

**TRANSPORTATION INVESTMENT AND ECONOMIC
EXPANSION: CASE STUDIES**

VOLUME I



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National Cooperative Highway Research Program
Transportation Research Board
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Preface

This report is the first of a two-volume report prepared as part of a project sponsored by the American Association of State Highway and Transportation Officials (AASHTO) Special Committee on Economic Expansion and Development. The main objective of the project was to prepare a report on what we know about the **fundamental ways in which transportation investment affects economic expansion** in today's global economic climate. The research project was conducted by Louis Berger International, Inc., based on a synthesis of previous studies and the results of selected case studies covering all modes and types of transportation investments. This work is intended to help focus on priority transportation investments that are most supportive of the nation's and the states' economic expansion objectives. This version is an update of an earlier version prepared in March 1994. Readers may particularly be interested in Section V of this report which discusses what we know and what we don't know about the linkages between transportation and economic expansion. A brief overview of the findings and conclusions of the project is also presented in a separate Summary Report.

Acknowledgment

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ABBREVIATIONS AND ACRONYMS

AAPA	American Association of Port Authorities
AASHTO	American Association of State Highway and Transportation Officials
ATLF	Advanced Truck Load Freight
ARC	Atlanta Regional Commission
ARTCC	Air Route Traffic Control Center
BART	Bay Area Rapid Transit
BPR	Bureau of Public Roads
CAAA	Clean Air Act Amendments
CAPUFE	Caminos y Puentes Federales de Ingresos y Servicios Conexos
CAT	Category
CBO	Congressional Budget Office
CIP	Capital Improvement Program
CIP	Capital Investment Plan
COE	Corps Of Engineers
CTPS	Central Transportation Planning Staff
DOT	Department of Transportation
DVRPC	Delaware Valley Regional Planning Commission
DWT	Dead Weight Tons
FAA	Federal Aviation Administration
FAIP	Freight Access Improvement Program
FHWA	Federal Highway Administration
FNM	Ferrocarriles Nacionales de Mexico (Mexico's National Railroad)
FTA	Federal Transit Administration
FY	Fiscal Year
GATT	General Agreement on Trade and Tariffs
GaDOT	Georgia Department of Transportation
GDP	Gross Domestic Product
GM	General Motors
GNP	Gross National Product
GSP	Gross State Product
HOV	High Occupancy Vehicle
IRR	Internal Rate of Return
ISTEA	Intermodal Surface Transportation Efficiency Act
ITS	Intelligent Transportation System
IVHS	Intelligent Vehicle Highway System
JIT	Just-In-Time
LA	Los Angeles
LBS	Laredo Bridge System
LRP	Long Range Plan
LOS	Level of Service
MAPC	Metropolitan Area Planning Council
MARTA	Metropolitan Atlanta Rapid Transit Authority
MDPW	Massachusetts Department of Public Works

MLS	Microwave Landing System
MnDOT	Minnesota Department of Transportation
MPO	Metropolitan Planning Organization
MTC	Metropolitan Transportation Commission
NAFTA	North America Free Trade Agreement
NAS	National Airspace System
NASP	National Airspace System Plan
NCHRP	National Cooperative Highway Research Program
NEPA	National Environment Policy Act
NHS	National Highway System
NPIAS	National Plan of Integrated Airport Systems
NPV	Net Present Value
PaDOT	Pennsylvania Department of Transportation
PCN	Priority Commercial Network
POB	Port of Baltimore
PSR	Pavement Serviceability Ratings
RISE	Revitalize Iowa's Sound Economy
SEPTA	Southeastern Pennsylvania Transportation Authority
TCM	Traffic Control Measures
TEA	Transportation Economic Assistance Program
TEU	Twenty Foot Equivalent Unit
TEDF	Transportation Economic Development Fund
3C PROCESS	Cooperative, Comprehensive and Continuing Planning Process
TIP	Transportation Improvement Program
TRACON	Terminal Radar Approach Control Facilities
TRB	Transportation Research Board
TxDOT	Texas Department of Transportation
UPS	United Parcel Service
US	United States
USDOT	United States Department of Transportation
V/C	Volume/Capacity
VMT	Vehicle Miles of Travel
WMATA	Washington Metropolitan Area Transit Authority

TRANSPORTATION INVESTMENT AND ECONOMIC EXPANSION: CASE STUDIES

Highlights

Transportation infrastructure has played a key role in the development of the nation's economy. The US has been a leader in transportation technology and service innovation, as demonstrated by the development of the national railroad, aviation and Interstate Highway systems. Historically, the role of transportation investment as a catalyst to stimulate economic development is well understood. The construction of new and expanded transportation systems contributed to the development of the interior and western US, and have significantly affected land development patterns.

The economic impact of more recent major transportation infrastructure investments, such as the Interstate Highway System and the National Airspace System, extend well beyond their effects on land development. For example, the most significant impact of the Interstate System has been the improvement in connectivity and reduction in travel time between population, production and distribution centers across the nation. This improved connectivity, coupled with deregulation, has significantly improved the **productivity** of the transportation industry and other users of the system. In contrast with the historical contribution of transportation as an essential ingredient in land and resource development, the manner in which transportation investment affects economic productivity in what is increasingly a service based economy, is the most significant way in which transportation investments can influence economic expansion in the future.

Recent studies by David Aschauer and Alicia Munnell concluded that insufficient infrastructure investment has been an important factor in the nation's low productivity growth rate in the 1970's and 1980's and that the role of infrastructure investment has been understated as an important input to economic expansion. Economists disagree as to the quantitative aggregate impact of transportation investment on the national economy and as to the cause and effect relationship between investment and economic expansion, but there is a general agreement that whether to stimulate expansion or to support it once it is underway, the nation, the states and the private sector need to consider new transportation investments to support sustainable economic expansion.

An expanded and more efficient transportation infrastructure to support future economic needs is then essential to improve the nation's **economic productivity and competitiveness** in the increasingly global marketplace. Although it is no simple matter to measure the linkage between transportation investments and overall economic well being, productivity and development, the history of transportation clearly demonstrates the importance of transportation investments to economic expansion. Over time, transportation investments

support fundamental economic changes, such as industry restructurings and changes in manufacturing and distribution processes that significantly increase productivity and influence living standards.

The relationship between transportation investment and industry restructuring is very complex since many factors other than transportation costs and services are involved. There is little doubt that properly targeted investments can increase productivity in the transportation sector that eventually gets reflected in reduced logistics/distribution costs and an overall national productivity increase.

Transportation Investment and Economic Expansion

Transportation investment is a necessary but not sufficient ingredient to economic expansion. It is one way in which capital investment can be channeled to build up the productive capacity and the efficiency of the economy.

The national debate about the budget deficit and the emphasis on reduced government expenditures at the State and local levels have sometimes failed to recognize the difference between operating expenditures and long-term investment. While most states separate operating and capital expenditures in their budget processes, the Federal government budget does not separate annual transportation operating expenditures from those investments aimed at increasing capacity and efficiency. A major portion of government transportation expenditures involves an investment in the future, and its impact should therefore not be measured solely in terms of short-term economic results. The full impact of constructing new or expanded highways, airports, rapid transit systems, and other transportation facilities can take years to materialize. This time-lag in being able to achieve the full benefits from the investment should be expected, just as private corporations invest in major facilities and equipment knowing that it will take years to achieve their targeted financial return.

Transportation investment has also been traditionally associated with short-term **job creation** during the construction period. Job creation programs with the objective of stimulating employment have been proposed periodically, since the federal infrastructure development projects of the 1930's were used to help reduce high unemployment rates. Such programs only have a longer-term impact on economic expansion to the extent that they also result in more fundamental increases in economic output, income and productivity.

Role of Transportation Investment at various stages of an area's Economic Development

Without transportation access, land cannot be used productively. In the early stages of development of an area, transportation investments are an essential, although not the only, ingredient to achieve development. The main purposes of transportation investment in undeveloped and underdeveloped regions is to **open up land for development** by reducing transportation costs.

In a more developed area, the basic transportation infrastructure is already in place, and there is already ways of moving people and goods to/from and through the area. In these developed areas, the emphasis of transportation investment is still on **reduced congestion, increased capacity, time savings, accident reduction, improved quality, increased reliability, and improved productivity**, rather than land development impacts.

Transportation improvements can then make possible additional economic production by expanding the geographic area that can be competitively served from a plant location, and by reducing costs and encouraging new businesses to locate, stay or expand in that region. In today's economic environment, travel time and delivery reliability have become as important as transportation costs for some transportation users.

Transportation and Competitiveness

The competitiveness of an area is based on its comparative advantage as a low cost producer. Since products and services are produced or provided by private firms or industries, national or regional competitiveness is achieved through the efforts of an area's individual firms to achieve high levels of productivity over time. To achieve or maintain competitive advantage, a firm must either produce and distribute its products at lower costs or develop different and innovative products that can be sold at higher prices. To do so, it must continuously improve efficiency, raise product quality, introduce new technology, etc. The type, quality and user costs of transportation services are part of the broad attributes that shape the environment in which local firms compete. As a result, transportation service can promote or impede the achievement of competitive advantage.

A transportation investment that increases economic activity in one State or local area can result in a reduction of economic activity in an adjacent or nearby jurisdiction. If the net result is an increase in the industry's competitiveness internationally and a resultant increase in economic activity, it is possible that a net growth in output and income could result at the national level. In many cases, however, efforts to retain jobs or to attract new industry in one State or local jurisdiction do not produce net gains in national economic output and income, but simply move the economic activity from one location to another.

Fundamental Ways in which Transportation Investment influences Expansion and Competitiveness

Economic competitiveness, expansion and development is affected by transportation investment fundamentally in two ways:

1. **by opening up or increasing the accessibility of land and other natural resources for new or higher density development, and**

2. **by reducing transportation costs, improving service quality and reliability, and increasing productivity of the various industries and economic sectors, making it possible to reduce the cost of manufacturing products or providing services per worker hour.**

The direct results of a transportation investment are then increased land accessibility (reduced travel times) and lower transportation costs. These primary effects of improved transportation result in benefits to both the users and the non-users of the new or improved transportation facility or service, since for example, the price of goods consumed by non-users will reflect the reduced transportation costs. The changed accessibility and lower transportation costs eventually result in business expansion, restructuring and/or relocation (increased production, fewer plant locations, fewer warehouses, lower inventory costs, etc.). The reduced transportation costs and increased market reach, as well as the business relocation, expansion and/or restructuring actions result in productivity increases, which increase the competitiveness of the business or an area in the global marketplace.

Eventually, the increased productivity and competitiveness result in increased output, jobs, and income, which are reflected in increases in transportation demand. The increased production and economic growth requires continuing transportation investment to further increase accessibility, lower costs and increase productivity, and meet the needs of the growing economy.

Transportation and Economic Productivity

Both public and private sectors have a role in improving productivity. The influence of transportation investment on the nation's economic productivity can be separated into three major categories:

- impacts on public sector transportation productivity (e.g. increased efficiency of public sector transportation construction projects or lower air traffic control costs - to the extent that cost savings are reflected in reduced tariffs, taxes, or other user fees)
- impacts on private sector transportation industry productivity, e.g. reduced unit costs associated with the use of larger trucks, higher speeds and/or less congested highways and airways, double-stack rail services, faster intermodal connections, etc.)
- impacts on private sector non-transportation productivity (e.g. reduced inventory costs, industry restructuring, changes in production processes, etc.)

An investment often requires both public and private actions to fully achieve its potential benefits. A public investment may not lead to the anticipated benefits if no private sector action follows. In some cases, the public sector reacts to private sector initiatives (such as

proposals by trucking or rail carriers, aircraft equipment manufacturers, etc.). In such cases, joint private-public initiatives can help assure that intended benefits are achieved. In all cases, the evaluation of public sector transportation investments should consider private sector commitments or the extent to which the investment may encourage private sector follow-through, as well as the investment's potential role in increasing productivity.

Transportation investment (e.g. to more efficiently use existing capacity, expand capacity, introduce new technology, use larger - more efficient vehicles, etc.) can lead to improved private sector productivity in several ways:

- by reducing transportation costs for existing firms at their present locations;
- by making possible expansion of markets at existing locations, thereby resulting in increased output;
- by opening up opportunities for restructuring of manufacturing and distribution processes (reducing plant locations, production of certain parts at different locations and assembly closer to consumer, reduction of warehouse locations and related inventory costs, etc.); and
- creating opportunities for innovative, new, more productive businesses that are dependent on more reliable or faster transportation access.

The relationship between transportation investment and industry restructuring is very complex since many factors other than transportation costs and services are involved. A specific transportation investment is unlikely in most cases to result in significant industry restructuring or the creation of new businesses. However, transportation investment programs that significantly reduce costs and increase speed and reliability can generate new business activity.

A large company usually has multiple manufacturing and warehouse locations. Transportation of a large number of supplier-originated, intracompany and customer-bound shipments must be accommodated on a daily basis. The inventory requirements, transit times, equipment needs, transportation costs, impacts on manufacturing production schedules are all factors that must be considered in analyzing how a transportation investment can create opportunities for industry restructuring. There is little doubt that properly targeted investments can increase productivity in the transportation sector that eventually gets reflected in reduced logistics/distribution costs and an overall national productivity increase.

Economic Trends and Implications for Transportation Investment

The US economy has undergone dramatic changes since the 1970's, many with significant implications for transportation investment. From an industrial base, emphasizing mass production of standardized goods, the US economy has been transformed into a post-industrial economy, producing a wider variety of high-technology specialized goods and more service-oriented.

Another sector of the US economy that has been growing rapidly is foreign trade, requiring easy access to seaports, airports and other ports of entry. International trade flows are concentrated in a limited number of seaports (over 80 percent of total tonnage in 1987 moving through the top 50 seaports), airports (major gateways), and other ports of entry (mostly at major highway connections to Canada and Mexico).

Industrial firms have evolved into large multi-national corporations. The emergence of multi-national corporations contributed to the growing integration of the US into the world economies. In such an integrated world economy, international trade will influence the structure of US industry, as well as the future demand for domestic infrastructure services. If the domestic transportation costs to move products from inland production centers are higher than the transportation costs from foreign locations across the ocean to consumer centers along the coasts (as is the case today for many products), US industries may face a competitive disadvantage in those markets. The North American Free Trade Agreement, in particular, is also likely to significantly affect cross-border movements and domestic transportation patterns.

Types of Transportation Investments that can have an impact on Economic Expansion, Productivity and Competitiveness

All types of transportation investment (new systems, expansion of an existing system, and system preservation investments) influence economic expansion and competitiveness to the extent that they result in increases in accessibility, improved service quality, increased reliability, increased capacity, and/or reduced transportation costs.

The development of a new transportation system, whether at a national or regional level (e.g. construction of a new railroad network, adding a controlled access highway system, a high-speed intercity rail system or a metropolitan rail rapid transit system), is an infrequent and costly undertaking. A new transportation system is typically implemented to achieve a higher level of service, by introducing new technology or through significant design improvements in the use of previously deployed technology. Historically, the introduction of rail and aviation technologies are the best examples of how new technology can significantly improve transportation service and impact economic activity patterns and expansion. The National System of Interstate and Defense Highways is perhaps the best example of new system development using previously deployed technology. A Magnetic Levitation System is an example of a possible future system using new technology presently

under study.

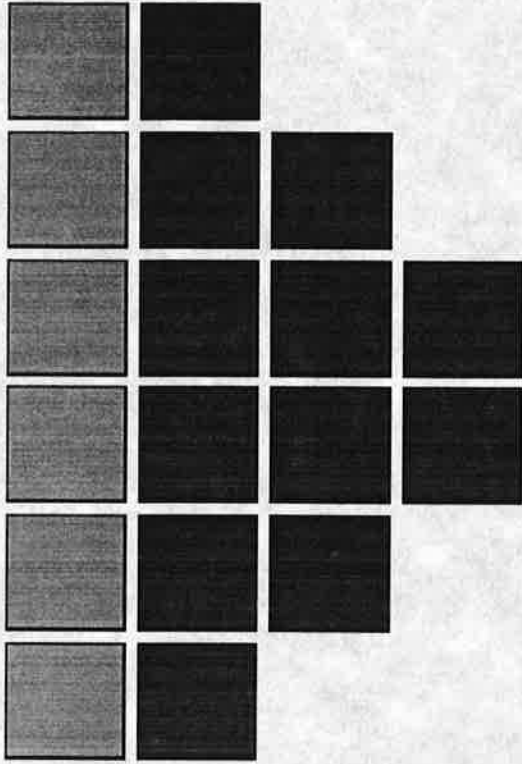
The history of transportation clearly demonstrates that new transportation systems have a large impact on economic expansion. Over time, such investments generally result in fundamental changes in development patterns, increased productivity, and improved living standards. However, it has always been difficult to fully foresee the impacts of new technology and/or significant increases in service levels not previously experienced.

A more typical transportation investment is the expansion of an existing system by adding new facilities, e.g. a new highway, rapid transit line, port terminal, airport, etc. System expansion improvements may also involve adding new technology (such as coordinated highway traffic signal system, computerized traffic incident control system, new microwave landing system and other air traffic control technology, semiautomatic container cranes, automatic vehicle identification equipment, and other cargo handling equipment). Most transportation system expansion, whether or not explicitly articulated, has as one of its fundamental objectives:

- expanding capacity
- reducing congestion and delays,
- improving safety, and/or
- supporting land development and economic growth plans

To the extent that these transportation investments reduce costs and improve productivity, they will also influence private sector operations and competitiveness.

The preservation and maintenance of existing transportation facilities is frequently not adequately considered nor given appropriate priority when identifying transportation investment requirements. Once a transportation facility is built, it becomes part of the infrastructure supporting the economy of an area. Businesses and individuals rely on it for their transportation needs. The condition of a facility is then as important in supporting the nation's or the states' economic objectives as its existence. The lack of periodic rehabilitation of existing infrastructure can lead to route closings, increased user operating costs, reduced speeds, and other similar negative impacts that affect area industries and businesses. Although efficient system operations and adequate maintenance do not typically generate the interest or excitement associated with building a new facility, it is fundamentally as important to supporting economic activity.



I. Introduction

LOUIS BERGER INTERNATIONAL, INC.



TRANSPORTATION INVESTMENT AND ECONOMIC EXPANSION: CASE STUDIES

I. Introduction

A. Background

Historically, transportation infrastructure has played a key role in the development of the nation's economy. However, as has been extensively documented, throughout our nation's history, transportation investment has been a **necessary**, but not **sufficient** condition for increased economic development. Only in cases where other prerequisites for development existed, has improved transportation infrastructure served as a catalyst for increased development. If we consider some of the most successful transportation infrastructure programs in terms of economic impact, such as the development of the railroads, the farm to market road program, and the Interstate highway program, they all made possible or contributed to the **development of land and/or natural resources** that could otherwise not be as productively used because of the lack of access.

Railroad construction stimulated the development of the interior and Western U.S., but the same kind of development could not have taken place if rich mines, dense forests and other vast resources had not been present. The farm to market road program made it possible to increase the agricultural production of the US by providing easier access to markets, but the program was successful since there also existed good agricultural land that could be cultivated, if the increased production could reach markets in a timely manner. Similarly, the Interstate Highway program contributed to suburbanization and land development at or near interchanges, where relatively inexpensive land was available for residential, industrial and commercial development.

However, the economic impact of the Interstate Highway System has extended well beyond its effects on nearby land development. The most significant impact of the Interstate System has been the improvement in connectivity between population, production and distribution centers, resulting from the higher service level, homogeneous highway network, serving all areas of the country. This improvement in Interstate connectivity, coupled with deregulation, has made possible significant **productivity increases** for the private transportation industry and other users of the system. In contrast with the historical contribution of transportation as an essential ingredient in land and resource development, the manner in which transportation investment affects economic productivity is the most significant way in which transportation investments can influence economic expansion in the future.

In a developed economy like the US, questions have been posed for some time concerning the cause and effect relationship between transportation investment and economic expansion, i.e. whether transportation investment still can serve as a catalyst for increased economic activity, or

whether the reverse is now true, i.e. increased economic output leads to larger public infrastructure investment needs. As long ago as 1966, Zwick noted that since "there is now a ubiquitous supply of transportation facilities in all areas of the US," the future needs of our economy must be anticipated in planning future transportation improvements. More recently, studies by David Aschauer and Alicia Munnell concluded that insufficient infrastructure investment has been an important factor in the nation's low productivity growth rate in the 1970's and 1980's and that the role of infrastructure investment has been understated as an important input to economic expansion.

Economists disagree as to the quantitative aggregate impact of transportation investment on the national economy and as to the cause and effect relationship between investment and economic expansion, but there is a general intuitive understanding that new and/or improved transportation facilities contribute to economic growth. Properly targeted transportation investments can support state and local development goals and are necessary to improve the states' and the nation's competitive position in the rapidly evolving global marketplace. Furthermore, there is general agreement that if transportation improvements are to be of value in supporting the nation's and the states' economic expansion goals, we must consider not only how transportation has affected economic growth in the past, but how transportation investments can support development in the future, particularly in light of the opportunities for increasing the market reach of our economic production and the competitiveness of our businesses in the changing global economy.

At the request of the American Association of State Highway and Transportation Officials (AASHTO) Special Committee on Economic Expansion and Development, this summary of prior work and selected case studies on Transportation Investment and Economic Expansion has been prepared to explore the **fundamental ways in which transportation investment affects economic development**. By exploring the linkage between transportation investment and economic expansion in the past and in today's policy environment, this study is intended to help AASHTO member departments focus on priority areas for transportation investment to support the states' economic expansion objectives.

B. Study Objectives and Approach

The objective of this study is to summarize, in simple and understandable language, available information on the linkages between transportation infrastructure investment and economic expansion.

At the state and local levels, various agencies have periodically conducted studies to demonstrate the economic impacts associated with transportation projects or facilities. A variety of research efforts have also been conducted over the years by TRB, AASHTO, USDOT and FHWA on the relationship between transportation and highway infrastructure investment and economic productivity at the national level.

These prior studies will be used to identify the fundamental ways in which transportation affects economic expansion and development, and case studies will be presented to explain how different types of transportation infrastructure investments can influence economic growth.

This report is then intended to summarize for AASHTO member departments how transportation investment can support economic objectives and what we know and what we don't know about the linkages between transportation investment and economic expansion.

At the request of AASHTO's Committee, the Transportation Research Board's National Cooperative Highway Research Program established an Advisory Panel for this project (see Appendix A). This Advisory Panel guided the study and helped define the specific research objectives and approach.

C. Definitions

Table I, on the next page, summarizes some of the key definitions related to economic expansion and transportation investment as used in this report.

Economic growth or economic expansion can be defined as growth in the total output of the national or a state's economy as measured by Gross National Product (GNP), Gross Domestic Product (GDP), or Gross State Product (GSP). It involves increases in the volume of economic activity, but does not necessarily imply an increase in the efficiency of the economic activity. Economic growth can occur without significant increases in productivity.

Economic development can be defined as the process whereby the real per capita income of the nation, state or local area increases over a sustained period of time. An increase in gross national product (GNP) does not necessarily result in an increase in personal income. Economic growth, therefore, does not always engender economic development.

If a more equitable distribution of income is another national or state objective, an increase in economic development or real per capita income may not in itself achieve that objective. Clearly, the economic growth and development objectives need to be precisely defined.

An increase in output per capita or per worker gives a much better indication of economic progress than a rise in the total output of goods and services. **Productivity increases**, i.e. achieving greater output from a fixed level of inputs, is an indicator of more efficiency in the production of goods and delivery of services. Productivity improvements makes possible increases in per-capita income and standards of living, generally defined as an increase in personal welfare and typically associated with increased consumption per capita.

