Structural Change in the New Economy.

Remarks by Chairman Alan Greenspan before the National Governors' Association, 92nd Annual Meeting in State College, Pennsylvania. July 11, 2000.

I am pleased to have the opportunity to meet with you today and address the remarkable changes that have been occurring in our economy. The current economic expansion has not simply set a new record for longevity. More important, the recent period has been marked by a transformation to an economy that is more productive as competitive forces become increasingly intense and new technologies raise the efficiency of our businesses. With the rapid adoption of information technology, the share of output that is conceptual rather than physical continues to grow. While these tendencies were no doubt in train in the "old," pre-1990s economy, they accelerated over the past decade as a number of technologies with their roots in the cumulative innovations of the past half-century began to yield dramatic economic returns.

As governors of our states, you have all been dealing with the practical effects of these shifts, which not only have increased prosperity but also are presenting important new challenges.

The process of innovation is, of course, never ending. Indeed, the substitution of physical capital, in which new technologies are embodied, for manual labor is an ongoing trend that began nearly two centuries ago when work in craft shops shifted to factories and then to assembly lines. However, the development of the transistor after World War II appears in retrospect to have initiated a special wave of creative synergies. It brought us the microprocessor, the computer, satellites, and the joining of laser and fiber optic technologies. By the 1990s, these and a number of lesser but critical innovations had fostered an enormous new capacity to capture, analyze, and disseminate information. Indeed, it is the proliferation of information technology throughout the economy that makes the current period appear so different from preceding decades. This remarkable coming together of technologies that we label IT has allowed us to move beyond efficiency gains in routine manual tasks to achieve new levels of productivity in now-routine information-processing tasks that previously depended upon people to compute, sort, and retrieve information for purposes of taking action. As a result, information technologies have begun to alter significantly how we do business and create economic value, often in ways that were not foreseeable even a decade ago.

One result of the more-rapid pace of IT innovation has been a visible acceleration of the process that noted economist Joseph Schumpeter many years ago termed "creative destruction"-- the continuous shift in which emerging technologies push out the old. Today our capital stock is undergoing an increasing pace of renewal through investment of cash flow from older-technology capital equipment and facilities into cutting-edge, more efficient vintages. This process of capital reallocation across the economy has been assisted by a significant unbundling of risks in capital markets made possible by the development of innovative financial products, many of which themselves owe their viability to advances in technology.

At the microeconomic level, the essential contribution of information technology is the expansion of knowledge and its obverse, the reduction of uncertainty. Before this recent quantum jump in information availability, businesses had limited and less timely knowledge of customers' needs and of the location of inventories and materials flowing through complex production systems. In that environment, decisions were based on information that was hours, days, or even weeks old. Businesses, to protect production schedules, found it essential, although costly, to carry sizable backup stocks of materials and to keep additional persons on their payrolls for making the necessary adjustments to the inevitable miscalculations and unanticipated shifts in demand for their products and services.

Of course, a great deal of imprecision persists, but the remarkable surge in the availability of real-time information has enabled businesses to reduce unnecessary inventory and dispense with labor and capital redundancies. Intermediate production and distribution processes, so essential when information and quality control were poor, are being bypassed or eliminated. There are no indications in the marketplace that the process of re-engineering business operations is slowing, although it has been difficult analytically to disentangle the part of the rise in output per hour that is permanent and that which is the consequence of transitory business cycle forces. The part based on information advances, of course, is irreversible. Having learned to employ bar code and satellite technologies, for example, we are not about to lose our capability in applying them. But until we experience an economic slowdown, we will not know for sure how much of the extraordinary rise in output per hour in the past five years is attributable to the irreversible way value is created and how much reflects endeavors on the part of our business community to stretch existing capital and labor resources in ways that are not sustainable over the longer run.

I have stressed information technology's crucial role on the factory floor and in distribution channels. But technological innovation has spread far beyond that. Biotechnology is revolutionizing medicine and agriculture in ways that were unimaginable just a few years ago, with far-reaching consequences for the quality of life not only in the United States but also around the world. Even more intriguing are those as yet unrealized opportunities for computers and information technology to expand our scientific knowledge more generally.

