BEYOND THE MILLENNIUM

Transportation and the Economy

ROBERT M. WHITE

It is a pleasure to join you on the occasion of this conference on the future of transportation. It is timely to discuss ideas that will shape transportation policies because it is evident to the traveler and the shipper alike that we have a system in a crisis of undercapacity and are increasingly unable to accommodate a burgeoning traveling population and a dynamic and growing national and world economy.

Transportation plays a special role in advancing our economic welfare. It is central to our ability to achieve our national economic and social goals. Fortunately, our transportation systems on land, sea, and air stand on the threshold of new technological opportunities impeded only by our social will to grasp them.

In this conference we seek to predict the future, which is a hazardous undertaking at best. It calls for both boldness and humility. Recall that we are considering a period some 30 years hence. Reflect that 30 years ago the United States sat astride the world economic scene as a colossus. Jet engines were completing their dominance of aviation propulsion systems. The space age had just been launched with the appearance of the Soviet Sputnik in 1957. Computers were just emerging from the vacuum tube generation, and the personal computer was but a distant dream. Biotechnology as a discipline and an industry was nonexistent, and the dominance of the U.S. automobile industry was unchallenged.

In this era of almost infinite technological possibilities, one is struck by the fact that pervasive effects on society of specific technological developments were not understood or had not been predicted at the time of their introduction. The invention of the steam engine, for example, and the age of steam power started from modest beginnings. The steam engine was invented in Britain to pump water from coal mines. Only much later did steam power become the basis for railroad transportation systems. When railroads were first put into operation they were visualized only as overland ways to connect canal transportation systems. In many cases transportation innovations developed outside the industry providing services with the old technology. Few surface or maritime transportation companies foresaw or participated in the air transport revolution. Carriage makers did not participate significantly in the development of the automobile. Stagecoach companies did not participate in the development of the modern railroads that supplanted them.

The predictions of even the experts can be subverted by unpredictable economic and political events, and our transportation industry has been particularly subject to these uncertainties. We need look no further than the consequences of the 1973 oil shock. Oil experts believed that by 1985 we would be paying $2 a gallon for gasoline at the pump. The present oil glut was unforeseen by virtually all the experts.

The uncertainties of predicting our technological future are paralleled by our present self-doubts about our ability to compete industrially in a global economy. One of the keys to being competitive in a global economy lies in our ability to provide safe, efficient, and low-cost transportation for goods and services.

For some years we have become inured to news about the deterioration

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NAE President Robert White discusses transportation and the economy in his keynote speech at the Conference on Long-Range Trends and Requirements for the Nation's Highway and Public Transport Systems.

Robert M. White is President of the National Academy of Engineering.

of the competitive position of the United States in the global economy. Television and newspapers assail us each month with news of the state of the trade deficit. We learn that we have become the number one debtor nation in the world. Our concerns are reinforced every day as the U.S. dollar bounces around historic lows against the currencies of our trading partners. We are unbelieving as we note that the trade balance in agricultural products has become negative. Even in key technological industries our trade balance is to our disadvantage. Toward the end of last year, however, a little-noticed but significant milestone was added to the lengthening list. In the third quarter of 1987, the trade balance in services turned negative for the first time in memory.

To fully understand the importance of transportation in rectifying this situation, we need to step back and place the transportation industry in perspective. It is common to structure the debate about U.S. competitiveness in the global economy principally in terms of the competitiveness of U.S. manufacturing industries. In this case the manufacture of aircraft, especially large passenger aircraft, has been one of the few bright spots in an otherwise grim picture. We continue to enjoy a trade surplus in aircraft. Unfortunately, we are all aware of the dismal situation facing surface transportation, especially automobiles, subway cars, and the moribund maritime industry.

Transportation, however, plays a special role because it is both a manufacturing and a service industry. Seventy-five percent of the U.S. work force is engaged in service industries, and employment growth in the United States during the past decade has been almost totally in the services sector. Services are the circulatory structure of the entire productive system. Service industries do such diverse things as provide and distribute energy, control and move information through communications networks, and generate new knowledge and new technology through research and development. Service industries allow the management and financing of the nation's entire production system and are the way we organize ourselves to meet essential needs such as health care. Transportation services are the bloodstream of the circulatory structure.

The transportation industry is both a driving and driven technological force. Whether it is the application of information, electronics, and computer technology to increase the capacity of highways, the introduction of new tracking, monitoring, and information systems to control air traffic, or new superconducting propulsion systems for railroads, the transportation industry is both developer and user of key technologies.

We need to recognize that the U.S. economy consists of interdependent production systems that include not only manufacturing but also services. Although each of these sectors exhibits considerable internal diversity, there is a technological/ecological principle at work that renders each sector dependent on all other sectors for the level of its productivity. In this industrial ecology the service industry and the service dimension of transportation occupy a central role because they hold an important key to unlocking the cost of the national production system.

The most important feature of modern economic reality is the now-universal understanding that harnessing science and technology for economic growth is the way to change the rules of the game. We see this in the thriving economies of Japan and Germany, in the newly industrialized countries of the Pacific Rim, and in the growing economic power of Brazil and India among the developing nations of the world.