Economic Competitiveness, or the competitive advantage of a nation or an area, is defined as the region's comparative advantage as a low cost producer, based on low cost labor, available natural resources, inexpensive land, efficient management and/or innovative technology. Since products

Table I: Key Definitions - Investment and Economic Expansion

ECONOMIC GROWTH	Growth in total output of the nation's or a State's economy
ECONOMIC DEVELOPMENT	Increase in real per capita income of a nation, a state, or an area over a sustained period of time
COMPETITIVENESS	Comparative advantage of an area as a low cost producer, based on low cost labor, available natural resources, inexpensive land, efficient management practices, and/or innovative technology
TRANSPORTATION EXPENDITURES	Public and private expenditures for the purposes of moving people and goods from one place to another
TRANSPORTATION INFRASTRUCTURE INVESTMENT	Public and private capital expenditures to develop and maintain the transportation facilities and services used by individuals and businesses
PRODUCTIVITY	Output from a fixed level of inputs in the production of goods and delivery of services

and services are produced or provided by private firms or industries, national or regional competitiveness is achieved through the increased competitiveness of specific companies or industries. Competitiveness then depends on the capacity of a nation's or an area's private firms to achieve high levels of productivity and to increase productivity over time. To achieve or maintain competitive advantage, a firm must either be able to produce and distribute its products at lower costs or develop different and innovative products that can be sold at higher prices. To do so it must continuously improve efficiency, raise product quality, introduce new technology, etc.

The type, quality and user costs of the national or an area's transportation infrastructure are part of the broad attributes that shape the environment in which local firms compete. It can therefore, promote or impede the achievement of competitive advantage. (See Michael Porter's "The Competitive Advantage of Nations.")

For the purposes of this report, transportation expenditures are defined broadly to include public and private expenditures for the purpose of moving people and goods from one place to another. Furthermore, transportation infrastructure investment is defined as the public and private capital expenditures to develop and maintain the transportation facilities and services that are used by individuals and businesses in meeting the nation's and the States' transportation needs.

There are three fundamental types of transportation investments regardless of mode or location:

1. Construction of a new system to introduce new technology and/or a higher service level
2. Expansion of an existing system through:
 - addition of new facilities (links or terminal connections), or
 - improvements to existing facilities that add capacity, and
 - addition of new technology to improve capacity and/or efficiency
3. Preservation and Maintenance of the existing facilities

The development of a new transportation system, whether at a national or regional level (e.g. construction of a new railroad network, adding a controlled access highway system, a high-speed intercity rail system or a metropolitan rail rapid transit system), is an infrequent and costly undertaking. A new transportation system is typically implemented to achieve a higher level of service, by introducing new technology or through significant design improvements in the use of previously deployed technology. Historically, the introduction of rail and aviation technologies are the best examples of how new technology can significantly improve transportation service and impact economic activity patterns and expansion. The National System of Interstate and Defense Highways is perhaps the best example of new system development using previously deployed technology. A Magnetic Levitation System is an example of a possible future system using new technology presently under study.

The history of transportation clearly demonstrates that new transportation systems have a large impact on economic expansion. Over time, such investments result in fundamental changes in development patterns, can significantly increase productivity, and can influence living standards. However, it has always been difficult to fully foresee the impacts of new technology and/or significant increases in service levels not previously experienced.

A more typical transportation investment is the expansion of an existing system by adding new facilities, e.g. a new highway, rapid transit line, port terminal, airport, etc. System expansion improvements may also involve introducing new technology to improve system performance (such as a coordinated highway traffic signal system, computerized traffic incident control system, new microwave landing system and other air traffic control technology, semiautomatic container cranes, automatic vehicle identification equipment, and other cargo handling equipment). Most

transportation system expansion, whether or not explicitly articulated, has as one of its fundamental objectives:

- expanding capacity
- reducing congestion and delays,
- improving safety, and/or
- supporting land development and economic growth plans

The preservation and maintenance of existing transportation facilities is frequently not adequately considered nor given appropriate priority when identifying transportation investment requirements. Once a transportation facility is built, it becomes part of the infrastructure supporting the economy of an area. Businesses and individuals rely on it for their daily transportation needs. The condition of a facility is then as important in supporting the nation's or the states' economic objectives as its existence. The lack of periodic rehabilitation of existing infrastructure can lead to route closings, increased user operating costs, reduced speeds, and other similar negative impacts that affect area industries and businesses. Although efficient system operations and adequate maintenance do not typically generate the interest or excitement associated with building a new facility, it is fundamentally as important to supporting economic activity.

Table II summarizes the typical objectives and major economic development impacts of the three major types of transportation investments. Obviously, in most areas of the US, transportation investment programs typically involve a combination of new construction, expansion of existing facilities and system rehabilitation.

D. Role of Transportation at various stages in an area's Economic Development

In the early stages of development of an area, transportation investments are an essential, although not the only, ingredient to achieve development. The main purposes of transportation investment in undeveloped and underdeveloped regions is to **open up land for development**. Without transportation access, developable land cannot be used productively. Basic industries, such as agricultural, mining, and industrial production require the efficient transport of large quantities of raw materials and the distribution of finished products to far away destinations. Transportation of the raw materials and finished products typically requires good highway, rail, waterway, and/or port facilities, depending on the production location sites and the markets served from these locations.

In a more developed area, the basic transportation infrastructure is already in place, and there are already ways of moving people and goods to/from and through the area. In these developed areas, incremental improvements do not typically have the same return than was possible in the early stages of an area's development. However, transportation improvements still make possible

Table II: Typical Economic Impacts of Transportation Investment Types

INVESTMENT TYPES	INVESTMENT OBJECTIVES	MAJOR ECONOMIC DEVELOPMENT IMPACTS
CONSTRUCTION OF NEW SYSTEM	<ul style="list-style-type: none"> ● Introduce new technology and/or ● Higher service levels 	<ul style="list-style-type: none"> ● Typically results in fundamental: <ul style="list-style-type: none"> - Changes in development patterns - Increases in standards of living - Increases in productivity - Increased market reach of production ● Difficult to foresee all impacts
SYSTEM EXPANSION	<ul style="list-style-type: none"> ● Addition of new links or terminals ● Improvements to existing facilities ● Improved technology 	<ul style="list-style-type: none"> ● Expanded production capacity ● Improved efficiency and safety ● Support land development
SYSTEM PRESERVATION AND REHABILITATION	<ul style="list-style-type: none"> ● Maintain condition of existing facilities 	<ul style="list-style-type: none"> ● Maintain efficiency and support economic activity

additional economic production by expanding the geographic area that can be competitively served from a plant location, and by reducing costs and encouraging new businesses to locate, stay or expand in that region. The emphasis of transportation investment is then on **reduced congestion, increased capacity, time savings, accident reduction, and improved productivity**, rather than land development impacts. In today's economic environment, reduced travel time and increased reliability have become as important as actual transportation costs for some transportation users.

Although an important prerequisite for economic expansion, the construction of transportation facilities and their use typically generate environmental impacts. In developed areas, transportation investments can also be supportive of environmental improvement objectives, such

as the reduction of air, water, and noise pollution. There are cases where transportation investments can be supportive of both economic expansion and environmental goals (such as congestion reduction investments). In other cases, there are trade-offs between the economic growth and environmental objectives. Transportation investment restrictions, such as limiting the ability of a non-attainment area to expand its highway network in order to achieve air quality goals, can affect transportation service levels, resulting in transportation investments that are not as fully supportive of an area's economic needs and objectives. If so, the result over the long-term is likely to be a shift in development to areas with higher quality environments that do not face transportation investment restrictions, and are therefore, better able to expand their transportation systems. Clearly, both economic expansion and environmental improvement are important national objectives, and the trade-offs between them need to be better understood.

E. Impact Area of Transportation Investments

The impacts of transportation investment on economic output and income depends on whether these impacts are measured from the national or state/regional/local perspective, and whether the national or regional economy is growing. In today's development environment, states and local areas continually aim at improving their competitiveness. Transportation infrastructure and service level is one way in which states and local areas compete to increase their economic output and income by attracting and/or retaining industries and jobs.

A transportation investment that increases economic activity in one State or local area can result in a reduction of economic activity in an adjacent or nearby jurisdiction. If the net result is an increase in the industry's competitiveness internationally and a resultant increase in economic activity, it is possible that a net growth in output and income could result at the national level. In many cases, however, efforts to retain jobs or to attract new industry in one State or local jurisdiction do not produce net gains in national economic output and income, but simply move the economic activity from one location to another.

Similarly, when the entire national or regional economy is growing, jurisdictions are competing for the growth taking place. However, when the national or regional economy is not growing, efforts by individual jurisdictions may only result in shifting economic activity from one jurisdiction to another.

When considering the effects of a transportation investment, it is important then to carefully define the impact area. The economic output and income effects may not be the same at both the national and state/regional/local levels. The impact area should be defined, at least, from the perspective of the funding organization. If possible, impacts at other levels should also be considered, to obtain as complete a picture of how a proposed transportation investment is anticipated to affect economic growth.

F. Approaches to consider the linkage of Transportation Investment to Economic Development

There are two different approaches that can be used to discuss the linkage of transportation investment to economic development, i.e.:

- by looking at the role of transportation investment as it affects the three traditional economic factors or inputs to production - **land and natural resources, labor, and capital**, and
- by looking at the major change component that affects growth in today's economic environment - **productivity**.

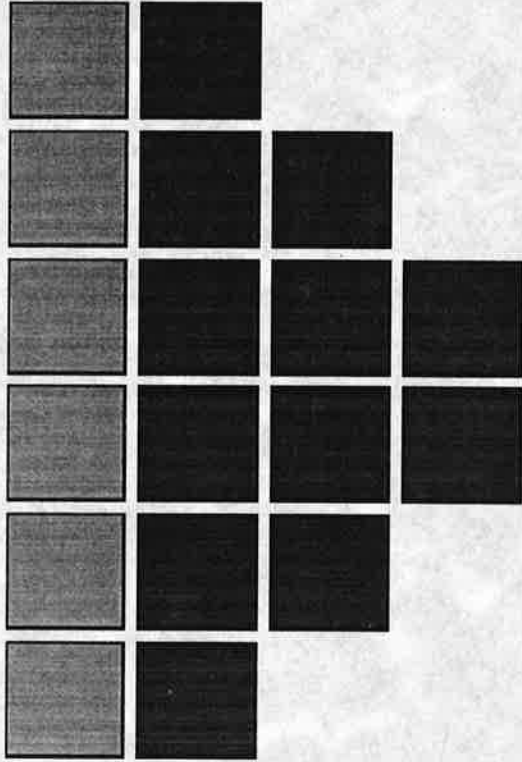
Under the first approach, we can consider the three traditional economic factors or inputs of production, and how transportation investments affect each of these factors. Investment in transportation facilities and services can be viewed as part of the capital investment needed to provide access to the land, natural and human (labor) resources required for the production process.

Under the second approach, **economic growth**, or an increase in economic output, can be explained by looking at the major change component - **productivity** - where productivity measures the change of output (production) per unit of input (work hour), including the efficiency in the use of capital, workers, technology, land, and other production inputs. Other productivity measures can also be useful in considering how transportation investment influences economic expansion (e.g. such measures as unit costs), since when costs are reduced, there is more value added per workerhour. Intuitively, there is general acceptance that transportation investment is an important factor in improving economic productivity, but the linkages are not clearly understood.

The contribution that transportation investment can make to the national or states' economic objectives are related to the stage of an area's economic development or its maturity. As noted above, historically, the fundamental ways in which transportation investment affected economic expansion has been primarily related to **land development and changes in land uses**. When large land areas of the US and major resources remained undeveloped due to lack of access, transportation facility development could significantly improve accessibility and could be used to stimulate economic activity in these areas, thereby not only increasing state and local economic activity but also increasing national economic output and income.

In a mature economy like the US, with few undeveloped areas and an already well developed transportation network, the nation's future economic growth will depend mainly on using existing resources more efficiently, i.e by reducing costs and increasing ease of access in already developed areas. Therefore, it is increasingly important to consider the ways in which transportation investment can influence long-term economic growth through its impact on increased productivity.

The next section of this report will briefly discuss the fundamental ways in which transportation investment affects economic expansion and development from the four perspectives, i.e. the three major inputs to production (land and natural resources, labor, and capital), as well as what we know and don't know about the linkages between transportation investment and productivity.



**II. Fundamental Ways in which
Transportation Investment is linked to
Economic Expansion**

LOUIS BERGER INTERNATIONAL, INC.



II. Fundamental Ways in which Transportation Investment is linked to Economic Expansion

As noted in the previous section, the linkage between transportation investment and economic development can be discussed from the perspective of the three traditional economic factors or inputs of production - **land and natural resources, labor, and capital** - since all three are affected by transportation investment. An alternative way to look at the linkage of transportation investment to economic expansion is to look at the main component affecting growth in today's economic climate - **productivity**. These four items - **land and natural resources, labor, capital, and productivity** - will be discussed briefly in this section, including what we know and what we don't know about the linkages between transportation investment and economic expansion. Table III summarizes the main linkages from the perspective of these four items. At the end of this section, a summary of the fundamental ways in which transportation investments can influence economic expansion and competitiveness is presented.

A. Land and Natural Resources Development

The most traditional view of the economic expansion and development impact of transportation infrastructure investments lies in its importance in **opening up land and/or natural resources for development**, as was historically the result of the construction of ports, railroads, farm to market roads, mass transit systems, interstate highways and airports. All types of transportation facilities can increase **accessibility** to raw materials, markets, employees and consumers, thereby making land more attractive for agricultural, industrial, commercial or residential development. Without access, land usually remains unproductive.

A higher level of access is necessary for more productive and/or higher density land development. Land access is one of the key factors affecting land value and development patterns. Various types of transportation investments can result in different kinds of development impacts, e.g.:

- the construction of metropolitan rapid transit systems centered in downtown areas encourage higher density development around rapid transit stations, such as has occurred in Washington, Atlanta, and San Francisco (see discussion in Case Study V, Appendix F).
- The construction of metropolitan area circumferential highways or beltways encourage increased suburban development (see Route 128 case study discussion in Appendix I).
- Interstate Highways in rural areas, such as I-70 in Colorado, have a major role in attracting new resort developments that are dependent on easy access to nearby metropolitan areas as well as tourists from other states and countries (see Appendix G).

Transportation network improvements can provide a competitive advantage for an area, since users respond to the relative or comparative location of alternative sites on the transportation system. Transportation investments then can increase the choice for both individuals and businesses when making residential and business site decisions.

**Table III:
Fundamental Linkages between Transportation Investment and Economic Expansion**

ECONOMIC FACTORS OF PRODUCTION AND GROWTH	TRANSPORTATION INVESTMENT LINKAGES
LAND	<ul style="list-style-type: none"> ● Without access, developable land and natural resources remain unproductive ● Opens up developable land and natural resources ● Influences individual residential locations ● Influences business locations ● Increases market reach of an area's production and services
LABOR	<ul style="list-style-type: none"> ● Short term job creation ● Long term employment increase due to increased economic competitiveness ● Increase labor pool, from which businesses select employees ● Open up job opportunities for individuals ● Reduce individual commuting time and cost, thereby increasing time and income for shopping and leisure
CAPITAL	<ul style="list-style-type: none"> ● Build up production capacity and increase efficiency ● Encourage non transportation private sector investment
PRODUCTIVITY	<ul style="list-style-type: none"> ● Public sector ● Private sector transportation industry ● Private sector non transportation industry

In today's environment, transportation investment can be used by states and local areas to open specific areas for development, to increase the accessibility of an area, or to achieve certain development density. This last approach is particularly relevant in urban areas. For example, transportation investments can assist state and local planning efforts to channel development into already developed urban land and away from environmentally sensitive regions where development should be discouraged.

Recent Federal efforts to achieve national environmental standards, e.g. air and water quality, can affect the competitive position of states and local areas to attract or retain business. For example, if no highway improvements are permitted in urban areas that do not meet national air quality standards, congestion levels will continue or grow, encouraging businesses to locate elsewhere. Rapid transit development in these urban areas can reduce congestion but can also encourage higher density, which without proper planning, may make it more difficult to provide adequate infrastructure for goods movement. Although the impact of these public initiatives on economic expansion will vary by state and local area, **transportation investment can be an important tool to facilitate efforts to achieve land development objectives at the state and local level.**

B. Labor - Employment Opportunities and Job Creation

Another way to look at the impact of transportation investments on economic development is to consider it from the perspective of the **labor** component of production. Transportation infrastructure also affects the labor component of production since increased accessibility (or a reduction in the time that it takes an individual to commute to a job location) can **open up job opportunities for individuals**. Similarly, from the employer perspective, improved transportation facilities and services can **increase the labor pool from which employees are selected**. In this way, new transportation facilities and services increase opportunities for residential and business locations and affect the individual's residential and the employers' industrial and commercial site decisions. Metropolitan area beltways and rapid transit development are examples of transportation investments that fundamentally change the accessibility of residential locations to jobs, the labor pool that employers can tap, as well as the long term pattern of residential and business locations in the area (see case studies in Appendices F and I). These types of transportation investments also can increase household and individual productivity, by reducing commuting times and costs, and thereby increasing time and disposable income for shopping and leisure activities.

Historically, growth in the American economy was based on the agricultural and the heavy manufacturing sectors, where location options were limited due to the need for access to natural resources or raw materials. Recently, economic growth has been centered in the service sector and high technology based industries, such as drugs, medical equipment and supplies, electronics, office and computer equipment, etc. These service and high technology manufacturing industries have more flexibility in site selection and place greater emphasis on **access to labor** in their location decisions rather than proximity to raw materials or consumers. Their location decisions today are affected by such factors as climate, quality of life, and management preferences, which

are influenced by the overall quality of transportation service. Similarly, the labor force today is more able to move, or to commute long distances (even by air) due to family and other personal considerations.

Transportation investment has also been traditionally associated with **job creation**, both direct employment during the construction period and longer-term as a result of the new economic activity that it makes possible by opening up land and natural resources for development. The size of the nation's total labor force is affected by population growth, the portion of the population that is employed, and the average hours worked. One approach to increasing economic output is then to pursue programs that increase the labor force factors of economic growth, i.e. population, employment rates and working hours. Long term trends in the US indicate decreases in weekly work hours and population growth rates, so public policy approaches to increase the labor force component of economic growth have been based on increasing employment rates.

Job creation programs with the objective of increasing employment have been proposed periodically in order to increase economic activity, since the federal infrastructure development projects of the 1930's were used to help reduce high unemployment rates. Short-term economic stimulus programs to invest in transportation infrastructure with the primary purpose of creating construction jobs can generate near-term economic activity in the project areas. However, such programs only have a longer-term impact on economic expansion to the extent that they also result in more fundamental increases in economic output, income and productivity over the long-term. Logically, there is some time-lag in achieving the economic impacts of transportation investment, as it takes time for their benefits (land development and reduced delays or costs) to be reflected in increased output and income. A complete assessment of the impact of transportation projects on the nation's or a State's economy should consider both short-term and long-term benefits.

States and local areas increasingly compete to attract or retain jobs in their jurisdictions. Transportation investment is one way in which governments can make their areas more competitive (see discussion of State Programs specifically aimed at attracting or retaining jobs in Appendix E).

C. Capital

A third way to discuss the linkage of transportation and economic growth is to look at the impact of transportation investment from the perspective of its role as a **capital investment**.

Transportation infrastructure can be viewed as a part of the capital investment that the nation or a state must provide to make possible increased production and/or to raise the standard of living. It is one way in which investment in facilities, equipment or technology development and applications can be channeled to build up the productive capacity and efficiency of the economy.

Since there is a total amount of capital to be invested for all purposes at any one time, public sector transportation investment can affect or "crowd out" the capital available for private sector

investment needs. At the same time, public or private sector transportation capital investment can add capacity and enhance productivity, raising the rate of return of businesses and encouraging more private sector investment. Both of these impacts from public sector transportation investment can counteract each other. The key to stimulating long-term economic growth from this perspective lies in **properly targeted transportation investments that enhance productivity and result in a net increase in private sector investment.**

The total capital invested in transportation affects the total capacity of the system to move people and goods. Without additional investment for expansion, increased demand can only be met through efficiency improvements, i.e. by being able to move more people and goods faster through the existing infrastructure, or it must be controlled, i.e. limit use through pricing or use restrictions. Over the long-term, it is unlikely that controlling demand or efficiency and productivity improvements can totally satisfy the increased transportation requirements from individuals and businesses without affecting the nation's overall productive capacity and efficiency. Therefore, additional capital for expanded transportation infrastructure will continue to be required to meet increased demand associated with a growing population and economy.

D. Productivity

In a mature economy like the US with a long-term trend towards increasing foreign trade and an increasing economic integration with other countries, the most relevant way to look at the linkage between transportation and economic expansion is to consider how investment in transportation infrastructure can increase productivity or the output per worker-hour.

US productivity growth in the 1980's was significantly slower than in the 1950's and 1960's. Until the mid-1980's, manufacturing employment trends were closely related to industrial production. Yet, beginning in the mid-1980's, industrial production has been increasing while employment has decreased. This trend has accelerated in the early 1990's. From mid 1992 to mid 1993 manufacturing employment decreased by 275,000 jobs while factory production increased by 4.6 percent. As noted in a September 29, 1993 Washington Post article, the major factor reducing US factory jobs is the continuing increase in production efficiency.

The long-term objective of transportation investment policy in the US should be to achieve economic expansion, **not** through direct job creation (more worker-hours), but through **increases in capacity, productivity and related production and distribution efficiencies** (increased output per worker-hour). Companies have been modernizing their manufacturing, distribution, and financial systems to reduce jobs and become more efficient. To compete more effectively, American businesses need to reduce transportation costs, increase speed and reliability of product delivery, and reduce inventory costs. Speed and reliability are also important to service industries, the fastest growing economic sector where most new jobs are being created. In the long-run, increased transportation productivity and reliability should result in a wider geographic reach and growing demand for a company's products or services, which should lead to increased competitiveness and economic development.

In the US, the role of developing and maintaining the nation's transportation infrastructure is shared by the private and public sectors. Therefore, the influence of transportation investment on the nation's economic productivity can be separated into three major categories:

- impacts on public sector transportation productivity (e.g. increased efficiency of public sector transportation construction projects, improved - smarter facility management, or lower air traffic control costs - to the extent that cost savings are reflected in reduced tariffs, taxes, or other user fees)
- impacts on private sector transportation industry productivity, e.g. reduced unit costs associated with the use of larger trucks, higher speeds and/or less congested highways and airways, double-stack rail services, faster intermodal connections, etc.)
- impacts on private sector non-transportation industry productivity (e.g. reduced inventory costs, industry restructuring, changes in production processes, etc.)

In addition, as noted in the section on "Labor" above, transportation investments can also increase individual or household productivity and standard of living (e.g. by reducing commuting time, costs and delays). The reduced commuting times and costs can also stimulate economic expansion by increasing leisure time or financial resources for shopping, entertainment, recreational or other activities. However, just like there is a limited total amount of capital, there is also a limited amount of time and resources that can be devoted to leisure and non-work activities.

Public Sector Transportation Productivity

Most transportation services in the US are operated privately (by railroads, airlines, steamship lines, barge lines, trucking firms, bus companies, and private automobiles) on facilities built, operated and maintained by public sector agencies (with the exception of the railroads which own, operate and maintain the rail facilities). The public sector role in transportation operations is mostly limited to public transportation (urban transit, commuter rail systems, and AMTRAK), as well as the operation of publicly owned facilities, such as the air traffic control system, inland and coastal waterways, highways, airports, and port terminals. An example of an ongoing effort to increase public sector transportation productivity is the modernization of the air traffic control system (see case study II on the National Airspace System - Appendix C).

