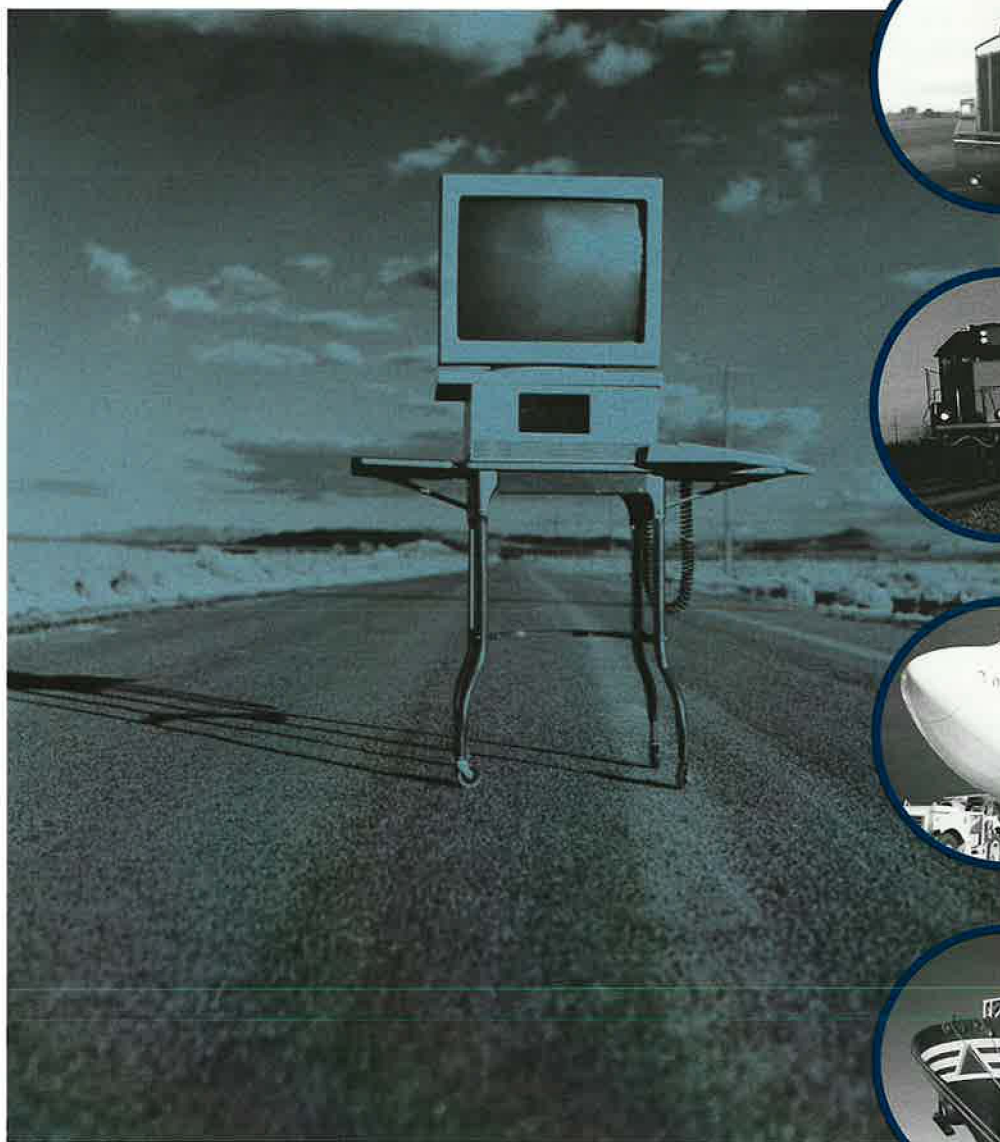


Developing an “E-Sensible” Transportation System

What Are the
Research and
Data Needs?

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The digital economy is becoming a major force in our society, and e-commerce is gaining prominence. The dotcom bubble of "irrational exuberance" may have burst, but according to U.S. census data (see Figure 1), e-commerce retail sales reached \$7 billion in the United States during the first quarter of 2001—a 33.5 percent increase from the first quarter of 2000. A significant portion of U.S. economic growth during the past decade is attributable to the productivity spurred by the Internet and information technology (IT).

Although e-business accounts for less than 1 percent of total retail sales, the digital economy is evolving rapidly, and the impact on transportation possibly will be significant. Already the digital economy is changing freight demand and movement as well as personal travel. However, little is known about how and to what extent e-commerce will influence or interact with transportation, and less is known about how these changes will affect safety, the environment and equity, and land use patterns.

