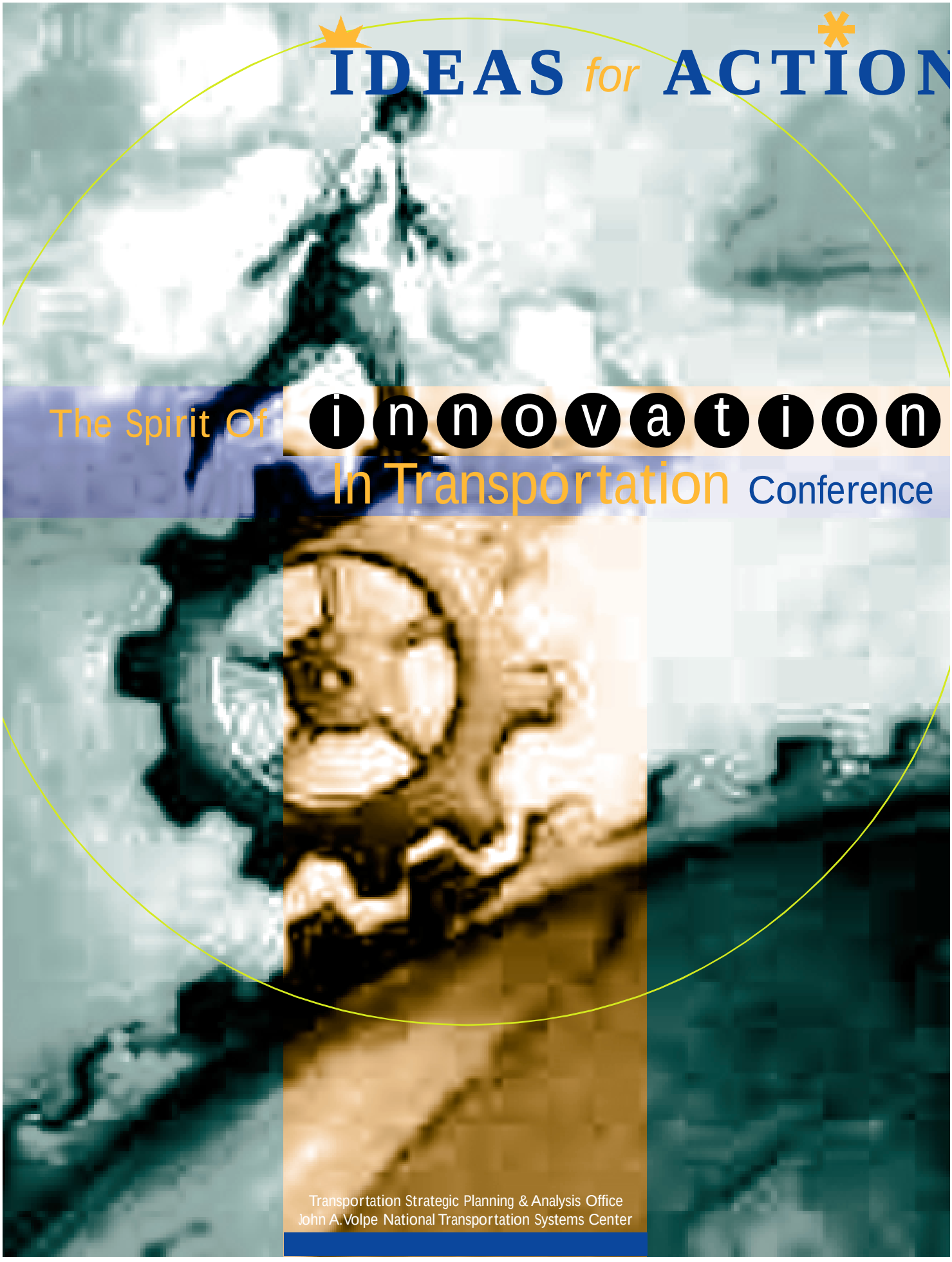

IDEAS for ACTION
The Spirit Of innovation
In Transportation Conference
Transportation Strategic Planning & Analysis Office
John A. Volpe National Transportation Systems Center

IDEAS for ACTION

The Spirit Of Innovation in Transportation Conference

June 24 -25, 1999
Cambridge, Massachusetts

Transportation Strategic Planning & Analysis Office
John A. Volpe National Transportation Systems Center

IDEAS *for* ACTION

The Spirit Of Innovation in Transportation

Our transportation system is the world's safest and most efficient. This system carries more people and goods safer, cheaper, faster, and better than ever before. Transportation is the engine running our economic growth. It accounts for $1.3 trillion, or 17 percent, of our gross domestic product – and its contribution will only grow in the future.

If transportation is the engine for growth, then transportation innovations are key to sustaining that growth in the next century. Just as the Interstate Highway System connected our country in the 20th century, the intelligent transportation infrastructure now being built will connect the world in the 21st century. High-speed rail, maglev systems, and fuel-cell ships will add capacity while preserving the environment. Reusable launch vehicles will lower significantly the costs of exploration and commerce in space. Ultimately, micro- and nano-technologies will make dramatically improved materials and vehicles possible – revolutionizing not just transportation but our entire society.

