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Case Study

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Building Missouri's Urban and Transportation Infrastructures to Support Economic Development

By Jerome J. Day

Executive Summary

This study presents the case for Missouri promoting more rapid economic growth by developing a Saint Louis–Kansas City urban corridor as a component and model for a subsequent, larger Kansas City–Columbus, Ohio, urban corridor. In the course of the development of these urban corridors, substantially enhanced transportation infrastructure investments would be necessary in order to realize the opportunities presented, and to obtain the benefits envisioned. This would involve large increases in the capacity of Interstate Highway 70, as well as opening up large areas of low-cost land for the location of new business ventures near to the highway developments.

This study also addresses the federal "Corridors of the Future" program, as well as addressing proposals that have been made to add truck-only lanes (TOLs) to the existing I-70. It also considers alternatives for providing advanced-technology freight transportation (based on enhancements of the current intermodal model), as well as high-speed passenger rail services that could be considered if the urban corridor concept were to be implemented.

Finally, the study elaborates the benefits of installing an advanced-technology freight railroad, with provision for passenger services, in the proposed urban corridor. It further contrasts the comparative benefits and costs of rail and truck movement of freight, including movement of freight by TOLs. The analyses presented here include a discussion of financing alternatives with a particular emphasis on the value of tolling, as a means of ensuring that those who use the infrastructure disproportionately pay a higher share of its costs.

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Freight movement within the urban corridor would be most economically provided on an enhanced 21st-century railway running down an interstate median strip.

The major conclusions of this study are:

- The urban corridor concept is a valuable paradigm for future urbanization. It enables and provides high-quality, high-speed, localized access to efficient, effective, and economical automobile, truck, transit, and rail movement for both passengers and freight. It discourages urban sprawl, preserves open spaces, and is environmentally friendly.
- The urban corridor requires a high-speed, high-capacity, and robust multimodal transportation infrastructure for people and freight.
- The best model for freight movement is the intermodal model.
- Freight movement within the urban corridor would be most economically provided on an enhanced 21st-century railway running down an interstate median strip.
- Freight movement on the new railway would be best provided by electrically propelled transporter vehicles, which are, in more conventional terms, simply and independently controlled and operated flatcars carrying conventional shipping containers.
- The intermodal model is best further developed by new current-day and future-technology railways. These would supplement and replace in the urban corridor much of our historic 19th-century railway technology and operational practices. This would greatly increase freight hauling capacity and reduce costs. Further, it would reduce the minimum long-haul trip for intermodal operations to about half of what it is today, for locations near an intermodal transfer point. Finally, it would reduce relative truck density on interstate highways, thereby reducing congestion, and improve the traffic environment for automobile drivers.
- Future transportation infrastructure and maintenance could well be financed by public-private partnerships (PPPs) and user fees, such as tolls. Gasoline tax revenues are dwindling with the advent of alternative power sources for automobiles, and financing from general revenues has grown increasingly dysfunctional.
- Almost all of the benefits ascribed to TOLs would be better realized by the urban corridor development featuring, among other benefits, high-speed, timely movement of freight by railway to an intermodal transfer point. The one exception is that trucks better serve shorter-haul freight movement.
- The type of advanced-technology electrified railway proposed in this study would result in a new freight movement paradigm, and in an increased volume of rail freight movement that would revolutionize modern concepts of rail freight movement.
- Even if the enhanced railway proposed in this study did not use electric power, a current-technology railway installed in the median strip of a new interstate highway in the urban corridor

would generate freight cost savings and other benefits sufficient to justify its installation.

We need to ask key Missouri leaders and policymakers to consider the question of what kind of urban and economic future we want for Missouri, and whether the urban corridor, combined with I-70 North, is the most cost-effective, most environmentally sensitive, and most efficient way to achieve this better future.

If we have the will and determination to achieve this better transportation future, along with a viable plan, then a way will surely be found to overcome the largest obstacles — namely, financing.

I. INTRODUCTION

Missouri today is facing the same economic challenges that it has always faced: how to produce economic opportunity, growth, and prosperity. However, Missouri is now uniquely presented with two great opportunities to aid in meeting these challenges and attaining these goals. If Missouri were to invest private and/or public money into an integrated infrastructure expansion across central Missouri, I believe the entire state would benefit greatly.

The first opportunity arises from the urbanization that is already occurring along the corridor running from Saint Louis to Jefferson City and Columbia to Kansas City. This is occurring as a dynamic component of the larger Kansas City–Columbus urban corridor. The development of this urban corridor is aligned to the I-70 highway transportation corridor.

The second opportunity is the redevelopment of the I-70 highway itself. This requires investment that will enable maximum economic development, concurrently providing a long-term solution to the overloading and congestion that, during the past decade, have become increasingly evident and wasteful.

During the past several years, there have been many new developments, including the election of a new national administration and Congress, the arrival of a new Missouri administration and legislature, and an economic downturn. Collectively — and, perhaps, paradoxically in some respects — these developments present a better long-term environment for proposals to address more comprehensively the transportation infrastructural needs for handling automobiles, trucks, large-scale rail freight movement, and high-speed intercity passenger rail service.

Missouri now faces a more favorable environment for taking a substantive stance because of the growing recognition that the state has serious deficiencies in its economic and transportation infrastructures. Furthermore, there is growing concern that establishing an integrative approach to transportation and urbanization, as well as ecological issues, requires a reformed approach to addressing many of these issues in a comprehensive, integrated manner. The urban corridor paradigm provides a framework for accomplishing this.

Additionally, other trends and events in the recent past, favoring the railway developments now being proposed, have led to increasing awareness of the need to achieve greater economy in the use of petroleum fuels. This need stems from the depletion and rising costs of these fuels, and the adverse externalities of their use. Taking these economic and environmental

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concerns into account, as a policy matter, could encourage us to seek to attract and make provision to move long-distance freight and people by new technology, such as modernized rail systems, rather than seeking to move more freight via highways.

This study also considers how financing of the proposals presented may best be carried out.

The proposals in this study are directed to two opportunities for improvement. First are the economic development opportunities that the urban corridor model present as an alternative to the current urbanization model of expanding concentric rings of suburbs around major cities. The second opportunity involves the more economical and environmentally friendly transportation services that an enhanced 21st-century railway infrastructure would provide for freight and passenger traffic. In neither case should these proposals be seen as an exercise in centralized urban or industrial planning. Instead, the proposals are presented to afford a wider choice of opportunities for considering what sort of developments we wish to be afforded to us in the 21st century.

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II. The Vitality of Missouri in the Kansas City–Columbus Urban Corridor

Models of Urbanization

At the outset, a few words about urban corridors: Demographers and economic geographers generally identify three great corridors of people and economic activity in the United States. The first to develop was the Boston–Washington, D.C., corridor and the cities between them, which is sometimes called the BosWash corridor. The second corridor to develop was the Chicago–Pittsburgh corridor, connecting the cities in between, including Detroit. It is known as the ChiPitts corridor. The third to develop was the San Francisco–San Diego corridor, including its interconnected cities. It is named SanSan.[1] Among the distinguishing characteristics of these elongated urban concentrations of people are the integration of economic activity in the corridors, and the fact that they are served by substantial transportation infrastructures. Historically, the Atlantic and Pacific waterways, as well as the Great Lakes, have fostered economic development by affording economical transport of people and goods. Missouri has seen the same effect on the Mississippi River and the Missouri River. In the latter half of the 19th century, the development of railroads played the same role that water transportation infrastructure played in promoting economic growth and well-being in the earlier period. In the 20th century, highways took over as the primary transportation infrastructural impetus to economic development and urbanization. As a result, we have seen the ongoing development of these elongated urban corridors with transportation infrastructures — preeminently now highways — that have fostered the interlinking of cities and economic activities between them. By providing quicker, higher-capacity, less costly interlinking of people and businesses along the corridors, these transportation infrastructures have greatly fostered economic growth, jobs, and prosperity. They have, as well, greatly improved the livelihood of people living in adjacent rural areas by reducing the costs of delivery of agricultural production materials. Additionally, they have reduced costs in getting agricultural products to both expanding local and national urban markets, as well as overseas export markets.

As a pattern for economic development, the vitality of urban corridors cannot be overemphasized, partially because this pattern has not been widely recognized. Conventionally, most people think of urbanization as a process in which a core major city expands outward in all directions along existing streets and roads, connecting it to other major cities. Suburban towns develop, and later more distant "ex-urbs" develop. This might be described as the agglomeration model of urbanization, wherein successive rings of urbanization develop around major core cities.

However, this pattern of development has several disadvantages. Among the disadvantages is the tendency to overload existing transportation infrastructures, particularly roads and highways. These tend to be organized along historical star-shaped patterns with traffic flowing to inner hubs in order to interchange to another highway out to the destination point. A partial solution to this has been the development of ring highways surrounding the central city. This was first exemplified by the building of Massachusetts Route 128 around Boston in the 1950s, predating the interstate highway system. Route 128 was originally built in line with what would become interstate standards, with two limited-access traffic lanes in each direction. By the time that it was completed in the early 1960s, Route 128 had attracted so much industrial, commercial, and urban development in its environs that serious congestion was occurring. This led to widening the route to three lanes. Today, the widened Route 128 has been re-designated as a component of I-95.

The original widening of this highway attracted so much additional development and traffic that officials decided to build a second, outer ring road around Boston about 10 miles further away. Today, this is I-495, and it is now heavily congested with no relief in sight. At this point, it is cautionary to consider whether Massachusetts' double-ring highway was the best choice to meet the area's urban development needs. An elongated Boston–Worcester–Springfield urban corridor westward from Boston would probably have better served the development of the state, particularly considering the extreme urban and financial problems that Springfield and the western part of that state face today, including the dying of old industries. But such an urbanization corridor could not develop while toll-free ring interstates were opening up new office parks and industrial sites around Boston. The attractiveness of Springfield and the western part of the state has been further reduced by the congested Massachusetts Turnpike (I-90). It is the sole interstate-standard highway to Worcester and Springfield, and it is heavily tolled with infrequent interchanges.

This story illustrates that simply building more ring highways and further development of hub-and-spoke configurations around major cities does not really offer a solution to congestion problems in modern urbanization. It simply encourages patterns of urbanization and further congestion that harm our cities and their surrounding areas, making them less

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desirable places to live for many people and aggravating the very problems it is meant to solve.

A further problem with this pattern of urbanization is that it tends excessively to draw people out of rural areas, and because these areas become depopulated, they are unattractive as locations for new industrial and commercial activities. Disparities follow, intensifying this pattern. Inner cities tend to deteriorate, choked by congestion and sprawling parking lots. As commercial activity diminishes downtown, the inner city becomes populated by urban poor living in older, substandard housing, leading to substandard schools and low-paying jobs as businesses desert the cities for more attractive locations in the suburbs and ex-urbs. Young people, in particular, desert the countryside for better-paying jobs in the outer urban areas surrounding the major cities. A tremendous demand develops for an ever more extensive web of expensive higher-capacity highways to serve this agglomerative urbanization process.

Alternatively, the urban corridor pattern of development tends to draw industry, commercial establishments, and people to the areas between the great cities, to the areas between Kansas City and Saint Louis, or between Kansas City and Columbus, for example. For several obvious reasons, as will be discussed later, such development requires a robust and efficient transportation infrastructure to form the backbone of the urban corridor.

Missouri's Role

Before going on to consider other aspects of the transportation infrastructure of urban corridors, some additional remarks are in order about Missouri's role in the development of the United States' transportation infrastructure.

Apart from the previously noted development of the BosWash, ChiPitts, and SanSan corridors, another great shift in the demographics and economic geography of the United States should be noted. Historically, the nation's population and centers of economic activity have been shifting to the west and south.

This continues into the current day, and there is every reason to conclude that this will continue into the future. This now presents Missouri with a new opportunity to reassert its traditional role as gateway to the West. This traditional gateway role is potentially now being expanded. Missouri stands astride the major land transportation route connecting the old BosWash and ChiPitts urban corridors with Mexico and the western and southwestern United States. The United States' rapidly increasing trade with Mexico is already leading Texas to plan new road building along the I-35 route in that state, running from the Mexican border at Laredo to the Oklahoma state line. This is the first part of the state's Trans-Texas Corridor project, which has been widely reported. Notably, most of the developing trade traffic of Chicago and the northeastern United States with Mexico currently tends to flow naturally across Missouri. Although much of this traffic may likely seek to follow the I-44 route across Missouri, it still enhances Missouri's role as a mid-continent gateway and crossroads, which a Kansas City to Columbus corridor also seeks to embellish.

Even more noteworthy is another transportation infrastructural aspect of the rapidly growing North American Free Trade Association (NAFTA). This association of the United States with Canada and Mexico is producing rapidly increasing North-South trade and truck transport between the three countries. At the southern end, this accounts for the needs that Texas is addressing in building a new highway along I-35. However, the *Los Angeles Times* describes a planned later development for the Trans-Texas corridor:[2]

> The second phase of the corridor, whose planning contract has yet to be handed out, would build a similar highway from the western edge of the Mexico border to east Texas. This might one day link to a separate, federally initiated eight-state expansion of Interstate 69, which currently runs between Port Huron, Mich., and Indianapolis.

