same kind of coal, using the same kinds of equipment, and operating under the same regulations. Production ranged from 58 to 242 tons per worker-day, a disparity of more than four to one. The GAO found that the main difference was in how management worked with employees. The most productive firm provided its employees with the greatest individual responsibility and involvement in decision-making. The evidence is further bolstered by the clear success of Japanese management practices, which are based on a commitment to cultivating people as valued resources (*22, 23*).

American managers have historically been inclined to ignore the potential of worker cooperation and motivation in raising productivity. Alfred P. Sloan, Jr., past chairman of the board of General Motors, commented on the attitude prevalent in the mid-1960's (*24*): "In the end, increased efficiency flows not so much from the increased effectiveness of workers, but primarily from more efficient management and from the investment of additional capital in labor-saving devices." Two decades later, this attitude remains. Recently, *Fortune* observed that "The typical American manager today holds forth in a rigid and stratified system that is the organizational equivalent of a multistory 19th-century factory building . . . no area of management has been more neglected than improving the way people work together" (*25*).

Although American firms adopted analytic techniques from the business schools, they largely ignored the evidence regarding participative management being reported by the schools at the same time. They probably did so because they had little real choice. In general, relations between American workers and managers have not been known for the mutual respect and commitment needed to build cooperative efforts. This adversarial relationship has roots in U.S. history going back to the 19th century, when many of our predecessors immigrated from domestic and foreign rural areas to work in our urban factories. Most had little industrial experience, many had substantial language difficulties, and virtually all had cultural norms and behavior patterns that conflicted with urban life-styles and factory practices. As a consequence of these differences, animosity between labor and management emerged and became pronounced, each saw declining mutual interest with the other, and the American labor movement arose as the only vehicle that could satisfy workers' unmet needs. It reinforced and institutionalized the adversarial relationship, which has continued to the present (*26*).

Government Regulation of Business

Government regulation can affect technological change and productivity growth by diverting management attention and business resources from product and process innovation to compliance activities. Riskier, longer term investment may be discouraged by uncertainties about the stringency, timing, and applicability of many regulations, often until courts pass on individual cases; by the imposition of higher regulatory standards on newer facilities; and by regulatory requirements for studies and permits that can introduce considerable delays between investment and income (*27–29*).

Among all forms of regulation, environmental protection requirements have the most significant measured effect on business. Denison (*29*) estimated that pollution abatement regulations reduced annual productivity growth in the United States by 26 percent between 1973 and 1976; the effect of worker health and safety regulations was about half that amount, with other regulatory forms having even smaller consequences.

Environmental requirements have their greatest effect on the process (food, chemical, metallurgical), automobile, and electric utility industries because these sectors produce more than their share of effluents. Interestingly, firms in the same industry have reacted very differently to the same regulations. For example, while some chemical companies were fighting all effluent regulations, others, such as 3M and Dow Corning, were reengineering production processes to capture and use previously discarded substances, often with considerable net cost savings. In fact, industry officials and other observers estimate that the process industries in general should be able to convert about half of their gross pollution load to profits before having to pay for abatement (*30, 31*). Ironically, only about 20 percent of the affected American firms have chosen this path. The majority have complied with environmental requirements by adding "end of the pipe" filters and other devices to block emissions, thereby raising their costs while reducing operating efficiencies (*32*).

The implication that the regulatory burden on American industry has weighed heavier than necessary is confirmed by the experience of other nations. For example, regulations were imposed on auto emissions in Japan well after they were in the United States, and the Japanese requirements have been more stringent. Both the Japanese and American auto industries initially regarded their respective requirements as being technologically unattainable. Yet Japanese auto manufacturers met the standards in both nations well before their American competitors (*33, 34*). In the steel industry, where coke ovens are a major source of pollution, U.S. firms have often operated their ovens at lower efficiency to reduce emissions while seeking to delay regulatory requirements. Japanese steel firms use a technology they discovered in the Soviet Union, using waste heat from the emissions to generate power for their plants while simultaneously reducing the emissions (*35*). Evidently the Japanese firms have taken a more innovative approach to complying with environmental regulations than their American counterparts. A further comparison of Japan and the United States suggests why this has happened.