These technological innovations will be major forces shaping transportation in the 21st century. They will ensure our competitiveness, enhance our environment, maintain security, and most important, save lives. How can we lay the groundwork for these changes? What can we do today to further the next century's transportation innovations?

WE WANT TO ACCELERATE THE **INNOVATIONS** THAT OFFER **GENUINE PROMISE** FOR MEETING THE TRANSPORTATION CHALLENGES OF A NEW CENTURY AND THE **NEW MILLENNIUM.**

Rodney E. Slater, Secretary of Transportation

TO LISTEN AND LEARN

On June 24 and 25, 1999, Secretary of Transportation Rodney Slater brought together nearly 400 leaders from the transportation and technology communities to explore these questions at **The Spirit of Innovation in Transportation** conference at the Department's Volpe Center in Cambridge, Massachusetts. The conference had three overriding objectives:

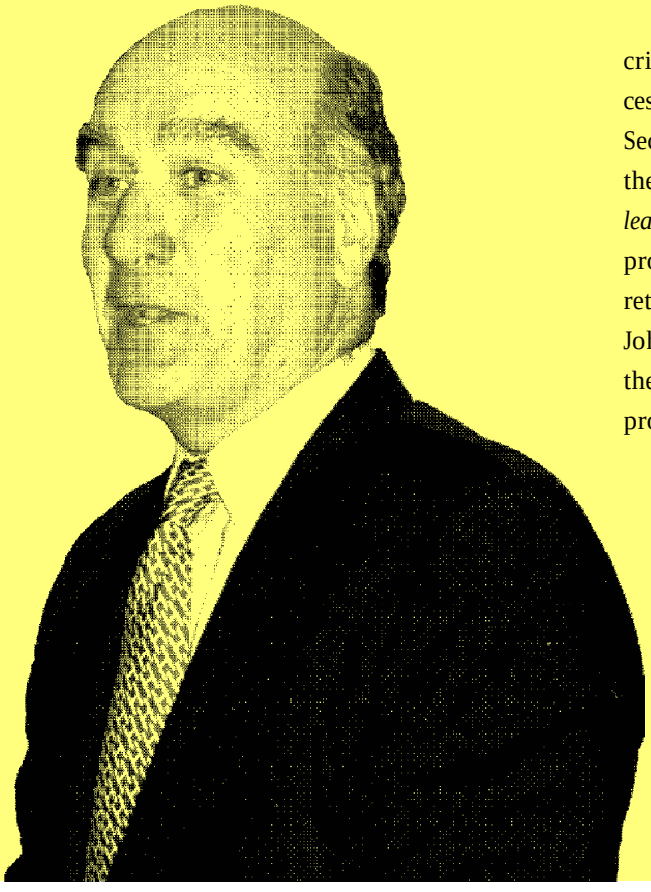
Identify how we can use technology to meet our transportation challenges.

Initiate a strategy and framework for innovation that moves technology forward from ideas to implementation.

Begin to create a climate for innovation that speeds the absorption of new technologies as we enter the next century.

THE KEY TO ALL OUR ECONOMIC **ACHIEVEMENT** SINCE THE BEGINNING OF THIS DECADE HAS BEEN TO LET **INDUSTRY LEAD,** AND FOR GOVERNMENT TO PROVIDE THE TOOLS, AND THE CLIMATE, SO IT CAN **SUCCEED.**

William M. Daley, Secretary of Commerce



Underlining the "spirit of innovation" is the Department's critical role as a partner and enabler in the innovation process. The innovation conference provided a forum in which Secretary Rodney Slater, Deputy Secretary Mort Downey, and the Department's top technology officials could *listen to* and *learn from* transportation and technology leaders about the prospects for innovation in the next century. Addresses by Secretary of Commerce William Daley, White House Chief of Staff John Podesta, and *Fast Company* editor Alan Webber laid out the challenges ahead of us – and the need for innovative approaches to meet these challenges head on.

THREE FACTORS FOR SUCCESS

Innovation will be key to our prosperity and the health of our transportation system in the 21st century. Above all else, **The Spirit of Innovation in Transportation** emphasized three factors that will be vital for success:

Innovation requires an educated and motivated workforce. We must develop a workforce with the skills to create, embrace, and use the transportation innovations of the next century. Transportation organizations must institutionalize education and training in their day-to-day operations. Learning should be lifelong and available to all – to technicians and operators as well as to engineers and professionals.

Innovation requires a commitment to long-term, enabling research. Basic research yields innovations that strengthen transportation and improve our quality of life. All sectors, both private and public, should increase the resources devoted to research and work together to ensure that this research addresses critical transportation challenges.

Innovation requires collaboration and partnership. Developing, deploying, and diffusing technology requires the active collaboration of all sectors of the economy: government at all levels, industry, labor, education, and the research community. These sectors must pool their resources to ensure that technology advances lead to true innovations.