To harness the economic potential of digital technologies, the transportation system must promote—not constrain—the growth of electronic commerce. For this reason, a comprehensive understanding and a quantitative estimate of the possible impacts of e-commerce on transportation and of transportation on e-commerce are crucial.

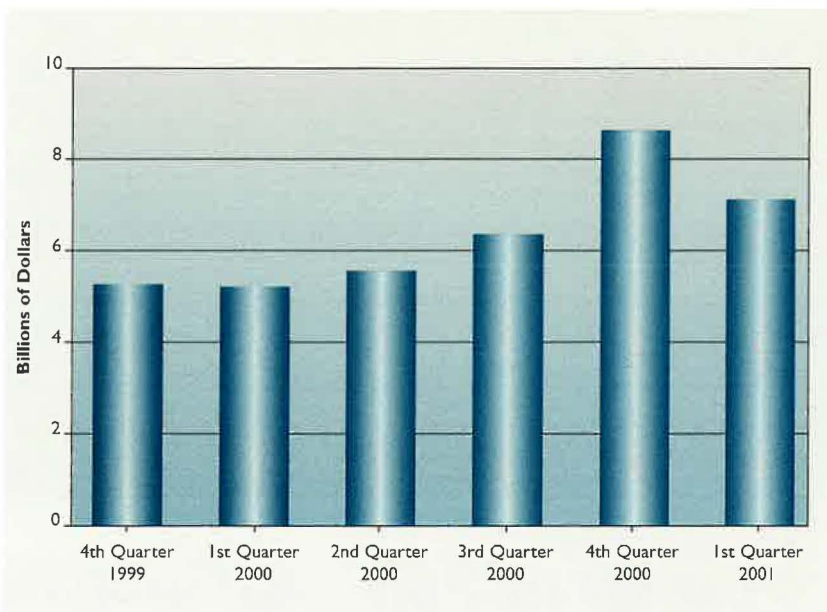
Identifying Research and Data Needs

The digital economy will induce changes in transportation demand and in transportation supply. Understanding these changes—which will affect the economy, society, energy consumption, the environment, and safety—poses a significant and multifaceted challenge.

To stimulate the development of an "e-sensible" transportation system, researchers and representatives of federal and local governments and the private sector gathered for a workshop to define an initial set of research and data needs. Cosponsored by the Oak Ridge National Laboratory and the Transportation Research Board, the Workshop on Implications of the New Digital Economy on Transportation: Developing Research and Data Needs was held at the National Academy of Sciences in Washington, D.C., September 14–15, 2000.

Research Priorities

The impacts of the digital economy on transportation (and vice versa) are uncertain, raising many questions and issues. The goal of the workshop was to identify and prioritize the research and data needs to address the questions and issues. The workshop discussions identified the ten most urgent needs.



1. Estimate the impact of the digital economy on freight transportation demand.

The most apparent impact of the digital economy on transportation is the change in freight transportation demand. Low cost and instant access to information about new products and markets are stimulating an increase in freight activity, both in the tons and the value of the goods transported.

Although freight activity has increased, the digital economy, with its benefits of accurate and timely information about suppliers, markets, and transportation requirements, has made supply chain networks—which integrate and organize the movement of goods among suppliers, manufacturers, distributors, retailers, and consumers—more efficient and more profitable than ever before. This gain in the movement of goods through more efficient supply chains may offset the increased demand for freight services, so that freight movement—for example, as measured in vehicle miles traveled—may not increase as much as some have anticipated.

Research should identify the changes that the digital economy may induce in freight transportation and the net impacts by estimating freight movements in terms of value, tons, and miles with and without the digital economy. The estimated differences in network demand by mode can address such questions as

- ◆ How does the digital economy affect transportation mode choices?
- ◆ Will increases in transportation demand reduce transportation costs? Will lower transportation costs induce increases in freight demand?

FIGURE 1 Estimated U.S. retail e-commerce sales.

SOURCE: U.S. Bureau of Census



**RESEARCH IS NEEDED TO IMPROVE
UNDERSTANDING OF HOW
INFORMATION TECHNOLOGY
CREATES E-BUSINESS OPTIONS THAT
CAN REDUCE THE TOTAL COST OF
ACQUIRING GOODS.**

◆ Will the efficiency that supply chains gain from the digital revolution offset the increased demand for freight transportation?

If the net impact of the digital economy on freight demand is sizable, the current capacities and spatial distributions of roadways, waterways, airways, railways, intermodal terminals, and connectors should be evaluated to meet the demand.