The northern end point of I-69, Point Huron, is near Detroit, and is at the western end of Canada's heavily industrialized corridor linking to Toronto and Montreal. Therefore, Port Huron and Detriot are the natural point of entry for NAFTA trade between Canada and Mexico, and trade between Canada and the United States in the areas west and south of Detroit. Much of this rapidly increasing traffic might be expected to travel through the corridor from Indianapolis along I-70 to Kansas City, and I-35 to Texas, or via I-44 across Missouri to I-35. That is, Missouri could expect to host this traffic unless the Trans-Texas Corridor's second phase to east Texas were to draw this traffic to a more easterly and southerly route, bypassing Missouri — say, through Dallas, Little Rock, Memphis, Nashville, and Louisville to Indianapolis. This southern route would also be attractive to much of the rapidly growing United States–Asian trade traffic that now (according to anecdotal reports) travels via I-70 through Missouri between southern California ports and Chicago and the northeastern United States.

This presents a vital opportunity for Missouri to attract these traffic flows further. Missouri also faces the opportunity to embellish its image and role as the crossroads and gateway to the West, Southwest, and Mexico. Although it may seem that Missouri has little to benefit economically from traffic that simply transits Missouri, such traffic is nevertheless important because it builds Missouri's image as a place at the crossroads, and a center around which trade, commerce, and people congregate. This translates into a desire for companies to want to locate their business operations in Missouri.

If we can better establish the concept of a Saint Louis–Kansas City urban corridor, we could greatly promote the attractiveness of Missouri as a location for industrial, commercial, and high-technology firms and institutes. Furthermore, if we can promote the advantages and feasibility of the Kansas City–Columbus corridor — what I will now call the KanCol Corridor — it would help to secure Missouri's role as the new mid-continent center of economic progressiveness and rapidly increasing prosperity.

Missouri's Advantages

It is important to recognize that Missouri is well-placed, and that it has some substantial resources for leading the development of these corridors. First and foremost, it has two great cities, Saint Louis and Kansas City, on its eastern and western borders. Both are cities of

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national importance in terms of population, and in terms of industrial and commercial activities. Substantial transportation infrastructure already connects these two cities, including the historic, navigable Missouri River, and rail and road links. Significantly, these links include I-70, the successor to U.S. Highway 40, the early 20th-century successor to the 19th-century "National Road." Halfway between Kansas City and Saint Louis, and central to the corridor, are the Jefferson City seat of state government and the University of Missouri in Columbia.

Furthermore, having all of these assets within one state makes it immeasurably easier to promote the development of a Kansas City–Saint Louis corridor as a precursor and model of the greater KanCol corridor.

Accomplishing this, or at least getting started on the further development of these corridors and our way to these goals, is not as difficult or as costly as might be imagined. Two subsequent sections of this study present some suggestions for how this solution could become a reality.

III. I-70, THE TRANSPORTATION BACKBONE INFRASTRUCTURE OF THE KANCOL CORRIDOR

Investment in Transportation Infrastructure: Historical Survey

Most people view highways not as investments, but simply as a way to get someplace. Many Americans view tax spending for road maintenance — such as building bridges or repairing potholes — or for building new highways as a necessary evil to alleviate congestion and failing infrastructure. However, this was not always the prevailing mindset. In times past, to a much greater extent than today, people have seen building new transportation infrastructure as an investment in the future, which establishes a foundation for subsequent economic growth and development. Such investments satisfy some of the necessary conditions for developing markets, creating jobs, lowering costs, and promoting prosperity. People need to regain the sense that expenditures for transportation infrastructure can accomplish much more productive purposes. These expenditures must not be conceived as solely or primarily intended to address problems of congestion and failing bridges and highways. Although we do need investments in infrastructure that will alleviate congestion and make repairs, more importantly, the investments must add substantially increased new capacity and relieve stress on existing facilities. Still more vital, we should attempt to make these investments in a manner that opens the way to new and substantially greater economic development and prosperity, in conjunction with promoting a beneficial model of urbanization.

There are many imaginative historical examples of making such massive public investments in transportation infrastructure, for achieving development, growth, and prosperity. It is important to understand both the economic and overall impacts that investments in transportation infrastructure have had on the development of the United States. If we choose to do so, we can make transportation infrastructural investments in a way that would convey multiple benefits extending well beyond the direct transportation benefits.

The initial historical example is the development of the National Road, also known as the Cumberland Road, first authorized by Congress in 1806 to run westward from Cumberland, Md. Although in 1825 Congress authorized construction to continue to Jefferson City, Mo., the road only reached as far as Vandalia, Ill., by 1839. At that time, allotted federal funding ran out and further construction ceased. The advent of railroads lessened interest in completing the road to Jefferson City.

Another early example of infrastructure investment having a significant impact on the development of the nation is the building of the Erie Canal across New York state. Completed in 1825, it was at the time derisively known by skeptics as Gov. Dewitt Clinton's "Big Ditch." This canal provided inexpensive, water-borne transportation linking the entire Great Lakes region to the Hudson River, New York City, and the Atlantic Ocean. It made that city the business capital of the nation. It was the primary infrastructural investment that led to the ChiPitts urban corridor development.

Another example is the massive public/private transportation infrastructure investment made in the building of the Trans-Continental Railroad from Omaha to San Francisco immediately after the Civil War. This was not an investment made to meet existing transportation needs. It was made because the existence of the railroad would encourage the economic development of the western United States and thereby facilitate the movement of people and goods, thus generating the prosperity that would validate its building.

A further example is the massive public investment in the building of the Panama Canal. This investment was made to reduce transportation costs between the United States' east and west coasts and to realize an opportunity to foster the economic development — as well as world status — of the nation.

Other examples can be briefly mentioned. The U.S. Army Corps of Engineers, for more than 100 years, has been making public investments in support of navigation on the Mississippi River and its tributaries. Additionally, it has made public investments in the Atlantic Inter-Coastal Waterway and the Gulf Inter-Coastal Waterway. Other examples of public investments in transportation infrastructure include the U.S. highway system of the 1920s, the interstate highway system of the 1950s, and the Federal Aviation Air Traffic Control System.

Decline in Missouri's Historic Role

It is also important to realize the impact that the aforementioned historical investments had in shaping Missouri's central role, and later its decline, in the development of the nation's transportation infrastructure.

Missouri established its initial gateway role by providing for water-borne access westward on the Missouri River, for traffic delivered to it from the Ohio and Mississippi rivers. It further provided the heads of the overland Santa Fe Trail,

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and the Oregon and California Trails. Additionally, through the development of the original National Road toward Missouri, and the National Road's full embodiment in U.S. Highway 40, Missouri supported the preeminent coast-to-coast highway.

Subsequently, Missouri has seen its role and recognition diminish.

Construction of the Erie Canal shifted northward the original traffic route to the West. The major route traveled across New York State and bordering the Great Lakes along what has become the ChiPitts corridor. With the subsequent development of the railroads in the period before the Civil War, the Great Lakes northern line was predominant, greatly reinforcing the ChiPitts corridor development. This northern line of development was reinforced so much that when the Trans-Continental Railroad was built, it was logically seen as an extension of the railroads from Chicago, across existing railroads in Illinois and Iowa to Omaha and on to San Francisco.

The earlier overland trail routes from the Kansas City area were abandoned, as well as the Pony Express route from Saint Joseph. Although in the 1920s the National Road was extended across Missouri as U.S. Highway 40 to San Francisco, when the interstate system was developed, the new coast-to-coast highway became I-80, which follows the line of the interstate-standard toll roads previously extending from New York to Chicago. I-80 then follows the line of the railroads across Iowa and the Trans-Continental Railroad to San Francisco.

I-70, however, the successor to the coast-to-coast U.S. Highway 40 primary route, does not extend to the West Coast. It ends at an insignificant junction with north-south I-15 in the deserts of Utah.

Justification of Investments — Return on Investment

The defining characteristic of all of the above-cited investments is that they were not made primarily to address existing transportation problems. They were made to better realize opportunities for economic growth and development, and in anticipation of the benefits that would flow from them in terms of agricultural development, commerce, industrial development, and general well-being. The investments were made to establish conditions promotive of future growth and prosperity, and to realize major opportunities to improve economic livelihood.

As will be elaborated upon in the subsequent sections of this study, it is neither timely nor within the scope of this study to deal substantively with financing aspects of the urban corridor development proposals advanced herein. However, I suggest that these proposals entail an investment in something much greater and beneficial than simple expenditures for maintenance, rebuilding, and congestion alleviation. We would be making an investment in our economic future, and yielding much greater benefits beyond the transportation realm. Consequently, I would be remiss not to address financial criteria for assessing whether a proposed financial investment is well-analyzed and considered.

Typically, financial evaluations of investment proposals center on such concepts as cost/benefit analysis, the rate return on the investment, the discounted cash flows stemming from the investment, and the net discounted present value of the future income stream arising from the investment. Without attempting to elaborate on these various measures, it is sufficient, for current purposes, simply to note that such measures are conceptually valid and proper for analyzing the investments proposed in this study.

There exists, in fact, a considerable body of literature presenting cases in which such measures have been computed for various transportation infrastructure projects. One reported, "Net rate of social return on highway capital was about 35% in the 1950s and 60s; it declined to about 10% in the 1980s, or just about equal to rates of return on private capital."[3] The high initial rate of return and its later decline may be attributable to a supposition that in the earlier years, more vital, higher return–yielding highways were built. In the later years, presumably less-urgent highways were built.

Despite such measures having been computed in many cases, there exist some rather thorny issues in their development. First, using such analytic measures usually requires that there be a well-defined life for the investment. (How long would the investment remain productive?) Related to this is how to account for repairs and maintenance expenditures, and their prospective timing and costs.

Second, these analytic methods tend to presume that there is a well-defined income stream that the project would generate as the return on the investment. However, depending on how the infrastructure investment is financed, there may or may not be such an income stream. For example, if public finance (taxes) is used, and tolls are not levied, there is unlikely to be any specifically identifiable revenue stream generated. If private investment is to be used, then a revenue stream (typically tolls) would have to be generated to repay the private investors who financed the project.

Perhaps the most difficult matter to deal with analytically is the variety of benefits that investments in transportation infrastructure yield, but which are difficult to quantify. Some examples include: How much would it be worth to reduce congestion by some notional amount? How much would property values be increased in the vicinity of the new transportation investment? How much would these increase property tax revenues? How many new jobs would be created by new business investments locating in the vicinity of the new highway because it is there? (Would the investment be located somewhere else in Missouri anyway if the highway is not built?) The examples could go on and on.

One approach may be to look at existing examples wherein there exists an identifiable revenue stream in the form of tolls, and ask how much people would be willing to pay for the immediate personal benefits that a highway project yields to them when they use it. One example that can be cited is tolling on I-95 in New Hampshire. For the 18-mile distance that I-95 runs through New Hampshire, the automobile toll amounts to more than 11 cents per mile. If an automobile driver travels 18 miles per gallon of gasoline, a gasoline tax of $2 per gallon would have to be levied to yield the same revenue! Admittedly, in New Hampshire's case, there seems to be a tendency to charge however much the traffic levels can support.

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Although it may be rather difficult to quantify the non-financial returns from investments in transportation infrastructure, the real benefits at the personal level are large, and many people are ready to pay comparatively high rates to obtain the personal benefits that superior highways provide to them.

Yet so many people want to use this highway and pay such tolls that I-95 in New Hampshire has four lanes in each direction for its entire length. New Jersey also has high tolls on the New Jersey Turnpike, and a large number of lanes in both directions. For a trip spanning the New Jersey Turnpike's 148 miles, the toll amounts to 6 cents per mile. Equivalently, a gasoline tax of $1.21 per gallon would be required to raise the same revenue from drivers. In California, State Route 91, for a 10-mile length, has toll rates varying hourly from a low of 13 cents per mile to a high of 99 cents per mile. Also in California, State Route 73, at peak times, charges almost 31 cents per mile for an 18-mile length of road.

To summarize, although it may be rather difficult to quantify the non-financial returns from investments in transportation infrastructure, the real benefits at the personal level are large, and many people are ready to pay comparatively high rates to obtain the personal benefits that superior highways provide to them. Having said that, it is nonetheless quite clear that they are not willing to pay for such investments from general tax revenues or gasoline taxes. The reason for this difference is quite obvious: People are willing to pay for what they use if and when they use it. They are not willing to pay for what they seldom use or perceive others using more and obtaining differential benefit to their own disadvantage.

In the final analysis, most people, but not all, inherently perceive the return on investment in interstate highway transportation infrastructures as yielding benefits far greater than the costs. But because the benefits accrue unevenly to different individuals, most people are not willing to socialize the costs of such investments further. They prefer for those to whom the greater share of the benefits accrue to shoulder a greater share of the costs. This is a major reason for the resistance to increased gasoline taxes to fund repair and development of the interstate system.

This question of who pays what and how much naturally leads into a further discussion of how to finance the building and operation of the transportation infrastructure that must be put in place to support the urban corridor. However, this discussion will be deferred until a later section of this study.

Missouri's Experience — Comparison of U.S. Highway 63 and U.S. Highway 65

In Missouri, we can see specific examples of the effects of demographic shifts and changes in economic activity and prosperity happening over the past 20 to 30 years along the U.S. Highway 63 and 65 corridors between I-70 and the Iowa state line. Significantly, these changes are directly related to transportation infrastructure investments, or the lack thereof.

Along Highway 65, the towns of Lineville, Mercer, and Spickard have been bypassed, and show few signs of increasing economic activity. The towns of Trenton and Princeton also show few signs of increasing prosperity. Chillicothe and Carrolton appear to be prospering somewhat more, but not especially so. By comparison, along Highway 63, Kirksville, Macon, Moberly, and rural areas nearby are prosperous and developing rapidly.