The future of the transportation industry, like other industries, clearly rests with the application of science and technology. The transportation industry's role in our national response to competition from abroad is complex, reflecting the complexity of the competitive issue itself. Competitiveness is determined by economic policy. It is a product of tax policy. It is dependent on political relationships. It is affected by the regulatory environment. It responds to financial relationships, and, finally, it depends on the invigorating contributions of science and technology. The transportation industry is affected by and in turn affects the competitiveness of all other U.S. industry in a global economy.

The cost of capital translates into the cost of aircraft or manufacturing plants, or the ability to install a subway system. The dollar/yen ratio translates into the competitive costs of equipment and access to foreign markets, and the competitiveness of the engineering work force.

Issues related to environmental regulation and public acceptance of new, large infrastructure needs of transportation for roads and airports translate into delays in construction, increased costs, and future deterioration of transportation capacity. The political dimensions of competitiveness translate into favorable financing by governments to companies abroad and penetration and servicing of markets in developing countries. The large passenger aircraft industry is particularly subject to this phenomenon.

The transportation industry is both a driving and driven technological force. It is one of the major markets for high-technology products. It is a user of materials, propulsion, energy, and computer and information technologies. Whether it is the application of information, electronics, and computer technology to increase the capacity of highways, the introduction of new tracking, monitoring, and information systems to control air traffic, or new supercon-

Members of the audience at the 2020 Conference, representing a wide range of organizations, include (left to right) *Ronald McCready, Puget Sound Council of Governments; Richard Robertson, FHWA; Thomas Deen, TRB; Lowell Jackson, FHWA; and Richard Forstall, Bureau of the Census.*

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A futures conference can play an important role in laying the basis for a national strategy to advance the development of safe, efficient, and low-cost transportation systems. However, whichever strategy emerges, it will be only part of the broader issue of developing a national strategy for harnessing science and technology for economic growth and ensuring the competitiveness of all U.S. industry, whether in manufacturing or services. Such a national strategy needs to be shaped around three major thrusts.

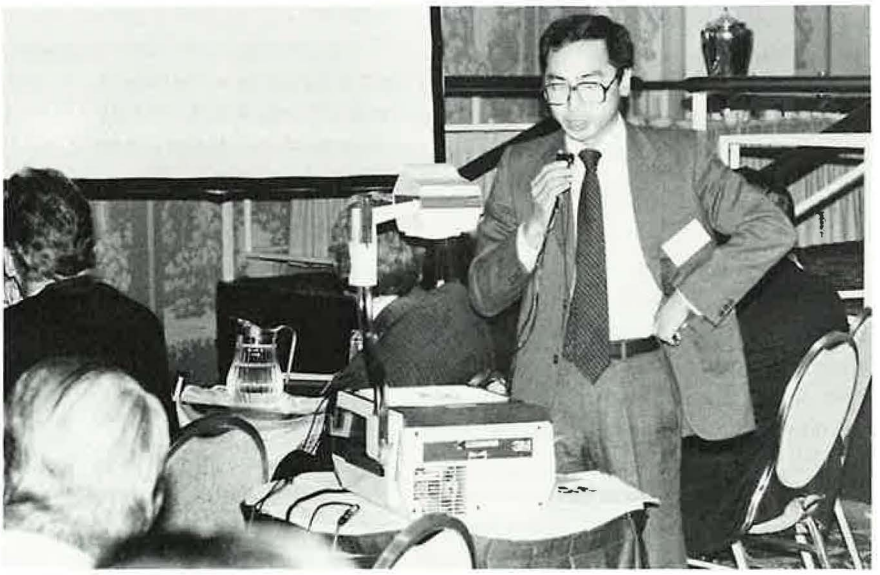
First, we need to regain lost competitiveness. Our national strategy must encourage manufacturing and service industries to adopt the goal of sustained improvement in products and services. We need to conceive and actually treat these activities as integrated systems from design through engineering, production, and marketing. The aircraft manufacturing industry has done this well. The automobile manufacturing industry is doing much better. Marshall McLuhan observed that in an information society, "the medium is the message." We need to become more aware that "the process is the product." This simple concept needs to be embraced by the management of both large and small American corporations.

Evidence is growing that solid progress is now being made in U. S. manufacturing industries. But such concepts are applicable to service industries as well. If services are to be competitive in the world marketplace, particularly in the case of transportation, then the quality and speed of and customer satisfaction with services will need the closest attention.

Second, a drive to capitalize on technology in the economics marathon must be set in motion by the globalization of the economy. It is essential that we look to the long-term health of the engineering and scientific research and development enterprise and its connection to both the manufacturing and service industries. The research infrastructure must be able to produce and capitalize on the technology on which future economic growth and competitiveness will depend.

What is wrong with the current system? By some measures we are doing fine. We invest more money by far in research and development than any other nation. Our system remains the most innovative in the world. Our most severe problem lies in our inability to reap the economic benefits of translating fundamental discoveries into commercial products as rapidly as do some of our competitors.