2. Estimate the impact of the digital economy on overall passenger transportation demand.

The digital revolution also will affect personal travel—the daily and weekly travel activity patterns of households. New technologies will influence trip frequency and length, as well as the temporal and spatial distributions and the modes and purposes of travel. However, the overall impacts on personal travel demand are as yet unknown, and the interaction between changes in freight transportation and changes in passenger transportation is unclear.

Research must identify the changes induced by the digital economy on passenger transportation and should estimate the net impacts. The research also should evaluate the net impact on transportation demand by combining changes in freight transportation demand with changes in passenger transportation demand.

3. Reengineer the transportation system to meet future needs and to foster economic development.

If the first two research activities conclude that current transportation capacities cannot meet the changes in freight and passenger transportation demand, there is a need to develop guidelines for

◆ Managing and operating the current systems to maximize efficiency, and

◆ Designing future transportation systems so that roadways, waterways, airways, railways, intermodal terminals, and connectors meet future demand and foster the development of the digital economy.

4. Understand changes in supply chain visibility, in-transit visibility, and inventory management.

More accurate and more up-to-date information on the availability and price of goods is changing the way businesses handle inventories. Access to near-real-time information about the location of in-transit vehicles and cargo is another facet of the IT revolution in supply chain management. The more that suppliers and their customers know about product inventories—including in-transit inventories—the more effectively, in theory, demand for goods can be met.

Research is needed to improve governmental as well as private sector understanding of how IT creates e-business options that can reduce the total cost of acquiring goods. The government must understand which sectors of the economy are most likely to benefit from new information technologies and must provide better assistance to companies seeking to trade in the rapidly evolving, and highly competitive, global marketplace. Understanding e-business logistics is also important in government efforts to ensure fair business practices, since suppliers and customers increasingly share information—sometimes proprietary—about their operations.

5. Create digital opportunities to improve efficiency, environmental sustainability, and transportation safety.

Many public sector procedures move at a glacial pace while information technologies advance at Internet speed. Some public sector procedures are able to implement and leverage the benefits of digital technologies almost immediately; however, many of the slowest-paced processes must capitalize as soon as possible on the benefits of digital technologies.

Research should investigate how to adapt public sector processes to create digital opportunities that maximize efficiency, maintain environmental quality, and improve transportation safety. A panel of visionary IT and transportation experts could convene to

- ◆ Identify opportunities,
- ◆ Estimate the costs and benefits,
- ◆ Explore and foster cost-sharing partnerships with other agencies and private-sector shareholders, and
- ◆ Pursue qualified opportunities.

6. Develop methods to estimate the impacts of the digital economy on energy, environment, and safety.

The changing demands on freight and passenger transportation may produce undesirable results, such as undermining energy efficiency, environmental quality, and highway safety. Increased freight traffic will subject the public to more trucks on the roads, and research shows that a greater percentage of trucks in traffic may have an adverse impact on highway safety. The increased demands on commercial drivers also raise other safety issues.

However, if part of the digital economy makes it possible to avoid certain trips—such as a personal trip to a bookstore—then the question arises: how will this decrease in demand for personal transportation counterbalance the increase in demand for freight transportation spurred by other parts of the digital economy?

In terms of energy efficiency and environmental quality, faster and guaranteed on-time delivery also may mean more vehicle miles traveled by vehicles carrying smaller payloads. More vehicle miles traveled may mean more pollutants emitted. According to speculations, about half of the trucks on the highway travel empty, and many others—especially in urban areas—carry only partial loads.

Will more complete information lead to more efficient use of transportation assets? Will the ability to use real-time in-vehicle communications in conjunction with real-time data on vehicle stock availability and customer demands allow significant savings in vehicle fleet utilization costs? Will savings be gained from—or at the expense of—additional vehicle miles traveled and fuel use? Planning the future transportation system requires identifying and developing methodologies to estimate the extent of undesirable impacts.

7. Assess the digital divide.

The digital economy, especially the growth in business-to-business and business-to-consumer e-commerce (despite the recent problems experienced by these sectors), offers the potential of bringing goods and services to economically depressed locations, as well as to disabled and elderly people who have limited mobility and access to goods and services.

How can the government encourage the use of Internet-based transportation information and services in economically depressed areas and among the elderly and persons with disabilities populations? What should be the role of the federal, state, and local governments in establishing community information networks and what effect will these have on transportation services and needs?

How can these services be provided in a way that minimizes the digital divide?

The digital economy may create a divide between people with access to information and people without it. Groups susceptible to being left behind by the digital technology revolution are in areas with large populations of low-income and poorly educated families and also include the elderly, minorities, and persons with disabilities. Research must develop ways to assess the extent of the digital divide and recommend strategies to prevent or reduce it.