FROM OUR FIRST GRADE CLASSROOMS TO OUR RESEARCH LABS, TO THE HIGHWAYS AND RAILWAY LINKS OF OUR **VAST NATION,** WE MUST WORK TO KEEP OUR **PROSPERITY** GROWING AND BEGIN ADDRESSING THE LONG-TERM CHALLENGES OF THE **21ST CENTURY.**

John D. Podesta, White House Chief of Staff

CALLS FOR ACTION

Five conference sessions generated "ideas for action" by the Department, the government, or the entire transportation and technology community:

- Innovation: New Ways and Opportunities
- Next-Generation Cybertechnology
- Transportation Fuels for the 21st Century
- Nanotechnology and Its Impact on Transportation
- Transportation Workforce for the 21st Century – A Challenge to Education

Summed up in the following pages, these actions will serve as a framework for a Department-wide strategy to ensure a climate for transportation innovation in the 21st century.

ONE PERSON WITH A **GREAT IDEA** AND THE WILLINGNESS TO TAKE A **LEAP OF FAITH** WITH THAT GREAT IDEA CAN INVENT THEIR OWN WAY OF WORKING AND **OVERTHROW** ALMOST ANY INDUSTRY TODAY.

Alan M. Webber, *Fast Company* Founding Editor

INNOVATION: New Ways and Opportunities

After World War II, the United States was the world's dominant economic and technological power. By the 1980s, though, other nations were rapidly gaining and in some areas overtaking us. Competition became intense. Companies went international and even transnational, as modern communication and transportation networks made it possible for anything to be made anywhere and shipped to any market.

In today's new global economy, the U.S. has both strengths and causes for concern.

Some indicators suggest we are retaining our ability to compete. The U.S. has the world's largest and most dynamic domestic market, a solid base of universities and research institutes, a large and skilled workforce, an entrepreneurial culture, and available venture capital.

WE LIVE IN A NEW, SMALLER, AND MORE **COMPETITIVE** WORLD WHERE OUR OWN **PROSPERITY AND** QUALITY OF LIFE DEPEND ON **OUR ABILITY** TO **SUCCEED** AT INTRODUCING INNOVATIONS.

Kelley S. Coyner, Administrator, Research and Special Programs Administration

Unfortunately, other indicators show where our competitiveness is slipping. The number of information technology patents filed in the U.S. from foreign nations is growing. We are devoting fewer resources to basic research, and fewer of us are getting degrees in key fields such as electrical engineering, computer science, and mathematics.

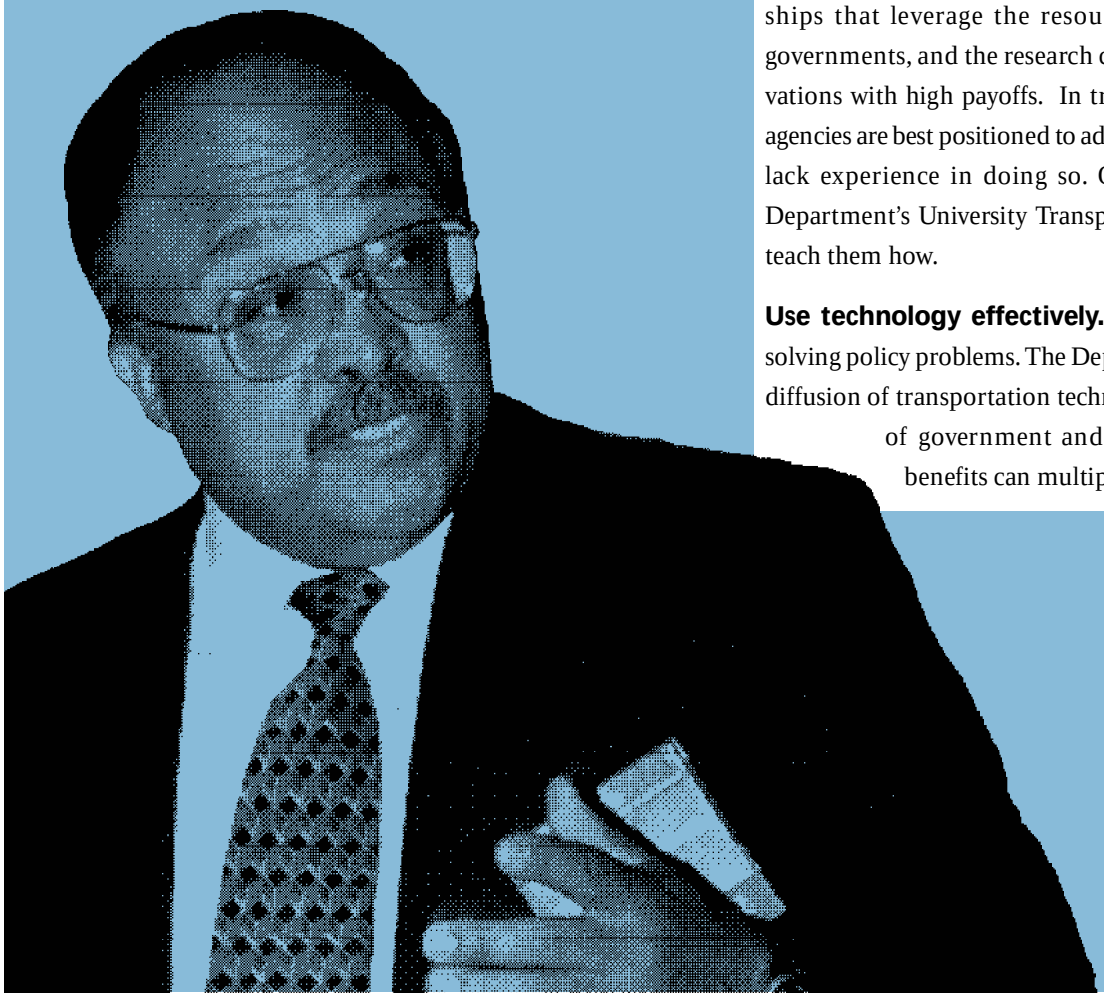
Our country's competitiveness depends on innovation. There are two chief concerns for maintaining our competitive edge in the 21st century. First is the need to strengthen our research base. Next is the quality of our talent pool – training the scientists, engineers, and technicians who will create the innovations that will be vital to propelling our economy forward.