Private Sector Transportation Industry Productivity

Private sector transportation industry productivity has increased rapidly during the past decade, primarily as a result of deregulation. Airline operating costs, freight transportation costs and the costs of other privately operated transportation services increased at a much slower rate than the ton-miles or passenger-miles moved. Deregulation made it possible for significant cost reductions for transportation carriers, through service rationalization, capacity reductions, labor concessions, etc.

In the future, improved transportation sector productivity can be achieved through targeted capacity increases and real-time tracking of transportation congestion, better asset and equipment management, new technology (automation, more fuel-efficient and larger size/faster vehicles, Maglev or high speed rail technology), information exchange methods (such as IVHS), improved intermodal connections, integrated logistics, etc. Most of these initiatives require action by both the public and private sectors. An example of an ongoing joint private-public initiative to increase private sector transportation productivity is the State of Pennsylvania program to increase clearances on major railroad corridors to be able to provide double stack railcar services (see case study III in Appendix D).

Non-Transportation Industry Sector Productivity

Transportation sector productivity, i.e. the actual costs of moving people and goods, also affects **business location decisions and non-transportation industry sector productivity**. However, major additional increases in overall industry productivity and competitiveness can also be achieved as a result of lower inventory costs, improved distribution systems, changes in production processes, and long-term industry restructuring, which are made possible by faster and more reliable transportation services. These additional impacts can be viewed as secondary effects of a transportation investment and although not easily quantifiable, they are clearly becoming more important in increasing American industry access to global markets and national competitiveness.

In an increasingly global economy with reduced trade barriers (such as recently agreed to in the North American Free Trade Agreement - NAFTA - and the latest GATT agreement), there is an ever-growing need to increase production efficiency to remain competitive. The US, the states and the local areas today compete globally in efforts to attract and retain business. In today's economic environment, if a company is not able to produce goods or deliver services at competitive prices from a certain US location, the business will eventually fail or move elsewhere. Industries requiring low skilled and inexpensive labor have shifted production facilities to lower cost developing countries. Companies have also decentralized their production, so some parts are produced in locations around the world while the product is assembled for final distribution at one or a few locations. Warehousing locations are also being consolidated to reduce inventory costs or meet customer requirements. These trends increase transportation demand and required reliability, making intermediate and finished product distribution more important for both manufacturing and service industries. In today's world, plant and distribution location decisions then place increasing reliance on fast and reliable product distribution to far away markets. Transportation infrastructure or systems that shorten the time for products to reach consumers has become an important aspect of maintaining America's competitiveness.

Public sector transportation initiatives should therefore be aimed not solely at providing adequate infrastructure capacity, but also at **increasing the efficiency of private sector output and distribution**. Increased production and distribution efficiency should increase jobs in the long-term, by increasing the competitiveness of America's products and services in the global

marketplace. To the extent that the linkages are understood, transportation investments that result in an increase in the long-term productivity of US business and of the transportation industry are the preferable approach to public sector program initiatives to stimulate a sustainable long-term economic expansion.

However, the linkage of transportation investment to productivity is a complex process that is not fully understood. Total distribution costs, including transportation and inventory costs, vary significantly, representing as much as 45% of total costs for some industries, while in other cases it can represent a relatively small portion of the total cost of a product or service delivered to the ultimate consumer. For example, for service businesses, logistics costs typically account for less than 10 percent of total revenues. A specific transportation investment is therefore, unlikely to influence a firm or an industry to change its inventory policy, restructure its production process, or relocate its operations. However, over time, a number of investments can affect private sector response, as firms consider how to take advantage of the transportation system, so as to minimize their inventory and transportation costs and thereby increase their market reach, global competitiveness and profit potential. Transportation investments that make it possible for businesses to increase their efficiency (by reducing congestion and delays, reducing travel time, and increasing reliability) should eventually result in an increase market for a firm's and an area's products.

As noted above, an investment often requires both public and private actions to fully achieve its potential benefits. A public investment may not lead to the anticipated benefits, if no private sector action follows. In some cases, the public sector reacts to private sector initiatives (such as proposals by trucking or rail carriers, aircraft equipment manufacturers, etc.), where there clearly is a private sector interest. In such cases, joint private-public initiatives can help assure that intended benefits are achieved. In all cases, the evaluation of public sector transportation investments should consider private sector commitments or the extent to which the investment may encourage private sector follow-through, as well as the investment's potential role in increasing productivity.

E. Summary

In conclusion, economic expansion and development is affected by transportation investment fundamentally in two ways:

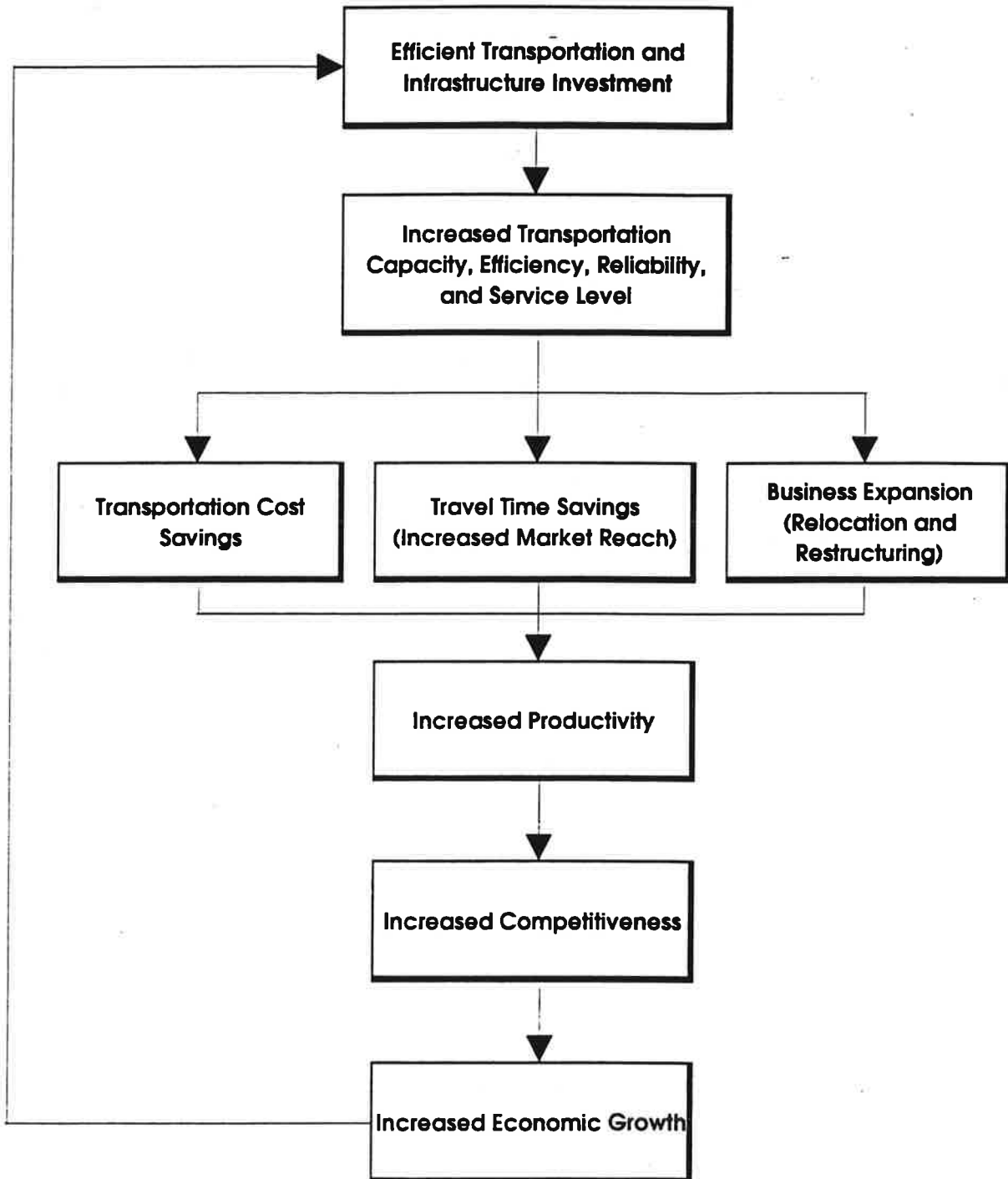
1. by **opening up or increasing the accessibility of developable land** and other natural resources for new or higher density development, and
2. by **reducing transportation costs and increasing productivity** of the various industries and economic sectors, making it possible to reduce the cost of manufacturing products or providing services per worker hour.

Figure I presents a simplified diagram of how a transportation investment can result in economic expansion. The direct result of the investment is increased land accessibility (reduced travel times) and lower transportation costs. These primary effects of improved transportation result in benefits to both the users and the non-users of the new or improved transportation facility or service, since for example, the price of goods consumed by non-users will reflect the reduced transportation costs. The changed accessibility and lower transportation costs eventually result in improved transportation service levels and reliability, encouraging business expansion, restructuring and/or relocation (increased production, fewer plant locations, fewer warehouses, lower inventory costs, etc.). The reduced transportation costs and increased market reach, as well as the business relocation, expansion and/or restructuring actions result in productivity increases, which increase the competitiveness of the business or an area in the global marketplace. Eventually, the increased productivity and competitiveness result in increased output, jobs, and income, which are reflected in increases in transportation demand. The increased production and economic growth requires continuing transportation investment to further increase accessibility, lower costs and increase productivity, and meet the needs of the growing economy.

The case studies in the Appendices refer to a myriad of economic indicators and other impacts that have traditionally been considered in analyzing the relationship between transportation investment and economic expansion, such as:

- jobs created and economic activity during construction
- longer term increases in jobs, economic output, and income
- increased accessibility to markets (reduced travel times, delays and congestion; changes in comparative locational advantage; and increase in an area's regional competitiveness)
- land development along the transportation facility (impact on urban form, land values and land use patterns, as well as impacts on national and statewide/regional land use and development patterns)
- Retention and expansion of businesses or attraction of new business, and increased accessibility to labor pool from a business location (impact of transportation on business location decisions)
- Accessibility to job opportunities for individuals from a residential location (impact on individual's residential location decisions)
- increased accessibility to job, shopping, leisure and vacation opportunities, thereby increasing personal choices and quality of life (reducing travel time, delays and congestion for commuting can increase personal productivity)

Figure 1: Simplified Diagram of Linkage between Transportation Investment and Economic Expansion



- reduced transportation costs (e.g. labor, fuel, accident, and other operating costs)
- taxes and revenues generated

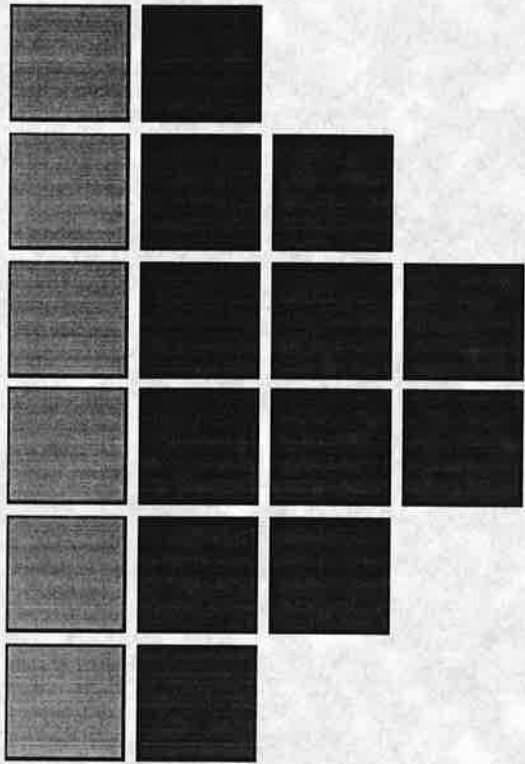
All of these measures of the linkage between transportation investments and economic activity are related to the two fundamental ways in which transportation investment affects economic development. Some of these measures, such as the jobs created during construction, represent short-term impacts of the transportation investment. Others are simply different ways to look at the opening up of land for development and the resultant changes in accessibility, or the reduction of transportation costs and resultant increase in productivity. Finally, some of these measures are only appropriate when viewed from the perspective of a state, local jurisdiction, or an individual firm (e.g. taxes or revenues generated and jobs retained or attracted). For example, in many cases, the jobs attracted may not result in a net increase in economic output or income at the national level, since whatever increases in economic activity are attributed to the transportation investment would take place some place else without the transportation investment.

In today's economic environment, there are some additional measures that are particularly relevant, and could be used to consider the relationship between transportation investment, productivity, and economic expansion. Examples include:

- reduced inventory requirements for businesses (may actually result from an increase in transportation **reliability** and a reduction in delivery time, thereby reducing inventory requirements and the **inventory cost** of goods while on transit, although at a **higher unit transportation cost**)
- reduced time and/or reliability for products to reach markets, which is particularly important for short cycle products which become obsolete rapidly (e.g. computer technology, high fashion apparel, electronic consumer products, flowers and high-cost perishables, etc.)
- relative competitiveness of American industry in global marketplace (requiring inputs from many foreign locations)
- competitiveness of regions to attract and retain business in expanding and higher paying industries
- potential for generating increased exports to free-trade partners, such as Mexico and Canada

Although it is widely recognized that transportation is an important ingredient in the competitiveness of the nation's or an area's products and services, these factors have not generally been explicitly considered in the evaluation of transportation investments, as they are difficult to fully quantify. However, it is widely recognized that transportation investments that make

possible higher levels of service, quality and reliability to business, and thereby increase competitiveness, should be an important reason for public sector investment, as it can help private sector firms open up new markets, create new jobs, and expand economic activity.



**III. What we know about the Influence
of Transportation Investment on
Economic Expansion**

LOUIS BERGER INTERNATIONAL, INC.



III. What we know about the influence of transportation investment on economic expansion

This section of the report synthesizes the results of previous work that can help understand the ways in which transportation investment influences economic expansion. The section is divided into four subsections that discuss the following topics:

- Why transportation investment is important as a public policy tool to facilitate economic expansion?
- Recent economic sector growth trends and the implications of those trends for transportation investment.
- How does transportation infrastructure affect private sector productivity?
- Role of different modes of transportation in influencing economic expansion.

A. Why is Transportation Investment important to Economic Expansion?

As noted in the previous section, transportation infrastructure can be viewed as a part of the capital investment that the nation, a state, or the private sector must make to increase production and/or raise the standard of living. It is one way in which capital investment can be channeled to build up the productive capacity and the efficiency of the economy.

Transportation investment is similar then to the spending on new factories, machines, computer systems, and warehouses that private sector businesses make to increase their productive capacity and efficiency. Just like national or state policies are designed to stimulate or facilitate economic expansion by encouraging private investment in additional productive capacity, new technology and more efficient production and distribution systems, so must the Federal government and the states and local jurisdictions consider how public sector transportation investments can increase economic production capacity and efficiency.

Transportation infrastructure investment enables private companies to produce their products or provide services at a lower cost, thereby increasing their competitiveness. When an airport adds to its runway capacity, making it possible for more direct or faster airline service to new markets, businesses located in the airport's vicinity can compete more effectively. Similarly, when a new highway is built and the travel time is reduced for nearby businesses, companies can spend less on truck driver wages for deliveries, truck wear and tear can be reduced, and in general, the company can lower the cost to deliver its products to the ultimate consumer and/or increase the size of its market.

The recent national debate about the budget deficit and the emphasis on reduced government expenditures at the State level have sometimes failed to recognize the difference between operating

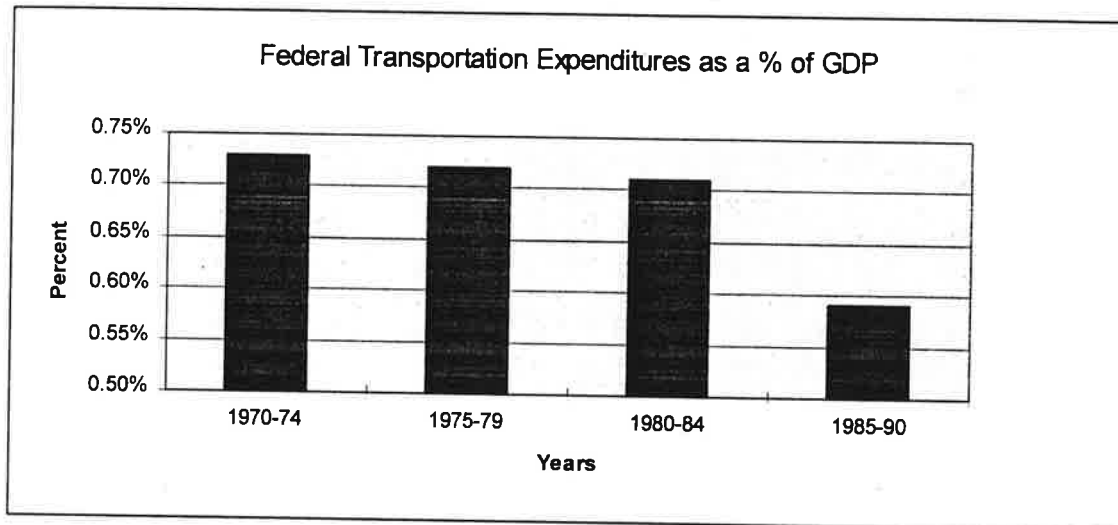
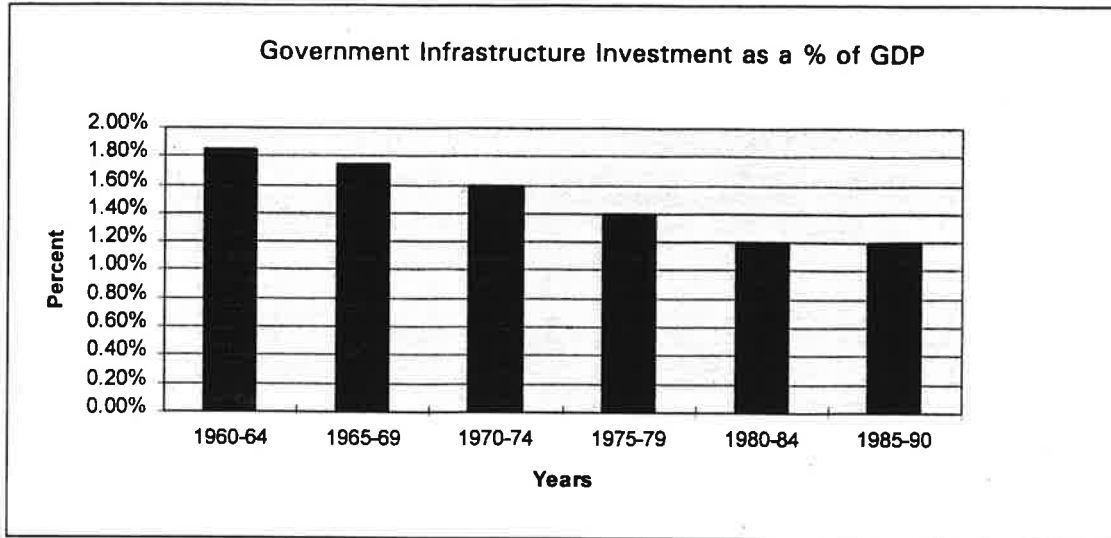
expenditures and long-term investment. While most states separate operating and capital expenditures in their budget processes, the Federal government budget does not separate annual transportation operating expenditures from those investments aimed at increasing capacity and efficiency. Actually, a major portion of government transportation expenditures involves an investment in the future, and its impact should therefore not be measured solely in terms of short-term economic results. The impact of constructing new or expanded highways, airports, rapid transit systems, and other transportation facilities can take years to materialize. This time-lag in being able to achieve benefits from the investment should be expected, just as private corporations invest in major facilities and equipment knowing that it will take years to achieve their targeted financial return.

Although most transportation investment is intended to increase productive capacity and efficiency, the extent to which a project contributes to these objectives varies considerably among projects. Transportation investment is not solely intended to achieve economic growth. Therefore, even if a relationship could be developed showing aggregate national economic growth performance as a result of different levels of transportation investment, such a relationship should not be the main basis nor the sole criteria to guide investment levels. Besides considering historical levels of transportation investment and their results, transportation investment commitments should be based on an analysis of specific proposals and their intended purposes.

In a way, this is again similar to the situation when considering appropriate research and investment levels in the private sector. No business can survive without periodic investment to modernize its facilities and introduce new technology, nor can it afford not to conduct research to develop new products and services. However, there is no fast rule as to what percentage of corporate resources should be spent on R&D or new product development. Long-term corporate growth generally requires a stable or growing level of commitment to capital investment and research. The same can be said about transportation investment and research and its importance to the nation's and the states' ability to successfully achieve a sustained economic expansion. The fact that infrastructure investment at all levels of government as a % of GDP has declined since the 1960's (see Figure II) can therefore be viewed with concern. Similarly, Federal government transportation expenditures have also declined as a % of GDP.

Two economists, David Aschauer and Alicia Munnell, have recently brought attention to what they conclude is the nation's inadequate public investment in all types of infrastructure in the past two decades. They correlated the public infrastructure disinvestment or over consumption with a decrease in aggregate productivity growth rates through macroeconomic studies. More specifically, they concluded that much of the decline in U.S. productivity growth rates that occurred in the 1970s was partly a result of declining rates of public capital investment in the nation's infrastructure, including transportation (Munnell, 1992). Both argued that public capital investment in infrastructure plays an important role in enhancing both productivity and private economic activity.

Figure II



Aschauer and Munnell findings are not without critics. First, critics contend that the macroeconomic studies have resulted in numbers that are not credible, and more importantly, they note that more evidence is needed on the causation issue. Eisner (1991) summarized this criticism by stating that the evidence is still inconclusive. He notes that the question "Does public capital investment contribute to more output?" is still unanswered, and rephrases the general research question to ask: Is higher output and income a consequence of having more private capital and more labor or do states with higher output and incomes invest more public capital?"

In many respects, the cause and effect relationship do not matter as much as the recognition that effective capital investment is necessary to sustain economic expansion. There is general agreement that transportation investment is an important ingredient to achieve or sustain economic expansion, i.e. whether to stimulate expansion or to support it once it is underway, the nation, the states and the private sector need to regularly consider appropriate transportation investments.

At the same time, if transportation improvements are to be of value in supporting the nation's and the states' economic expansion goals, it is important to consider the economic sectors that can benefit from different types of investment. Similarly, it is appropriate to take into account the industries where the nation or a state can be competitive in the global economy, as well as consider the transportation needs of those industries with greatest potential for future growth.

B. Economic Trends and Implications for Transportation Investment

The US economy has undergone dramatic changes since the 1970's, many with significant implications for transportation investment. From an industrial base, emphasizing mass production of standardized goods, the US economy has been transformed into a post-industrial economy. This post-industrial economy produces a wider variety of specialized goods and is more service-oriented.

There are several recent trends underpinning the metamorphosis of the US economy from an industrial to a post-industrial economy:

1. low growth rate of agricultural, mining and other older traditional sectors;
2. decline of basic manufacturing, changes in manufacturing processes, and decentralization of manufacturing;
3. increases in the service sector of the economy; and
4. increases in the role of foreign trade and integration into the global economy.

The transportation requirements of the nation's economic sectors in light of their growth trends will be reviewed in this section. Four major economic sectors, i.e. agriculture, mining, manufacturing, and services, as well as foreign trade are discussed.