There are certainly many disparate factors involved in accounting for the economic differences along these two highway corridors. But undoubtedly, a major factor is that Highway 65 has remained as it was engineered early in the last century: a two-lane with, by today's standards, low capacity. It is a difficult highway for commercial traffic. No one would likely locate a major job-producing venture along this highway. Highway 63, on the other hand, has been mostly upgraded to a four-lane interstate-standard highway, with a divided center strip. Which came first: the modern highway, or the economic prosperity that attracted people and businesses to locate along this corridor, necessitating highway development? In truth, they have progressed concurrently. Unquestionably, however, putting into place a modern highway infrastructure has been a condition as well as a cause for the economic development that is occurring so remarkably along the Highway 63 corridor.

IV. The Way Forward: The KanCol and Kansas City–Saint Louis Urban Corridors

Understanding Urban Corridors

In considering how best to go about building these urban corridors, three important points need to be kept in mind at the outset.

The first point is that these urban corridors already exist as geographical and demographic entities aligned along I-70. They are currently developing, albeit rather slowly, as well-organized corridors but do not display significant integration as economic entities. Thus, it is possible to speak of them as existing entities, although unrecognized and underdeveloped. It is also appropriate to speak of urban corridors as something to be identified and further developed to better realize the benefits that accrue. These benefits include those arising from using the urban corridor concept to better organize our thoughts and actions in economic development matters. In this study, as the occasion demands, urban corridors are alternatively construed in conceptual terms, or as currently existing (albeit underdeveloped as such) realities. Otherwise, they will more frequently be treated as something to be developed because the benefits that accrue from the urban corridor concept are not currently being much realized.

The second point to note is that further developing the Kansas City–Columbus (KanCol) urban corridor would be much more significant in overall economic impact. However, because of its size and the various states and other interests involved, promoting it and actually making significant progress in developing it would be more difficult to achieve early on. Moving forward with the development of the Kansas City–Saint Louis urban corridor would be much easier because of the natural advantages that Missouri already has for this development, as have been previously cited. Consequently, the remainder of this study will primarily be concerned with how to get started with the

People are willing to pay for what they use if and when they use it. They are not willing to pay for what they seldom use or perceive others using more and obtaining differential benefit to their own disadvantage.

Although urban corridors are certainly an economic reality, they also represent a state of mind in certain respects. It is time to move forward with our thinking in terms of urban corridor concepts.

Missouri portion of the KanCol corridor. Progress on development of this latter portion would serve as an incentive and model for the development of the full KanCol corridor.

The third point to keep in mind is that initially moving forward with a Kansas City–Saint Louis urban corridor concept does not really cost much. This initial impetus, although only a starting point, could ultimately affect economic conditions, unleashing real economic forces in the private sector that would make possible further investments to achieve the growth and prosperity inherent in the urban corridor development concept. Nevertheless, as the next section of this study makes clear, a full exploitation of the urban corridor concept, for all of the benefits that accrue from it, would require massive investment in the I-70 transportation infrastructure in the Kansas City–Saint Louis urban corridor.

In summary, although urban corridors are certainly an economic reality, they also represent a state of mind in certain respects. It is time to move forward with our thinking in terms of urban corridor concepts.

Steps to Be Taken

For current purposes, it is sufficient to realize that in moving forward with the development of the Kansas City–Saint Louis urban corridor, promotion is the vital starting point. Through public relations, educating the citizenry, and related measures, we can promote the concept that Missourians come together and actively pursue a more unified social and economic community, as well as a new model of urbanization. It would involve a cooperative, coordinated, integrated interlinking of the people, communities, and economic activity of those who live along a rapidly developing urban corridor into a larger social and economic community. It would transcend, but not otherwise affect, existing county, town, or other civil or governmental boundaries or jurisdictions, except to urge people living within them to work together more closely and collaboratively. This is not economic planning; rather, it is a means of better enabling and empowering community and economic development and well-being, as well as addressing existing urbanization and roadway congestion problems.

Obviously, a great amount of public education would need to be undertaken in order to generate support for this concept. Before people will support it, they must understand it in all of its aspects. This would require extensive analytical cost/benefit studies and further comparison of the corridor model of urban development with the current agglomeration model. Comparative environmental studies would be needed, along with further studies of the comparative impacts of both models on nearby and distant rural areas, and on smaller cities and towns. Further studies of the potential impact on property values would be necessary.

Other than these public analytical studies, which are aimed at better informing people about the corridor concept, it would be necessary to bring closer together those people along the corridor who are already promoting related economic development. This is most important. Relevant to this are many business groups, fraternal groups, civic organizations, chambers of commerce, an array of community and governmental organizations, as well as individuals.

These all involve key people who are actively working to improve economic conditions in their various communities and circles of interest and acquaintance. By and large, many of these now direct their efforts largely at bettering their respective local communities.

When it comes to attracting business investment, such efforts by local boosters can give the appearance of cross purposes among those who could present themselves more strategically. Those promoting investment and economic development could present themselves first as part of the Missouri community and economic environment, then the broad urban corridor community and economic environment, and finally as part of their smaller local community and economic environment. These local connections can be integral parts of a larger, closely-knit, economically integrated, cooperating whole.

Working Collaboratively as a Region and State

If, for example, Saint Louis and Kansas City were seen to be competing for the same investment project by a large national or multinational company, they would likely each be perceived as promoting themselves at the expense, and to the detriment, of the other. This would be more likely to produce a lose/lose/lose outcomefor Saint Louis, Kansas City, and the entire state. On the other hand, if both cities were to encourage a company to invest and locate in Missouri, then to promote investment and location along the Kansas City–Saint Louis corridor, and, as a subsidiary matter, to invest and locate in their own city, a successful outcome for Missouri, the corridor, and one city or the other is much more likely to occur. For the city that did not win — well, they probably would not have won anyway without wider collaboration. But, in a broader sense, the successes and increased prosperity of any local community contributes to the betterment of the whole. For the city whose bid for the investment did not succeed, they could look forward to better prospects in the next case, because in an urban corridor atmosphere of mutual community support, their prospects would be enhanced by the efforts of the broader community.

Prompting people to work together more cooperatively and collaboratively can be achieved by actually bringing the key people into more frequent interaction with each other in their daily work, in attending conventions, sharing booths at trade shows and investment seminars, or traveling together in foreign trade missions. The list could go on and on. However, the idea is clear: Missourians could substantially benefit if they find ways to demonstrate that leaders along the corridor are working cooperatively and collaboratively to improve economic conditions for the betterment of new investor members of the corridor community, as well as for the current members of the corridor community.

In summary, at this initial stage, Missourians face an opportunity to move forward with urban corridor development. Getting Missouri's key players in economic development and transportation development together could be the first step to begin promoting the urban corridor concept and justifying the investment in transportation infrastructure that it requires.

For current purposes, it is sufficient to realize that in moving forward with the development of the Kansas City–Saint Louis urban corridor, promotion is the vital starting point.

V. The Way Forward: The I-70 Transportation Infrastructure for Urban Corridor Economic Development

Missourians could substantially benefit if they find ways to demonstrate that leaders along the corridor are working cooperatively and collaboratively to improve economic conditions for the betterment of new investor members of the corridor community, as well as for the current members of the corridor community.

Recent Planning for I-70

A few years ago, the Missouri Department of Transportation (MoDOT) initiated a public consultation process concerning what to do about I-70, particularly the ever-increasing congestion. Three alternatives were put forward for consideration.

One alternative would be simply to increase the capacity of I-70 by widening it to three lanes or more throughout its full length. This would require substantial rebuilding of overpasses, bridges, and interchanges, as well as the roadway itself. This would all have to be done while the existing highway traffic had to be accommodated, causing further congestion in many already congested locations while construction was in progress in that area. Nevertheless, this alternative has advantages in that it could be implemented gradually as funding permitted, upgrades could first be put in place in the most congested areas, and it could be readily seen by the public as an effort to do something immediately about the worst problem areas.

A second alternative would be to upgrade U.S. Highway 50 to the full interstate standard throughout its entire length. Highway 50 is currently approximately interstate-standard for about 70 miles eastward from Kansas City and a few miles westward and eastward of Jefferson City. This alternative would draw traffic away from the existing I-70, thereby alleviating congestion. However, construction between Saint Louis and Jefferson City would be relatively expensive because of unfavorably hilly terrain, and would probably require bypassing many towns. Also, the routing into southwest Saint Louis would be problematic for through traffic to and from Illinois.

A third alternative would be the building of a new I-70 highway, presumably along an open field pathway north of the existing highway. Again, it would probably need to be far enough northward to go through open land avoiding the substantially higher land acquisition costs closer to the existing I-70. It would presumably also afford direct interstate highway services to a string of towns across the state that are now somewhat more distant from I-70. Finally, and most importantly, at its interchanges and frontage roads, a new I-70 would open tens of thousands of acres of relatively low-cost land for industrial and commercial development. Such land would be extremely attractive for business development because of its ready access to a new interstate-standard highway. Equally, hundreds of thousands of acres of low-cost land would be made much more attractive for urban development.

Although MoDOT merits commendation for its efforts to elicit public input into the decisions about how to address problems with I-70, it appears that an economically inferior alternative, to substantially widen and rebuild the existing I-70, has won out. I perceive that this outcome is the result of two considerations.

First, as MoDOT is charged with building and maintaining the state roadways, it is constrained to find the most cost-effective engineering solution to problems that present themselves, such as I-70 congestion. It is neither explicit nor implied that MoDOT has a responsibility to look into matters of urbanization policy or economic development in making such highway development decisions; these are the responsibility of others in the state government. Yet these matters are so closely intertwined with transportation infrastructure development that suboptimal decisions are likely to result from not taking all of the relevant issues into consideration.

The second consideration leading to the decision not to pursue the building of a new I-70, I am sure, is the matter of cost. It is well known that in Missouri, and in the entire country, it is increasingly difficult to find money to even properly maintain existing highways and bridges, much less build new ones. The interstate system, largely designed and built more than 50 years ago, is overloaded and much of it is worn out. So long as it is thought that road building and maintenance must be financed by taxes — and fuel taxes, at that — the situation is only likely to deteriorate in the current environment. Many factors contribute to this, but it is not my intention to address them in this study, except to note one important point.

If discussions about how to ensure future growth and development opportunities — and, in particular, highway maintenance, repair, and congestion matters — are dominated at the outset by cost and finance issues, there might never be any progress. We must first consider what our future infrastructure needs might be without undue regard to cost and financing. If we find a development that is sufficiently attractive and desirable, we can then study whether it is affordable. For current purposes, it is sufficient to say that if we find that an enhanced urban corridor developed around an improved transportation infrastructure is sufficiently attractive and desirable, we might then find a way to finance the investment, either publicly, privately, or in combination. In order to launch such a massive undertaking, we must consider future possibilities and which options will lead to improvement, carefully identifying the most effective way forward.

Proposals for New I-70 Transportation Corridors

What exactly is being proposed as the new transportation infrastructure for the Saint Louis–Kansas City urban corridor?

Let us consider the traffic volume along I-70 today, and include the natural traffic demand growth that can be expected in the future, even if the urban corridor concept is not supported. Additionally, let us include the much greater traffic demand that would be induced by the economic development resulting from urban corridor implementation. The U.S. highway system, which began development in the 1920s, was overwhelmed by the time of the 1950s. Similarly, the interstate highway system designed in the 1950s is overwhelmed in many areas today. It appears that any new highway development tends to become overwhelmed within about 40 years. Therefore, I shall take approximately 40 years as a planning horizon.

It is well known that in Missouri, and in the entire country, it is increasingly difficult to find money to even properly maintain existing highways and bridges, much less build new ones.

The first and most urgent transportation priority is to build a new interstate-standard highway between Saint Louis and Kansas City. Subsequently, U.S. Highway 50 needs to be upgraded through its entire length to the interstate standard.

Considering the three alternatives advanced by MoDOT, Missouri may need, if it desires high growth and prosperity, to implement aspects of all three alternatives over the next 30 to 40 years, or even sooner. The first and most urgent transportation priority is to build a new interstate-standard highway between Saint Louis and Kansas City. Subsequently, U.S. Highway 50 needs to be upgraded through its entire length to the interstate standard. In the meantime, as necessary for repair and conservation, and to meet urgent congestion problems, the existing I-70 can be addressed. The latter efforts need not be primarily directed at expensive increases in the capacity of the existing I-70, instead draining off new and existing traffic to the two new alternatives.

The result should be that by year 2050 or so, Missouri would have three interstate-standard highways providing the backbone structure for the urban corridor between Kansas City and Saint Louis, along with a complementary provision for railway traffic. For purposes of convenience, I will refer to them as the existing I-70, a completely new I-70 North or I-70N, and a renamed U.S. 50, which I will call I-70 South or I-70S. This, in part, follows the established convention in which Minnesota's portion of I-35 splits into I-35W through Minneapolis and I-35E through St. Paul.

The new I-70N could follow an alignment similar to the existing U.S. Highway 50, renamed as I-70S. That is to say, I-70N can optimally be about 20 miles or so north of existing I-70. Without being prescriptive, it might, for example, follow an alignment from northern Saint Louis through such towns and cities as Mexico, Moberly, then Marshall or Carrollton, to Excelsior Springs and connecting to I-35/I-435 into Kansas. As the existing I-270 connector in northern Saint Louis to I-70 in Illinois is already congested, another crossing of the Mississippi River would likely be necessary, probably to the vicinity of Alton, Ill., and the junction nearby of I-70 and I-55. For the time being, this could be seen as a part of the subsequent greater KanCol urban corridor development. Interestingly, these developments, if they can be realized, would likely prompt Illinois to promote further development in the Chicago–Saint Louis corridor and the KanCol corridor.