RSPA Administrator Kelley Coyner.

IDEAS *for* ACTION

WE CAN ONLY SUSTAIN A LONG-TERM **COMPETITIVE ADVANTAGE** BY LEARNING FASTER THAN THE REST OF **THE WORLD.**

Maurice Holmes,
Massachusetts Institute of Technology



Revitalize basic research. All sectors of the economy should increase the resources devoted to research. In particular, we must support the long-term enabling research that will generate the next century's technological breakthroughs. At a minimum this will require a return to funding levels of 15 to 20 years ago – before huge cuts in corporate research and the downsizing of defense.

Commit to a new paradigm for education. As a nation, we must improve and expand education in math and science – from elementary school to college. Moreover, we need to replace the traditional "terminal degree and out" concept with one of *lifelong learning*. Our rate of learning today is much slower than the rate of technological change. Employers must make meaningful learning experiences available to workers throughout their careers – both to improve skills and to keep up with new technologies.

Work together. We must encourage and reward partnerships that leverage the resources of private companies, governments, and the research community to produce innovations with high payoffs. In transportation, state and local agencies are best positioned to adopt new technologies but may lack experience in doing so. Other partners, such as the Department's University Transportation Centers, could help teach them how.

Use technology effectively. Technology is a key tool for solving policy problems. The Department should promote the diffusion of transportation technologies throughout all levels of government and the economy, so that their benefits can multiply.

CYBERTECHNOLOGY

Technologies for sensing, storing, processing, display-ing, and communicating information – "cybertechnologies" – are transforming the transportation system's operation and use.

A technical revolution is occurring, ultimately comparable in importance to the automobile and the jet engine. Though the course of this "cyber" revolution is not clear, it is affording unprecedented opportunities to improve the mobility of people and goods everywhere.

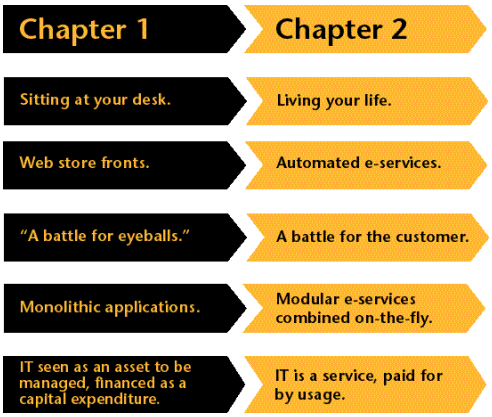
Cybertechnology innovations apply to two broad areas: local or stand-alone applications, for example, crash avoidance or cockpit automation, and system operations, such as traffic and logistics management. All facets of transportation are incorporating these advances. Cybertechnologies are transforming vehicles and their components and subsystems. But they also are improving transportation's physical elements, by means of an information "overlay" that is changing virtually every process involved in providing transportation services.

COMPUTING IS EXPANDING **EXPONENTIALLY.** THE BIG **CHALLENGE** IS TO PLAN FOR AND COPE WITH **RAPID** OBSOLESCENCE.

T.D. Fehr, Boeing Commercial Airplane Group

Beyond changes in transportation services, cybertechnology is reshaping our transportation demand. New ways of working, innovative business models, and lifestyle changes are changing our needs for transportation – and the ways in which we satisfy them.

As with earlier innovations, cybertechnology applications may at first provide only modest improvements. Yet, as these mature and link up with other applications and innovations, they can truly transform transportation, dramatically improving efficiency and making possible entirely new services.



Today's Internet is only the first chapter of a major technological shift.