We have, however, begun to do useful things. The National Science Foundation has established its Engineering Research Centers and will soon expand them with Science and Technology centers. Industry has pioneered new alliances with universities, and universities are exploring new ways of linking with industry. What still needs to be done by government is to create an environment favorable for the commercialization of technology, and many of the necessary actions lie outside the realm of engineering and technology. Economic, tax, regulatory, health, and environmental policies directly affect the ways in which and the degree to which technology advances in industrial applications.



Ryuichi Kitamura of the University of California, Davis, addresses conference participants in the session on Lifestyles.

We need to be still bolder in our thinking about how government and industry can respond to these challenges by fostering research and development on commercially useful technologies. What is the logic? Simply that the nature of competition in a global economy has changed. We now confront a world in which other countries have structured their technological policies and programs to achieve global competitiveness while we have been content to believe that our present structure can meet the new challenge. Like it or not, other countries, as a matter of policy, have now developed government-industry relationships that are able to focus resources in key technological areas to increase market share in aircraft, automobiles, machine tools, or transportation systems. They have adopted policies that enable them to invest in key technologies for the long term and have insulated these activities from the vagaries of short-term market forces.

If we are to play this game successfully, we need mechanisms appropriate to our system that permit long-term investments that individual companies cannot make. One focus of these efforts must be on technological development activities that bridge the gap between scientific discovery and commercialization. The government is already actively pursuing such a course, but in an ad hoc and largely opportunistic way. There has been no broad policy recognizing that there should be government obligation and therefore there has been no consistent approach to the problem.

Several approaches can be taken.

- Recognize that certain strategic, commercial, and defense industrial research and development needs warrant special attention and government support when the private sector is unable to marshal the resources to meet these needs.
- Increase long-term government investment in research on technological problems, the solution of which is essential to the industrial health of this nation.

Three concepts need to be central elements of a national technology strategy for economic growth and competitiveness. We must focus on improving the processes of manufacturing and service industries to achieve quality in and customer satisfaction with U.S. products and services at low cost. . . invest in our research infrastructure . . . take steps to strengthen educational systems.

- Strengthen the processes that lead from discovery to commercialization.
- Develop institutional mechanisms to respond to private-sector initiatives from industries prepared to shoulder a significant part of the financial burden for important research and development on industrial strategic technologies; and be prepared to capitalize on discoveries to encourage engineering development of, for example, high-temperature superconducting materials.
- Involve industry directly in decisions about resource allocation and modes of achieving results.

Third, we need to strengthen our educational systems across the board. If our research and development infrastructure has a weakness, so does our educational infrastructure. Why is this so important? Simply, unless the United States becomes a place where value is added to products, then we cannot be competitive in a broad range of economic activities with other nations that have low wage rates and growing technical and scientific capabilities.

Mathematics and science education from kindergarten through high school must be strengthened. Math and science attainment levels of students in the United States seriously lag those of our industrial allies. Problems also exist at the university level. There has been a decrease in interest in careers in science and engineering among our own citizens. We have become dependent on foreign students in our graduate schools of engineering. We need to increase the numbers of American citizens seeking university degrees in engineering and science.

In summary, three concepts need to be central elements of a national technology strategy for economic growth and competitiveness. First, we must focus on improving the processes of manufacturing and service industries to achieve quality in and customer satisfaction with U.S. products and services at low cost. Our objective is to regain competitiveness where it has been lost.

Second, we must invest in our research infrastructure in new ways. The objective is to ensure the creation of new technology and to foster transfer from scientific discovery to commercialization.

Third, we must take steps to strengthen educational systems. The objective is to ensure the cultivation of future talent in science and engineering.

We face either a dynamic future, incorporating competitive U.S. industries and continued rapid economic growth, with attendant improvements in standards of living, environmental quality, and health care; or we face a future of gradual deterioration of the industrial production capacity of this country compared with other countries, with all the unfortunate consequences that would result. The choice is ours.

1989 TRB Annual Meeting—Advance Registration Information

The Chairman and the Executive Committee of the Transportation Research Board extend to you a cordial invitation to attend and take part in the Board's **68th Annual Meeting**. This meeting is considered to be the largest and most comprehensive conclave of transportation researchers and practitioners in the world and provides an excellent opportunity for the individual who desires to maintain a high level of professional competence in this complex field. Papers on a wide variety of subjects will be presented and discussed by transportation professionals.

The meeting will be held at the Sheraton Washington and Omni Shoreham hotels, **January 22–26, 1989**. Advance registration is available. To take advantage of the lower preregistration fees, please return your registration form by December 15, 1988. For more details on advance registration, or to receive a preregistration form, please write or call

Transportation Research Board
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We look forward to seeing you in January!

Thomas B. Deen
Executive Director

ADVANCE REGISTRATION FORM: (Deadline for reduced fee—**December 15, 1988.**)
Please print or type. Direct all questions to Conference Registrar at 202-334-2934. A confirmation will be sent to you.

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