In considering this proposed urban corridor with its three parallel interstate-standard highways, it is important to recognize the tremendous potential for economic development that such a plan presents: a band, roughly 50 miles in breadth across the 250-mile width of central Missouri, with every location within 10 to 20 miles of an interstate-standard highway. This would be, in every economic respect, an attractive region. To the north of the corridor would be green agricultural regions. To the south of the corridor would be the green forested regions of Missouri's recreational lakes and rivers, and the Ozark Mountains.

This would also entail a new environmentally sensitive transportation corridor, in that I-70N and I-70S would tend to maintain substantial green areas between themselves and the existing I-70. I-70N should enable long-term growth and embody an extra-wide median separator for future expansion, underground utilities, such as optical fiber cables, and future high-speed passenger and/or freight services via railway, monorail, or whatever is developed in the future.

With respect to building the new I-70N through open country, the land acquisition costs may be relatively low. The entire length would present thousands of attractive, relatively low-cost building areas well served by superior transportation facilities. It would be attractive for businesses seeking new production sites and office parks. Near the interchanges and along the frontage roads would be thousands of low-cost business building sites with close access to interstate-standard transportation. Additionally, the building of I-70N and the nearby businesses it would attract would make the inexpensive land near the highway attractive for urban development. The business and commercial development, together with the residential development that would spring up, attracted by the businesses, would constitute the building of the urban corridor.

On the other hand, the alternative of simply increasing the capacity of the existing I-70 would only attract more traffic to that sole roadway between Kansas City and Saint Louis, shortly creating new congestion problems, and failing to create the much greater private investment and economic development that I-70N would produce.

Can there be any doubt that if the alternative of simply upgrading the existing I-70 were implemented, soon after the expansion is completed we would again be faced with renewed congestion and needs to alleviate it? At that time, the problems would be even more intractable because of the increased urbanization that would have occurred alongside the existing I-70. Finally, we would have foregone the much greater economic growth and development that would have occurred in the interim if the low-cost land along an I-70N, along with its associated freight and passenger rail infrastructures, had been more readily accessible to private investment and development.

Getting started with the building of I-70N at this stage would require a substantial public education campaign to present and justify the reasons for going forward with this project. In large measure, this would require the same initial efforts as described above for moving forward with the urban corridor concept.

VI. 'Corridors of the Future' Program

One of the more significant recent transportation development events is the approval announcement by the Federal Highway Administration of the I-70 "Corridors of the Future Phase II Application,"[4] a joint proposal of the Departments of Transportation of Missouri, Illinois, Indiana, and Ohio for "Interstate 70 Dedicated Truck Lanes." The dedicated truck-only lanes (TOLs) are envisioned to be the dual-use (automobile and truck) lanes of the existing I-70. The plan suggests the building of new dedicated automobile lanes alongside, but separated from, the existing I-70 lanes, which would become TOLs. The proposal was advanced under the leadership of the Indiana Department of Transportation, and approved for initial federal funding totaling $5 million.

The proposal is to rebuild the existing I-70 highway *in situ*, along with its overpasses and interchanges, while it remains in operation, and to build

With respect to building the new I-70N through open country, the land acquisition costs may be relatively low. The entire length would present thousands of attractive, relatively low-cost building areas well served by superior transportation facilities.

At this point, we face the decision of whether it is better to move forward with addressing the congestion problems on I-70 with a completely new urban corridor multimodal transportation infrastructure, or installing truck-only lanes in the existing I-70 corridor.

additional traffic lanes alongside it for automobiles. This plan is at considerable variance with what I have proposed in the earlier sections of this study regarding the urban corridor concept and a new I-70N transportation infrastructure including provision for rail and freight passenger services.

At this point, we face the decision of whether it is better to move forward with addressing the congestion problems on I-70 with a completely new urban corridor multimodal transportation infrastructure, or installing TOLs in the existing I-70 corridor. This involves looking at the "Corridors of the Future Phase II Application" more closely, in comparison with the alternative of moving more freight by rail. The remainder of this study will be largely devoted to this topic, along with financing issues. I shall now address the the relative merits of the urban corridor concept, as proposed in the preceding sections of this study, in comparison to the TOL proposal. Determining which would be the better course of action will ultimately require that we analyze the efficiency of increased movement of freight by enhanced rail rather than by relying on TOLs.

The introduction of the "Corridors of the Future Phase II Application" states:[5]

> Our shared goal is to reduce congestion and improve safety on the Corridor and, thereby, improve commerce and expand economic growth to our region. Our vision is to accomplish this by developing a dedicated truck-only lane (TOL) Corridor along the approximate 800 miles of I-70 that crosses our four states.

Overall, with the exception of one major aspect, the proposal embodies well-justified, well-documented, and well-presented statements of the needs, major design aspects, and implementation plan for moving forward with the development. It also includes many statistical tables and figures in support of its arguments. However, although TOLs are the proposed solution, and the proposal documents the use of limited-access lanes elsewhere in the country, most of the examples cited are high-occupancy vehicle (HOV) lanes to encourage carpooling. Further, for reasons that the remainder of this study will make clear, it is dubious that the TOL concept is the most cost-effective design. This is especially true when one takes into consideration the broader economic benefits to be achieved through the urban corridor concept, as outlined in previous sections of this study.

Additionally, to the extent that benefits are sought through reduced mixing of cars and trucks on the same roadway, there is another design alternative that seems not to have been considered. The motivating arguments for the TOL design proposal are relief from congestion, and safety benefits deriving from the separation of large-truck freight from automobiles. The alternative of separating long-haul freight from trucks through relatively greater use of railways seems not to have been considered.

Finally, the TOL proposal presents the potential for technological advances that may be forthcoming with a new, modernized truck highway infrastructure, such as "high speed electronically controlled vehicle operation, truck trains that move cabs between yards on an automated conveyance system where they are assembled and dissembled, etc."[6] However, many of the same advantages are potentially more readily and economically realizable with a new, modernized railway infrastructure, either instead of or in addition to TOLs.

The proposal document states that the "proposed truck-only lane paradigm offers the prospect that the project can provide a corridor of such length and breadth *as to change America's national interstate transportation model*" (emphasis added).[7] The following paragraph states that the "vision of this project is the vision of the future, providing economies of scale required to influence, and potentially shift freight movements across the Midwest *and the United States"* (emphasis added).[8]

The document additionally comments on the 800-mile length of the proposed TOLs:[9]

> This distance will, in some cases, make the Corridor an attractive, cost-effective alternative to rail, enabling rail loads to be more cost-effectively transferred to trucks in Kansas City or Columbus, bypassing the significant rail congestion in Chicago that is a detriment to time-sensitive shipments.

The above statements indicate that such a development would likely culminate in a change in our country's future freight movement as momentous as the decision in the 1950s to allow trucks onto the new interstate highway system. The document often asserts that it is not a good idea, for safety and other reasons, to mix automobile traffic and truck traffic in the shared usage of the same highway. In retrospect, we may ask whether we made a mistake in earlier years in providing inducements to shift freight from railroads to highway trucking — but that is likely to lead to a fairly sterile discussion. It would be similarly sterile to discuss whether a mistake was made when we built the interstate highway system in such a fashion that it resulted in the agglomeration model of urban growth. The situation as it exists now presents the question, "How do we best move forward?" More specifically, the real question before us is whether it is better to try to move relatively more freight on an enhanced highway or on an enhanced railroad infrastructure.

Finally, the "Corridors of the Future Phase II Application" places great emphasis on the distaste and discomfort that automobile drivers have for sharing a highway with trucks. But the idea of TOLs is oversold as a solution, in that smaller trucks would still be allowed in the automobile lanes. More importantly, it would still be the case that all types of trucks would drive along with automobiles on most parts of the interstate system. Trucks sharing the road only becomes a problem when congestion gets out of hand and when the proportion of trucks on the highway in relation to automobiles gets so high that automobile drivers begin to feel hemmed in. The problem is not trucks, per se. Rather, the problem is congestion and lack of highway capacity. The answer is a relative reduction in the number of trucks on highway lanes shared with automobiles, but not necessarily the introduction of TOLs.

It is not exactly clear why the four state Departments of Transportation have chosen this particular approach. There are probably a variety of reasons of greater or lesser appeal to the various departments. In Missouri's case, it seems clear that MoDOT is wary of

For reasons that the remainder of this study will make clear, it is dubious that the truck-only-lane concept is the most cost-effective design.

The problem is not trucks, per se. Rather, the problem is congestion and lack of highway capacity.

potential problems in financing the project, in the face of widespread public distaste for tolling of transportation facilities. It would presumably be easier to obtain legislative acquiescence to tolling of trucks to aid the financing of a truck-only highway. Yet, as will be addressed later in this study, implementing selective user fees in the form of modern electronic tolling is the only broadly feasible and equitable long-term solution to the highway-financing conundrum. In Indiana's case, there remains great interest in extending I-69 to the Mexican border. If the I-70 TOL proposal is implemented, it would greatly promote Indiana's case for extending of I-69 and making Indianapolis the hub for a developing truck-only highway system.

In any case, it is apparent that, although the state Departments of Transportation generally have a responsibility with respect to railroads within their respective states, they have a much larger constituency in the trucking industry than in the railroad industry. But is this justification for providing the trucking industry competitive support over and above the railroad industry? The United States already make this choice once, in the 1950s, when sanctioning the idea that the interstate system would be used to shift freight away from railroads, with all of the ensuing complications that are now leading to proposals for freight-only highways.

To summarize briefly, the "Corridors of the Future Phase II Application" presents a solid case to fund enhanced infrastructure for freight movement. But the main points that are made for providing TOLs on the highway apply equally well for enhanced rail facilities. Most of the benefits of TOLs are better achievable by moving a greater portion of freight with an improved-technology railroad infrastructure. This, incidentally, is the same situation that occurs with respect to freight movement by rail and high-speed passenger rail. Again, similarly, there are complementary as well as contrary issues between rail movement of freight and high-speed passenger rail. There are also such issues between truck and rail movement of freight. The challenge is to determine the most appropriate or optimized balances, partially by ensuring level playing fields for all participants, including the broader public, while securing maximum environmental, economic, and social benefit.

I shall now examine more concisely the nature and relative benefits of moving more freight by rail rather than more by long-haul trucking.

VI. OPPORTUNITIES FOR THE FUTURE

Introduction

This section presents a broad treatment of the comparative benefits that would be offered by an enhanced railroad infrastructure in the urban corridor development proposed in this study. Good references for gaining a deeper understanding of key issues in developing an integrative approach to national transportation infrastructure include "Future Options for the National System of Interstate and Defense Highways"[10] and "Transportation, Invest in America: Freight-Rail Bottom Line Report."[11]

Environmental Opportunities

Any project, such as those discussed in this study, must satisfy various legislatively mandated requirements. It is not the purpose of this study to go into detailed specifics. This subject is adequately covered in the "Corridors of the Future Phase II Application"[4] document, at least insofar as current requirements are concerned. However, it is only reasonable with respect to the future to adopt a planning stance that anticipates future developments in this area, especially when such can be done at little or no alternative additional costs.

With regard to possible future eventualities, we all know that there is increasing public concern about all types and sources of pollution, particularly with respect to transportation, air, water, and noise pollution. There are widespread and conflicting views about the extent to which the byproducts of internal combustion engines fueled by petroleum or other carbon products contribute to air pollution, and especially whether this is a significant factor affecting global climate change. Indeed, there are even differing views about whether carbon dioxide should be considered an air pollutant. Yet there is an increasing outcry for reducing our "carbon footprint" and for introducing carbon taxes.

In any case, it is well recognized that, per ton-mile of freight delivered, using technologies currently in place, rail transport of freight produces substantially less air pollution. Not only that, but because alternative power sources (see the sub-section later in this study about electric power) are less likely to be available to trucking, rail freight can become even more efficient and environmentally friendly.

Water pollution is not a significant reason for preferring rail freight movement to truck movement, except for minor matters. The wearing down of tires leaves rubber residue on the highway, which subsequently becomes part of the rainwater runoff. Also, the petroleum-based (asphalt) surfaces on some of the roadways, through wear, become a pollutant. Finally, where snow and ice are a winter problem, the use of various melting compounds (primarily salt) is a cause for concern to some people. One reason for co-locating a railway in the median of a highway is that it better enables noise control measures to be implemented.

What may be taken as the final word on this issue is contained in the American Association of State and Transportation Officials' (AASHTO) "Transportation, Invest in America: Freight-Rail Bottom Line Report": "... the railroad industry is relatively benign to the environment, including lower emissions per ton-mile than trucking ..."[12] Further, it details:[13]

> The U.S. Environmental Protection Agency estimates that for every ton-mile, a typical truck emits roughly three times more nitrogen oxides and particulates than a locomotive. Related studies suggest that trucks emit six to 12 times more pollutants per ton-mile than do railroads, depending on the pollutant measured. According to the American Society of Mechanical Engineers, 2.5 million fewer

With regard to possible future eventualities, we all know that there is increasing public concern about all types and sources of pollution, particularly with respect to transportation, air, water, and noise pollution.

tons of carbon dioxide would be emitted into the air annually if 10 percent of intercity freight now moving by highway were shifted to rail.

This is not the appropriate occasion for comprehensively analyzing the merits or lack thereof for any of these issues. Nevertheless, where we can do so at little or no additional cost, we should try to adopt courses of action that are otherwise analytically and economically more beneficial, especially when they are also more environmentally friendly.

Where we can do so at little or no additional cost, we should try to adopt courses of action that are otherwise analytically and economically more beneficial, especially when they are also more environmentally friendly.