IDEAS *for* ACTION

AS FAR AS WE THINK WE'VE COME TODAY WITH THE **INTERNET,** WHAT HAPPENS NEXT IN THE SECOND GENERATION IS TRULY GOING TO **CHANGE THE WAY** CIVILIZATION IS GOING TO COME TO BE.

Sanjay Srivastava,
Hewlett Packard Corporation

Define a vision. Local applications of cybertechnology may provide local benefits, but may not represent the best approach for the transportation system as a whole. It is the Department's role to identify future challenges, establish national goals, promote technology diffusion, and forge a consensus on system evolution.

Provide the framework. Many advances are possible only because the underlying elements, such as the government's Global Positioning System, are already in place. Other innovations will require a new framework of communication standards, data definitions, and frequency allocations. Government and industry must work together to assure that this framework is ready and in place for the next century.

Build an information infrastructure. Cybertechnology depends on the availability of accurate and comprehensive data – in transportation, digitized highways, transit routes, nautical charts, weather information, and more. A seamless system requires an information "backbone" integrating all of this data and ensuring compatibility. The Department is working with the transportation and technology community to build such a backbone – the National Intelligent Transportation Infrastructure, or NITI.

Collaborate. The direct links that are possible across the transportation sector – from manufacturers to service providers to users – are redefining virtually every business process. Cybertechnologies' enormous potential can only be realized through active collaboration and the broadest possible information sharing among all of these partners.

FUELS AND VEHICLES

In the past two decades, changes in vehicle technology and fuel have helped us make great strides in improving air quality. Many of these changes, such as catalytic converters and unleaded gasoline, are now spreading around the world.

Yet, continued concerns about ozone, the buildup of greenhouse gases, and our reliance on imported oil are creating interest in far more distinct alternatives to our petroleum-intensive transportation system. A number of potential future directions look promising, though it is not clear which will ultimately be the best choice or how we will make the transition.

For cars and light trucks the most promising new technologies include advanced spark- or compression-ignited engines; hybrid electric drivetrains; lighter, stronger materials; fuel cells; efficient accessories; and on-vehicle fuel processors. A switch to a fuel source other than petroleum would accelerate many of these advances. More important, switching from petroleum would help to make our transportation activities more "sustainable" – in terms of our natural environment, our economic growth, and our national security.

THERE'S A LOT OF IMPROVEMENT POTENTIAL IN THE **MAINSTREAM** TECHNOLOGIES. WE SHOULD BE OPTIMISTIC ABOUT THAT, AND IT RAISES THE STAKES FOR **ALTERNATIVE** TECHNOLOGIES. NOT ONLY DO THEY HAVE TO BE SIGNIFICANTLY BETTER THAN WHAT WE'RE NOW DOING, THEY HAVE TO BE SIGNIFICANTLY BETTER THAN **EXTRAPOLATIONS** OF WHAT WE'RE NOW DOING.

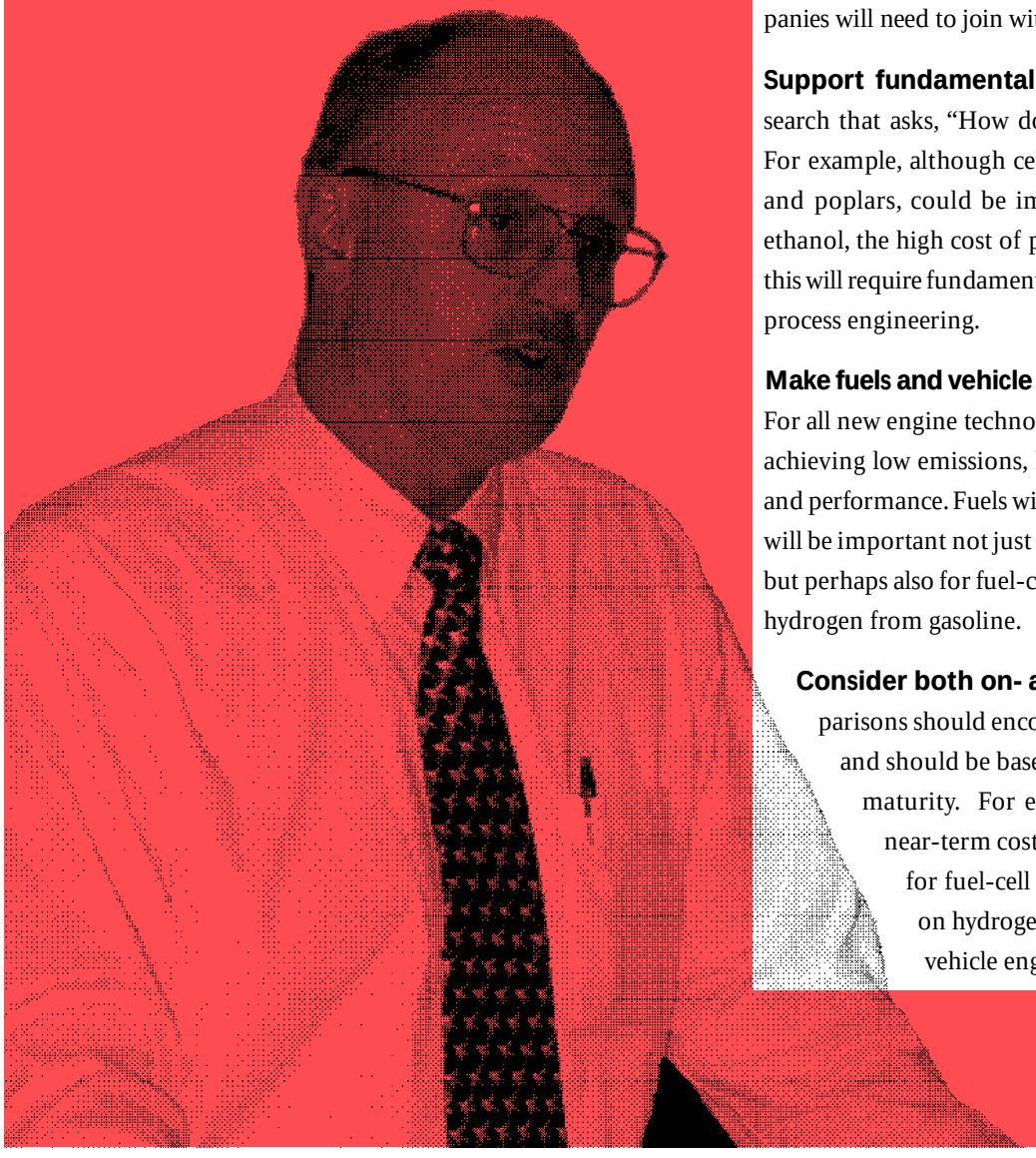
John Heywood, Massachusetts Institute of Technology