Table 3. Air quality objectives for selected Organization for Economic Cooperation and Development countries, 1975; from (*34*, p. 25). N.A., not available.

Nation	SO_2 (ppm)	Particulates (mg/m^3)	NO_2 (ppm)
Japan	0.04	0.10	0.02
West Germany	0.06	N.A.	0.15
United States	0.14	0.26	0.13
Sweden	0.25	N.A.	N.A.
France	0.38	0.35	N.A.

First, there is little difference between the substance of environmental regulation in both countries, except that in Japan, as shown in Table 3, air quality objectives are more stringent than in the United States. In both nations, environmental standards have been set without a clear scientific basis or a balancing of costs and benefits; emission requirements are established on a plant-by-plant basis, with stricter standards generally imposed on new plants; and tax incentives or low-interest loans help defray comparable compliance costs. Neither country has made significant use of market incentives such as emission fees or offsets to reduce pollution (*34*, p. 76).

There is, however, a striking difference between respective regulatory processes. In both Japan and the United States, environmental and business interests are often bitter antagonists. But in Japan, once emission standards are set, they are enforced by persuasion and technical guidance rather than by coercion. In the United States, although the Environmental Protection Agency should be in an excellent position to help firms meet compliance requirements, it apparently cannot do so because of the threat of political reprisal by environmental groups (*31*, p. 4.3). Penalties for noncompliance are low in Japan, high in the United States. Evidently, social cohesion encourages compliance in Japan, while such forces are largely absent in the United States. Following the Japanese practice of settling differences by negotiation, rather than by trial, there have been few court challenges of government abatement initiatives. In the United States, protracted litigation often seems to be the rule (*27, 34, 36*).

The remarkable ability of the Japanese to resolve conflicting interests has been attributed by Drucker (*37*) to a strong national sense of common purpose and destiny and a well-developed art of resolving differences for the greater common good. Apparently the same levels of trust and cooperation do not exist in the United States. The different behaviors of Japanese and American firms under essentially the same environmental regulations thus may be due to the problems of innovating in a hostile climate. It is difficult to conclude that the regulations themselves are at fault.

Social Context

Although we tend to overlook the connection between culture and economic behavior, there is ample evidence that a society's values, priorities, and attitudes importantly condition the performance of its enterprises.

Barnard (*38*) has described how the survival of the firm requires compromises between the often conflicting needs of its employees, investors, customers, and others upon whom it depends. Since employees are whole people who bring their personal concerns to their place of work, a firm's performance might be expected to decline with increasing conflict in the society from which they are drawn.

In the particular case of technological innovation, Burns and Stalker (*39*) and Lawrence and Lorsch (*40*) showed that effective performance requires interdisciplinary collaboration in a climate that encourages the easy flow of new ideas and the ability to confront and work through differences as they arise. Argyris (*41*) added to this understanding with his description of how the innovative process is significantly hindered by the presence of psychological blocks to interpersonal communication and problem-solving. It is an elementary finding of social psychology that such blocks arise more frequently among people who are socially heterogeneous. Rogers (*42*), for example, reviewed more than 1000 case studies of new ideas introduced into a wide variety of contexts—including Third World peasant villages, American high schools, and business enterprises. Regardless of the idea or the setting, Rogers found that new ideas spread more slowly among individuals having different beliefs, values, education, and social status.

The more an innovation departs from incremental change from the perspective of those involved, the greater the need to confront new ideas and for collaboration among the firm's various participants.

The more discordant the social environment from which these participants are drawn, the more difficult it becomes to suppress the discord to sustain successful innovative behavior.

For the United States, Huntington (*43*) has described how our belief in the right of every individual or group to equality and self-fulfillment and our distrust of authority set up social conflicts when wealth or benefits are not perceived as being fairly distributed or when too much power has accumulated in one place. These conflicts are more prevalent in America than in most other nations, where inequality and established social hierarchy are more accepted.