This will be my stance in considering whether Missouri should, as a public policy matter, seek to move more long-haul freight by an enhanced truck-only highway infrastructure, or by an enhanced railway infrastructure.

Enhanced Railway Opportunities

Any new major development in the I-70 corridor should also embody an extra-wide median separator for possible future expansion, underground utilities, such as optical fiber cables, and possible future high-speed passenger and/or freight services via railway, monorail, or whatever is developed in the future.

The current “Corridors of the Future Phase II Application” does not make provision for this, and probably could not have such a provision made without relocating the TOL provision outside of the current I-70 alignment, although strong economic benefits would accrue from such relocation.

Interest in alleviating problems along the existing I-70 has become focused on truck freight solutions rather than on automobile solutions, so it is appropriate to consider more comprehensively the opportunities that are offered by an enhanced railroad solution, running down the median of any new highway solution. An immediate advantage of this co-location is that there would be no railway grade-level truck, automobile, or pedestrian crossings.

Any new railway must be compatible with existing rail freight movement technology and systems,while at the same time being capable of upgrading to newer technological developments. This means that current-technology trains must be able to operate over it. It also means laying double sets of tracks, end-to-end. Furthermore, if high-speed passenger rail service is to be offered, it may be necessary to make provision for extra sets of tracks, as it may not be feasible or practical to operate rail freight services at the 100–200 mph speeds made possible by latest-technology passenger rail services. Nevertheless, even though such services may not be contemplated at the outset, it would be a grave mistake if the initial outlay of physical infrastructure did not make provision for such speeds in the future. In any case, the provision of a new railway infrastructure provides a much better opportunity for high-speed rail services along the entire urban corridor.

Perhaps needless to say, the new railways must provide, through improved rail-beds and by other measures, for substantially heavier loads, much heavier usage, lower down-time and costs for maintenance, and substantially higher speeds than are current for most freight movement.

Ultimately, what is being proposed here is a gradual evolution to substantially reduced highway long-haul truck traffic relative to automobile traffic. This would be accomplished by greatly expanding use of the proven intermodal freight movement paradigm, for both long-distance and somewhat shorter-distance movements, and also for the sake of the much greater economy offered by rail freight movement. This would be further achieved by greatly speeding up the rail portion of intermodal freight movement, and by significantly improving efficiency and productivity of railway workers through automation and computerized control systems. With the various improvements that can be made by the newer technologies, the threshold of around 500 miles, at which intermodal freight currently comes into its own, becomes much lower. Also, by shortening the end-to-end transit time for intermodal freight movement, time-sensitive shippers would have less need for more expensive end-to-end truck movement of freight on highways.

It would be reasonable to expect a shortening of the current 500-mile threshold to no more than 250 miles, in most cases. The shortening would arise partially because the efficiencies of the new technologies, with their lower operating costs, would shorten in-transit times. Other than the benefits to shippers and consignees from speedier delivery, thereby reducing their costs, lower railroad operating costs would lead to lower prices paid by shippers and consignees. Finally, substantially higher rail freight volume would lead to economies of scale that are not as readily available in truck freight shipping. The importance of these scale economies arises from the very capital-intensive nature of railroads, which generate high fixed costs. On the other hand, rail marginal variable costs can be comparatively quite low. An efficient strategy and policy for inexpensive freight delivery would involve spreading comparatively high fixed costs over a high volume of freight delivery, thus lowering unit costs and prices to shippers.

Finally, while lower prices to shippers would emerge, higher profits would likely emerge for railroads. Higher freight traffic would lead to better utilization of capital. With this, there would be a better return on capital and a lower cost of borrowing for the railroads . All of these are factors that would yield lower costs and prices for rail freight movement (although the same types of benefits would also accrue to a substantially lesser degree from improved transportation infrastructure for truck movement of freight).

Although the “Corridors of the Future Phase II Application” produced by the four state Departments of Transportation makes a substantial presentation of the benefits that newer technology can offer in the context of a new TOL environment, many of the same technological developments offer even greater benefits in the movement of freight by rail. In this respect, the document presents an unbalanced perception and suggests benefits that appear contrary to the benefits arising from rail movement of freight as presented in AASHTO’s “Transportation, Invest in America: Freight-Rail Bottom Line Report.”[11] There is a need for a reconciliation of the rail/truck comparative benefits, in terms of developing a unified perspective of a truly integrated national transportation system. Such a system would be one in which each mode of transportation, including water, rail, truck, and air, plays

Ultimately, what is being proposed here is a gradual evolution to substantially reduced highway long-haul truck traffic relative to automobile traffic.

This study is fundamentally concerned about economics and patterns of urban development, specifically, urban corridor development. Equally, it is concerned with the economic role that transportation infrastructure development plays in economic growth.

the role most naturally suited to its own inherent strengths alongside the others in a 21st-century environment. The current gyrations in oil and minerals markets, as well as in financial markets, likely herald a new century quite different from the final half of the 20th century.

The Urban Corridor Benefits Reiterated

In 1859, Abraham Lincoln, not yet president, traveled from Saint Joseph, Mo., to Council Bluffs, Iowa, where he conferred with F. Granville Dodge, a civil engineer who later became a Union Army general responsible for rebuilding southern railways that were destroyed by retreating Confederate forces. They spoke about building a railway from Council Bluffs, bridging the Missouri River to Omaha, and onward to San Francisco.

Later, as president, he secured passage of legislation enabling construction of the Trans-Continental Railroad. Subsequently, Gen. Dodge was appointed chief engineer for building what became the Union Pacific Railroad.

The preceding sections of this study have outlined the economic and other benefits accruing from the urban corridor concept. It remains only to reiterate that this study is fundamentally concerned about economics and patterns of urban development, specifically, urban corridor development. Equally, it is concerned with the economic role that transportation infrastructure development plays in economic growth. It is not concerned with highway or railroad development per se, except insofar that they are a condition and cause of the former.

It is important to keep clearly in mind our goals, priorities, and objectives. To an excessive extent, transportation infrastructure planning and design today is driven by an attempt to find remedial solutions to problems that, with better foresight and analysis, or perhaps more extensive use of pricing in the form of tolling, would not have occurred. Examples of such avoidable problems include the congestion problem, or the problems of excessive utilization of the interstates for long-haul trucking, which is prompting the current interest in TOLs to separate automobile and truck traffic. (Interestingly, the virtue of separating the two had been recognized in the early part of the 20th century in the parkway developments north of New York City and in Connecticut. These parkways embodied most of the design features of the later interstate highways, but did not admit commercial traffic.)

When highway engineers become too orientated toward finding engineering solutions to traffic problems, they often find only palliatives to the underlying problem and its symptoms, not sensitive enough to the greater economic benefits that could be obtained from a different approach to solving the problem. Instead, the underlying problem needs to be addressed, rather than simply an attempt to deal with symptoms such as congestion, or an excessive proportion of trucks on the interstates. Even if we were to build some TOLs in some instances, most interstates would remain shared roadways with both trucks and automobiles.

To reiterate, we could benefit from a broader approach to looking at transportation needs, of all modes, and how to provide for all of these needs in a cost-effective, integrative way that maximizes economic and other social benefits. This is what the urban corridor concept offers.

I cannot imagine that President Lincoln was looking for an engineering solution to a "problem" when he brought the Trans-Continental Railroad to the fore. Lincoln's problem-solving skills were plenty occupied by the Civil War, yet he still had the time and foresight to take action with such issues as the Homestead Act and the Trans-Continental Railroad. Lincoln's vision involved building the future of the American nation. Today, private investment in our transportation system is needed in order to emulate that foresight, vision, and spirit.

Benefits to Passenger Rail

The urban corridor concept outlined in the preceding sections of this study embodies a substantial transportation corridor infrastructural backbone. Although the urban corridor sections are concerned more with the I-70N highway infrastructure of that transportation corridor, it is apparent that in providing the highway infrastructure, provision must be made for eventual inclusion of rail services in that corridor.

With the presentation of the TOL proposal, it is evident that transportation authorities are more interested in addressing issues related to freight movement in the existing I-70 right-of-way than with improvements to automobile traffic capacity occurring as a byproduct of additional lane capacity provision for trucks only. Consequently, the latter sections of this study are focused on the alternative of rail freight services within the new transportation infrastructure backbone supporting the urban corridor.

However, an underlying consideration supporting the whole concept of the urban corridor, and integral to it, is that embedding a rail freight provision in the corridor infrastructure makes the attainment of passenger rail, both long-distance, high-speed, and shorter-distance (local), lower-speed passenger rail more readily realizable.

In Missouri's case, it is unlikely that Amtrak could ever achieve satisfactory service between Kansas City and Saint Louis on the existing rail line between the two cities, much less high-speed service. With respect to high-speed services, it is almost mandatory that they have double tracks and no-grade crossings. However, it would be relatively easy and inexpensive to make provision for this within the overall transportation infrastructural provision for the new urban corridor backbone north of the existing I-70.

Summary of Opportunities

All of this simply illustrates the merits of not looking at transportation problems and their solutions in discrete unimodal ways. We must look at them in integrative ways, especially with respect to their solutions. Because everything is related to everything else, we must look for synergistic solutions in which each modal solution supports the solution to other modal problems, or we will surely arrive at suboptimal solutions to the overall set of problems. That doesn't mean that it will be easy to solve all of the problems in an integrative set of solutions, or that we will ever totally succeed in doing so. But we should attempt at least to give it our best efforts.

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VII. SOLUTION: NEW RAILROAD IN THE URBAN CORRIDOR

Cost of transport and cost of time in delivery remain today the main criteria for shippers in deciding whether to use water transport, railroad transport, truck transport, or airplane transport, with air transport having taken over substantial amounts of the lightweight, high-value, time-critical, long-distance transport from surface transportation.

Review of Railroad Technology

Preceding sections of this study reviewed broadly the history of transportation growth in the United States. It is now time to look more directly at the growth of railroad technology, and where this technology has positioned the industry today.

The most salient aspect of railroading, as it developed in the 19th century, is its application of mechanical power in the form of steam engines to the movement of people and goods over land. Because it operated over land, and was not dependent on waterways, railroads offered much better connectivity to all areas of the developing nation than waterways and steamboats. As railroads developed, and provided improved connectivity, they largely replaced water-based transport on rivers and canals, except for very heavy materials that had low unit values (minerals and grain are significant examples), and which were to be transported between two locations that were connected by waterways.

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The basic land transportation paradigm embodied by the railroads has been unchanged since Roman times: a primary mover (horses, oxen, or steam engine) pulling one or more wagons.

Railroads were probably the second-earliest and most transformative technological achievement (after the steam engine itself) of the Industrial Revolution. Today, almost two centuries later, and with new technological revolutions occurring seemingly every few years, it is amazing how much railroading technology appears the same today as it did 100 years ago. There appear to be only two exceptions to this, one minor and the other perhaps major. The minor change is the replacement of steam engines with diesel electric locomotives, but this didn't have much direct impact on how rail freight movement operations were conducted. A more significant impact has occurred with the introduction of information technology to improve rail car tracking, train makeup, and various other aspects of day-to-day operations management. Still, the same paradigm remains, with minor modifications for unit trains, intermodal operations and the like, the same as it was a hundred years ago: a continuing process, which by today's industrial standards is considered labor-intensive, of assembling discrete railroad cars into a train, attaching them to a primary mover, and pulling them down the railway to another yard for a labor-intensive breaking down into distinct, discrete cars, and then reassembling many of them into a new train that will travel to a farther destination. The minor exception to this is the advent of unit trains, which stay in one piece from origin to destination.

A central problem is that railroading today is overly locked into 18th-century technologies and practices, and is constrained from moving beyond them by geography, politics, existing physical infrastructure, and other relics of the past. These, along with the capital-intensive nature of railroads, make it extremely difficult to introduce new freight movement technologies in an evolutionary way that is upwardly compatible with older technologies and operational practices.

There is an informative analogy to be drawn here. The productive processes in 19th-century manufacturing were subsequently termed “job lot” processes. Without trying to describe such processes exactly, it is sufficient to say that Henry Ford, with his assembly lines, developed what became known as “process flow” production. As the 20th century progressed, attention focused more and more on the latter method. Today’s petroleum refinery is a good example of process flow production, as is continuous casting in a steel mill.

The point of all this is that processes in railroading more closely resemble 19th-century job lot production, and less closely resemble today’s process flow production. There is no need to cling to archaic methods for using modern technology. Newer microprocessor sensor, feedback, and control technology can help us move into the future. We need to reconceive railroading as an evolutionary process evolving forward from today’s concept of assembling trains, moving from point to point, and disassembling them. The technology for doing this is available now. For nearly a half-century, computer science students and their research professors have routinely developed their knowledge and honed their skills in computerized sensors, as well as feedback and flow control systems, by working with hobbyists’ electric model railroad systems!

We need to conceive moving freight by railroads as a continuous flow of goods containers, all in more or less continuous motion, with many different entering points and exit points in the mechanical transport system. Think of an airport baggage handling system, or a robotic warehouse automated picking system, both writ large.

Today, we have evolving technologies to do this. We don’t need new science or unavailable technologies in order for this proposal to come into being. Implementation is simply a matter of engineering current electric, hydraulic, and microprocessor sensor, feedback, and control technologies. These are currently being used in many goods movement applications. These technologies are certainly scalable to shipping industry container sizes.

Railroads today use an early application of some of these technologies, for example, in multimodal shipping transfer facilities. Moving forward with the developments being made in this area, and extending them to the actual movement of containers between multimodal transfer points, would make such an evolution both feasible and more cost-effective than any other solution.