1. Agriculture

The nation's agricultural production has increased over the years, even though the portion of the labor force and the acreage devoted to farming has continued to decline. Historically, high levels of productivity in the agricultural sector have been achieved by a public sector led effort of agricultural research and extension services. Improved farming techniques, increased use of fertilizers, new technology and equipment have made it possible to increase production.

In the early years, agricultural production could only be sold in nearby towns, or it could be moved through the nation's waterways. The development of an extended railroad system, followed by a network of rural highways, including farm to market and feeder routes made it possible the movement of agricultural production to elevators, food processing locations, consumer markets, and/or ports around the nation. Today, much of our agricultural production is moved to distribution and processing centers, consumption locations, or to anywhere around the world through water, rail, and road networks. Many agricultural products move in bulk, but some are also increasingly moving in standard containers. The agricultural sector, however, has not been a major factor in the nation's recent economic expansion, although there may be specific needs locally that require transportation investments to meet expanded agricultural production needs.

2. Mining

Waterways, railroads, and road networks also play an important role in the transportation of the production from the mining sector. Most of the nation's mining output also moves as bulk products typically by rail and water to industrial plants and/or ports. The competitiveness of our mining products in worldwide markets is sometimes significantly influenced by transportation costs, as can be the case for coal. Port coal facilities and its transportation from mines moves almost entirely by rail, involving private sector infrastructure. Mining has also not been a significant factor in the nation's recent economic expansion, although there may be specific needs that require transportation investments to handle expanded or new mining production.

3. Manufacturing

In the manufacturing sector, basic industries have declined, as new industries, such as semi-conductors, bio-technology and computers have emerged. In many instances, the physical inputs and outputs of these new industries are small but highly valuable. Many manufacturing units have also adopted new techniques that permit rapid adaptation to changes in demand, and the production of various goods with the same production line. In a study carried out in 1987, the US Department of Commerce observed that "the computer integrated flexible manufacturing system will break the hold that the search for economies of scale has had on manufacturing up to now. Big scale, single purpose, long production run plants will be a thing of the past".

The new production processes often involve multi-use machines, complex task programming, higher skills, and the ability to receive inputs just-in-time (JIT). An example of this development is provided by industries operating on the basis of JIT inventory control systems. The JIT system was developed in response to the high interest rates of the 1970's and high inventory carrying costs it generated. However, it continues to be increasingly used as a means of reducing inventory requirements and costs. The use of JIT is especially important to the electronics and automobile industries.

The growing decentralization of manufacturing also leads to an increase in the total number of freight movements required for production. Many products are partially assembled at different locations, sometimes in different countries, and then moved to final assembly locations. Domestically, as trucking accounts for a large share of intercity and intra-metropolitan transport, this trend puts added pressure on the roadway system.

Another change in manufacturing is the trend towards increased production of low volume, high value goods increasing demand for fast transportation of small quantities. As evidenced in a 1987 US Department of Commerce report, the physical inputs of these goods tend to be also small, but highly valuable. These developments suggest that future economic growth will require less in the way of transportation of heavy industrial raw materials per unit of output. This may have important implications for the relative use of competing transportation modes in the future. For example, demand for air freight and truck services may increase relative to water and rail services.

4. Services

At the same time, the US economy has become more service-oriented. The service sector, such as retailing, financial services, food service, health care, tourism, government and communications has been growing at a faster rate than other economic sectors. A broad definition of the service sector includes all activities not classified as goods producing (i.e. everything except manufacturing; mining; construction; agriculture; forestry; and fishing). Between 1972 and 1986, goods producing industries declined by nearly 10%, while service industries increased by 11%. In the late 1980s, the service sector accounted for 67% of GNP, and 69% of all wages and salaries. Service industries are not as affected by economies of scale, so they are generally not as concentrated in few locations. Their site selection criteria is typically more flexible than that for manufacturing plants, but also places increasing importance in access to labor as well as consumers.

The increase in the service sector in the decades of the 1970's and 1980's is the most important trend in the transformation of the US economy. Most of the nation's jobs created since 1970 have been in the service sector; accordingly, the share of employment in the services sector has risen from 56.5% in 1947 to 76% by 1987.

From a national perspective, several service industries, such as retailing and distribution services (transportation, communications, wholesale services) did not grow faster than the rest of the economy during the last two decades. But, in certain areas (e.g. tourism) these services have grown dramatically. Tourism is one of the most consistent growth industries in the world (represents about 12% of the world's GNP, ranks third among all export industries and second in terms of employment generation among all industries in the US). Travel and tourism is the first, second or third largest employer in 37 States. These businesses require a large unskilled or semi-skilled labor force at the place of service provision.

Tourism depends directly on transportation infrastructure - e.g. airports, highways, intercity rail and urban transit - (mostly involving movement of people rather than goods). The growth of tourism nationally has been significantly facilitated by improved access resulting from investment in transportation facilities. An example of the impact of a transportation investment on tourism growth is the construction of I-70 west of Denver which had profound implications on economic development in western Colorado (see case study in Appendix G).

In the past, most service businesses required face-to face interaction with clients. Therefore, the service sector offered a large number of clerical entry level positions for high school graduates in metropolitan areas. As a result of the on-going computerization and physical separation of routine-task functions from management locations, the number of entry level positions have declined, and much of the labor shifted to lower density locations (both at the national and metropolitan level, to respectively rural and suburban areas).

At the same time, the change in life style in the last two decades, has led to longer hours for services requiring extensive face to face interaction, thus increasing part time labor. The location of such services also have increasingly been decentralized into suburban areas. The outcome of these two trends resulted in a higher demand for low-wage labor, on a part time basis, in suburban areas. The decentralization of service activities in search of access to low wage labor and proximity to customers affects the direction of commuting. These jobs involve commuting across communities, rather than to the urban core, increasing suburban transportation needs.

Consequently, the competitiveness of a metropolitan region as a business location now requires a highway system that provides good accessibility among the various suburban areas, in contrast to being solely directed toward the central city/downtown, a transportation need that can more effectively be served by transit systems.

Spatial separation of functions within firms, as well as the long distance interactions among firms has also resulted in an increase in air travel by managers and professionals in headquarters and R&D facilities, as well as in the service sector. In this respect, good road access to a major hub airport is quite important for this group of skilled executives and professionals.

As the nation's economy has shifted away from agriculture, mining and heavy manufacturing into increasing emphasis on the service sector and high value manufacturing, the demand for freight

transportation (as measured by tonnage moved) has increased at a lower rate than GNP growth. The ratio of freight ton-miles per dollar of GNP declined from 0.9 in 1950 to 0.7 in 1987¹. However, it is important to note that higher value transportation services (typically involving higher value products) have become more important than the movement of bulky, heavy products.

5. Foreign Trade

Another sector of the US economy that has been growing rapidly is foreign trade, requiring easy access to seaports, airports and other ports of entry. International trade flows are concentrated in a limited number of seaports (over 80 percent of total tonnage in 1987 moving through the top 50 seaports), airports (major gateways), and other ports of entry (mostly at major highway connections to Canada and Mexico). Extensive investments in intermodal transportation (dedicated intermodal terminals, double-stack railcars, integrated domestic-international container transfer facilities, etc.) have accompanied the growth of foreign trade flows.

Industrial firms have evolved into large multi-national corporations. The emergence of multi-national corporations contributed to the growing integration of the US into the world economies. In such an integrated world economy, international trade will influence the structure of US industry, as well as the future demand for domestic infrastructure services. If the domestic transportation costs to move products from inland production centers are higher than the transportation costs from foreign locations across the ocean to consumer centers along the coasts (as is the case today for many products), US industries may face a competitive disadvantage in those markets. The North American Free Trade Agreement, in particular, is also likely to significantly affect cross-border movements and domestic transportation patterns.

The US has shared in the unprecedented growth in international trade over the last 20 years, and the impact of foreign trade on the American economy has increased significantly. As shown in Table IV, the share of trade (imports and exports) as a percentage of GNP increased from 12% in 1970 to about 15% in 1980, and to 22% in 1990.

In world trade, there has also been a shift from heavy and high labor content products to high technology production with high skilled labor input. These industries have low "blue collar" content but higher transportation service requirements.

Another change has been the rising importance of the information-and knowledge-based manufacturing industries encompassing the pharmaceutical, telecommunications, analytic instruments and information processing. International trade in these area is growing rapidly and participation in these segments of world trade will become increasingly important for continued growth.

¹ See "National Transportation Strategic Planning Study" Figure 5-19. US Department of Transportation, March 1990.

Table IV: US Economy Share of Foreign Trade (in billions of 1987 Constant US\$)

	1970	1975	1980	1985	1990
GNP	2,805	3,135	3,696	4,216	4,872
Exports^a	134	196	274	266	499
Imports^a	189	216	284	412	577
Exports & Imports as % of GNP	12%	13%	15%	16%	22%

(Source: World Tables, 1992, the World Bank.)

Table Notes:

- a. include Merchandise and Non Factor Services. (Non Factor Services refer to items such as: travel, transport, freight, insurance, etc.)

Table V summarizes merchandise trade for both exports and imports over the 1980-88 period. The data illustrate the rapid growth in the "knowledge" based or "high tech" industries. US merchandise exports grew at an annual average rate of 7.6% over the 1980-88 period. "High tech" exports increased at an annual rate of 8.1% over the 1981-88 period. The increased role of "high tech" exports is even more dramatically illustrated by its rising share of manufactured exports: from 35% in 1981, rising to 41% in 1988.

There is every indication that exports will play an increasingly important role in future US economic expansion. Production needs and the associated infrastructure requirements will have to include attention to transportation infrastructure needs, such as border points of entry, airports, seaports, and their inland connections.

6. Summary

Recent economic trends indicate that certain types of transportation investments are particularly important to support the expanding sectors of the economy, such as those aimed at:

- increased reliability and faster freight delivery, including better control of highway traffic incidents, reduced congestion and bottlenecks;
- meeting air transportation requirements of management/professional staffs of businesses with decentralized operations;
- commuting needs for service sector low skilled labor to suburban and rural areas;

Table V: Growth in US Foreign Merchandise Trade

A. Growth in Merchandise Trade per annum (in %)			
Period	Exports	Imports	
1980-88	4.5%	7.6%	
B. Growth By Category of Exports (in billions of US \$)			
Period	Total Mfg	High Tech Mfg	Agric. Exports
1981	171.7	60.4	43.8
1985	167.8	68.4	29.6
1986	179.9	72.5	26.6
1987	200.0	84.1	29.1
1988	255.3	104.3	37.6
Growth per annum:			
1981-88	5.8%	8.1%	-2.2%

(Source: US Department of Commerce United States Trade: Performance in 1988, September 1989, Tables B1 - B6, pages 82 -87.)

- increased efficiency of the nation's border ports of entry, seaports and airports systems to handle foreign trade needs, including improved inland access connections by rail and highway;
- new technology applications to improve transportation industry productivity and reduce costs;
- improved intermodal connections and rail clearances for railroads to be able to operate newer technology, more efficient railcars (e.g. double-stack and trilevel railcars), including combined domestic and international services;
- meeting the transportation needs of the tourism industry (including intercity travel to tourism destinations as well as travel to attractions in metropolitan areas); and

- increasing accessibility and market reach, even though growing businesses have more flexibility in business location decisions, since transportation access remains an important factor in location decisions and competitiveness.

C. How does transportation infrastructure affect private sector productivity?

Fundamental to understanding how a firm behaves or how an economic sector is affected by transportation infrastructure is understanding the private sector motivation to maximize profits. Typically, when operating plans and production schedules are established, a firm assumes the existing transportation infrastructure to be fixed. Similarly, in most cases, a firm will assume existing conditions in deciding where to locate. The impacts of transportation investment can then take a long time before being reflected in productivity increases or expanded output, since it takes time after a transportation facility is completed before it is reflected in business relocation decisions or changed production plans.

Businesses will restructure their operating processes when they identify an opportunity to decrease costs or to facilitate the profitable expansion of their operations. If transportation investments result in a less expensive or more reliable service, businesses and industries will respond in an attempt to reduce their operating costs or expand their markets. The cost reductions may result in increased profits and/or production. Such cost reductions can be achieved in numerous ways including decreases in personal and business travel times, freight delivery time reductions, decreases in fuel and other operating costs, and opportunities for reducing inventory requirements as a result of improved reliability.

Expansion of operations as a result of a transportation investment may take place because of increased access to new and larger markets or restructured operations that reduce costs and increase profitability. Reducing costs and restructuring the production process of a firm or industry typically leads to productivity increases, creating an opportunity for expansion of production and economic growth.

Transportation investment (capacity expansion, new technology, use of larger - more efficient vehicles, etc.) can then lead to improved private sector productivity in several ways:

- by reducing transportation costs for existing firms at their present locations;
- by making possible expansion of markets at existing locations, thereby resulting in increased output;
- by opening up opportunities for restructuring of manufacturing and distribution processes (reducing plant locations, production of certain parts at different locations and assembly closer to consumer, reduction of warehouse locations and related inventory costs, etc.); and

- creating opportunities for innovative, new, more productive businesses that are dependent on more reliable or faster transportation access.

The relationship between transportation investment and industry restructuring is very complex since many factors other than transportation costs and services are involved. A specific transportation investment is unlikely in most cases to result in significant industry restructuring or the creation of new businesses. However, transportation investment programs that significantly reduce costs and increase speed and reliability can generate new business activity.

A large company usually has multiple manufacturing and warehouse locations. Transportation of a large number of supplier-originated, intracompany and customer-bound shipments must be accommodated on a daily basis. The inventory requirements, transit times, equipment needs, transportation costs, impacts on manufacturing production schedules are all factors that must be considered in analyzing how a transportation investment can create opportunities for industry restructuring. There is little doubt that properly targeted investments can increase productivity in the transportation sector that eventually gets reflected in reduced logistics/distribution costs and an overall national productivity increase.

D. Impact of different types of transportation infrastructure investment

Not all transportation infrastructure investment can be expected to result in the same increase in the nation's or the States' productive capacity or efficiency. Clearly, investments in different types of transportation projects, modes and locations can have very different purposes and result in different impacts in terms of stimulating economic expansion in various areas. The following paragraphs will summarize what we know as to how different modes and types of transportation investments influence economic growth.

This summary will review investments:

- by mode and type (new or expanded facilities, system preservation and maintenance, and facility management),
- in different areas (rural vs. urban), and
- how these investments can influence development from different perspectives (National, Statewide/regional/local, and private industry/economic sectors).

1. Highways

At the national level, there is no question that highway investment has been a key ingredient in the nation's economic development. The construction of a nationwide system of arterial roads based on uniform standards made it possible for individuals to travel long distances by road and for businesses to similarly move cargo by highways. The Interstate Highway System, approved

in concept in 1944 and initially funded by the Federal Highway Act of 1956, has been called "the most ambitious public works program since the Roman Empire" and represents perhaps the largest single infrastructure investment program ever undertaken in the US. The Interstate System has reshaped the economics of residential, commercial, and industrial locations throughout the nation, providing a level of mobility and accessibility unequalled anywhere else in the world. Construction of the system has made it possible for individuals to commute to their workplaces from distant low-density rural and suburban areas. Similarly, coast-to-coast trucking services became more competitive. The result is that firms have been able to reduce their warehouse locations and production facilities, so they can now efficiently serve the entire US from fewer plant and/or warehouse locations.

It is generally accepted that highway investments contribute to national and regional/local economic development both during the construction period and in the long-term.

The impact of highway investments on long-term economic development has been the subject of many studies. In general, there is agreement that highways have been an important factor in increasing long-term economic expansion. This relationship is explained by various authors in different ways, with different approaches used to measure how highway investment can result in an increase in land development, economic production or efficiency. As noted previously regarding all transportation investments, the fundamental ways in which highways influence long-term economic activity can be traced back to transportation cost reductions and the opening of land for development made possible by increased accessibility.

The fundamental ways in which highway investment contributes to economic growth can then be summarized as follows:

- Short-term Employment during construction;
- Long-term reduction in transportation costs and related productivity increases; and
- Travel time reductions and improved accessibility, which results in land development and increased economic activity.

The long-term impacts of highway investment, basically relate to an increase in accessibility and a reduction in transportation costs, are then further reflected in:

- a. increases in long-term employment, productivity and income growth, and
- b. increased wealth, tax base and standard of living.

Employment During Construction

During the 1930's following the Depression era, and at times thereafter, a major objective of highway construction was to increase employment. In today's economic environment, although highway investments can create short-term employment opportunities during the construction phase, these economic impacts are typically minor and in most cases, are at the expense of employment growth elsewhere.

Reduced Transportation Costs

The most direct, most readily measurable, and the most fundamental way in which highway investments influence economic development is by reducing the transportation costs to move people and goods between one location and another. This reduction in transportation costs can affect both individuals and businesses. For individuals, it can result in reductions in the cost for commuting, vacation and other traveling. For businesses, transportation cost reductions can reduce their overall production and distribution costs, and thereby increase profitability and make their products more competitive.

Reduced Travel Time, Increased Accessibility and Location Decisions

A highway investment typically reduces travel times between two points, and thereby results in increased accessibility to an area. Increased land accessibility is closely related to a reduction in transportation costs, since the time to move people or freight is one of the major factors that accounts for the reduction in transportation costs.

For individuals, highway investment can result in increased accessibility to job, shopping, leisure and vacation opportunities, thereby increasing personal choices and **quality of life**. Freeway construction around urban areas have made it possible for individuals to commute as much as 50 to 60 miles from their workplace. For businesses, highway investment can increase the **market reach** of their products and services, due to faster access to more destinations for person travel and goods movement.

Increased land accessibility also affects location decisions of individuals and businesses. Individuals will consider changes in land accessibility when making their residential location decisions. Similarly, businesses will specifically consider accessibility, not only transportation costs, when evaluating plant and distribution sites.

New interregional highway construction - network connectivity

There are several types of new highway investment depending on its purpose and its location. Most recent new highway construction in the US has been part of the effort to develop the now nearly completed 42,796 mile Interstate System connecting the major cities in all states, most state capitals, tourist attractions and key industrial areas. This system carries more than 21 % of all

highway travel. The Interstate System consists entirely of limited access facilities designed for longer distance, faster through travel, and built to high design standards to meet 20 year traffic forecasts. Other new highway corridors have been built or proposed to connect other activity centers not directly linked to the Interstate System. In late 1993, US DOT and the States identified a new National Highway System consisting of more than 150,000 miles (including the Interstate System) to be approved by Congress in accordance with ISTEA. This more extensive system will provide an interconnected highway network of national significance roads.

The major economic and development impacts of new highway construction can be summarized as follows:

- a. Changes in land accessibility and the resulting land development along or near interchanges
- b. Changes in residential and business locations
- c. Reductions in transportation costs, and
- d. Impacts on business competitiveness, market reach, economic productivity, industry restructuring, and the location of national economic activity

When a new intercity highway corridor is constructed, it not only reduces transportation costs and times for those individuals and businesses that previously travelled between the two end points of the new facility. Typically, a new highway connection also results in "generated travel," i.e. increased transportation demand made possible by the new facility, either by increased trip-making, longer distance travel, or the demand generated by new economic activity. A new highway connection then increases total transportation demand in the area, by creating new opportunities for increased personal travel along the corridor and by increasing the market reach of businesses in the area.

Since few freeway links existed when the Interstate System was defined, most of the links were built as new highways through rural and urban areas. Construction of the system then resulted in significant increases in the relative locational advantage of cities served by the new highways and land near the new highway interchanges. Land located near interchanges or in cities along the Interstate have generally experienced an increased rate of development and an increase in property values (see also discussion of Case Study I in Appendix B).

New urban highways

In urban areas, new highway construction is aimed primarily at reducing congestion and opening up new land for development. New highways can significantly affect the pattern of land development and strength of the downtown core. If a new highway reduces congestion, the area's competitiveness for attracting and retaining business can be positively affected. In today's

environment, the reliability of local delivery of overnight packages and other time-dependent freight can be an important factor in business location decisions.

In urban areas, land values along new highways and interchanges typically increases after the highway construction. Commercial and residential development along the highway generally follows the highway construction. The existence of congestion-free, limited delays and a relatively efficient highway transportation system is an important factor affecting individual and business location decisions. For example, the construction of Route 128 in Metropolitan Boston made possible an increase in employment in the communities along its route from less than 25,000 in the late 1950's to over 85,000 by 1974 (see discussion of Route 128 economic impacts in Appendix I).

An area can develop even in the absence of significant highway investment (e.g. the population of Charles County, Maryland grew from 32,572 in 1960 to 101,154 in 1990). In such situations, typically the development generates increased demand for additional highway investment. Thus, even though highway investment significantly influences land development, so does increased land development generate additional highway demand. If additional highway capacity is not provided in a timely manner, congestion increases and the quality of life for residents and businesses is affected.

New Rural Connections

In rural areas, there is a weak relationship between the construction of a highway and overall economic output or employment. The lack of a new highway does not necessarily mean economic decline as was often the case with the construction of the railroads in the 19th Century. The most direct relationship involves the effect on tourism or traveller related services (food, lodging, gasoline and recreation establishments). Construction of a new highway in a rural area can affect economic activity in a variety of ways, such as:

- if agricultural land is taken for highway construction, it can have some impact on agricultural production
- highway bypasses of small urban areas can reduce congestion and improve local traffic flow, but can also reduce business for existing establishments.
- rural highways can generate industrial or commercial development along its corridor, if other ingredients for economic development are present, such as unexploited natural resources, inexpensive land, labor, tax levels, tourist attractions, business climate, etc.

An example of the profound implications of new highway construction in a rural area when other prerequisites for increased development are present is the ski resort development west of Denver after construction of Interstate 70 and the Eisenhower Tunnel. In 1950, only a few hundred

people depended on skiing for their livelihood in Colorado. Today, it is estimated that the State's recreational industry accounts for 66,000 jobs, over \$2.5 billion in annual retail sales, and \$1.3 billion in personal income. The ski resort industry includes more than 27 ski areas and provides an estimated \$113 million in tax receipts. Recreational tourism represents the largest industry in the Western Colorado area. The population and employment growth that has occurred in the corridor would not have been possible without the increased accessibility that resulted from I-70 and other transportation investments (see discussion in Appendix G).

Expansion of Existing Highway - Increased capacity

Since the nation already has a very extensive highway system connecting to nearly all major cities, tourist attractions, agricultural areas, and other industrial activity areas, most of the future emphasis in highway construction will involve the expansion of existing facilities to add capacity, increase safety, and increase system efficiency (e.g. reduce congestion and travel time through incident management, improved traffic control, etc.).

These types of highway investment can be expected to affect economic expansion through their impact on economic productivity and transportation cost reduction, and are less likely to significantly influence land development. Many of the State's transportation programs aimed at economic development are targeted at projects intended to attract or retain businesses by increasing capacity and the efficiency of already existing facilities (see Appendix E).

Improvements to existing highways can also be important in increasing transportation reliability, a particularly relevant issue for many fast growing economic sectors. In today's economic environment, the ability to reduce inventory costs (by eliminating warehouses and/or operating with a Just in Time inventory management system) or improve service levels to customers, is affected by the reliability of the travel time on the transportation system.

Highway System Maintenance and Preservation

As has been previously discussed, one of the fundamental ways in which transportation investment affects economic expansion is through the reduction of transportation costs that result from that investment. Over the past 30 years, the national highway system has been significantly expanded resulting in a significant reduction in transportation costs. However, unless the condition of the system is properly maintained and preserved, user costs increase over time. Therefore, maintaining highways in proper condition is as important as their existence. Today, many of the existing older highway facilities are in need of significant rehabilitation. Furthermore, highway operations and maintenance does not typically generate the interest or excitement associated with building a new facility. As a result, maintenance and rehabilitation needs are affected by state and local budget priorities, and frequently are not adequately analyzed nor given appropriate priority. As the Interstate Highway System nears completion, the emphasis on investment has been shifting to preservation of the facilities rather than adding new links or lanes, as discussed in Case Study I (Appendix B).