As I indicated earlier, the major contribution of advances in information technology and their incorporation into the capital stock has been to reduce the number of worker hours required to produce the nation's output, our proxy for productivity growth. Echoing a debate that is as old as Adam Smith, some view this so-called labor displacing investment and the introduction of innovative production processes as a threat to our economy's capacity to create new jobs. But because technological change spawns so many opportunities for businesses to expand, the introduction of new efficiencies has today, as in the past, created a vibrant economy in which opportunities for new jobs and businesses have blossomed.

An intriguing aspect of the recent wave of productivity acceleration is that U.S. businesses and workers appear to have benefited more from the recent advances in information technology than their counterparts in Europe or Japan. Those countries, of course, have also participated in this wave of invention and innovation, but they appear to have been slower to exploit it. The relatively inflexible and, hence, more costly labor markets of these economies appear to be a significant part of the explanation. The elevated rates of return offered by the newer technologies in the United States are largely the result of a reduction in labor costs per unit of output. The rates of return on investment in the same new technologies are correspondingly less in Europe and Japan because businesses there face higher costs of displacing workers than we do. Here, labor displacement is more readily countenanced both by law and by culture. Parenthetically, because our costs of dismissing workers are lower, the potential costs of hiring and the risks associated with expanding employment are less. The result of this significantly higher capacity for job dismissal has been, counterintuitively, a dramatic decline in the U.S. unemployment rate in recent years.

But one less welcome byproduct of rapid economic and technological change, and the necessary heightened level of potential job dismissal that goes with it, is the evident insecurity felt by many workers despite the tightest labor markets in decades. This anxiety stems, I suspect, from a fear of job skill obsolescence, and one very tangible measure of it is the pressure on our education and training systems to prepare and adapt workers to effectively run the new technologies.

These pressures are likely to remain intense, even though they may wax and wane, because I see nothing to suggest that the trends toward a greater conceptual content of our nation's output and, thus, toward increased demand for conceptual skills in our workforce, will end. The rapidity of innovation and the unpredictability of the directions it may take imply a need for considerable investment in human capital. Even the most significant advances in information and computer technology will produce little additional economic value without human creativity and intellect.

The heyday when a high school or college education would serve a graduate for a lifetime is gone; basic credentials, by themselves, are not enough to ensure success in the workplace. Today's recipients of diplomas expect to have many jobs and to use a wide range of skills over their working lives. Their parents and grandparents looked to a more stable future--even if in reality it often turned out otherwise. Workers must be equipped not simply with technical know-how but also with the ability to create, analyze, and transform information and to interact effectively with others. Moreover, learning will increasingly be a lifelong activity.

Certainly, the notion that human and physical capital are complements is not new. Technological advance has inevitably brought with it improvements not only in the capital inputs used in production but also new demands on workers who must interact with that increasingly more complex stock of capital. Early in this century, these advances required workers with a higher level of cognitive skills, for instance the ability to read manuals, to interpret blueprints, or to understand formulae.

Our educational system responded: In the 1920s and 1930s, high school enrollment in this country expanded rapidly, pulling youth from rural areas, where opportunities were limited, into more productive occupations in business and broadening the skills of students to meet the needs of an advancing manufacturing sector. It became the job of these institutions to prepare students for work life, not just for a transition to college. In the context of the demands of the economy at that time, a high school diploma represented the training needed to be successful in most aspects of American enterprise. The economic returns for having a high school diploma rose and, as a result, high school enrollment rates climbed.

At the same time, our system of higher education was also responding to the advances in economic processes. Although many states had established land grant schools earlier, their support accelerated in the late nineteenth century as those whose economies specialized in agriculture and mining sought to take advantage of new scientific methods of production. Early in the twentieth century, the content of education at an American college had evolved from a classically based curriculum to one combining the sciences, empirical studies, and modern liberal arts. Universities responded to the need for the application of science--particularly chemistry and physics--to the manufacture of steel, rubber, chemicals, drugs, petroleum, and other goods requiring the newer production technologies. Communities looked to their institutions of higher learning for leadership in scientific knowledge and for training of professionals such as teachers and engineers. The scale and scope of higher education in America was being shaped by the recognition that research--the creation of knowledge--complemented teaching and training--the diffusion of knowledge.

In a global environment in which prospects for economic growth now depend importantly on a country's capacity to develop and apply new technologies, our universities are envied around the world. The payoffs--in terms of the flow of expertise, new products, and startup companies, for example--have been impressive. Here, perhaps the most frequently cited measures of our success have been the emergence of significant centers of commercial innovation and entrepreneurship where creative ideas flow freely between local academic scholars and those in industry. Not all that long ago, it was easy to recite a relatively short list of places where these activities were clustered. But we have witnessed in recent years a great multiplicity of these centers of innovation. State support, both for the university system and for small businesses, has been an important element in the vitality of these centers.