Safety

Safety is a good, but somewhat disjointed, starting point in a discussion of a new approach to railroading. A concern with safety must pervade and always provide at least a background against which any proposals must be tested before they can be further considered for viability. In the case of railroading,

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as it has been and is currently being conducted, any proposed changes must meet a high standard to at least meet current railroad safety performance. Railroads have an enviable record as being the safest way to move goods and people about.

That said, there are two major safety issues that have always faced railroads. The first is the matter of grade crossings. Although railroad crossings promote safety with visual and audible warnings, as well as automated gates lowered across the roadway, eliminating grade crossings entirely is the only way to thoroughly excise this problem. That may not be generally feasible for all railway crossings, but this proposal involves running a new, enhanced railroad infrastructure down the median separator of an interstate highway. There are no grade crossings on interstates, and consequently, the enhanced railway proposed herein would have no such crossings.

With regard to safety and medians, a digressive comment is in order. The proposals herein involve highway and railroads running in parallel to each other. Many motorists experience unease if they are traveling too closely alongside a train. To ameliorate this, measures must be taken to provide an extra-wide separation median between the highway lanes and the railway tracks, or to provide for visual screening of the railway from the highway. The second safety issue is the matter of train collisions. These have mostly been a problem of head-on collisions in single-track block railways. This proposal, however, involves double tracking throughout. There would never be occasion for two trains running in opposite directions on the same tracks.

As far as a train running into the rear of the train ahead of it on the same track, today's GPS technology, in conjunction with automated inter-train radio communications and automated radio telemetry communications to and from each train, can readily maintain positive speed and position control. The Federal Aviation Administration (FAA) is currently proceeding with such a system, in three dimensions rather than two. In the worst-case scenario, that of a breakdown of positive communications, if electric power were to be used, the control system would, as a last resort, simply shut down power to the section of tracks in which the train in question is located.

Derailments occur so infrequently in today's railroads that their occurrence is not a serious concern in comparison with that of keeping motor vehicles on the road. Highway guardrails and concrete separator barriers consist of attempts to keep errant vehicles from running off the road, yet the two steel rails on which railway vehicles run do a far superior job of providing positive directional control than anything envisaged for highways. The superior human safety aspects of railroads' lighter environmental impacts, discussed earlier in this study, merit further reference here.

In summary, safety concerns and risks are much more effectively addressed and managed in the case of railway transportation than that of highway transportation.

Lower Operating Costs Per Ton-Mile, Now and in the Future

In the earliest days of railroading, it was realized that using two iron rails, or later steel rails, offered two very significant advantages. The first advantage lay in the fact that the rails offered guidance to wherever the railway vehicle was intended to go. The train "driver," the engineer, did not have to steer the engine and a long train of freight or passenger cars. The engine and all of the following cars went wherever the rails led them. This has resulted in great manpower savings, whereas with trucking, each truck needs a driver. Trying to gain the benefits of this manpower saving, the trucking industry is now seeking to implement truck trains on the highways by hitching two or three trailers to a single tractor cab and driver. But they are not likely to achieve the manpower savings offered by multiple-car trains.

The second advantage that steel rails offer is that there has never been found a more broadly applicable and economical method for long-haul movement of goods on land, than steel wheels moving on steel rails. This has to do with immutable laws of physics regarding friction. With minor caveats, all of the fuel that is consumed in moving freight, whether by rail or by truck, is used to overcome friction. Much less friction is encountered in moving freight by rail. Two major types of friction are encountered in both rail and truck movement: rolling and aerodynamic.

There is ample evidence affirming the lower-per-ton-mile operating costs of railroads. The AASHTO's "Transportation, Invest in America: Freight-Rail Bottom Line Report"[11] presents data (Figure 24, p. 38) showing the decline in rail rates versus other modes of transportation for the years 1980 to 2000 (2000 being the latest year for which statistics were available when the report was prepared). The figures show rail rates indices declining relative to truck rates during the entire period, and truck rates increasing relative to rail during the entire period. The index is set at 100 in 1990. Whereas the truck index was lower than the rail index before 1990, the rail rate index had moved about 10 percent lower than trucking by 2000. This is attributable partially to railroad deregulation, which occurred in the mid-1980s.

The AASHTO report again certifies the low operating cost of railroads in terms of fuel consumption:[14]

> In 2000, railroads moved a ton of freight an average of 396 miles per gallon. If 10 percent of the freight moved by highway were diverted to rail, the nation could save as much as 200 million gallons of fuel annually. On average, railroads are three or more times more fuel efficient than trucks.

More recently, in 2008, CSX Railroad has run television advertisements reporting that they are achieving 436 miles per gallon of fuel for moving one ton of freight. Warren Buffett, speaking at Columbia University on Nov. 12, 2009, stated that the Burlington Northern Santa Fe (BNSF) Railroad he had recently purchased moves one ton of freight 450 miles while consuming one gallon of fuel. The consistency of these three reports lends credibility to their accuracy. For whatever it's worth in view of its vagueness and imprecision, CSX has also stated in an advertisement that a single train carries the load of 280 trucks.

The future holds the probability that microprocessor technology will yield even greater manpower and other savings,

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Apart from the labor costs required to operate the trains, the next most significant variable cost is the fuel, as is also the case with trucking.

as railroads increasingly integrate the physical control of freight movement by rail with their current computerized rail car tracking, train makeup and breaking apart, and movement planning systems. The technologies for this are also being explored by the trucking industry for truck-only highways. But the development of the necessary vehicle movement control systems is more readily achievable in the case of railroads. The two rails eliminate the need for someone to guide the train. It would be much more difficult to automate and safely engineer this steering function for vehicles on highways.

Reduced Rolling Friction

Apart from the labor costs required to operate the trains, the next most significant variable cost is the fuel, as is also the case with trucking. In moving freight by either train or trucks, almost all of the fuel is used to overcome friction, with a minor amount being expended in moving the load uphill to a higher elevation. (As will be seen later in this study, some of the energy expended going uphill can be recovered in going downhill, and some of the power expended in acceleration can be recovered with regenerative breaking.)

When a wheel rolls, because of the load it carries and the force of gravity, a distortion occurs in both the wheel and the surface it rolls across. This induces a resistance to movement called rolling friction. The force necessary to overcome this friction depends on the diameter of the wheel and the nature of the two surfaces that are in contact. A rolling steel railroad wheel of the same diameter as a rubber tire produces much less rolling friction than the rolling tire on pavement, assuming both are supporting the same weight.

The coefficient of rolling friction for steel on steel is about 0.0005 meters; the coefficient of rolling friction for rubber on concrete is in the range 0.015 meters to 0.035 meters.[15] Simple arithmetic shows that rolling friction for rubber on concrete is in the range of 30 to 70 times that of steel wheels on steel rails. The much lower rolling friction for steel wheels on steel rails partially accounts for the much better fuel performance of rail freight movement in comparison to trucks.

Reduced Aerodynamic Friction

Aerodynamic or air friction is produced by a truck or train moving through the air. It is often termed “wind resistance.” This is largely related to the frontal area of the truck or train as it moves through the air, and the air turbulence produced at the back of the truck or train as the air fills in the space behind the moving truck or train. It also depends of the speed of the truck or train.

Streamlining can reduce aerodynamic friction, but there has not been much attention given to this in either the trucking or rail industries. The notable exceptions are high-speed passenger trains and the deflectors that are increasingly being mounted atop truck cabs to ease the flow of air over the following trailer.

Insofar as a truck and a train have the same frontal area, and are traveling at the same speed, there will be roughly the same amount of air resistance and friction caused by the movement forward. The air turbulence and drag created at the end of the truck and train will also be very roughly the same. But typically, the train has many cars. After the locomotive at the front has, so to speak, plowed a pathway through the air, the following cars pass through with virtually no frontal friction. And there is following turbulence mostly only after the last car. For trucks and trailers, this frontal friction and following friction occurs for each truck cab and single trailer. It is partially in the interests of reducing these types of aerodynamic frictions that the trucking industry desires to put two and three trailers on a single tractor (although the more substantial reason is to reduce the number of truck drivers required).

Regarding aerodynamic friction, the "Corridors of the Future Phase II Application" states:[16]

> More [than] 50 percent of the fuel consumed by a typical five-axle tractor-trailer combination is a result of aerodynamic drag. Research estimates that truck platoons can reduce fuel consumption by 10 to 20 percent.

And:[17]

> [Truck Platooning] is a mass flow concept of maximizing the through-put of commercial vehicles on a highway using physical and/or electronic connections that allow the entire platoon to be controlled as a single unit.

In other words, a truck platoon would be a train of trucks on a truck-only highway. The objective of such platooning would be to gain the benefits described above by eliminating, for the truck platoon, much of the total front-end air resistance and the rear-end turbulence that the same number of individual truck tractor and trailer rigs, traveling separately, would experience. Only the first tractor and the last trailer, respectively, would experience these effects.

Another benefit sought from this basically concept is possibly eliminating the requirement for drivers for the entire platoon, except for the first truck tractor. Railroads have demonstrated this for almost 200 years. The concern is whether it can be practically implemented in an environment involving steered rubber tires on pavement as well as it has been implemented for steel wheels on steel guiding rails.

The more salient point in all of this is the estimate that, for trucks, aerodynamic friction accounts for more than 50 percent of fuel consumed. This implies that much of the remaining fuel consumption can be accounted for by the rolling friction of rubber tires on pavement. Largely eliminating this rolling friction by using steel wheels on steel rails, and considering as well the much lower aerodynamic friction for trains, it becomes easy to see why rail freight is so much more fuel-efficient than freight movement by trucks, and therefore causes much less air pollution.

Reduced Fuel Costs — Possibility of Electric Power

The three preceding sections of this study have presented the case and some of the reasons for railroad freight delivery having a lower cost per ton-mile than trucking. These have focused mainly on the lower fuel costs per ton-mile that result from the nature of railroad technology, despite the fact that current railway freight movement technology is largely based on a paradigm and technology developed in the 19th century.

After the locomotive at the front has, so to speak, plowed a pathway through the air, the following cars pass through with virtually no frontal friction. And there is following turbulence mostly only after the last car. For trucks and trailers, this frontal friction and following friction occurs for each truck cab and single trailer.

A very serious complicating factor in Missouri is that the existing railway lines between Kansas City and Saint Louis are only partially double-tracked. This produces substantial delays, with one train sitting stopped on a siding while awaiting an oncoming train in the block ahead to clear the tracks.

However, building a new enhanced-technology railroad brings the opportunity for further savings. Some of these savings arise from the same considerations that would also occasion savings for the trucking industry if higher capacity truck-only roadways were provided to the trucking industry. First, the existing east-west railways between Kansas City and Columbus are congested. Note that one of the justifications for the TOL proposal is that shifting rail traffic to trucks between Kansas City and Columbus would alleviate rail congestion in Chicago. If the rail capacity between these two cities allowed for rail freight to be shifted to a rail route connecting them, it would already have been done.

A very serious complicating factor in Missouri is that the existing railway lines between Kansas City and Saint Louis are only partially double-tracked. This produces substantial delays, with one train sitting stopped on a siding while awaiting an oncoming train in the block ahead to clear the tracks. The evidence of this is clearly presented in the great difficulty that Amtrak has with passenger trains between the two cities. Amtrak uses the same tracks as the freight trains and the unit coal trains traveling between the two cities. Amtrak frequently is not able to achieve a good on-time arrival record because of track congestion between the two cities, although Amtrak has seen substantial improvement during the past year thanks to the opening of additional, longer, track sidings, double tracking of bridges that had been congestion points, and other changes.

Time and fuel wasted on sidings, additional waste in the long, slow process of stopping a train, then starting and bringing the train back up to speed, are all factors that cost money and irritate shippers who need quick and reliable delivery schedules for time-critical materials. Time wasted in delivery of freight also causes poorer utilization of capital and necessitates a larger capital stock for the railroad company, which reduces their return on equity and pushes up their borrowing costs.

The new, enhanced railroad called for in this study would not be subject to any of the delays indicated above, because it would be double-tracked throughout. It would have an improved roadbed and gentler curves where necessary to permit higher speeds. It would have no-grade crossings, which would also permit higher speeds. Trains would start and stop infrequently, saving fuel and time.

A further possibility is that train locomotives could be totally powered by electricity. This is nothing new. Freight trains in Europe have been electrically powered for years, as have passenger trains in the United States. Interestingly, the Ministry of Railways in India recently asked for submissions of an “Expression of Interest” from parties who wanted to be considered for contracts in conjunction with the following (emphasis added):[18]

> Ministry of Railways has launched its flagship project, the dedicated freight corridors (DFCs) entailing construction of 3300 kilometers of *mostly double, electrified, high axle load track, with liberal space envelope, for high capacity wagons and heavy haul freight trains at ... top speeds of 100 km/hr ...*

Electric trains offer the ultimate in ecologically friendly freight and passenger transportation: virtually zero pollution. Opponents will argue that the electricity must be generated somewhere. But even if it is produced from coal-fired generating plants rather than nuclear, wind, or solar sources, it is still less polluting than powering vehicles with diesel engines. It is much more feasible to capture air pollutants at the electricity-generating plant than to capture them at the moving site of the diesel engine truck. Although limited market demand argues against major taxpayer investment in high-speed passenger rail, private investment in freight rail is another story.