Lack of adequate maintenance or rehabilitation (e.g. the lack of timely snow removal, deferred pavement patching or resurfacing, bridge posting or closing) result in increased transportation costs and delays, which negatively impact businesses and economic productivity. The condition of a highway system can be a critical factor in the daily transportation costs (truck and car wear and tear, fuel efficiency, etc.) of businesses and individuals. It can then also affect individual and business location decisions, as well as an area's competitiveness.

In 1988, the US Congress commissioned a review of the implications of alternative highway investment strategies. The analysis revealed that projects aimed at properly maintaining highway conditions can be expected to result in the highest real rate of return on the investment. Table VI presents national averages of the expected returns on various types of highway investment based on the 1988 Congressional Budget Office analysis.

Table VI: Expected Returns of Different Types of Highway Investment

INVESTMENT TYPE	EXPECTED REAL RATE OF RETURN ON INVESTMENT (National Averages)
4R Projects ^a to Maintain Current Highway Conditions (Average Present Serviceability Ratio of 3.1) ^b	30 percent to 40 percent
New Construction, Urban Areas	10 percent to 20 percent
4R Projects to Upgrade Sections Not Meeting Minimum Service or Safety Standards	3 percent to 7 percent
New Construction, Rural Areas	Low ^c
4R Projects to Fix All Deficiencies Above Minimum Service and Safety Standards	Negative

(Source: Congressional Budget Office, based on data from the Federal Highway Administration.)

Table Notes:

- a. 4R projects are those involving restoration, resurfacing, rehabilitation, or reconstruction.
- b. Present serviceability ratings score highway conditions on a scale from 0 (very bad) to 5 (excellent). A rating of 3.1 puts the Federal Aid System in good to very good condition.
- c. Economic returns may be higher for replacement of substandard bridges on the national truck network.

2. Air transportation

The nation's air transportation system is an important and growing sector of the national economy. The public sector provides the infrastructure and operates the airspace system (Federal government) as well as the airports (State and regional/local governments or public authorities). The airspace system is one of the most technologically advanced infrastructure systems in the world. It is an example of how transportation investment programs can contribute to US technological leadership and thereby increase the nation's competitiveness and exports (see discussion in Appendix C).

Although the air transportation system handles a relatively small percentage of the nation's total person travel and freight movement, its importance can be best understood when considering that:

- nearly all international travelers other than from Canada and Mexico arrives or departs the US by air, and
- in 1990, about 28% of the value of all exports departed the US by air.

The air transportation system is particularly important to the tourism industry and to companies competing internationally.

Airports and aviation are significant contributors to local, state and regional economies. Airports are usually associated with a significant share of local business. Airport economic studies have demonstrated that they generate significant:

- revenues,
- jobs,
- personal income, and
- taxes

from airline, ground transportation, concessions, and other services. The direct (on-site income), indirect (off-site income) and induced (based on the multiplier effect from direct and indirect income) for Los Angeles International Airport in 1988 was estimated at \$28.6 billion.

An analysis of the economic impact of Oakland International Airport by Martin O'Connell Associates (Case Study VII discussed in Appendix H) concluded that, as of 1991, the airport supported 51,000 jobs, \$3.6 billion in business revenue and \$1.6 billion in personal income. This level of airport activity would not have been possible without investments totaling hundreds of millions of dollars.

General aviation airports, i.e. those airports without commercial air service, are also important to an area's economy. In a study of the economic impact of Maryland airports by Wilbur Smith & Associates, it was found that many private businesses rely on general aviation facilities as a

base for their corporate/business aircraft. Businesses use these aircraft for executive and emergency travel. The 32 airports without commercial service in Maryland generated \$178 million in annual economic impact, \$21 million in taxes, and over 2700 jobs.

This study also noted that airports also have a major role and impact on attracting and serving business activity, such as:

- economic benefit when a manufacturing plant needs a key part flown in or the assembly line must be shut down;
- savings from "just in time" inventory systems that typically rely on some air transportation;
- meeting travel needs of company executives;
- emergency medical situations; and
- importance as a factor in site selection (56 percent of corporate site selection personnel consider proximity to commercial airport important or essential, and 46% consider proximity to general aviation airport important or essential).

The influence of airports then extends well beyond the airport site. The location of airports influences business locations and for certain technology and high-value products industries, proximity to an airport with good airline service can be a significant factor affecting site selection decisions, as witnessed by the large industrial and office parks that have been developed around major airports. Alliance Airport in Texas and other airports around the country were developed primarily as catalysts for land development around them.

The tourism industry - second largest source of employment in the US and fastest growing industry worldwide - also has some strong links with air transportation service. International visitor spending in the US was approximately \$34.4 billion in the US during 1989.

Air transportation influences economic expansion in today's economic environment in the following ways:

- provide the fastest regional, national and international access to businesses increasingly competing in a global economy;
- main mode of transportation for the movement of high-value, low weight products;
- used by many industries for just-in-time inventory and production systems that are being increasingly used by manufacturers;

- provide access to customers of knowledge intensive industries, financial services, tourists, and other fast growing segments of the increasingly important service sector of the economy; and
- airports are themselves major employment generators and have become major catalysts for nearby land development (hotels, conference centers, headquarters of major businesses, aviation training, aircraft maintenance, warehouse and distribution centers for parts and perishable products, suppliers of custom built and specialized equipment, engineering support for companies with dispersed client locations, etc.).

Airport investments can also be aimed not just at serving local industry and maintaining the competitiveness of the area, but also to attract a "hub" serving also through passengers and cargo, thereby becoming a generator of related jobs and economic activity that otherwise would flow through a competitive gateway.

Most of the services that are provided by the air transportation system are used by individuals and businesses who are willing to pay the cost, because of the time savings or their other service requirements.

As is the case with all transportation improvements, investments in the air transportation system then influence economic expansion primarily through their:

- impact on land development near airports;
- increased accessibility to markets served as reflected in reduced travel time or congestion; and
- reduced costs and increased productivity of the air transportation system.

The increased accessibility and productivity further influences business location decisions, and industry competitiveness, as firms make use of the increased market reach and service level made possible by the improved air transportation infrastructure.

3. Railroads

The historical role of railroad transportation investment in stimulating economic growth in the US is well known. When the railroads were built, many towns not located along its routes disappeared. Major railroad connecting points grew to become some of the largest cities in the US (e.g. Chicago, St. Louis, and Kansas City). Railroad investment stimulated economic growth primarily by opening land for development that was then mostly inaccessible for economic production. The construction of the US railroad network was financed mostly by private enterprise, except for the land grants contributed by the Federal government. Initially, railroads served as the main mode of transportation for long-distance person and freight movement. With a few exceptions in high-density population corridors served by AMTRAK, railroads today do not carry significant numbers of passengers.

In today's economic environment, more than 50% of cargo moving by railroads is bulk commodities that in most cases, can not cost-effectively be moved any other way. Railroads are then an important factor in the nation's productive capacity of iron ore, steel, agricultural products, chemicals, and other bulk products. In some cases, such as coal, railroad costs can significantly affect the competitiveness of US exports.

After many decades of losing volume and market share of general merchandise cargo to the trucking industry, railroads have recently begun to attract back additional general merchandise cargo businesses. Governments and railroad carriers have recently been investing in double stack equipment, new modern intermodal terminals, and line-haul clearance improvements, so as to reduce costs and increase productivity to move intermodal cargo. Case Study III discussed in Appendix D describes the joint private-public efforts to increase railroad clearances along major corridors in Pennsylvania. These investments are aimed at increasing the competitiveness of the state's manufacturing and distribution industries.

Until recently, the major railroads have faced an overcapacity situation and have been involved in a significant downsizing initiative. Over the past decade, short line railroads have been created as many lines have been abandoned by the major railroads. Line abandonments can result in increased transportation costs for previously served businesses. In many cases, the potential loss of jobs to the local economy has resulted in public subsidy programs to retain businesses.

The major ways in which railroad investment can influence economic expansion in today's economic environment is by:

- the application of new technology to reduce costs and increase productivity,
- investing in clearance and terminal improvements that also reduce operating costs, streamline intermodal connections and increase productivity, and
- restoring lines, adding connections or preserving service to attract industrial development

An interesting example of the impact of transportation on location decisions is the recent selection by BMW of its new US plant in South Carolina. Although clearly many factors were considered, the selected site is located on a rail line with high clearances to be able to use tri-level railcars. This example highlights how transportation access and flexibility are important factors in industrial site selection.

Railroad Network Additions

Due to the significant growth experienced in some intermodal corridors, for the first time in many years, some observers have begun to predict a need for capacity additions in some railroad corridors. Historically, railroads have always maintained that the intermodal business was not

profitable enough to invest in additional capacity. The importance of the intermodal business to railroads has increased in the past decade and as a result, railroads have been investing significantly in new terminals and equipment. If demand continues to increase, the need for additional capacity may require line-haul network capacity expansion projects.

4. Urban Rapid Transit Systems

Historically, many urban mass transit systems developed as private sector investments with a profit-making motive. The rationale for investment in many cases was largely dependent on the profit-making potential of land development at or near transit stations, rather than from transit operations. Urban mass transit systems influenced the shape of large older cities. These systems allowed the high density development of urban areas like New York and Chicago. With increased reliance in automobile travel and the resultant decentralized development and suburbanization that has characterized urban growth patterns since World War II, the importance of access to urban mass transit systems has diminished as a factor influencing development and individual and business location decisions.

Today, public sector organizations own and operate mass transit systems nationwide. Mass transit systems are now viewed by many as a public service as well as a policy tool to influence future development patterns and achieve more compact, higher density urban cores. In addition, many of the nation's older urban areas future development potential is constrained by congestion and the high density of the urban core, so that mass transit expansion is necessary to help reduce congestion and/or increase the capacity of the urban core to support job expansion.

New rapid transit system construction

In cities without rail mass transit service, development of new mass transit systems have been pursued by many metropolitan areas with the objective of stimulating growth and channeling development along the new transit corridors. Besides the transportation objective of efficiently moving large numbers of people and reducing congestion, new urban mass transit system investments are generally pursued to achieve the following three land and economic development objectives:

- Sustain and maintain dense development and growth in the downtown core;
- Manage the shape of land use development; and,
- Create and stimulate economic growth and employment opportunities.

For the modern mass transit systems, construction of rail mass transit is also viewed as a city-building exercise with long-term implications for a region's economic health and status. The metropolitan areas who invested in mass transit perceived themselves taking significant strides toward their place among a hierarchy of national and international cities. Clearly, economic expansion is an implied goal of rail mass transit investment; growth and development is anticipated to follow from becoming a "world class" city (see also discussion in Appendix F).

The major ways in which mass transit investment can influence economic expansion in today's policy environment is by:

- encouraging high density land development near stations and in the downtown core of a metropolitan area, by making these areas more attractive as business locations,
- reducing highway congestion in the area and making possible job expansion and residential development in areas that otherwise could not support further development
- providing transportation to inner city residents helping them gain access to jobs,
- increasing the locational advantage of suburban sites for clerical and labor intensive office operations.

System Preservation and Rehabilitation

Mass transit investments today are also necessary to rehabilitate and maintain the aging infrastructure in the older cities. Without this service, the economies of the urban cores could not function, leading to the loss of businesses and jobs.

In the case of older mass transit systems that have become obsolete and expensive to maintain, it is still crucial to the urban and economic structure of a region that they be preserved, rehabilitated, and modernized. Just as is the case with any major transportation investment, once a rail mass transit system is in place, it becomes part of the economic engine driving the region. In the Philadelphia area, a 1991 study found that a shutdown of the SEPTA urban transit system would over time result in a loss of about 10% of the total metropolitan area jobs (see Case Study discussion in Appendix F). The investment requirement for maintenance and upgrading are typically large (SEPTA rehabilitation needs were estimated at \$4.5 billion), but rehabilitation and upgrading of older rail transit systems is as necessary as investing in new facilities.

5. Water Transportation

Ports and inland waterways are major elements of the nation's transportation infrastructure. The Federal government is responsible for all waterways in the nation, and State and local jurisdictions, through government agencies or independent public authorities invest in ports mainly for the purpose of attracting jobs and economic development to their areas. Typically, these ports compete with other ports in the region for cargo in their local hinterland, and with ports around the nation for cargo destined to farther inland destinations. From the national perspective, ports are a key factor in maintaining the nation's competitiveness for exports. They are particularly important as the nation's economy becomes more closely integrated into the global economy

Inland waterways are the least expensive means of transportation and are critically important to industries with requirements for large volume movements of bulk materials that are not time-sensitive. Because of their slower speed and transfer costs, inland waterways typically are only viable for handling bulk movements from origins or destinations near a waterway or coastal port. Historically, inland waterways affected development by encouraging industries to locate along their routes, and by providing the cheapest transport mode for handling long-distance bulk cargoes, such as chemicals, agricultural products and petroleum. In today's economic environment, although there is little need for expansion (other than when needed to support a specific private industrial development), it is important to maintain the existing waterway system (including channel dredging, locks and dams, and other infrastructure), particularly where it serves industries that rely on that system.

Port facilities are viewed by local governments as catalysts for development. Having a port locally with extensive direct and fast international service can help attract jobs and other related business to the area. A 1991 study carried out by Martin O'Connell Associates estimated that the impact the Port of Oakland maritime operations generated some 190,000 jobs, \$729 million in business revenue and \$430 million in personal income (see Appendix H). This current level of port operations in the Oakland area could not take place without past investment efforts. Oakland was the first port in the West Coast to build specialized container facilities as early as 1962. Port investments, such as those in Oakland, are typically aimed not just at serving local industry and maintaining the competitiveness of area industries, but also at attracting through cargo and related jobs and economic activity that otherwise would flow through a competitive gateway.

One other aspect of water transport infrastructure is the dredging of access channels to ports. Uncluttered channel access and water transport routes linking ports to the ocean are vital to keeping ports operating and increasing US competitiveness. The dredging process involves excavation of soils and rocks in the access channels, as well as transportation and disposal or use of the material removed. The environmental impacts of dredging are of paramount concern to local residents, which can be affected by pollution from the dredged material as well as by degradation of the areas in the vicinity of the deepened waterways. A complex process, dredging is not typically considered by some as a transportation investment and is little understood outside of the group of experts and specialists who work on such projects, both in terms of its importance to the nation's or an area's economic well being and its environmental impacts (see Appendix K).

Port investments then are related to increased economic activity and can influence economic expansion in the following ways:

- as important direct generators of economic activity and revenue production, through their operations and through their attraction of transshipment and intermodal inland cargoes;
- through capacity expansion to meet increased trade needs;

- through technology applications and other innovations to increase productivity of port operations and reduce cargo handling costs;
- typically represent a significant catalyst in nearby land development (such as warehousing and other related distribution businesses); and
- makes an area more attractive to influence business location decisions, since businesses and individuals seek access to more efficient port operations, with adequate capacity, fewer delays, easy cargo intermodal transfers and access to highways, and increased services connecting to foreign and domestic markets.

Port investments are also major factors in the economic development competition among various areas in the US. Some would argue that a national port strategy would be appropriate to avoid over-capacity and wasteful investments. On the other side, some could argue that the competitive system that exists encourages lower user costs and efficiency in operations that could not exist under a centralized investment policy.

6. Ports of Entry

Foreign trade has been increasing in importance over the last two decades, growing from 12% of GNP in 1970 to 22% in 1990. Canada and Mexico are the US two largest trading partners. Trade with Canada and Mexico moves mostly across the ports of entry along the border, connecting major highways and railroads in the two countries across the border.

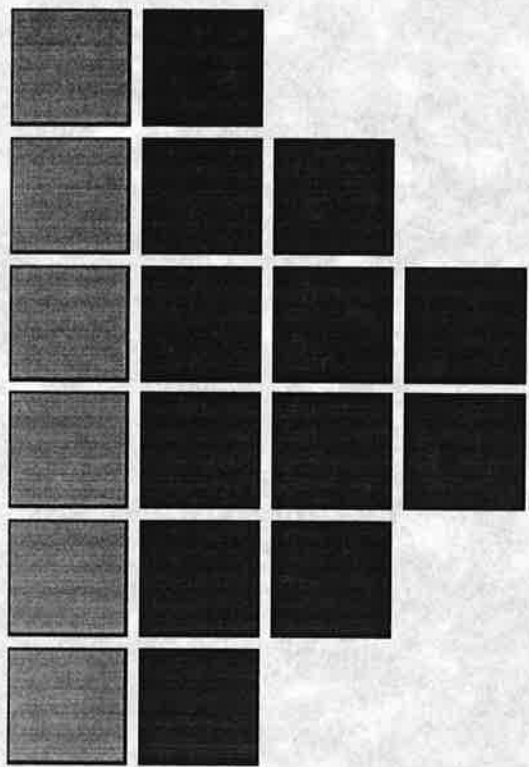
Ports of entry at the border crossings can impact the economy of the region they serve. The infrastructure of a border crossing port of entry consists of three major components: the highway or railroad border crossing itself, the highway and/or railroad facilities connecting the border crossing to the major transportation facilities in both sides of the border, and the international inspection facilities (see Appendix J).

The main objective of transportation infrastructure investment at a port of entry is to accommodate growing trade and the development associated with that increased trade. Transportation investments associated with a port of entry are related to increased economic activity as follows:

- by facilitating increased trade
- by providing options to industries that require fast access across the border to increase their competitiveness, and
- as a key ingredient to attracting employment and economic growth to the local region.

E. Conclusion

In conclusion, the ways in which transportation investment have affected economic expansion in the past is well documented in qualitative terms. The continuing need to provide an expanded and more efficient transportation infrastructure to support future economic requirements is essential to improve the nation's competitiveness. Although it is no simple matter to measure the linkage between transportation investments and overall economic well being, productivity and development, the importance of these investments to growth of the national and regional economies in today's increasingly global economic environment is well understood.



IV. Case Studies

LOUIS BERGER INTERNATIONAL, INC.



IV. Case Studies

A. Introduction

The study approach to investigate the linkage between transportation investment and economic expansion is based on the selection of case studies that can assist AASHTO member departments to focus on priority areas to support economic expansion. The selection of case studies was intended to cover all types of transportation investment in both rural and urban areas.

Since the intent is to assist the States in future investment decisions, it is important to focus on the type of investments that States should be considering in the future. At the same time, it is important that we consider investments made some time ago, so information on actual results can be obtained, rather than rely solely on feasibility studies for projects that have not yet been built. It was therefore decided to consider as potential case studies, projects that were built some years ago as well as programs and projects with completed feasibility studies but not yet constructed.

B. Approach to Case Study Selection

The study identified potential case studies by reviewing publications and papers, as well as through informal contacts with Federal, State and local agencies, as well as practitioners. Based on the literature review and these contacts, a list of potential case studies was developed (see Table VII).

The primary criteria in selecting case studies was to end up with a list of not more than 8 case studies that was diverse enough to include projects involving:

- all modes of transportation,
- urban and rural settings,
- both freight and people movement, and
- both system preservation and facility expansion.

Other criteria considered included factors related to availability of information, project completion, and the importance of economic objectives in the investment decision, such as:

- Economic development objectives articulated in investment decision
- Relevance of information on linkage between investment and economic development at the State level
- Available data and pre-investment analysis
- Time since investment and available information on economic development results and impacts.

Table VII: List of Case Studies Considered Initially

NATIONAL LEVEL	<ul style="list-style-type: none"> A. Interstate Highway System (construction and preservation) B. National Airways System C. Industry Studies D. Proposed New Systems or innovations (IVHS, Freight Highway Corridors) E. Investments to enhance foreign trade and competitiveness F. Dredging and Port Investment Policy to enhance coal exports (Baltimore, Norfolk dredging projects) G. Amtrak Equipment or High Speed Corridors H. National Inland Waterway Study I. Railroad Intermodal Clearance and Capacity Projects (Pa., APL, NS, Conrail)
STATEWIDE/REGIONAL LEVEL	<ul style="list-style-type: none"> A. Avenue of the Saints (St. Paul-St. Louis) B. Wisconsin Highway 45/29 Corridor C. Georgia Economic Development Program D. Michigan Economic Development Fund E. Industrial Access Fund - North Carolina F. Minnesota Freight Program G. Port Impact (Seattle or Baltimore) H. Airport Impact (General Aviation) I. Arkansas/Mississippi Greater Ridge Bridge - Lower Mississippi IWT J. Shelby Intermodal Terminal (Montana) K. Scenic Byways, Casino construction southeast Connecticut or Colorado Ski area (linkage to tourism industry) L. Rail and Motor Freight (Northwest Indiana Study, Northwest Mo.) M. Global Air Cargo facility in North Carolina N. Santa Teresa Intermodal Facility (New Mexico)
METROPOLITAN	<ul style="list-style-type: none"> A. BART B. MARTA C. E-470 Colorado Access to new Denver Airport D. Metropolitan Beltways/Highways (Route 128 Boston, I-84 Hartford, Rte. 34, New Haven) E. Dallas-Fort Worth Airport F. Scottsdale Airpark G. Denver Airport H. Seattle Airport I. Heliport J. RR Abandoned Line K. Bradley International Airport L. Railroad Passenger Station (Boston South Street, Washington Union Station) M. Buckeye Basin Greenbelt Parkway - Toledo

C. Selected Case Studies

Eight case studies were initially selected for review, involving transportation investments in all modes at the national, state or metropolitan levels. All of these case studies should be relevant to the States, whether directly for implementation of similar project types, or through their relationship with Federal and/or local programs. The eight case studies initially selected are:

1. Interstate Highway System (national studies - emphasis on system rehabilitation and preservation)
2. National Airways System
3. Pennsylvania railroad clearance projects

4. State Transportation Economic Development Programs
5. Rapid Transit Development - BART, MARTA, WMATA, and SEPTA
6. Impact of I-70 on Colorado Tourism
7. Port and Airport Economic Impacts - Oakland, and
8. Metropolitan Beltway - Route 128

After the initial case studies were completed, it was decided that two additional case studies dealing with two important types of transportation investments that have not traditionally been considered as extensively in the literature would be added. These two additional case studies deal with transportation investments that are particularly important as foreign trade increases as a share of the nation's GDP. The additional case studies selected are:

9. Border Crossings - Laredo, Texas Port of Entry, and
10. Dredging of Port Access Channels - Baltimore

Each case study is discussed in a different appendix to this report, and every appendix is presented in 5 sections. The first section briefly describes the investment, including where appropriate, a project location map, the investment amount, funding sources, timing of decision and construction, and other relevant information. The second section presents the investment objective(s) and decision-making process, particularly specific economic development objective(s), and whether articulated, and the role of economic expansion objective in investment decision.

The third section of each appendix briefly describes the analysis or methodology used for project evaluation prior to investment decision, particularly whether a comprehensive economic analysis was carried out and whether economic expansion and development was considered in the analysis.

The fourth section of each appendix discusses the project objectives achieved and, to the extent available, information on the results obtained after the investment. In particular, conclusions regarding economic development results and impacts of project and/or investment are presented to the extent available. Other information on project use, economic benefits and/or impacts are also noted, including comments from knowledgeable observers or prior studies.

Finally, the fifth or last section of each appendix includes some lessons learned from the case studies, including relevant conclusions on linkage between transportation investment and economic expansion, and what we know and what we don't know as to results compared to articulated objectives.

A brief summary of the lessons learned from each case study are included in the rest of this section. The last section of this report includes the overall study results and conclusions on what we know about the linkages between transportation investment and economic expansion.