Secretary Rodney Slater with
David Mikoryak of Lockheed Martin.

IDEAS *for* ACTION

WHAT WILL THE **DOMINANT** ENGINE TECHNOLOGY DURING THE NEXT CENTURY BE? ONLY THE **MARKETPLACE** CAN ANSWER THIS **QUESTION.**

James Spearot,
General Motors Corporation



Be optimistic, realistic, and patient. There is a long list of possible vehicle and fuel improvements. We need better systems analysis to determine which pathways represent the best investments for both companies and the nation.

Ask focused questions. Those making the decisions in industry, government, and other sectors must ask a wide range of detailed questions about candidate technologies – and use their resources to address them – if they are to make intelligent judgments about bigger-picture issues.

Partner. Getting entirely new vehicle and fuel systems into the marketplace will require ongoing collaboration and action among government at all levels, industry, labor, researchers, consumer groups, and other partners. To have an impact, small companies will need to join with major players in the industry.

Support fundamental research. There is a need for research that asks, "How does the technology actually work?" For example, although cellulose fuel sources, such as grasses and poplars, could be important for future production of ethanol, the high cost of processing is a barrier. Overcoming this will require fundamental innovations in biotechnology and process engineering.

Make fuels and vehicle technologies more compatible. For all new engine technologies, changes in fuel will be key to achieving low emissions, high efficiency, and acceptable cost and performance. Fuels with lower sulfur content, for instance, will be important not just for new gasoline and diesel engines, but perhaps also for fuel-cell vehicles with systems that extract hydrogen from gasoline.

Consider both on- and off-vehicle costs. Cost comparisons should encompass both the vehicle and the fuel and should be based on similar levels of technological maturity. For example, while methanol may have near-term cost advantages over hydrogen as a fuel for fuel-cell vehicles, a large-scale system based on hydrogen may actually be cheaper, since the vehicle engineering can be simpler.

NANOTECHNOLOGY

"Nanotechnology" is the building of devices and materials at the level of atoms and molecules and the exploitation of the new and improved properties at this scale. These novel properties are due to the different behavior of things at the level of the nanometer, the unit of measurement representing one-billionth of a meter – or about ten times the size of an individual atom.

Nanotechnology implies the direct control of atoms and molecules. Broadly, it comprises three areas of research: the design of atomically engineered "building blocks"; the assembly of these building blocks into new, "nanostructured" materials with tailored characteristics; and the assembly of these new materials into useful devices.

WE ARE IN THE BEGINNING OF A **PROCESS** WHICH IS GOING TO AFFECT ALL OF OUR LIVES IN VERY REAL WAYS IN THE **COMING CENTURY.** THE QUESTION IS NOW, HOW CAN DOT AND ALL AGENCIES REALLY HELP TO **ENERGIZE THE PROCESS?**

Richard W. Siegel, Rensselaer Polytechnic Institute

Today nanotechnology is yielding atomic- or molecular-scale components in everything from hard disks to coatings – resulting in sales totaling tens of billions of dollars a year. It is revolutionizing virtually every area of technology and will have a direct and dramatic impact on transportation. Ultimately, nanotechnology will yield lighter, more efficient cars made of "nanoparticle-reinforced" materials; smart materials that monitor their own status and health; uninhabited vehicles for defense and commercial uses; and carbon-based "nanotubes" that serve as hydrogen supersponges in fuel cells.