Social discord in America is manifest in different ways. Sometimes, as in the 1960's, it flares up in riots and demonstrations that seem to engulf the entire population (*43*). It may also be more subtle but no less pervasive. Over the past 20 years, for example, the number of civil lawsuits filed in the federal courts has increased seven times faster than the population. Commenting on this increase, Chief Justice Warren Burger warned that "we may well be on our way to becoming a society overrun by hordes of lawyers, hungry as locusts, and brigades of judges in numbers never before contemplated" (*44*). On the surface, this growth in litigation might appear to be tied to increased government regulation and extension of the legal process to those who previously could not afford it. But the formal adversary system has spread to many other quarters. Today, schools must provide students a hearing before dismissal and the courts are being asked to review the outcomes of sports events and to intervene in business and family affairs on issues that a few years ago would have been widely regarded as best settled in private. In addition, many of the government rules and regulations that affect businesses, individuals, state and local governments, hospitals, and universities appear to be nothing more than an institutionalization of adversarial relations. Public constraints and reporting requirements imposed on private personnel, financial, purchasing, and other practices seem necessary in a society that has significant conflicts between the interests of its members and no ready alternative for resolving them. These impositions are neither a fault of government nor a response to the failure of private institutions. They simply mirror the character of the society that spawned them. The growing reliance on the legal process at the expense of social intercourse to resolve disagreements suggests a weakening of the mutual trust that is part of the fabric of a progressive nation.

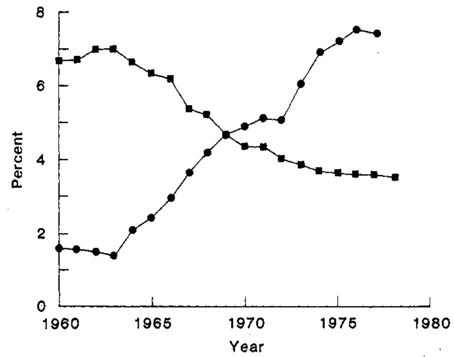

Fig. 1. Decline in proportion of business R & D funds devoted to basic research (■) and rise of inflation, shown as calculated 5-year moving average of GNP price deflator (●), in the United States since 1960. Use of a moving average models decision-makers' use of memories of the recent past and anticipation of future conditions to make investment decisions. Sources: basic research data from (*9*, p. 263); GNP deflator from (*52*).

Some observers have argued that the success of Japanese management practices in the United States demonstrates that American management, rather than the American culture, is the cause of our technological weakness. For example, within 3 years after Matsushita purchased Motorola's television assembly plant in Franklin Park, Illinois, productivity increased by 30 percent and defects dropped from more than 150 to fewer than 4 per 100 sets. Production workers and middle managers were the same under American and Japanese ownership. Only top management changed (*45*). But this and similar examples do not support the contention that management is the primary determinant of technological capability. The new Japanese owners in Franklin Park came from a tradition of participative management that had been nourished by their culture. They were committed to continue this practice at their new plant. Moreover, the employees had an incentive to try new work practices, for they knew that their jobs would be lost if the plant's productivity and quality did not improve. Similarly, the existence of a relative handful of innovative American firms such as IBM and Kodak that have "open" environments does not prove that American managers must shoulder the blame for our economic malaise. The important point is that our society has produced so few of these firms.

In Japan, technological advance and economic growth have clearly benefited from social cohesion and a strong desire for progress. In West Germany, the vigorous postwar economic growth has been widely attributed to a labor-management coalition that held common interests above mutual differences and a public spirit that gave enterprise and progress a high national priority. A recent survey of the senior executives of the largest Japanese and American corporations is illuminating. The Japanese believed that their nation is "goal-directed, expanding, production-oriented, strong and stable," while the Americans regarded the United States as "consumption-oriented, weak, drifting, vulnerable, unstable and declining" (*46*).