There is yet another advantage of electric power for railway transportation. When it is necessary for an electrically powered vehicle to slow down, electric regenerative braking can be employed. When the vehicle is to be slowed down with regenerative braking, the electric motor powering the vehicle becomes an electric generator and exerts a braking force on the vehicle. The electricity generated is fed back into overhead power lines, and is available to power other moving vehicles. This results in further savings, which reduces overall costs. In order for this to be practical as a braking method, each of the cars of the train would have to have its own electrically powered driving wheels. There are several other benefits that might prompt industry to develop this rail transportation vehicle, or "electric flat-car transporter."

It must be be kept in mind that even if the new proposed railway is to be electrified, provision must be made for existing trains to operate over the new trackage with current diesel electric locomotives, for at least a transitional period of time. This would enable existing unit trains and other trains to operate over the new trackage without a change of locomotives.

Improved Yard and Railway Operations

Rail yards, where trains are made up and split apart, are one of the most vital, as well as difficult, parts of railway operations for saving time and reducing costs. Yet it is vitally important that progress be made in this area, because shortening end-to-end rail transit time is the key to attracting more time-sensitive freight. Again, cutting down yard time for in-transit freight leads to greater shipper and consignee satisfaction, enables charging of higher shipping rates, and improves capital utilization. This is particularly important in the case of mixed carload trains.

Our national transportation goal, for the public good as well as for the trucking and railroad industries, should be to move freight as economically and as effectively as possible, with the latter term including the notion of timeliness. With respect to yard operations, it appears that the primary objective of improving operations must lie in shortening end-to-end shipping times. To this end, railroads must progressively lead shippers to more and more containerization and intermodal operations. This needs to be complemented with intermodal transfer facilities that feature very quick transfer to and from trucks and rail carrier vehicles. The final key requirement is to get the truck-carried container, once it is loaded onto an electrically powered rail carrier vehicle, moving down the railway to its destination with absolutely minimal waiting time. Similarly, with incoming rail carrier

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vehicles and their containers, they must be offloaded onto trucks and continue on their way almost immediately.

If this can be done, it should be possible in the Kansas City–Columbus rail corridor to locate an intermodal transfer yard every 100 to 250 miles, or even closer. In Missouri, intermodal yards would be located at Kansas City, Saint Louis, and probably at Columbia or Jefferson City, accessible to U.S. Routes 54 and 63, which run north-south. At roughly 100 miles between multimodal transfer yards, this would put any freight originator or receiver who is up to 50 miles on either side of the rail line at a distance of no more than 75 to 90 miles by road from an intermodal transfer yard (i.e., no more than a two-hour truck drive). Let us assume the same distances between transfer yards across Illinois, Indiana, and Ohio. Then, as an example, consider a freight container trip going to and from shipping points served within a two-hour truck drive of an intermodal transfer yard, and between transfer yards that are at least 300 miles apart. For this example, intermodal shipping would become time-competitive with end-to-end trucking. This calculation is based on an electric transporter speed of 60 miles per hour, and assumes almost no yard waiting time. It further assumes that once the time-sensitive electric transporter vehicle carrying freight containers started moving down the railway, there would be no stopping until it reached its destination at an intermodal transfer yard. It would simply bypass intermediate intermodal transfer yards.

The latter two assumptions need careful examination. But, to summarize and conclude the above analysis: Given that the conditions specified could be satisfied, rail freight between two intermodal locations as close as 300 miles would be faster than end-to-end truck transport, as well as less expensive. Even with up to four hours of total truck time in delivering the freight container to and from the source and destination intermodal transfer yards, intermodal freight movement could be quicker than freight movement solely by truck, as well as less expensive.

How can these assumptions be validated, and how can the time be saved? Earlier, I proposed that the enhanced railway be electrified and that the individual “rail transport vehicles,” which are essentially flatcars, could each be electrically powered and independently controllable. Once a container was moved from a truck and placed on the electrified transporter, the transporter with its load could, automatically and autonomously, under computerized control, be brought onto the mainline tracks. In doing this, computerized control of other transporters moving on the mainline would need to have their speeds adjusted in order to open a time slot large enough for the incoming transporter to be switched into the stream of traffic already on the mainline tracks. In this merging process, the nearer the joining transporter could be to the speed of the mainline traffic, the shorter the time slot would have to be.

At the destination multimodal yard, a similar process would occur, and the transporter would be switched out of the mainline and into its receiving yard. At each multimodal yard along the railway, any transporters not destined for that yard would simply continue on down the mainline until they reach their destination yard. A transporter with its freight load put on the mainline in Kansas City, which was destined for Cleveland, could never stop moving until it reached the Cleveland multimodal transfer yard.

Once a transporter had joined the mainline stream of traffic, if the distance to the next transporter in front or behind were close enough, and if other conditions warranted, it would be desirable for the transporters to have their speeds adjusted as appropriate, so that the distance would be closed and the two transporters would be coupled. This would reduce aerodynamic friction, for the reasons outlined earlier in this study. The same processes would also apply to build up longer "trains" of transporters.

Notice that the proposed plan for yard processes, and the carrier vehicle movement to the mainline, and movement down the mainline, do not envisage any human manning or "driving" of the transporter vehicles.

Conventional trains, such as unit trains, could run on the same mainline, interspersed with computer-controlled electric transporters. If the conventional trains were running at substantially slower speeds than the electric transporters, there would be a tendency for the transporters to queue up behind the slower train, and the transporters would have to be slowed down. Dealing with this would require occasional sidings for the slower trains to be pulled off the mainline until the queued transporters had passed.

The above presents how it will hopefully be possible to move forward in an evolutionary way from today's models of train and yard operations to a new railroading transportation paradigm. Obviously, many aspects of what has been proposed need much further investigation, analysis, and testing before this could be realized. Nevertheless, the starting point must be recognition that our 19th-century railroad technologies can only be updated by freeing ourselves from the limitations of our 19th-century railroad physical infrastructures. This requires building a new railroad physical infrastructure as a part of any new I-70 interstate highway infrastructure.

Although the fullness of benefits of this new railroading paradigm come only with its full implementation, there are still substantial, though lesser, benefits that can be obtained without railway electrification and other changes that are dependent on electrification. Simply operating current-day technology trains, and using current-day yard processes, on a new railway in the urban corridor would yield sufficient benefits to warrant its implementation.

Lower Labor Costs, More High-Skilled Jobs

It is clear that implementing the new railroading paradigm envisaged in this paper would involve substantial changes in the workforce for this new type of railroad. The introduction of substantially greater amounts of automation in the operation of railroad yards, and the automation of movement over the railway, would involve relatively more workers in electrical, electronic, and information technology areas, as well as in maintenance of electric transporter vehicles, monitoring the movement of trains and transport vehicles on the railway. There would be relatively fewer train crews and yard workers.

Notice that the proposed plan for yard processes, and the carrier vehicle movement to the mainline, and movement down the mainline, do not envisage any human manning or "driving" of the transporter vehicles.

It must be realized that a variety of safety elements would be addressed by the elimination of grade crossings, and the placement of the railway in the median of an interstate highway would protect against casual human intrusion into the railway right-of-way.

In particular, running a highly automated system as proposed herein would require a substantial amount of remote television monitoring and information visualizing in rail movement control centers. It might be necessary to equip each transporter vehicle with television cameras that could be remotely monitored. There would also be a requirement for a large network of sensors, which would also have to be monitored. To a considerable extent, routine monitoring could be automated, although if an abnormal situation were to be picked up by the sensors, the on-duty staff at the control center would have to quickly bring before themselves good, comprehensive information, and, if necessary, live video of the problem situation, in order to take timely corrective action.

It must be realized that a variety of safety elements would be addressed by the elimination of grade crossings, and the placement of the railway in the median of an interstate highway would protect against casual human intrusion into the railway right-of-way. These, along with the movement guidance feature of the two rails, and microprocessor sensors and speed controls, would in most cases eliminate the need for on-board trainmen, as is the requirement today. But this would certainly not eliminate the need for implementing failsafe operating processes and procedures, which would have to be controlled by central monitoring and control staff on a 24-hour basis.

These considerations, along with the future growth of freight movement by both truck and rail, warrant the conclusion that this new paradigm would not much effect employment in the railroad industry. In the trucking industry, there would be much more short-haul trucking and substantially less, relatively speaking, long-haul trucking.

Overall, even with the manpower savings envisaged, it is likely that the total employment in both the railroad and the trucking industries would increase with the growing freight volume anticipated in the future. (Extensive forecasts are contained in “Corridors of the Future Phase II Application” and “Transportation, Invest in America: Freight-Rail Bottom Line Report”). Hiring could well exceed normal attrition in both industries.

Higher Speed, Quicker End-to-End Delivery

Our ultimate public policy goal regarding freight transport should be to achieve better end-to-end freight delivery. As outlined throughout this paper, the comparative “better” comprehends many things. Particularly important among them is higher speed, yielding quicker delivery of freight. In part, this would involve higher-speed movement of freight transport vehicles, whether electrified or conventional trains. The other aspect would involve less time wasted while freight sat stationary, awaiting train make-up.

Achieving higher movement speeds would require, among other things, better roadbeds than are often provided today, better maintenance of the roadbeds, gentler curves, and fewer requirements to slow down for such things as grade crossings. An enhanced railway infrastructure would provide many of the necessary features.

A more important area for time saving is the elimination of waiting time through implementation of double tracking. Greatest time saving occurs in yard operations by automation and the use of independently movable electric transport vehicles. Because they could be merged into the ongoing flow of transporters on the mainline, time would not necessarily be lost in waiting for train make-up. Also, it would not be as important to sort out electric transporters by their ultimate destinations as it is today for conventional trains.

A further issue is just how quickly the freight must be delivered from end to end. This obviously depends on the needs of shippers and their consignees, and on the prices and costs for higher-speed delivery. Aerodynamic friction makes costs to the transport provider (railroad or trucking company) higher in a non-linear fashion as speed increases. But higher transport speed yields better utilization of capital, so there is a trade-off here. There seems insufficient benefit in delivering the freight any sooner than the consignee needs it (or has paid to receive it). And, to the extent that earlier delivery is needed, or not needed, this would affect costs and could be reflected in prices. For this to become operative, the railroad must be able, on an individual shipping container basis, to hasten or retard the speed of movement of its electric transporter vehicle. Providing that its scheduled delivery time could be met, this might involve switching a less-urgent transporter vehicle and its container(s) off the mainline and onto a siding at an intermodal transfer yard for a while. This would allow other freight transporters requiring movement at higher speed to pass the non-urgent freight. Later, it would become timelier for the previously delayed freight transporter to rejoin the mainline in order to achieve its scheduled delivery time. This would enable all electric transporter vehicles to operate at the optimally slowest energy-saving speeds as determined by traffic loading, and by other conditions as they may be set. All of this sounds quite complicated to schedule, if done manually. But computerized scheduling and load-balancing systems can accomplish this relatively easily. Airlines deal with far more complex problems with flight scheduling, and with passenger seat-filling and bumping.

The development of computerized freight movement control programs would almost make it possible never to fail meeting a container delivery schedule, with the exception of unforeseeable disasters. The flow of freight throughout the system would be almost continuous. Movement would depend on the amount of freight traveling in the system, the delivery date and time the shipper had agreed to pay (higher price for speedier delivery), and the slowest, electricity-saving average speed that the freight had to travel through the system in order to arrive at the agreed time. With look-ahead load anticipation forecasting systems (which could be encouraged through discounts and surcharges if in-bound container movements were notified to the intermodal transfer yard within various timespans in the next few hours, days, or months), it would be possible to anticipate the likelihood of forthcoming congestion. This would indicate that the transporters needed to run at a higher speed, and they could be automatically made to do so. The system could also identify transfer yards with forthcoming transporter vehicle shortages or surpluses. In fact, it would

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be possible to completely automate the migration of empty transporter vehicles to areas of the system where shortages were anticipated. This would yield better utilization of capital.

Notably, there are very stringent physical requirements in implementation of this paradigm (no grade crossings, electrification, double-tracking, etc.). If the paradigm were to be extended more broadly, these physical requirements and their costs would probably limit the paradigm to Class 1 railroads, which have the most financial resources. This probably would not be feasible for short-line railroads. However, it might well be the salvation of short-line railroads, as it would provide to them a growing volume of rail freight, as well as unit trains, going to and from areas that are too far from a main-line intermodal transfer yard.

The above statement indicates that it is difficult to envisage that this paradigm, if implemented more broadly, would become more prevalent than four or five trans-continental lines and five or six north-south lines. The ultimate network would probably be very much like the air transport hub-and-spoke model, with 20 to 30 rail-truck intermodal transfer hubs, and enhanced railways connecting them.

However, as freight volume expands during the 21st century, the paradigm is certainly geographically extensible and more broadly applicable. It would also provide a better infrastructure for other, not-yet-discovered, 21st-century technological advances.

Concluding Remarks

The "Corridors of the Future Phase II Application" states that U.S. Class 1 railroads are:[19]

> ... primarily private corporations whose service area and track infrastructure is typically either in the eastern or western U.S. The I-70 Corridor project area bridges the service areas of both east and west based rail companies.
>
> Currently, commodities traveling across the country by rail go into the Chicago area and switch from the eastern/western carriers and rail lines. If the I-70 TOLs Corridor project is completed, it would provide an option for long distance freight to trans-load in the intermodal facilities in the Kansas City or Columbus areas, and avoid the congestion in the Chicago and I-80/90 corridor.

This admitted need to improve freight movement suggests innovating beyond the current model for better efficiency. Why would or should we, as a public policy matter, seek to shift freight from rail to truck and back to rail for the 670-mile Kansas City–Columbus intercity trip? Surely, it would be better to solve the rail congestion and bottleneck in Chicago by building a better rail interconnection between the origin and destination.