Nanotechnology has the potential to change almost every human-made object. However, the challenges are formidable. Nanotechnology today is roughly where information technology was in the 1950s. Realizing its promise will require a long-term, balanced investment and a strong alliance among government agencies, national laboratories, academic institutions, and the private sector.

The unique properties of carbon nanotubes make them ideal for hydrogen storage in fuel cells.

IDEAS *for* ACTION

ELECTRONICS NOW IS AT THE **TENTH OF A MICRON** SCALE. WE'RE TALKING ABOUT SOMETHING **TWO ORDERS OF MAGNITUDE** LESS IN SIZE.

Mildred Dresselhaus,
Massachusetts Institute of Technology

Look ahead. DOT, and every federal agency, must look ahead to consider the implications of nanotechnology 10, 20, or even 30 years from today. A central challenge for the Department will be to bring together researchers and users to encourage nanotechnology research leading to transportation applications.

Support critical research. Nanotechnology promises to revolutionize transportation and our entire society, but it is still at the level of basic research. More long-term work is needed to continue discovery of novel phenomena, processes, and tools; to design and process the engineered building blocks; and to apply nanotechnology to the manufacture of transportation systems and materials.

Build a national network. A network of centers of excellence at top universities would build on the capabilities of the National Nanofabrication Users Network and other centers that now exist. Such centers would form strong and enduring partnerships with industry and federal laboratories in nanotechnology research, development, and training.

Partner, partner, partner. Multidisciplinary partnerships will be essential if we are to exploit nanotechnology discoveries to meet national needs. Such partnerships must include federal laboratories, universities, and industry to avoid duplication of effort and hasten technological advances.

Develop a new breed of researchers. The scientists and engineers who will make nanotechnology's promise a reality will work across the disciplines of physics, chemistry, biology, and engineering, and in the interfaces between them. This multidisciplinary perspective will be critical for rapid progress and should be nurtured in our educational institutions, including our University Transportation Centers.

Support efforts for a national initiative. A coordinated federal initiative would expedite nanotechnology advances and ensure U.S. leadership in the field. The Administration is proposing a National Nanotechnology Initiative, which includes DOT, that would strengthen and promote both interagency and public-private collaboration.

TRANSPORTATION WORKFORCE

Globalization and the rate of technological change demand a new emphasis on the training and education of the transportation workforce.

Transportation today is a global business, with companies providing products and services to diverse markets worldwide. In this "shrinking" world, transportation workers must have the skills to communicate and work with people anywhere on the globe – requiring new work roles and entirely new ways of interacting.

Likewise, today's transportation professionals must adapt to a steady infusion of new technologies. This places continuing demands on those who design, build, operate, and maintain our transportation system and who make or provide transportation products and services.

THE ORGANIZATIONAL **ARMOR** THAT WE GIRD OURSELVES IN TO FIGHT **THE GOOD FIGHT** IS ABOUT 30 TO 40 YEARS OLD – TOO HEAVY, TOO INFLEXIBLE, TOO FRAGMENTED TO EFFECTIVELY GET THE **JOB DONE** TODAY.

Beverly Scott, Rhode Island Transit Authority

Meeting these challenges is a prerequisite for innovation in the next century. In large part, the success of the transportation workforce depends on how well transportation organizations and educational institutions understand and adapt to change.