8. Estimate the digital economy's impacts on land use patterns.

The digital economy is redefining the interrelationships of production, distribution, and warehousing. These new relationships will alter the geography of business, which in turn will alter the need for new roads, new transit services, and new freight pick-up and delivery services.

Regional planners need to know if the digital economy will encourage or discourage the geographic expansion of cities. For example, companies generating higher percentages of sales via cyberspace will become “location neutral.” Will this encourage the spread of offices, warehousing, and other activities into the suburbs?

Residential neighborhoods also may change. Neighborhoods traversed by large numbers of just-in-time, small-package delivery trucks may seek changes in street layouts and stricter controls of freight traffic. It is unclear how significant growth in to-the-home goods delivery services may affect residential preferences and even retail locations. Will large, multipurpose shopping malls remain popular? Or will home delivery or direct-to-the-customer wholesale activity make malls less common? Will “brick and mortar” establishments change their business models?

Research should project the changes that the digital economy will induce in urban land use patterns and in the relationship between residential areas and local concentrations of delivery and pickup facilities, as well as the changing patterns around ports and intermodal terminals. Research also should examine the digital economy-induced changes in the relationship between rural and urban communities and how the changes may affect rural economic growth. Finally, research should evaluate the associated implications for transportation planning.

9. Estimate the impact of digital economy-induced transportation on economic growth.

Economic growth and transportation are vitally linked—each sustains the other. Transportation

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breeds economic growth, economic growth demands additional transportation, and the cycle continues. Understanding the relationships between transportation and digital economy-induced growth is crucial to keeping the cycle strong and vital.

The digital economy may pose unprecedented requirements for transportation. Research is needed to anticipate the requirements, estimate the impact, and plan future transportation systems proactively and strategically.

10. Create digital opportunities for transit.

The digital economy will introduce opportunities and challenges for public transit. Intelligent transportation systems that use digital technologies also can improve transit operations, service, and ridership (see sidebar on page 19).

However, the digital economy also may affect the demand for transit in other ways—for example, through the likely consequences of increased geographic dispersion and decentralization of activities. Digital communications may lead to significant changes in daily work practices, with a large percentage of the population telecommuting from home.

This scenario may increase urban sprawl and decrease demand for traditional transit, because proximity to the workplace would be less important to residential location. In addition, digital communication connections will affect the traditional role of cities and urban areas as a central gathering place. These issues require investigation to

- ◆ Identify how digital technologies can improve transit operations;
- ◆ Assess the impact of technology on daily life and businesses;
- ◆ Define techniques to model the interactions between land use and transportation demand and supply in the digital information age; and
- ◆ Assess the potential role of transit services in narrowing the digital divide, for example by providing on-demand transit services to economically disadvantaged populations.

Data Needs

The research goals should define the data needs—that is, all of the research projects should include specific plans to meet fundamental data requirements. The workshop participants recommended that data collection efforts should leverage results from nontransportation surveys—for example, the annual survey of manufacturers by the U.S. Bureau of the Census.

Workshop participants identified the following priorities for data:

◆ Focus on collecting meaningful information on the entire transportation network, including data on multimodal freight movements—such as what and how much (in terms of tons and values) is moving from where to where and by what modes—as well as data on the extent of door-to-door transportation and on home-based freight trip rates.

◆ Develop benchmarks for changes in transportation demand and supply spurred by the digital economy (in tons, values, and passengers).

◆ Because the digital economy may alter traditional supply chains by altering business interactions between carriers and customers, develop a strategy to improve the alignment of customer and carrier data and to address privacy and security concerns.

◆ Measure transportation changes induced by e-commerce on economic growth and productivity.

Digital technologies offer unprecedented opportunities and tools for collecting data. With these opportunities arise concerns about the positive and negative impacts of new data forms (e.g., data on individual transactions), and the coordinated access and use of data from public and private sources. Data that were inaccessible in the past are now becoming available, presenting the opportunity to define meaningful measures of performance for evaluating the transportation system.

Next Steps

To maintain the momentum of the workshop and to ensure careful consideration of the identified needs, participants called for a task force with greater stakeholder involvement to refine and prioritize the research needs. The task force would evaluate the potential benefits of the research programs from the perspectives of cost and practicality; implement research programs through funding partnerships from agencies such as the U.S. Department of Transportation, the Department of Energy, the Environmental Protection Agency, the American Association of State Highway and Transportation Officials, state departments of transportation, and the private sector; and evaluate research program results.

Acknowledgments

This article is based on the author's summary of the proceedings of the Workshop on Implications of the New Digital Economy on Transportation: Developing Research and Data Needs. The workshop participants are the sources of the ideas and insights; however, the author is solely responsible for the views expressed in this article.