Economic Context

In a market economy, the present and anticipated future prices of goods and services bear importantly on business investment decisions and on the use of technology. Rapid or unpredictable price changes inhibit resource allocation for longer term developments. Inflation and the post-1973 energy crisis stand out as major sources of price discontinuity in the American economy.

Economists may disagree about the causes of inflation, but its nonlinear relationship with technological progress is readily described. At low inflation rates, technical advance contributes to productivity growth, which in turn reduces the growth rate of prices paid for goods and thus dampens the rate of inflation. But at sufficiently high rates, inflation inhibits the predictability of future business conditions, frustrating the selection of longer term R & D goals (*47*). As shown in Fig. 1, the proportion of U.S. industrial R & D funds devoted to basic research has varied inversely with inflation. Higher inflation rates also inhibit capital investment, an important vehicle for the introduction of new technology, by raising the costs of new facilities well above the original costs of the facilities to be replaced. This makes depreciation charges on present facilities insufficient to finance new investment.

Inflation may also be the culprit behind Wall Street's demands for short-term gains. In recent years the investment community has put a premium on quarterly (or at least annual) increases in corporate profits. Lesser performance is likely to depress the price of a company's stock, making it difficult to raise the capital needed for growth and, incidentally, making the firm a more attractive candidate for take-over. This pressure for short-term gains causes firms to reduce expenditures that can only have long-term benefits (*48*). It has undoubtedly encouraged the use of analytic management techniques because it creates an incentive to select investment opportunities that offer the greatest present value.

It has been proposed that the rapid escalation of energy prices has been a root cause of America's technological decline. But by 1973, when the energy crisis hit the United States, the attitudes and practices described earlier had been well established. The rise in energy prices may have added to our economic problems, but it did not cause them. In fact, for a while the press and the government reacted to the crisis as an oil industry hoax (*49*). The resulting price controls on domestic oil increased our dependence on the oil-exporting countries and slowed the development of alternative energy technologies.

Perspective on the Future

We have seen that the technological vitality of the United States depends on the ability of U.S. industries to draw on the knowledge and skills of all employees and is inhibited by adversity, social discord, and inflation. The obvious question is whether Americans can change their ways. We will change if we develop a common interest that can bridge our differences. The growth of international economic competition may provide the impetus. Until very recently, success in international markets has been considered a matter of survival in Europe and Japan but an added benefit or even irrelevant for most American firms. Today, a growing number of American manufacturers and workers realize that their businesses and jobs are threatened by foreign competitors. In response, General Motors and other companies, with the cooperation and support of the labor unions, have embarked on wide-ranging worker participation programs (*50*). Early results are promising. Perhaps as labor and management find more in common, this new attitude will propagate to a wider audience. The drive to meet overseas competitors who pursue long-term strategies toward their markets and technologies may also encourage similar practices in the United States.

These steps are significant, and more will have to follow. Industry must lead the change because it understands the consequences better than most and is in a position to act. Government must overcome the important problem of inflation and avoid politically attractive economic traps such as propping up declining firms and industries through subsidies or trade barriers. We have seen that the inhibiting effect of some government regulations on business is caused by adversity in the regulatory process. Under these conditions, reducing the stringency of the regulations may have the counterproductive effect of heightening conflicts with the original beneficiaries. A more productive approach might be to reduce the adversity by using regulatory conflict resolution techniques that have recently appeared (*51*), or to encourage compliance through economic incentives such as the environmental "bubble" concept or "offset" policies. In some instances, government regulation has become a surrogate for mutual trust. Under these conditions, rather than impose the same burden on everyone, it might be more constructive to encourage trust by relaxing reporting requirements when compliance is evident. Firms that have performed well as equal opportunity employers, for example, would profit from a reduced federal paperwork burden.

American businesses, government agencies, individuals, and others have come to rely increasingly on rules and regulations that purport to govern our relationships. But many of the procedures we have created to protect ourselves from each other have also masked our mutual interests and inhibited the collaboration necessary for our common gain. Public and private measures that reduce conflict and build mutual trust are thus likely to make important contributions to our economic progress.

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