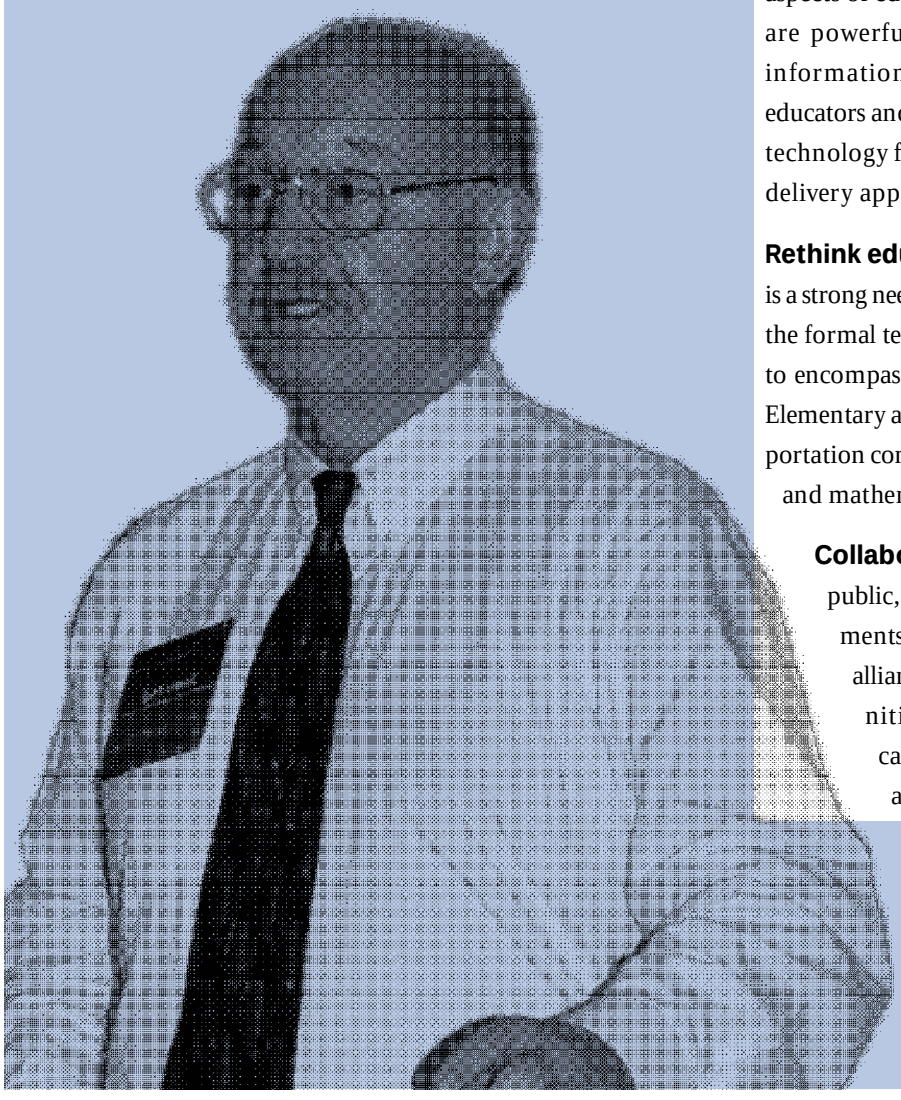
Today's transportation educators have a different set of rules than their predecessors. To prepare the next-generation workforce, educators and organizations must meet three critical needs. First, they must bring together the public, private, and academic sectors. Next, they must supplement the traditional focus on technical issues with training in transportation management and policy. And, finally, they must create an interest in transportation early on – starting at the K-12 levels – and make education available throughout one's transportation career.

Students at the Robert F. Kennedy Elementary School in Cambridge, Massachusetts.

IDEAS *for* ACTION

WE HAVE TO GO TO THE HIGH SCHOOLS THAT DON'T ACHIEVE AS MUCH, AND TO THE **YOUNG PEOPLE** WHO WANT TO **ACHIEVE.** WHET THEIR APPETITES – FIND A WAY TO **TALK** TO THEM.

Sonny Hall,
Transport Workers Union of America



Overcome cultural barriers. Organizational barriers inhibit transportation innovation. All too often, a lack of training and fear of change work against the acceptance of new technologies or practices – particularly in public agencies. One solution is for federal, state, and local agencies to work together to establish "regional centers of excellence" for innovation in transportation.

Address "people aspects." Transportation must consider the changing demographics of the workplace. Traditional jobs and careers should be broadened to include under-represented groups – especially in key leadership positions. Given today's global economy, transportation organizations should recruit internationally and train employees to work in "global teams."

Exploit technology. Technology is transforming all aspects of education. Information technologies, in particular, are powerful tools for analyzing problems and sharing information about potential solutions. Transportation educators and trainers should make greater use of information technology for distance learning and other non-traditional delivery approaches.

Rethink educational processes. At the college level, there is a strong need for a transportation curriculum that transcends the formal technical requirements of science and engineering to encompass transportation management and policy issues. Elementary and secondary curricula should incorporate transportation components and emphasize subjects, such as science and mathematics, that are essential to the field.

Collaborate and partner. Partnership among the public, private, and academic sectors can leverage investments in transportation education and create bold new alliances. Potential partners should look for opportunities to share technical knowledge, create new career opportunities, conduct joint research, and apply innovative technologies.

IDEAS *for* ACTION

These Ideas for Action are a first step in an ongoing, collaborative process with the entire transportation and technology community. The Department is interested in any idea that supports a climate for innovation, that helps to institutionalize such a climate to speed technology absorption, and that contributes to meeting our national transportation goals.

The Department has set up a website for the exchange of ideas and insights on the innovation process. Reactions or comments to **Ideas for Action** or **The Spirit of Innovation in Transportation** conference can be sent to the Department directly via:

http://www.volpe.dot.gov/spirit/index.html

WE WANT TO LEAVE A LEGACY THAT INCLUDES A **POLICY ARCHITECTURE** FOR TRANSPORTATION **DECISION MAKING** IN THE 21ST CENTURY THAT PUTS A FOCUS ON **TECHNOLOGY** AND HUMAN CAPITAL **INVESTMENT** AT ITS CORE.

Rodney E. Slater, Secretary of Transportation

Transportation Strategic Planning & Analysis Office
John A. Volpe National Transportation Systems Center
Research and Special Programs Administration
U.S. Department of Transportation

Volpe National Transportation Systems Center
55 Broadway
Cambridge, MA 02142