D. Summary of Lessons Learned from Case Studies

Case Study I - INTERSTATE HIGHWAY SYSTEM

The Interstate Highway System represents perhaps the largest single infrastructure investment ever undertaken. The basic rationale for the system was to connect all major cities in all states, most State capitals, tourist attractions and key industrial areas, defense establishments, and major economic centers by the construction of a limited access highway network to the highest engineering standards that would be able to move long-distance interstate commerce traffic faster and more efficiently. The system was designed based on estimated traffic volumes to meet the anticipated demand for a 20 year planning period. It now carries more than 21% of all highway travel.

The Interstate System was selected as a case study because it highlights the effects of a transportation investment at the national level involving a new system using existing technology to achieve a higher level of service for the long distance movement of individuals and freight. In addition, this case study will also be used to discuss the implications of such a massive investment in terms of longer-term maintenance and rehabilitation requirements.

A major investment such as the Interstate Highway System, involving the development of a new national system providing a high level of service to reduce transportation costs and travel times, has had profound implications on land and economic development, as well as economic productivity. Although there is no simple way to measure the linkage between the investment and economic well being, productivity and development, several conclusions can be reached:

- The most direct, most readily measurable, and frequently the most fundamental way in which highway investments influence economic development is by reducing the transportation costs of moving people and goods between one location and another. The Interstate Highway System significantly reduced long-distance transportation costs (including travel time and delay costs), made possible the development of coast-to-coast trucking services as a competitor to rail, and thereby increased the service options for businesses to move their freight. The transportation cost reductions associated with the construction of the Interstate System also resulted in a reduction in the costs of consumer products and an increase in the productivity and competitiveness of American businesses.
- The fact that the Interstate System carries 21% of all highway travel is the best indicator of its importance to the national economy.
- The Interstate System made possible the development of reliable, coast to coast trucking services, thereby increasing options and service for freight movement. The system resulted in a reduction in the cost of consumer products and the ability of firms to serve consumer markets from fewer plant or warehouse locations.

- The safety benefits of the Interstate Highway System are readily apparent in highway safety data. The System was designed for safe, limited access, high speed travel, and its accident and fatality rates per million VMT are less than half those of other types of highways.
- The local and regional impacts of the Interstate Highway System on land development have been significant.
- Access to an Interstate Highway has become an important factor in business location decisions.
- Traffic congestion costs large amounts of money, and it is reasonable to conclude that Interstate Highway improvements which alleviate congestion (primarily in urban areas and highly traveled links) will be good investments and will be positive factors in attracting or retaining businesses.

It is clear that future investment in the Interstate Highway System will be needed to assure that the system continues to serve the economic needs of the nation. Further investment should include greater emphasis on facility management, as well as connections to other highway systems and modes, aimed at increased efficiency.

Case Study II - NATIONAL AIRSPACE SYSTEM

The National Airspace System (NAS) is the largest and most technologically advanced aviation infrastructure in the world. It is probably the most complex, but one of the least visible elements of the nation's transportation infrastructure. Its purpose is to control air traffic, and provide information and communications links to pilots. It is also one of only two elements of the nation's transportation network that is solely a Federal government responsibility (the other is the waterway network).

In 1981, the Federal Aviation Administration (FAA) published the first National Airspace System Plan (NAS Plan). The plan involved a comprehensive strategy for improving the safety, capacity, and productivity of the air traffic control system. The Congressional Budget Office (CBO) estimated the total cost of the plan to be approximately \$10.7 billion, the investment would begin in 1982 and would continue over two decades. At the time, this investment represented roughly 36 times the previous capital expenditures for air traffic control, and one of the largest federal public works investment ever undertaken. By 1991, more than 40% of the original NAS plan projects were completed. Additional projects have been added over the years to reflect new opportunities for cost reductions and introducing new technologies.

The NAS was selected as a case study involving the deployment of new technology, with the objective of achieving increased productivity in the public sector. This case study also requires private investment to achieve the intended improved efficiency, since the new technologies are

dependent on aircraft based equipment. This case study is based solely on historical information available at the time it was prepared. The NAS Plan is an evolutionary document, and as such, has not and will not remain static. Changes and alterations to the original Plan have occurred, most notably in the present emphasis on the Global Positioning System (GPS) technology instead of the Microwave Landing System (MLS) approach and the present approach to achieve a more limited consolidation instead of the larger consolidation envisioned when the original version of the plan was prepared.

The original 1981 FAA plan specifically identified four broad goals:

- Reduce the cost of operating the traffic control system,
- Accommodate anticipated growth in air traffic,
- Improve the safety of air travel, and
- Upgrade the quality of flight services.

The FAA's investment would reduce the cost of operations and accommodate future air traffic growth as efficiently and safely as possible. Greater automation within the system would facilitate further system efficiency gains. The resulting improvements in labor productivity from the new technologies would allow increased facilities consolidation, staff reductions, and provide for future air transportation needs. The NAS plan is based mostly on technology development and achieving higher productivity in the operation of the airspace system and in the use of the system.

The NAS improvements and the investment in new technology resulted in increased productivity (flights per traffic controller) and savings for both users and non-users of the system. It has increased the capacity of the system to meet the airlines need to add flights. It has also contributed to US technological leadership in an area with great potential for increasing exports.

The plan was based from the outset on a rigorous analysis of economic benefits and costs. The relationship between airways system benefits, however, and the nation's economic expansion is unclear. In general, the investment resulted in the following:

- increased capacity to meet increased demand for flights and cargo,
- decrease in air transportation travel time, reduced congestion, and increasing reliability for time-sensitive freight,
- reduced airways operating costs, which should be reflected in lower taxes or fees for passengers, air carriers, and other system users, and
- reduced aircraft and airline operating costs (through lower fuel use and less flying time), which should be reflected in lower airline fares or air cargo rates.

The NAS investment then decreases air transportation costs and increases the potential service levels that air carriers can offer, thereby increasing the market reach of the nation's products and services. At the same time, it increases the competitiveness of the US in the global marketplace, both through the technology development and through the additional air service links that it makes possible.

The investment directly contributes to economic development through increased air traffic controller productivity and decreased air transportation costs. These benefits accrue not only to persons and businesses that use the airways. Lower air transportation costs may be passed on to consumers as lower prices for consumer goods that move by air, to workers as higher wages, or to owners of businesses and aircraft equipment as higher net income.

Case Study III - **PENNSYLVANIA RAILROAD CLEARANCE PROJECTS**

Public sector transportation investment can result in economic expansion primarily through increased productivity achieved by private sector transportation carriers and/or users of their services. The US is probably the only country in the world where the railroad system was developed and is mostly operated by private enterprise. Since deregulation in the early 1980's, the industry has significantly improved its productivity. The primary increases in productivity occurred because of reductions in the labor force, increases in equipment utilization, network downsizing, and use of higher capacity railcars.

Freight rail service and costs can have a significant impact on a State's competitiveness. The State of Pennsylvania and other eastern states faced such a situation when the rail industry (initially at the initiative of steamship lines) began to use double stack railcars for internodal services in the mid-1980's. Double stack railcars can result in significant line-haul cost savings (over 40% compared to conventional intermodal cars). Double-stack services first started operating from the West Coast ports mainly to move international cargo inland. The efficiencies made possible by the new railcar technology can be expanded if the equipment is more fully utilized, so railroads and other operators of the service (steamship lines) quickly began to use available capacity to fill slots with domestic cargo. The double-stack network has expanded rapidly, and is one of the main reasons why rail internodal services have grown rapidly in recent years, even attracting truckload carriers.

In April 1993, Pennsylvania approved the investment of approximately \$35 million to improve clearances on two major corridors, in cooperation with Conrail and the Canadian Pacific Railroad. Work on a third corridor is also being pursued, pending formal commitment by CSX and the State of Maryland, since it also involves connections through that state. The project will increase clearances to allow use of higher capacity, more efficient railcars, such as double-stack container railcars and tri-level autorack railcars.

It is clear that the state and the railroads have very different investment objectives. For the State of Pennsylvania, the objectives include:

- 1) providing higher productivity, lower cost transportation service to manufacturers and distributors who operate from Pennsylvania;
- 2) attracting additional business, such as central distribution and warehousing services, wholesale distribution, and integrated retail firms operating throughout the North-East region; and
- 3) encouraging economic development.

For the railroad, the objectives focused on developing new markets and increasing their internodal competitiveness. Both the state and the railroads benefit if the investment attracts additional cargo as a result of the improved transportation service.

Although the project is still in its implementation stage, some lessons in terms of how investment in transportation can impact the economic development of a region or a state can be drawn:

- A public-private partnership may be an appropriate way to achieve the needed transportation improvements when the private carriers are unwilling to make their own commitments and there is some question as to the role that the public sector should play.
- Transportation service availability (such as double-stack container service or tri-level autorack service) can be a significant competitive factor for industry site selection and retention of existing businesses.
- The transportation investment commitment by the State, including spending public funds on privately own assets, reflects the importance of maintaining a competitive transportation service to attract and retain industry.
- The investment was originally considered to improve the competitive position of the Port of Philadelphia for international cargo, but analysis concluded that the largest beneficiaries of such an investment are the domestic shippers making it possible for the State to participate in the rapidly growing long-haul domestic container markets with profound implications for Pennsylvania based manufacturing and distribution industries.

Case Study IV - STATE TRANSPORTATION ECONOMIC DEVELOPMENT PROGRAMS

State and local economic development officials have long recognized the importance of transportation infrastructure among the factors considered by businesses in their site selection process. In recent years, nearly half of the states have established transportation investment programs to address the specific need for new or upgraded highways and/or rail access to attract or retain businesses or industries. These state transportation programs are often closely tied to broader State economic development programs. Depending on the State, this type of investment may involve near-term targeted projects to benefit specific private developments, and/or longer-

term regional transportation projects that are anticipated to foster the prerequisite conditions for economic development.

This case study explored several examples of state transportation investment programs that have been undertaken recently with the specific goal to promote economic expansion. The **Michigan and Wisconsin** programs were selected as examples of programs that make relatively small near-term investments aimed at influencing business location decisions. The **Pennsylvania, Minnesota, Wisconsin, and Georgia** programs were selected as examples of long-term state highway investment with a focus on economic development objectives.

In the case of targeted assistance near-term programs to provide incentives to businesses facing a location decision or a specific transportation problem, the following conclusions can be reached:

- Despite the best efforts of program officials, and even considering the emphasis on transportation improvements intended to reduce business costs, typically it is not possible to conclude unqualifiedly whether a transportation investment in fact leads to a business location decision or job preservation that otherwise would not have occurred.
- To ensure non-speculative economic development projects, considerable private funds and/or planning and time are generally required, but there is always the question of the necessity of the public sector contribution to finalize the private sector decision. Even when private businesses state that their decision depends on the transportation infrastructure investment, there will be instances when the public monies would not have been necessary, or private investment could have substituted.
- These investments are State economic development decisions, which should be guided by the overall State economic development strategy. In many respects, the decision is not very different than the common decision that any private business must make as to whether to reduce prices (or subsidize) an initial sale in order to get repeat business.

Regarding long-term State highway programs aimed at transportation investment with a focus on overall regional or State economic development, the following conclusions can be reached:

- Some State Highway Investment Programs focus in and near **laggard economic centers** where it is felt the greatest economic growth potential may exist if transportation access is improved. It is generally agreed that transportation investment does not ensure economic expansion, unless other prerequisites also exist (natural resources, competitive labor, business climate, etc.).
- Other programs emphasize access to population and employment centers, seeking to ensure **connectivity** with regional and national markets, which in today's global economy can be a significant factor in attracting or retaining business. To the extent that such investments facilitate trucking productivity, improve access to raw materials, tourist destinations and

other export industries, as well as increase the market reach of key industries in the State, such programs are likely to impact positively the State's economic long-term growth objectives. However, in today's environment, business location decisions are affected by many factors, so it is not possible to easily quantify such impacts.

- Some investment programs are aimed specifically at providing a statewide system of 4-lane arterial, based on the conclusion that the existence of multi-lane arterial development is related to higher density land-uses and increased economic activity levels. The economic development process also involves establishing a positive business image and climate. To the extent that the State has been perceived as having a less efficient highway system, such a program can assist State economic development efforts. However, properly designed 2-lane highways with adequate shoulders, access control, and similar design speeds, can provide as efficient transportation service as 4-lane arterials. Such trade-offs should be carefully considered in designing statewide highway programs aimed at economic expansion, since it is widely acknowledged that transportation investment alone will not satisfy the preconditions requisite for development (i.e. other available infrastructure, labor, education, etc.).
- Programs aimed at specific network deficiencies affecting trucking productivity (such as bridge postings, seasonal truck restrictions, network-wide or specific locations with weight and/or size restrictions that affect truck routings and productivity) are most likely to result in transportation cost reductions to businesses located in the State.

Justification for these statewide programs center on **the competitive economic development efforts of nearby states and the need to reduce transportation costs and enhance productivity**. To the extent that the state's residents are not unduly tax-burdened vis-a-vis other states, that the state's basic transport network is underdeveloped, and that the traditional transportation benefits (i.e., travel-time savings, lower transport costs, accident reductions) stemming from construction are sufficient to justify the investments, these programs are likely to be economically attractive.

There has been some criticism that State transportation programs aimed at economic expansion do not generate a net gain in income or output, but simply affect the pattern of development. The economic development or growth benefits of highway improvements in terms of increased output, income or productivity, are difficult if not impossible to precisely measure. However, **properly targeted** State highway investments to reduce transportation costs, increase the productivity of firms located in an area, or attract new business, **can** be a valuable tool to increase the competitiveness of a State or local area and therefore, increase its economic activity over the long-term.

Case Study V - **RAPID TRANSIT DEVELOPMENT**

Historically, urban mass transit systems influenced the shape and size of large older cities. These systems allowed the high density development of urban areas like New York and Chicago. With

increased reliance in automobile travel and the resultant decentralized development and suburbanization that has characterized urban growth patterns since World War II, the importance of access to urban mass transit systems has diminished as a factor influencing development and individual and business location decisions.

Mass transit investments today are necessary to rehabilitate and maintain the aging infrastructure in the older cities. These systems are viewed as an essential public service. Without this service, the economies of the urban cores could not function, leading to the loss of businesses and jobs. In addition, development of new mass transit systems have been pursued by many metropolitan areas with the objective of stimulating growth and channeling development along the new transit corridors.

This case study discusses the economic development impacts of four urban mass transit systems, three of which are modern (constructed within the last 20 years), and an older, established system in need of major rehabilitation as follows:

- **BART** (Bay Area Rapid Transit), San Francisco-Oakland, California.
- **MARTA** (Metropolitan Atlanta Rapid Transit Authority), Atlanta, Georgia.
- **SEPTA** (Southeastern Pennsylvania Transportation Authority), Philadelphia, Pennsylvania.
- **WMATA** (Washington Metropolitan Area Transit Authority), Washington, DC.

All modes of mass transit are considered, including rail (commuter trains and subways), buses, and light rail (trolleys), but the emphasis is on rail, since as the highest capacity technology, it is viewed as the mass transit system with greatest influence on development patterns and also requires a larger investment commitment.

Besides the transportation objective of efficiently moving large numbers of people and reducing congestion, new urban mass transit system investments are generally pursued to achieve the following three land and economic development objectives:

- Sustain and maintain dense development and growth in the downtown core;
- Manage the shape of land use development; and,
- Create and stimulate economic growth and employment opportunities.

For the modern systems, construction of rail mass transit is also viewed as a city-building exercise with long-term implications for a region's economic health and status. The metropolitan areas that invested in mass transit perceived themselves as taking significant strides toward improving their place among a hierarchy of national and international cities. Clearly, economic expansion is an implied goal of rail mass transit investment; growth and development is anticipated to follow from becoming a "world class" city.

New mass transit systems in major US metropolitan areas have influenced the location of development. Each of the three metropolitan areas analyzed which built rail mass transit systems in the last 20 years, were growing rapidly when the systems were started, and have continued to grow. However, the economic development process is so complex, that it is not easy to isolate the unique contribution of mass transit, so the specific consequences cannot be accurately measured in terms of employment created and income generated. Several general observations can be made about the linkages between mass transit investment and economic change:

- mass transit systems have resulted in high density development around stations and have been a major factor in maintaining vibrant urban economies in large US cities;
- it is not possible to conclude that the metropolitan area derives greater economic benefit and competitive advantage as a whole (as opposed to a transfer from one part of the area to another);
- Cities seek a "world-class" image by developing mass transit systems and although such effects are not measurable, there is some recognition that such systems do add to an area's image as an important center.
- mass transit investment improves the access to downtown areas, and makes these areas more attractive as business locations for regional headquarters, central offices, financial institutions, and major government agency regional or national headquarters;
- older mass transit systems are an essential component of the urban economy;
- providing transportation to inner city residents helps them gain access to jobs;
- mass transit systems increases the locational advantage of suburban sites for clerical and labor intensive office operations; and
- the tourism industry can be a beneficiary of mass transit investment, if attractions are located close to transit stops, and there is convenient access from hotels, rail and airport facilities. This has been the experience of Washington and Atlanta.

Case Study VI - **IMPACT OF I-70 ON COLORADO TOURISM**

Opening up land and natural resources for development is one of the traditional purposes of transportation investment. In the state of Colorado, the construction of Interstate I-70, one of the major east-west national corridors of the Interstate System, was not planned with the intention of increasing accessibility to tourist areas. However, the highway was planned along and near ski slopes which significantly reduced travel time from the resort areas to the Denver metropolitan area and its international airport.

The I-70 Corridor was selected as a case study to examine the effects of constructing a major highway through an area having potential for tourism development but requiring improved access. This case study highlights the role that the construction of I-70 has played in serving tourist areas, and expanding and diversifying the state's economic base. Often an "export" industry serving the residents of other states and nations, tourism has steadily increased in Colorado since the construction of I-70.

The transportation investment in the I-70 Corridor, including the construction of the Eisenhower tunnel, has clearly had a major impact on economic development in the corridor. In 1950, only a few hundred people depended on skiing for their livelihood in Colorado. By contrast, today it is estimated that the state's ski and recreational resort industries (both summer and winter) account for 66,000 jobs, over \$2.5 billion annual retail sales, and \$1.3 billion in personal income. The ski resort industry includes more than 27 ski areas and provides an estimated \$113 million in tax receipts. The U.S. Forest Service received approximately \$6.6 million in fees as well. Recreational tourism represents the single largest industry for the state's Western slope.

This economic activity is generated by around 10 million skier resort visits annually, including 6.8 million destination visitors (persons staying overnight) and 2.9 million "day tripper" visits. Colorado draws an average of 10,000 out-of-state visitors a day to the state's resorts. Out-of-state visitors typically account for about 35 percent of the skier visits.

It is not realistic to assume that the population and employment growth that has occurred in the corridor would have been possible without an increase in accessibility for both Metropolitan area residents and out-of-State visitors. The major impact of the investment was the reduction in travel time between the resort areas near the highway and Denver and its airport. The result has been significant land development, job creation, and economic activity associated with the tourism industry. This growth has had profound implications on land and economic development in western Colorado. Although there is no simple way to measure the linkage between the investment and economic development in the corridor, several points can be made:

- I-70 brought more dependable, safe, faster, and cost efficient access from the Denver metropolitan core and its airport to the rural, mountainous hinterland.
- The level and spatial location of tourist development would not have been the same without the construction of I-70 and its tunnels. Tourism development was closely linked with the improved accessibility brought about by the transportation improvements.
- I-70 contributed to active recreation "life-style" choices of many Denver area and Colorado residents. The active outdoor lifestyle supported by these resorts has not only attracted a year-round clientele, but also increased the competitiveness of the Denver area as an attractive business and residential location.

Case Study VII - PORT AND AIRPORT ECONOMIC IMPACTS - OAKLAND

Ports and airports are major elements of the nation's transportation infrastructure. State and local jurisdictions, through government agencies or independent public authorities invest in these transportation facilities mainly for the purpose of attracting jobs and economic development to their areas. Typically, these transportation facilities - particularly ports - compete with other ports in the region for cargo in their local hinterland, and with ports around the nation for cargo destined to farther inland destinations. Recently, with the establishment of more hubs and international gateways, larger airports also increasingly compete for international and long distance travel not originating in, or destined to, the local area.

Port and airport facilities are viewed by local governments as catalysts for development. Having an airport or port locally with extensive direct and fast domestic and international connections can serve as an important incentive to attract new business to the area. Depending on the competitive situation in the region, ports and airports can be profit-making enterprises. Because of their ability to generate their own revenues, they usually are structured to function with some autonomy and with independent financial authority.

The Port of Oakland, a public enterprise established in 1927 by the City, operates both the Oakland International Airport and the Oakland marine terminal facilities. It was selected as a case study of transportation investment by a local jurisdiction, with the explicit objective of generating economic activity and serving the needs of local businesses. The focus is on the economic impact of the aviation and maritime investments on the economic impact to the communities they serve.

The overall objectives behind the investments are the following:

- for the aviation-related investments, upgrade and maintain aviation facilities to keep pace with increased passenger demand and to make airfield improvements that result in increasing overall airport capacity; and
- for the maritime-related investments, help the port maintain its current competitive position and business volumes, and to achieve a "moderate" growth rate in the future.

As of 1991, airport operations in Oakland supported some 51,000 jobs, \$3.6 billion in business revenue, and \$1.6 billion in personal income. In addition, in 1992, maritime operations generated some 190,000 jobs, \$729 million in business revenue, and \$430 million in personal income. These economic impacts are not the direct result of any specific investment. However, the current level of operations at the Oakland seaport and airport would not have been possible without past investment efforts totaling some \$840 million (as of mid-1993).

To illustrate further the importance of facility investment to attract business to seaports or airports, one can point to the following historical development. On the maritime side, Oakland was the first port in the West Coast to build specialized container handling port facilities, as early

as 1962. During the 1968-74 period, the competing ports of Los Angeles and Seattle made significant investments in container port facilities and were able to attract significant business and gain parity with Oakland.

In the 1980's, intermodal transportation developments focused on the initiation of double-stack services to the Midwest and East Coast of the US (requiring tunnel clearances that not all railroads could provide from Oakland). LA/Long Beach developed a new Intermodal Container Transfer Facility 4 miles from their container berths to minimize drayage costs from the rail yard to the berth. Seattle and Tacoma developed several facilities with on-dock rail access. Other West Coast ports also were able to provide deeper access channels. Oakland was not able to invest in new port facilities at the same rate as competitive ports did, and as a consequence the Port lost a significant share of the West Coast market.

This case study sheds some light on the relationship between transportation investment by a major port and airport organization and the economic development generated. The investment criteria usually considered by port officials include (1) the financial viability (measured typically by the pay back period and debt coverage ratios), and (2) the regional economic impact of the project(s), as measured by the number of jobs and the amount of income generated. These type of transportation investments then:

- are important direct generators of economic activity and revenue production, through their operations,
- typically represent a significant catalyst in nearby land development,
- make an area more attractive to business location decisions, since businesses and individuals seek access to more efficient port and/or airport operations, with adequate capacity, fewer delays, easy passenger and cargo intermodal transfers and access to highways, and increased services connecting to foreign and domestic markets.

In conclusion, although it is no simple matter to measure the linkage between these investments and increased economic productivity and development, the importance of these investments to growth of regional economies in today's increasingly global economic environment is well understood.