Certainly, if we are to remain preeminent in transforming knowledge into economic value, the U.S. system of higher education must remain the world's leader in generating scientific and technological breakthroughs and in preparing workers to meet the evolving demands for skilled labor. With two-thirds of our high school graduates now enrolling in college and an increasing proportion of adult workers seeking opportunities for retooling, our institutions of higher learning increasingly bear an important responsibility for ensuring that our society is prepared for the demands of rapid economic change. Equally critical to our investment in human capital is the quality of education in our elementary and secondary schools. As you know, the results of international comparisons of student

achievement in mathematics and science, which indicated that performance of U.S. twelfth-grade students fell short of their peers in other countries, heightened the debate about the quality of education below the college level. To be sure, substantial reforms in math and science education have been under way for some time, and I am encouraged that policymakers, educators, and the business community recognize the significant contribution that a stronger elementary and secondary education system will make in boosting the potential productivity of new generations of workers. I hope that we will see that the efforts to date have paid off in raising the achievement of U.S. students when the results of the 1998-99 international comparisons for eighth graders are published.

Whatever the outcome, the pressures to advance our education system will continue to be intense. As the conceptual share of the value added in our economic processes expands further, the ability to think abstractly will be increasingly important across a broad range of professions. Critical awareness and the abilities to hypothesize, to interpret, and to communicate are essential elements of successful innovation in a conceptual-based economy. As with many skills, such learning is most effective when it is begun at an early age. And most educators believe that exposure to a wide range of subjects--including literature, music, art, and languages--plays a considerable role in fostering the development of these skills.

As you know, school districts are also being challenged to evaluate how new information technologies can be best employed in their curricula. Unfortunately, this goal has too often been narrowly interpreted as teaching students how to type on the computer or permitting students to research projects over the Internet. Incorporating new technologies into the educational process is indeed likely to be an important element in improving our schools, but it must involve more than simply wiring the classroom. Human capital--in the form of our teachers--and technology are complements in producing education output just as they are in other business activities. To achieve the most effective outcome from new technologies, we must provide teachers with the necessary training to use them effectively and to provide forums for teachers and education researchers to share ideas and approaches on how best to integrate technology into the curriculum. And we must create partnerships among the states, the school systems, labor and industry to develop appropriate standards and guidelines for the teaching of information technology in the classroom.

A crucial concern today--and I know that the National Governors' Association is working hard to address this issue--is that the supply of qualified teachers will be insufficient to meet the demand. Indeed, a substantial number of teachers are scheduled to retire over the next decade, and how to replace them and meet the additional demand from rising enrollments is certain to be a significant challenge in the years ahead.

Finally, the pressure to enlarge the pool of skilled workers also means that we must strengthen the significant contributions of other types of training and educational programs, especially for those with lesser skills. It is not enough to create a job market that has enabled those with few skills to finally grasp the first rung of the ladder to achievement. More generally, we must ensure that our whole population receives an

education that will allow full and continuing participation in this dynamic period of American economic history.

We need to foster a flexible education system--one that integrates work and training and that serves the needs both of experienced workers at different stages in their careers and of students embarking on their initial course of study. Community colleges, for example, have become important providers of job skills training not just for students who may eventually move on to a four-year college or university but for individuals with jobs--particularly older workers seeking to retool or retrain. The increasing availability of courses that can be "taken at a distance" over the Internet means that learning can more easily occur outside the workplace or the classroom--an innovation that may be particularly valuable for states with large rural populations for whom access to traditional classroom learning is more difficult.

In summary, we are in a period of rapid innovation that is bringing with it enormous opportunities to enhance living standards for a large majority of Americans. Our ability to take advantage of these opportunities is not only influenced by national policies but is also determined importantly at the state level. States with more flexible labor markets, skilled work forces, and a reputation for supporting innovation and entrepreneurship will be prime locations for firms at the cutting edge of technology. Not all new enterprises will succeed, of course. But many will, and those that do will provide the impetus for further economic progress and expanding opportunities in their communities. Your leadership as policymakers will be a key element in promoting an environment in which you join with others in business, labor, and education to realize the potential that technological change has for bringing substantial and lasting benefits to our economy.