Case Study VIII - **METROPOLITAN BELTWAYS: ROUTE 128 AND I-495 BOSTON**

Route 128 is a circumferential beltway located approximately ten miles from the Boston, Massachusetts Central Business District. It passes by or through twenty-seven communities on approximately 66 miles of roadways extending from Braintree to Gloucester. Route 128 is now also designated as Interstate 95, but planning and construction of this highway route started before the Interstate Highway System was designated. Route 128/Interstate 95 is a limited access highway varying from 2 to 4 lanes in each direction for a total of approximately 211 lane miles,

55 grade separated interchanges, 6 other interchanges, and approximately 65 other bridges, including streams, rail, and local roadway crossings. Its busiest sections carry between 80,000 and 150,000 vehicles per day. Planning for Route 128 started in the late 1920's. The first improvements were made in 1932-3. Construction of a 4 lane divided highway started following World War II. The facility was completed in the late 1950's, but addition of lanes has continued. A fourth lane is scheduled to be added to the only heavily traveled segment that is not yet 4 lanes.

Interstate Route 495 (I-495) is Boston's outermost circumferential highway, lying some 20-25 miles beyond Route 128. It was conceived and built as part of the National System of Interstate and Defense Highways. This 6 lane limited access highway runs for a length of approximately 125 miles with 12 full cloverleaf interchanges, 37 other grade-separated interchanges, and approximately 320 bridges. Its busiest sections carry approximately 90-105,000 vehicles per day.

Route 128 was selected as a case study of the relationship of major metropolitan area highway investment to economic development because:

1. It is considered to be the first major circumferential highway built around a U.S. city,
2. It was built in segments over a period of 30 years and periodically expanded, and
3. It has proved to be the key infrastructure element which has shaped the Boston region's economic growth since the late 1940s.

As a circumferential highway planned and built along an undeveloped area, I-495 resembles and was conceived after Route 128 achieved renown as Boston's Golden Semi-Circle success. The I-495 investment created another opportunity to follow the Route 128 example and therefore, it could be viewed as built to deliberately shape development along the corridor. Evidence indicates that I-495 received priority not because there was a demonstrated need as in Boston's congested neighborhoods nor because of development objectives, but because it could be built with little or no opposition and property-taking costs were low. In Boston, vehicular congestion was an undeniable problem, but the property takings involved in building circumferential "inner belt" highways would clearly lead to major political controversies that would delay or stop the project.

The initial objectives for Route 128 were quite different from what became its role as a catalyst and vital infrastructure for development of the regional economy. Its potential role as the new major distributor route for the Boston Metropolitan area was probably not generally realized or well understood until the 1950s. Transportation planners focused on improving the transportation performance of existing systems of public transportation and radial highways. They were dealing with solving the problems of the day rather than how a highway such as Route 128 might influence changes in the economy or land development patterns.

Early analysis and plans suggest there was little understanding of the potential effect of transforming Boston's until-then radial roadway system into a hub, spoke, and wheel tread system of limited access highways by constructing Route 128. The change in the distances that could be reliably traveled within reasonable travel time budgets in the Boston area appears, in retrospect,

to have been extremely important to the economic development of the area. By 1974, there were over 1,200 different firms, employing over 85,000 people in the communities along Route 128. That number was less than 25,000 in the late 1950s. Such growth could clearly not have occurred without the connectivity between radials that Route 128 provides. In fact, the transportation planners of 1948 expected that the construction of an expanded Route 128 would enhance the economic value of downtown Boston. Initially, it enabled people and businesses to move out of Boston to less costly and less populated areas west of the City; within a decade, it also began to generate both residential and commercial development in the communities to the west of Route 128.

Both the transportation and economic analyses carried out on Route 128 confirm the assumption that highways, in general, and metropolitan limited access highways or beltways, in particular, facilitate and redirect economic growth. At the same time, it is not possible to isolate the specific impact of the highway investment, since economic growth is generated and is affected by so many forces independent of transportation decisions.

In fact, post-facto analyses conducted in 1957-8, 1974, and 1992 confirm the expectation that the investment in Route 128 was worthwhile to both municipalities and to the state economy. The analyses of commercial and residential property value changes in Lexington, Needham, and by extension other communities, were sufficiently detailed to demonstrate that the economic performance indices of areas within 1 mile of interchanges increased as much as 20%-30% beyond those of areas further away. The history of Route 128 supports a basic observation about the effect of circumferential highways on regional growth. It offers direct automobile access and development opportunities on land significantly less expensive than in or near the central city.

The studies also confirm the transportation planning assumptions that ease of regional access is a major locational factor for commercial and industrial enterprises. They also demonstrate that people move in order to live within a reasonable commute of work, i.e. the average commuting time budget was approximately 20 minutes in 1951, 1957, and today. In other words, although it is rarely quantifiable, travel time for both people and goods has significant economic value. It is a useful analytic tool for transportation investment decisions.

In general, Route 128 has lived up to its transportation objectives. Even though planners have usually underestimated traffic demand, its roadway capacity is only strained in a few locations. It has also lived up to the rather vaguer economic performance expectations and neither transportation professionals nor academics have attempted to separate the amount of growth that might be attributed to Route 128 beyond overall growth of the regional economy. In many ways, this is not considered a useful question because no decision-making process requires the answer. In any case, there is no way to know how much the Boston area might have grown if Route 128 was not built, although clearly the pattern of development would be different.

It is still possible that Route I-495 will develop in a way similar to Route 128. Presumably this will happen as both population and the economy grow and as congestion near Route 128 causes

an exodus to cheaper, accessible land. This would repeat the pattern by which congestion and property value pressures in the area within Route 128 caused people and businesses to move out from Boston and its inner suburbs. It is not clear whether there is a boundary beyond which the existing modes of transportation can no longer support the extension of the low-density development pattern characteristic of the Boston Metropolitan region.

In a numerical sense, the transportation objectives of highways such as Route 128 and I-495 are relatively well known, articulated, and measurable, e.g. traffic can be counted. Economic objectives are not articulated beyond "More growth is good" in part because they raise difficult methodological and policy issues, such as who benefits and who loses from the investment, and in part, because such impacts are difficult to fully foresee.

One major lesson from a review of the Route 128 and I-495 history seems to be a fairly consistent underestimation of traffic demand and the resulting congestion. This may in part be due to the absence of articulated consistent **regional** objectives for transportation, land development and economic performance.

Another lesson that may be learned from the history of Route 128 and I-495 is that it takes some time for people in general to understand the nature of ongoing change. Just as the telephone was at first misconstrued as a device to read written documents over long distances, transportation planners only began to grasp how Route 128 was affecting the regional economy in the late 1950s when it had already been in use for some time:

"The desire line patterns illustrate vividly the type of lateral movement made possible by Route 128. Prior to the building of Route 128 a road net did not exist that could accommodate these desires. Thus, traffic has been "generated" by the highway and its adjacent land use changes, an event that was not anticipated when original traffic estimates were made."²

This fact was indirectly acknowledged in 1963 by the Massachusetts Department of Public Works in one of their guideline documents for Route 128 planning: "...Growth has brought many problems, some of which could have been relieved if there had been greater knowledge of its potential impact."

Case Study IX - **BORDER CROSSINGS - LAREDO, TEXAS PORT OF ENTRY**

Foreign trade has been increasing in importance over the last two decades, growing from 12% of GNP in 1970 to 22% in 1990. The growth of international trade is highlighted by the recent agreements and ongoing discussions regarding the creation of a few major multinational markets (NAFTA, Europe, Asia-Pacific, Southern Cone countries-Mercosur).

² See "Report on Proposed Reconstruction of Yankee Division Highway Auto Route 128." Massachusetts Department of Public Works, 1958.

Mexico is the US third largest trading partner. In the 5 year period from 1987 to 1991, US exports to Mexico increased by 145 percent and they doubled from 1989 to 1994, even before the NAFTA agreement became effective. Imports have also grown rapidly, and the devaluation of the peso in late 1994 has resulted in significant growth in northbound trade.

The Laredo, Texas Port of Entry was selected as a case study of transportation investments that are aimed at expediting and accommodating the fast growing international trade at the US border in Mexico. The case study will be used to discuss how ports of entry at the border crossings can impact the economy of the region they serve, and in particular, how multi-national liberalized trade and/or free trade areas can affect transportation infrastructure investment requirements at the border area.

The infrastructure of a border crossing port of entry consists of three major components: the highway or railroad border crossing itself, the highway and/or railroad facilities connecting the border crossing to the major transportation facilities in both sides of the border, and the international inspection facilities.

Laredo is the largest US port of entry for trade with Mexico, handling about 38% of all trade between the US and Mexico. In 1994, Laredo handled 59.4 percent of all loaded trucks crossing the Mexico-Texas border and 67.6% of all loaded rail car crossings. Imports to the US through the Laredo District of US Customs increased to \$49.5 billion in 1994, while exports have reached \$50.8 billion.

The main objective of transportation infrastructure investment at the Laredo port of entry has been the need to accommodate growing US-Mexico trade and the development of maquiladora plants, trucking terminals, warehouses, etc., associated with that increased trade. Maquiladora plants established by US and foreign firms use low costs Mexican labor to assemble export products (ranging from automobile parts to integrated circuit boards, television components, hospital supplies, garments and food items. In 1987, there were 79 maquiladoras plants served by the City of Laredo in the border area. By 1992, there were 78 maquiladora industries in Nuevo Laredo alone, and there were about 200 maquiladoras in the border area using the Laredo port of entry, including most of those located in Nuevo Laredo, Tamaulipas, and Nuevo Leon. In addition, Laredo handles much of Mexico's trade with Canada, Europe, and the Far East, reflecting shipper's preferences for the lower cost and higher efficiency of US ports and land transportation services.

Based on the history of the construction of transportation infrastructure at the Laredo port of entry, the following lessons can be drawn as to its relationship to economic expansion:

- Although a major portion of border crossing demand is locally based, overall demand is significantly affected by binational trade trends that can result in rapid growth or cause significant unanticipated changes in the flow patterns, such as those due to border delays, currency exchange fluctuations, and other global competitive factors.

- Adequate transportation infrastructure and border processing efficiency (e.g. customs, drug enforcement and immigration inspection) are competitive factors for industry and trade- related business site selection and affect the production and distribution of goods throughout the US.
- For a local area along the border, like Laredo, an investment in transportation and related infrastructure is a key ingredient to attracting employment and economic growth to the region. Laredo has become the second largest growing city in the US mainly due to its strategic location along the border at a time of rapid growth in binational trade, but also because of its continuing efforts to improve the transportation infrastructure and thereby, respond to and plan for increased demand. Some of the infrastructure may be underutilized initially, due to lack of immediate connections or the time that it takes to fully implement long-term development plans, but the available infrastructure adds considerably value to the area's strategic location.
- The experience with the construction of binational bridges highlights the importance of a more coordinated binational process leading to transportation infrastructure decisions. Such a binational process is being proposed along the entire US-Mexico border. A process where infrastructure needs and priorities could be assessed in a coordinated manner with the participation of private and public interests from both sides of the border would provide a mechanism to consider comprehensively the potential binational importance and the economic development impact of projects, as well as the needs of long-distance traffic serving international trade.
- Increased traffic across the border can also bring about negative impacts, such as congestion, that affect local businesses. Laredo officials and private interests have recognized the importance of not only assuring adequate highway capacity across the border, but also of accommodating rail movements away from the downtown area, separating commercial vehicle traffic from passenger vehicles and pedestrians, and providing highway bypass routes around the congested downtown area. These kinds of improvements help assure that trade flows can be handled as efficiently as possible, while minimizing local impacts.
- Although historically most of the transportation infrastructure at the border crossings was a result of demand for increased international trade, as the area has grown local development objectives have began increasingly important in determining transportation needs, such as the city's objective of separating commercial traffic from tourist and pedestrian traffic.

Case Study X - **DREDGING OF PORT ACCESS CHANNELS - BALTIMORE**

Ports and inland waterways are major elements of the nation's transportation infrastructure. Uncluttered Channel access or water transport routes that link the port to the ocean, are vital to

maintaining and increasing US competitiveness, as it is estimated that 95 percent of U.S. overseas trade moves in and out of U.S. ports. Adequate access channels are then particularly important as the nation's economy becomes more closely integrated into the global economy.

Ports are always seeking ways to expand their service area, thereby attracting greater volumes which can be served profitably by larger vessels. These larger vessels can help achieve greater economies of scale, which benefit shippers, producers and consumers. An efficient and modern port system capable of handling all sizes and categories of vessels and commodities affords the greatest potential for increasing business.

In order to keep ports functioning and increase market share, dredging is a critical endeavor. Channels with depth constraints limit the efficiency of large vessels, and even prevent the passage of some of the larger vessels which cannot arrive or depart the port fully loaded. Dredging of ports and their access channels is essential to assure competitiveness and to maintain the flow of international commerce. Maintenance dredging assures adequate depths for vessels presently engaged in domestic and overseas trade, whereas channel deepening is undertaken to allow larger ships to call on a port.

The dredging process involves excavation of soils and rocks in the access channels, as well as transportation and disposal or use of the material removed. Environmental impacts of dredging are of paramount concern to local interests which can be affected by pollution from the dredged material as well as degradation of the areas in the vicinity of the deepened waterways. The US Corps of Engineers (COE) is responsible for the dredging of the navigable waterways..

A 1993 Dredging and Disposal Survey by the Harbors and Navigation Committee of the American Association of Port Authorities (AAPA) documents that actual depth is not always the same as authorized depth, particularly in North Atlantic and New England ports. About 100 million cubic yards of material need to be dredged annually to maintain navigation channels in the US. In addition, the AAPA survey identified plans to dredge between 9 and 28 million cubic yards annually to deepen channels over the next few years.

This case study of dredging investment was selected because it involves projects aimed at both bulk commodity traffic as well as the faster growing container or general cargo trade. The case study reviews the investment to deepen the Port of Baltimore's (POB) main or southern channels from 42 to 50 feet while at the same maintaining the authorized 35-foot depth on the northern approach channels during the late 1980's. These investments were selected as a case study because they are aimed at both:

- maintaining safe navigation for existing traffic at the time, and
- attracting new business by allowing larger vessels with deeper drafts to access the POB.

The underlying investment objective for **deepening the POBs main channels** was to increase the POB competitiveness, especially in the dry bulk trade, by lowering transport costs and permitting

access to the Port by larger vessels. Deepening the main shipping channels had been under discussion since the 1950's, but after the initial studies were completed, environmental concerns delayed construction. During this period, numerous studies were undertaken, focusing on issues such as an appropriate dredge disposal site. By 1984, Hart-Miller Island had been selected as the dredge disposal site. The original justification for the project was based on a benefit/cost analysis conducted by the Corps of Engineers from a national perspective. In 1984, the project was evaluated from the State's perspective with regard to benefits and costs. It was determined that the project could be justified in terms of increased bulk tonnage for the port and increases in employment and income if the state costs could be kept within certain limits. A substantial cost reduction was achieved, due in large part to a design solution which permitted the desired 50-foot channel depth, but reduced its width. Construction was initiated in 1987 and completed in 1990.

In contrast to the objective of the deepening project of the main or southern approach channels, the **maintenance** project to assure that the authorized depth on the northern approaches were maintained on a year round basis was aimed not at the dry bulk cargo trade, but at preserving and increasing the competitiveness of the port in the container trade. With respect to maintenance dredging, a cost-benefit analysis had concluded that an additional one-time maintenance project would permit the 35-foot northern approach channel depth to provide economic benefits above the \$26 million and annual budgeted amounts estimated to achieve and maintain that depth. The one-time maintenance project was completed in 1987.

Besides environmental issues, both the channel deepening and the maintenance dredging projects were delayed by a major shift in federal policy in the 1980s which for the first time required a local cost-sharing responsibility for dredging projects. Neither of the POB projects were carried out until the 1986 Water Resources Development Act was enacted by Congress. Up until that time, the federal government had assumed the full costs for deepening and maintaining navigational channels.

The history of these projects points out that an investment to deepen and maintain port channels can have a significant impact on regional economic development and competitiveness. Dredging for maintenance purposes preserves present traffic levels, while deepening of waterways allows larger vessels to make use of a port. In turn, this increases business and generates employment opportunities. Such impacts cannot be fully demonstrated or quantified because of the many factors that affect port demand and competition. Although it may be difficult to fully demonstrate or quantify the economic benefits derived from a dredging investment or the lost cargo due to dredging delays, several conclusions can be made:

- Port operations must be viewed in the same context as any other business. In an increasingly competitive industry, ports must pursue opportunities to handle larger vessels with lower unit costs, improve service levels to equal or exceed those of competitors, and minimize costs. The delays in maintaining and deepening the Port of Baltimore access channels affected the port's competitive position and its ability to attract cargo and generate employment.

- As port and vessel technology improves, shippers will expect higher quality of service and lower rates. Deeper and adequately maintained channels are necessary to fully utilize the efficiencies of larger vessels and their loading/unloading systems.
- Without frequent maintenance dredging that assures channels are available year-round at their authorized depth, the efficient movement of goods by vessels is impacted limiting the ability of steamship lines and shippers to fully load vessels and increasing costs.
- Given that current and future trends emphasize the use of larger vessels with greater drafts to transport bulk commodities and containers, and particularly with the advent of 5,000 TEU vessels, ports will need deeper channels to remain competitive and serve the growing requirements of increased foreign trade. The consequences of not deepening harbor channels and waterways to accommodate greater ship sizes will be an inability to fully realize reduced costs and improved productivity, which affects our nation's competitiveness in the global marketplace.
- A balance must be sought between the economic and environmental impacts of dredging port channels. The port of Baltimore deepening project was delayed for many years, and was therefore not completed when it would have produced significant positive impacts during the coal export boom of the early 1980's.

Other ports throughout the nation have also experienced long delays in their channel deepening or maintenance dredging projects, primarily due to environmental concerns related to the disposal of dredged materials. Significant negative economic impacts are associated with such delays. Ports experiencing long delays in their efforts to deepen or maintain access channels include Port Newark/Port Elizabeth, Oakland, Boston, etc. Presently, there is no time-limits for reaching decisions on acceptable disposal methods, nor is there a decision-making framework to balance the economic costs associated with dredging delays versus minimum environmental safeguards for disposal and associated costs. The result is continuing delays and/or uneconomic proposals for disposal.

In conclusion, the economic importance of dredging port access channels regularly is clear, although not well understood by the public. The importance of these investments to the nation's competitiveness in an increasingly global economy has not generally been well articulated in the public policy and decision-making process, and as a result, there have been delays in project implementation, which affect the nation's export competitiveness.

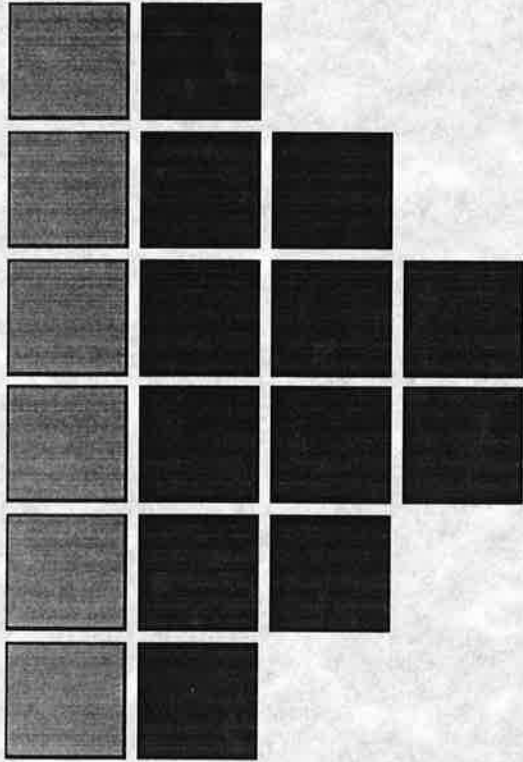
E. Conclusions from Case Studies

The case studies describe the range of economic development impacts associated with different types of transportation investments. The major lesson learned is that **all transportation investments studied have influenced economic growth**, although in all cases, it is not possible to fully quantify these impacts.

The following conclusions can be reached from the case studies:

1. The history of transportation investments clearly demonstrates that transportation improvements are an important, often critical, ingredient affecting an area's economic development, particularly when major new technology and service level improvements are introduced. This conclusion is well established and understood intuitively, although the economic development process is very complex and therefore, the impact of a transportation investment is often difficult to fully foresee.
2. The most direct, most readily measurable and the most fundamental way in which transportation investment influences economic development is by reducing transportation costs to move people and goods.
3. The development benefits of transportation investments can take long periods to materialize and are affected by many other factors. While it may not be possible to isolate or quantitatively measure the specific impact of a transportation investment on economic development, the importance of transportation investment as a key ingredient to economic expansion cannot be underestimated.
4. Land development and increased accessibility have been the major ways in which transportation investment have influenced economic growth in the past (e.g. Rapid Transit Development, Metropolitan Beltways, and Interstate Highways). Historically, transportation investments have played a fundamental role in stimulating or influencing growth at the national, state, regional and local levels.
5. Congestion is a major factor that affects economic expansion and productivity in today's competitive environment. Congestion impacts industry competitiveness. It particularly affects the service and high value product manufacturing industries that count on fast and reliable product distribution and service delivery to remain competitive. Congestion reduction is a major objective of transportation investment (e.g. Interstate Highways, Airspace System Plan, Rapid Transit Development), whose achievement is critical to future economic expansion.
6. States and local jurisdictions compete for economic activity. Transportation investments are a policy tool often used to increase the competitiveness of an area to attract or retain businesses (e.g. Port and Airport investments, Pennsylvania Railroad Clearance project, State Transportation Economic Development Programs, Border Crossing Infrastructure, Channel Deepening). Such investments can achieve their intended results, provided they are properly targeted so as to measurably reduce transportation costs and increase service quality and reliability, without negatively affecting the tax burden of residents and other industries.

7. In general, comprehensive economic analysis has not been used often as a basis to evaluate the feasibility of transportation investments or to compare the rate of returns of alternative transportation investments. Except for the National Airspace System, the Baltimore Channel Dredging and the Pennsylvania Clearance Projects, investment decisions on the transportation projects studied were not based on an analysis of their economic benefits compared to costs.
8. Access to seaports, airports, and border crossing ports of entry, and the related infrastructure at the various types of ports that handle the nation's international trade flows are also becoming important competitive factors for regional and local economic growth and the nation's economic competitiveness (e.g. Laredo, Baltimore, and Oakland). The increased share of international trade points out the importance of improved efficiency for handling passenger and cargoes at the nation's borders and ports.
9. An appropriate balance between economic and environmental objectives is essential to assure implementation of the most cost-effective and economically sound projects, with the greatest potential for facilitating economic expansion. Delay of needed transportation infrastructure investments affects the nation's, the State's and the local area's competitiveness and potential for growth.
10. All economic impacts of a transportation investment are related to the use of the infrastructure being provided. Therefore, to the extent that demand projections can be accurately developed, such projections can serve as an excellent indicator of the potential economic impact of a project. However, only a comprehensive economic analysis for a proposed investment can help define the project that can result in the greatest economic benefits. Furthermore, only a consistent analysis of alternative investments can assist in the selection of projects with the greatest potential influence on economic expansion and competitiveness per invested dollar.



V. Summary of Study Conclusions

LOUIS BERGER INTERNATIONAL, INC.



V. Summary of Study Conclusions

A. What we know and What we don't know about the linkage between transportation and economic expansion

Is there a Role for Transportation in Supporting Economic Expansion?

Transportation investment is a necessary and key ingredient to economic expansion. It is one way in which capital investment can be channeled to built up the productive capacity and the efficiency of the economy.

Can transportation investment result in short-term economic expansion?

Transportation investment has been traditionally associated with short-term **job creation** during the construction period. Job creation programs with the objective of increasing employment have been proposed periodically in order to increase economic activity, since the federal infrastructure development projects of the 1930's were used to help reduce high unemployment rates. Short-term economic stimulus programs to invest in transportation infrastructure with the primary purpose of creating construction jobs can generate near-term economic activity in the project areas. However, such programs only have a longer-term impact on economic expansion to the extent that they also result in more fundamental increases in economic output, income and productivity over the long-term. Logically, there is some time-lag in achieving the economic impacts of transportation investment, as it takes time for their benefits (land development and reduced delays or costs) to be reflected in increased output and income.

The national debate about the budget deficit and the need to reduce expenditures at all levels of government has sometimes failed to recognize the difference between operating expenditures and long-term investment. A major portion of transportation expenditures involves investments to increase production capacity and efficiency. Their impact should therefore not be measured solely in terms of short-term economic results. The impact of constructing new or expanded highways, airports, rapid transit systems, and other transportation facilities can take years to materialize. This time-lag in being able to achieve benefits from the investment should be expected, just as private corporations invest in major facilities and equipment knowing that it will take years to achieve their targeted financial return.

Does transportation stimulate long-term economic expansion and if so, what is the appropriate level for national transportation investment?

Economists disagree as to the quantitative aggregate impact of transportation investment on the national economy and as to the causality relationship between investment and economic expansion, but there is a general intuitive understanding that new and/or improved transportation facilities contribute to economic growth. Furthermore, there is general agreement that transportation investment is an important ingredient to achieve or sustain economic expansion, i.e whether to

stimulate expansion or to support it once it is underway, the nation, the states and the private sector need to consider new transportation investments to support economic expansion over the long-term.

Can transportation investment contribute to economic competitiveness?

The competitiveness of an area is based on its comparative advantage as a low cost producer. Since products and services are produced or provided by private firms and industries, national or area economic competitiveness is achieved through the efforts of an area's individual firms to achieve high levels of productivity over time. To achieve or maintain competitive advantage, a firm must either produce and distribute its products at lower costs or develop different and innovative products that can be sold at higher prices. To do so, it must continuously improve efficiency and innovate. The type, quality, and user costs of transportation services is part of the attributes that shape the environment in which local firms compete, so transportation can promote or impede the achievement of competitive advantage.

Fundamentally, how does transportation investment influence long-term economic expansion and competitiveness?

Economic competitiveness, expansion and development is affected by transportation investment fundamentally in two ways:

1. by **opening up or increasing the accessibility of land** and other natural resources for new or higher density development, and
2. by **reducing transportation costs and increasing productivity** of the various industries and economic sectors, making it possible to reduce the cost of manufacturing products or providing services per worker hour.

The direct results of a transportation investment are then increased land accessibility (reduced travel times) and lower transportation costs. These primary effects of improved transportation results in benefits to both the users and the non-users of the new or improved transportation facility or service, since for example the price of goods consumed by non-users will reflect the reduced transportation costs. The changed accessibility and lower transportation costs eventually results in business expansion, restructuring and/or relocation (increased production, fewer plant locations, fewer warehouses, lower inventory costs, etc.). The reduced transportation costs and increased market reach, as well as the business relocation, expansion and/or restructuring actions result in productivity improvements, which increase the competitiveness of the business or an area in the global marketplace.

Eventually, the improved productivity and competitiveness result in increased output, jobs, and income, which are reflected in increases in transportation demand. The increased production and

economic growth requires continuing transportation investment to further increase accessibility, lower costs and increase productivity, and thereby meet the needs of the growing economy.

How does transportation investment affect economic productivity?

Both public and private sectors have a role in improving productivity. The influence of transportation investment on the nation's economic productivity can be separated into three major categories:

- impacts on public sector transportation productivity (e.g. increased efficiency of public sector transportation construction projects, improved facility management, or lower air traffic control costs - to the extent that cost savings are reflected in reduced tariffs, taxes, or other user fees)
- impacts on private sector transportation industry productivity, e.g. reduced unit costs associated with the use of larger trucks, higher speeds and/or less congested highways and airways, double-stack rail services, faster intermodal connections, etc.)
- impacts on private sector non-transportation productivity (e.g. reduced inventory costs, industry restructuring, changes in production processes, etc.)

An investment often requires both public and private actions to fully achieve its potential benefits. A public investment may not lead to the anticipated benefits, if no private sector action follows. In some cases, the public sector reacts to private sector initiatives (such as proposals by trucking or rail carriers, aircraft equipment manufacturers, etc.), where there clearly is a private sector interest. In such cases, joint private-public initiatives can assure that intended benefits are achieved. In all cases, the evaluation of public sector transportation investments should consider private sector commitments or the extent to which the investment may encourage private sector follow-through, as well as the investment's potential role in increasing productivity.

Transportation investment (capacity expansion, new technology, use of larger - more efficient vehicles, etc.) can lead to improved private sector productivity in several ways:

- by reducing transportation costs for existing firms at their present locations;
- by making possible expansion of markets at existing locations, thereby resulting in increased output;
- by opening up opportunities for restructuring of manufacturing and distribution processes (reducing plant locations, production of certain parts at different locations and assembly closer to consumer, reduction of warehouse locations and related inventory costs, etc.); and

- creating opportunities for innovative, new, more productive businesses that are dependent on more reliable or faster transportation access.

The relationship between transportation investment and industry restructuring is very complex since many factors other than transportation costs and services are involved. There is little doubt that properly targeted investments can increase productivity in the transportation sector that eventually gets reflected in a national productivity increase.

Which types of transportation investments have an impact on economic expansion?

All types of transportation investment (new systems, expansion of an existing system, and system preservation investments) influence economic expansion to the extent that they result in increases in accessibility, increased capacity, and/or reduced transportation costs.

The development of a new transportation system, whether at a national or regional level (e.g. construction of a new railroad network, adding a controlled access highway system, a high-speed intercity rail system or a metropolitan rail rapid transit system), is an infrequent and costly undertaking. A new transportation system is typically implemented to achieve a higher level of service, by introducing new technology or through significant design improvements in the use of previously deployed technology. Historically, the introduction of rail and aviation technologies are the best examples of how new technology can significantly improve transportation service and impact economic activity patterns and expansion. The National System of Interstate and Defense Highways is perhaps the best example of new system development using previously deployed technology. A Magnetic Levitation System is an example of a possible future system using new technology presently under study.

The history of transportation clearly demonstrates that new transportation systems have a large impact on economic expansion. Over time, such investments result in fundamental changes in development patterns, can significantly increase productivity, and influence living standards. However, it has always been difficult to fully foresee the impacts of new technology and/or significant increases in service levels not previously experienced.

A more typical transportation investment is the expansion of an existing system by adding new facilities, e.g. a new highway, rapid transit line, port terminal, airport, etc. System expansion improvements may also involve adding new technology (such as coordinated highway traffic signal system, computerized traffic incident control system, new microwave landing system and other air traffic control technology, semiautomatic container cranes, automatic vehicle identification equipment, and other cargo handling equipment).

Most transportation system expansion, whether or not explicitly articulated, has as one of its fundamental objectives:

- expanding capacity

- reducing congestion and delays,
- improving safety, and/or
- supporting land development and economic growth plans

To the extent that these transportation investments reduce costs and improve productivity, they will also influence private sector operations and competitiveness.

The preservation and maintenance of existing transportation facilities is frequently not adequately considered nor given appropriate priority when identifying transportation investment requirements. Once a transportation facility is built, it becomes part of the infrastructure supporting the economy of an area. Businesses and individuals rely on it for their transportation needs. The condition of a facility is then as important in supporting the nation's or the states' economic objectives as its existence. The lack of periodic rehabilitation of existing infrastructure can lead to route closing, increased user operating costs, reduced speeds, and other similar negative impacts that affect area industries and businesses. Although efficient system operations and adequate maintenance do not typically generate the interest or excitement associated with building a new facility, it is fundamentally as important to supporting economic activity.

What is the role of Transportation investment at various stages in an area's Economic Development?

Without transportation access, developable land cannot be used productively. In the early stages of development of an area, transportation investments are an essential, although not the only, ingredient to achieve development. The main purposes of transportation investment in undeveloped and underdeveloped regions is to **open up land for development** by reducing transportation costs.

In a more developed area, the basic transportation infrastructure is already in place, and there is already ways of moving people and goods to/from and through the area. In these developed areas, the emphasis of transportation investment is on **reduced congestion, increased capacity, time savings, accident reduction, and improved productivity**, rather than land development impacts. Transportation improvements can then make possible additional economic production by expanding the geographic area that can be competitively served from a plant location, and by reducing costs and encouraging new businesses to locate, stay or expand in that region. In today's economic environment, travel time and delivery reliability have become as important as transportation costs for some transportation users.

Do transportation investments that increase economic expansion in a State also expand the national economy?

The impacts of transportation investment on economic output and income depends on whether these impacts are measured from the national or state/regional/local perspective and whether the national or regional economy is growing. In today's development environment, states and local

areas continually aim at improving their competitiveness. Transportation infrastructure and service level is one way in which states and local areas compete to increase their economic output and income by attracting and/or retaining industries and jobs.

A transportation investment that increases economic activity in one State or local area can result in a reduction of economic activity in an adjacent or nearby jurisdiction. If the net result is an increase in the industry's competitiveness internationally and a resultant increase in economic activity, it is possible that a net growth in output and income could result at the national level. In many cases, however, efforts to retain jobs or to attract new industry in one State or local jurisdiction do not produce net gains in national economic output and income, but simply move the economic activity from one location to another.

Similarly, when the entire national or regional economy is growing, jurisdictions are competing for the growth taking place. However, when the national or regional economy is not growing, efforts by individual jurisdictions may only result in shifting economic activity from one jurisdiction to another.

In today's global economic context, how can transportation investment facilitate economic expansion?

There are several recent trends underpinning the metamorphosis of the US economy from an industrial to a post-industrial economy:

1. low growth rate of agricultural, mining and other older traditional sectors;
2. decline of basic manufacturing, changes in manufacturing processes, and decentralization of manufacturing;
3. increases in the service sector of the economy; and
4. increases in the role of foreign trade and integration into the global economy.

These economic trends indicate that certain types of transportation investments are particularly important to support the expanding sectors of the economy, such as those aimed at:

- increased reliability and faster freight delivery, including better control of highway traffic incidents, reduced congestion and bottlenecks;
- meeting air transportation requirements of management/professional staffs of businesses with decentralized operations;
- commuting needs for service sector low skilled labor to suburban and rural areas;

- increased efficiency of the nation's border ports of entry, seaport and airport systems to handle foreign trade needs, including improved inland access connections by rail and highway;
- new technology applications to improve transportation industry productivity and reduce costs;
- improved intermodal connections and rail clearances for railroads to be able to operate newer technology, more efficient railcars (e.g. double-stack and trilevel railcars), including combined domestic and international services;
- meeting the transportation needs of the tourism industry (including intercity travel to tourism destinations as well as travel to attractions in metropolitan areas); and
- increasing accessibility and market reach, even though growing businesses have more flexibility in business location decisions, since transportation access remains an important factor in location decisions and competitiveness.

How can highway investments affect economic expansion?

As is the case with all transportation investment, the fundamental ways in which highways influence long-term economic activity can be traced back to transportation cost reductions and the opening of land for development made possible by increased accessibility, resulting in increased productivity, market reach and industry competitiveness.

How does a new highway connection impact economic and land development?

The impacts of a new highway connection permeates the entire local and regional economy. The major economic and development impacts of a new highway can be summarized as follows:

- a. Land development along or near interchanges
- b. Changes in residential and business locations
- c. Reductions in transportation costs, and
- d. Impacts on business competitiveness, market reach, economic productivity, industry restructuring, and the location of national economic activity

When a new intercity highway corridor is constructed, it not only reduces transportation costs and travel times for those individuals and businesses that previously travelled between the two end points of the new facility. Typically, a new highway connection also results in "generated travel," i.e. increased transportation demand made possible by the new facility. A new highway

connection then increases total transportation demand in the area, by creating new opportunities for increased personal travel along the corridor and by increasing the market reach of businesses in the area.

How do new urban freeways affect economic development?

New urban highways can significantly affect the pattern of land development and strength of the downtown core. Land values along new urban freeways and near interchanges typically increases after the highway construction. Commercial and residential development along the highway generally follows the highway construction. The existence of congestion-free, limited delays and a relatively efficient highway transportation system is an important factor affecting individual and business location decisions. For example, the construction of Route 128 in Metropolitan Boston made possible an increase in employment in the communities along its route from less than 25,000 in the late 1950's to over 85,000 by 1974.

An area can develop even in the absence of significant highway investment (e.g. the population of Charles County, Maryland grew from 32,572 in 1960 to 101,154 in 1990). In such situations, typically the development generates increased demand for additional highway investment. Thus, even though highway investment significantly influences land development, so does increased land development generate additional highway demand. If additional highway capacity is not provided in a timely manner, congestion increases and the quality of life for residents and businesses is affected.

When a new highway reduces congestion, the area's competitiveness for attracting and retaining business can be positively affected. In today's environment, the reliability of local delivery of overnight packages and other time-dependent freight can be an important factor in business location decisions.

How do new rural highways affect economic development?

In rural areas, the most direct relationship involves the effect on tourism or traveller related services (food, lodging, gasoline and recreation establishments). Highway bypasses of small urban areas can reduce congestion and improve local traffic flow, but can also reduce business for existing establishments.

Construction of a new highway in a rural area can generate industrial or commercial development along its corridor, if other ingredients for economic development are present, such as unexploited natural resources, inexpensive land, labor, tax levels, tourist attractions, business climate, etc. An example of the profound implications of new highway construction in a rural area when other prerequisites for increased development are present is the ski resort development west of Denver after construction of Interstate 70 and the Eisenhower Tunnel.

How do air transportation system investments affect economic expansion?

The air transportation system is particularly important to the tourism industry and to companies competing internationally, important economic growth sectors nationally. Air transportation influence economic expansion in today's economic environment in the following ways:

- provide the fastest regional, national and international access to businesses increasingly competing in a global economy;
- main mode of transportation for the movement of high-value, low weight products;
- used by many industries for just-in-time inventory and production systems that are being increasingly used by manufacturers;
- provide access to customers of knowledge intensive industries, financial services, tourists, and other fast growing segments of the increasingly important service sector of the economy; and
- airports are themselves major employment generators and have become major catalysts for nearby land development (hotels, conference centers, headquarters of major businesses, aviation training, aircraft maintenance, warehouse and distribution centers for parts and perishable products, suppliers of custom built and specialized equipment, engineering support for companies with dispersed client locations, etc.).

Airport investments can also be aimed not just at serving local industry and maintaining the competitiveness of the area, but also to attract a "hub" serving also through passengers and cargo, thereby becoming a generator of related jobs and economic activity that otherwise would flow through a competitive gateway.

Most of the services that are provided by the air transportation system are used by individuals and businesses who are willing to pay the cost, because of the time savings or their other service requirements.

As is the case with all transportation improvements, investments in the air transportation system then influence economic expansion primarily through their:

- impact on land development near airports;
- increased accessibility to markets served as reflected in reduced travel time or congestion; and
- reduced costs and increased productivity of the air transportation system.

The increased accessibility and productivity further influences business location decisions, and

industry competitiveness, as firms make use of the increased market reach and service level made possible by the improved air transportation infrastructure.

How can railroad investments affect economic expansion?

After many decades of losing volume and market share of general merchandise cargo to the trucking industry, railroads have recently begun to attract back additional general merchandise cargo businesses. Governments and railroad carriers have recently been investing in double stack equipment, new modern intermodal terminals, and line-haul clearance improvements, so as to reduce costs and increase productivity to move intermodal cargo. An example is the joint private-public efforts to increase railroad clearances along major corridors in Pennsylvania. These investments are aimed at increasing the competitiveness of the state's manufacturing and distribution industries.

The major ways in which railroad investment can influence economic expansion in today's economic environment is by:

- the application of new technology to reduce costs and increase productivity,
- investing in clearance and terminal improvements that also reduce operating costs, streamline intermodal connections and increase productivity, and
- adding connections or preserving service to attract industrial development.

How do urban rapid transit systems influence economic expansion?

In cities without rail mass transit service, development of new mass transit systems have been pursued by many metropolitan areas with the objective of stimulating growth and channeling development along the new transit corridors. Besides the transportation objective of efficiently moving large numbers of people and reducing congestion, new urban mass transit system investments are generally pursued to achieve the following three land and economic development objectives:

- Sustain and maintain dense development and growth in the downtown core;
- Manage the shape of land use development; and,
- Create and stimulate economic growth and employment opportunities.

Construction of rail mass transit is also viewed as a city-building exercise with long-term implications for a region's economic health and status. The metropolitan areas who invest in mass transit aim at improving their place among a hierarchy of national and international cities.

The major ways in which mass transit investment can influence economic expansion in today's policy environment is by:

- encouraging high density land development near stations and in the downtown core of a metropolitan area, by making these areas more attractive as business locations,
- reducing highway congestion in the area and making possible job expansion and residential development in areas that otherwise could not support further development
- providing transportation to inner city residents helping them gain access to jobs,
- increasing the locational advantage of suburban sites for clerical and labor intensive office operations.

Mass transit investments today are also necessary to rehabilitate and maintain the aging infrastructure in the older cities. Without this service, the economies of the urban cores could not function, leading to the loss of businesses and jobs.

How are port investments related to economic expansion?

Port investments are typically aimed not just at serving local industry and maintaining the competitiveness of area industries, but also to attract through cargo and related jobs and economic activity that otherwise would flow through a competitive gateway. Port investments then can influence economic expansion in the following ways:

- as important direct generators of economic activity and revenue production, through their operations and through their attraction of transshipment and through cargoes;
- through capacity expansion to meet increased trade needs;
- through technology applications and other innovations to increase productivity of port operations and reduce cargo handling costs;
- typically represent a significant catalyst in nearby land development (such as warehousing and other related distribution businesses); and
- makes an area more attractive to business location decisions, since businesses and individuals seek access to more efficient port operations, with adequate capacity, fewer delays, easy cargo intermodal transfers and access to highways, and increased services connecting to foreign and domestic markets.

Port investments are also major factors in the economic development competition among various areas in the US. Some would argue that a national port strategy would be appropriate to avoid over-capacity and wasteful investments. On the other side, some could argue that the competitive system that exists encourages lower user costs and efficiency in operations that could not exist under a centralized investment policy.

How are port of entry investments related to economic expansion?

Ports of entry at border crossings influence economic expansion in a similar way as seaports and gateway airports. They impact the national and local economy by facilitating increased binational trade, by providing options to industries that require fast access across the border to increase their competitiveness, and by attracting employment and economic growth to the local region.

B. Difficulty in measuring linkages between transportation investment and economic expansion

As noted above, intuitively it is understood that transportation investments result in economic productivity increases to the extent that they lower transportation costs and travel times. These time and cost reductions may be realized in numerous ways, including increases in safety, decreases in fuel and other operating costs, lowering of business inventory requirements and costs, lowering of travel times, increases in travel time reliability, etc. These productivity increases not only accrue to persons and businesses whose vehicles use the transportation facility, but to others as well. In a competitive, free market economy, lower transportation costs is passed on to consumers as lower prices for consumer goods, to workers as higher wages, or to owners of businesses as higher income.

Although the importance of transportation facilities and services to the nation's, the states' and a local area's economic efficiency and to society's well being is widely accepted, it has been difficult to establish quantitative linkages that fully measure how transportation investments result in economic expansion thru increases in accessibility and/or productivity. An area can develop rapidly in some cases even in the absence of transportation investment, eventually increasing demand and resulting in congestion. Many studies have clearly documented the role of transportation investment in land development, since land development records over time clearly demonstrate how transportation investment can result in more productive and/or higher density land use.

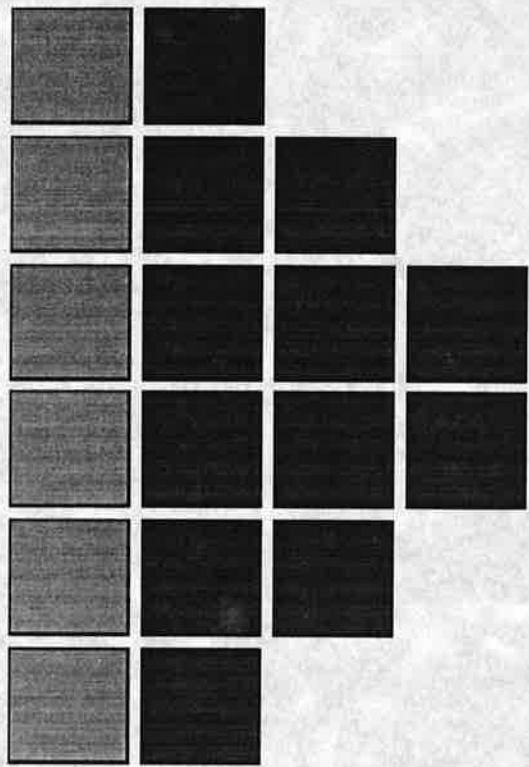
At the same time, **it is not possible to isolate the specific impact of a transportation investment**, since economic growth is a very complex process. Economic expansion is generated and is affected by many forces independent of transportation decisions, and transportation facilities are built for many reasons -- only one of which is potential economic benefits. Therefore, there are significant data problems associated with conducting detailed analysis to quantitatively measure the relationships between investment and economic growth, even as a retrospective analysis of changes associated with prior improvements. There are significant challenges in collecting the data that detailed analysis would require, and even if this data were assembled, in cases where a transportation investment is made, **there is no way to know how much an area might have grown if the transportation investment is not made**. Similarly, in cases where a transportation investment is not made, there is no way to know how much the area might have grown if the investment would have been made.

Furthermore, it is even more difficult to clearly demonstrate the role of transportation investment in increasing national, industrial, or State productivity. Although procedures have varied by mode and project type, typically, transportation project evaluation analysis is conducted at the local level, where planners compute direct user benefits, project costs, and also consider the indirect effects of a project. The indirect effects generally are intended to include social, environmental and economic impacts that do not accrue to the facility users. National or Statewide economic productivity benefits are mainly related to the user benefits, but in today's economic environment, go beyond the traditional benefit measures of savings in travel time, vehicle operating costs and accidents.

As discussed in this report, impacts on industry restructuring and competitiveness, such as lower inventory policies based on "just-in-time" inventory management, and reliability of goods delivery, are typically not accounted in traditional user benefit estimation methodologies. Not all industrial sectors will be affected the same way through transportation investment, nor will all types of transportation investment result in increases in productivity. The impact of transportation investment on each industrial sector, overall economic output, national or State income can be very different depending on investment types, and which industries are able to capitalize on the transportation investment to reduce costs, increase their competitiveness and expand their production.

Finally, the impact of transportation investment on economic development is very complex and difficult to fully foresee. Future investments will not necessarily result in similar impacts as those seen in the past, because no two areas are exactly the same and many other factors affecting economic production and competitiveness are also changing. All economic impacts of a transportation investment are related to the **use of the infrastructure** being provided. Therefore, to the extent that demand projections can be accurately developed, they can serve as an indicator of the impact of a project. Only a comprehensive economic analysis for a proposed investment can help define the project that can result in the greatest economic benefits. Furthermore, only a consistent analysis of alternative investments can assist in the selection of projects with the greatest potential influence on economic expansion and competitiveness per dollar invested.

AASHTO, TRB, and USDOT-FHWA have initiated additional research efforts to increase our knowledge on the linkages between transportation investment and productivity. This report summarizes what we know and what we don't know on this subject, based on recent research, but clearly the linkages are very complex and much remains to be done to provide better information for decision-making regarding prioritization and needed levels of investment.



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