The document further states:[20]

> Shift in Trucking Operations – Alternatives that will Attract Trucks – TOLs, particularly on longer interstate corridors, can improve operating efficiencies for the trucking industry. As conceived, The I-70 "Corridor of the Future" will allow for seamless long-haul trucking operations over a nearly 800 mile stretch of highway. This distance will, in some cases, make the Corridor

> an attractive, cost-effective alternative to rail, enabling rail loads to be more cost-effectively transferred to trucks in Kansas City or Columbus, bypassing the significant rail congestion in Chicago that is a detriment to time-sensitive shipments.

Undoubtedly, TOLs would improve operating efficiencies over what the trucking industry experiences today. But that is an answer to an irrelevant question. The real questions facing public policy resolution are: Which approach is better for meeting our future transportation needs? Are TOLs the better way forward? Or is the better way forward the intermodal model? I propose we use the proven intermodal model supported by an enhanced railroad infrastructure, as proposed in this study, and by others.

Again, it states:[21]

> The I-70 dedicated truck-only lanes (TOLs) project can address major issues facing transportation today: namely, congestion, safety, and the enormous growth and time-sensitivity of freight logistics. The proposed TOLs project can provide a corridor of such length and breadth as to change America's national model for interstate transportation.

Indeed, it could provide such a model, but it also leads to a paradigm shift that we should urgently seek to avoid. Such a shift would encourage almost all future, as well current longer-distance, freight to be moved by truck. The greater economies and the more benign environmental effects and safety of rail freight movement, as well as the benefits of the urban corridor development, as outlined in this paper, should make evident the proper way forward. Finally, TOLs would probably sound the death knell for short-line railroads.

Every benefit offered by TOL development, save one, is better afforded by enhanced rail development. The sole advantage that trucks would continue to offer is in shorter-distance, time-sensitive delivery of freight. This is why the intermodal paradigm holds such merit, if it were to be applied more broadly and more intensively.

Neither rail, nor truck, nor TOLs, nor intermodal freight operations can or would accomplish much to alleviate current urban congestion. However, the urban corridor model, featuring linear urban development alongside a robust transportation infrastructure, would much better prevent future development of urban congestion. For this to be effective, the robust transportation infrastructure would need to include integrated facilities for truck and rail freight, for long-distance rail passenger services, for slower-speed local rail passenger services, and for automobile and bus passenger services. Along with these, there would have to be intermodal facilities for people, as well as for freight.

It is noteworthy that the TOL proposal appears inconsistent with the views expressed in a report prepared for the Transportation Research Board of the National Academies. The following is representative:[22]

> Interregional transportation will continue to be multimodal, with aggressive programs assumed to maintain modal shares, as a matter of policy. Neither passenger nor freight accessibility

The real questions facing public policy resolution are: Which approach is better for meeting our future transportation needs? Are truck-only lanes the better way forward? Or is the better way forward the intermodal model?

can be efficiently provided by highways alone and new highway development can be designed explicitly to accommodate other modes. In this analysis, aggressive assumptions about transit and private freight rail were made ...

With the economic growth that maximum-efficiency freight movement would induce, there would be much more traffic than there is today for both the trucking industry and the railroad industry. If an irrelevant increase occurs in railroad's market share, for the sake of the public good, so be it.

Even the above statement begs the question of why we should assume that modal shares need to be maintained, especially when safety, economic, environmental, and technological considerations, as well as the broader public good, indicate that this might not be the most efficient plan. We should consider the unique advantages and benefits inherent in both of these competing modes of freight movement, and seek a balanced integration of both of them. Thus, we seek to maximize overall public good for the 21st century. With the economic growth that maximum-efficiency freight movement would induce, there would be much more traffic than there is today for both the trucking industry and the railroad industry. If an irrelevant increase occurs in railroad's market share, for the sake of the public good, so be it.

VIII. FINANCING

Improved Prospects for Investments in Infrastructure

Somewhat paradoxically, in view of the current economic downturn, there seems to be an improving prospect for both public and private investment in infrastructure, including transportation infrastructure. Public investments are currently being addressed to "shovel-ready" projects, in improving deteriorated highway and bridge infrastructure. This is understandable, in that current political rhetoric emphasizes job creation. Unfortunately, job creation would receive little short-term help from the infrastructure developments being proposed here, because they would take many years to reach fruition. However, infrastructure development aids long-term growth and job creation. The currently improved climate for infrastructure investment reflects a growing realization that the United States, as a nation, has been over-borrowing to support an excessive level of consumption, at the expense of a consequential insufficient savings and investment rate — particularly in areas of our economy that would lead to increasing productivity, lowering costs, and growing prosperity.

It is likely to take years rather than months to work out of our current economic crisis, because of the substantial structural changes that will have to be made, both public and private, in the nation's financial and non-financial institutional environments. It is unavoidable that, to come out of this current crisis, we will eventually have to become a society that consumes relatively less, saves relatively more, and invests more. In broad terms this includes as investments those expenditures that improve the productivity of the workforce, such as education, health care, and public safety, including environmental safety. But also included are transportation investments, such as envisaged in this paper, as well as conventional productivity-increasing investments including research, development of new technologies, and embedding them in new, improved plants and equipment, as well as new work processes. It is in these senses that an increasing realization of the importance of savings and investment is yielding a better climate for carrying forward the infrastructure investments proposed in this paper.

Current Situation

As I address the matter of financing infrastructural developments, I immediately face the issue that railroad companies are private entities, which are supposedly financed privately. On the other hand, interstate highways are supposedly public entities and are supposed to be financed from government revenues. However, the facts are somewhat different. At least since the building of the Trans-Continental Railroad in the 1860s, and continuing into the present, railroads have received government financing. And highways are increasingly being financed by so-called public-private partnerships (PPPs), which will be discussed shortly.

The AASHTO "Freight-Rail Bottom Line Freight Report" presents, on pp. 75 through 79, information about the public financing of railroads, including PPPs. Nevertheless, in the case of railroads today, public finance represents a relatively small portion of funding, and mostly amounts to governmental assistance in minor infrastructural improvements to existing railroad right-of-ways. There is little more that needs to be said on this, except that any private railroad company, or combination of them, would face considerable obstacles if they attempted to finance the total costs of the enhanced railroad infrastructure as envisaged in this paper. But further, given that the proposed enhanced railroad is to be built in conjunction with a new interstate highway, why should the railroad pay the entire cost? Building the two together results in much lower total costs than building each of them separately. Without going deeply into this matter, it suffices at this point to say that cost sharing is a useful alternative way to finance large-scale projects like this one.

What exactly is a public-private partnership? According to the National Council for Public-Private Partnerships:[23]

> A Public-Private Partnership (PPP) is a contractual agreement between a public agency (federal, state or local) and a private sector entity. Through this agreement, the skills and assets of each sector (public and private) are shared in delivering a service or facility for the use of the general public. In addition to the sharing of resources, each party shares in the risks and rewards potential in the delivery of the service and/or facility.

A variety of methods and sources of finance for highways are comprehensively presented in the following papers:

- Samuel, Peter, and Robert W. Poole, Jr., "The Role of Tolls in Financing 21st Century Highways," Reason Foundation, Policy Study 359, May 2007. This study also contains presentations of innovative finance alternatives and long-term concessions.[24] Also worth reading is the official "Policy Summary" of this study.[25]
- "Corridors of the Future Phase II Application," Presented to the Federal Highway Administration, May 24, 2007. Contains

It is unavoidable that, to come out of this current crisis, we will eventually have to become a society that consumes relatively less, saves relatively more, and invests more.

The driving public often gets a better deal when privately owned companies play a part in maintaining the highway system, even though drivers may have to pay tolls.

presentation on "Innovative Project Delivery" in section 3.4.1 and "Innovative Project Finance" in section 3.4.2.[4]

- Stokes, David C., Leonard Gilroy, and Samuel R. Staley, "Missouri's Changing Transportation Paradigm," Show-Me Institute Policy Study No. 14, Feb. 27, 2008.[26]

To characterize the presentations in the above-referenced papers briefly, they all strongly endorse the use of PPPs to facilitate the financing of highway infrastructure. As the needs of the public, as represented here by the government, and the needs of private parties may best be served, these partnerships may involve any combination of one or more of the following: highway financing, design, engineering, building, operation, and maintenance. Where the contract includes operation and maintenance, the contract usually lasts for 30 or more years.

When financing is involved in the partnership arrangement, the central issue is that a revenue stream must be identified that would pay off the implicit borrowings that must be done (by the private party to the partnership) to finance the project. Typically, this is accomplished by tolling vehicle operators for using the highway.

As explained in the above-referenced papers, government entities tend to engage in such partnerships because they often cannot arrange financing as comprehensively or quickly as the private party to the partnership can do so; they find that they cannot design, engineer, and build the highway as inexpensively as the private partner can; or they cannot operate and maintain the highway as inexpensively or as effectively. Thus, the driving public often gets a better deal when privately owned companies play a part in maintaining the highway system, even though drivers may have to pay tolls. Not only do private companies provide greater efficiency, but gasoline taxes and other revenues available to government highway administrations are simply not sufficient for funding. A more cost-effective way to fund highways is necessary, and this is the advantage of PPPs.

With the advent of PPPs, we are living in an age of innovative finance for design, engineering, building, operation, and maintenance of transportation infrastructure. In one sense, this is nothing new. Consider the case of air transportation, an industry replete with government agencies such as the FAA and the Civil Aeronautics Board (CAB). The airlines are mostly private, except for some special agencies, as well as the Air Force and other military aviation. In addition, there are private and corporate aircraft. PPPs are linked and coordinated by a great web of law, contracts, and other conventions, and funded by a combination of federal, state, and local government and private sources.

All of this serves to indicate that there is nothing new or inappropriate in the mixing of public and private funding to support a transportation mode. There is no need to assume that only one method is possible for financing highway infrastructure and its operation and maintenance, nor is there any reason to insist on strictly private provision of the same for railways when a PPP would allow significant cost savings are possible for both the public and private halves of the arrangement. If PPPs have been so effective for the air transportation industry, it is reasonable to surmise that they might also work well in the railroad industry.

At this point in our history, PPPs in the railroad industry are a historical anachronism. As a matter of public policy, why should we carry on with providing a public transportation infrastructure to the trucking industry, while insisting that infrastructure for a competing industry, railroads, remain much more exclusively a matter of private entrepreneurship? The answer is simple and straightforward: because that is the way it started out in the 19th century, and because that is the way our nation has always done it. (The major exception was the Transcontinental Railroad, which entailed what we would today call a PPP.) But is this rigid separation of funding a good solution, and does it provide a sound pathway for rail or highways into our 21st-century future? It would make more sense to create a more level playing field for both of these competing industries, based on analyses of the current situation. In the new millennium, the United States would do well to develop a sound, modally integrated, national transportation policy.

Loss of Gasoline Tax Revenue

Up to the current time, highway infrastructural investments, and their subsequent maintenance, have been largely financed by federal and state gasoline (and diesel) fuel taxes. However, for several reasons, this is becoming an increasingly problematic way to finance such investments and their maintenance in the future.

A complicating factor in any discussion of financing the building of highways and maintenance, is the deteriorating yield from the current per-gallon tax on gasoline. The current model of taxing gasoline consumption, as a proxy for road usage, not only fails to take into account inflation; it has deleterious side effects. The current public policy emphasis on increasing per-gallon mileage causes decreased tax yield per mile traveled, or per vehicle hour on the highway. These could be alternative measures of road capacity utilization. Basing costs on road usage might necessitate the installation of a GPS or other miles-driven or time-on-the-road measurement device in the vehicle, which could be read periodically for billing purposes. However, such devices might make it difficult to implement pricing dependent upon congestion, location, or situation. In any case, the advent of hybrid vehicles, and fully electric, home-charged, battery-powered vehicles, threatens to further reduce the revenue yield from gasoline taxes, in relation to actual usage of the roads.

There seems to be little public awareness of this issue as yet. Public perception in general appears to be that drivers will consume less gasoline by driving higher-mileage conventional vehicles or hybrid vehicles, and thereby pay less for gasoline — and, implicitly, less in gasoline taxes per mile traveled. This line of thought would seem to hold that those with fully electric automobiles would only have to pay for the electricity to charge the battery — no road usage taxes at all! As the relative frequency of high-mileage gasoline vehicles and fully electric vehicles increases on the highway, it will not be sustainable for such drivers to avoid some kind of payment for use of the roads.

Up to the current time, highway infrastructural investments, and their subsequent maintenance, have been largely financed by federal and state gasoline (and diesel) fuel taxes. However, for several reasons, this is becoming an increasingly problematic way to finance such investments and their maintenance in the future.

Many people resist paying higher gasoline tax rates because a large proportion of those tax revenues are being used for interstate highways (and some for non-highway uses) that only regularly serve a small portion of the population.

Another way of looking at this in a simple fashion is to consider the per-mile cost of gasoline taxes. Currently, for Missouri, the total federal and state gasoline tax is about 36.0 cents per gallon, which is the sixth-lowest in the nation and far lower than both the national average of 47.0 cents per gallon and the state with the highest rate, California, with combined federal and state taxes of 65 cents per gallon.[27] For the Missouri automobile owner, this works out to be a penny per mile if a car gets 36 miles per gallon, or two cents per mile if it gets only 18 miles per gallon. Notably, toll road charges elsewhere in the United States cost several times that per mile figure. Is it any wonder that there is resistance to the very concept of tolling for highway usage instead of financing highways with gasoline taxes?

Yet, as noted earlier in this study, the real nature of the problem is that many people resist paying higher gasoline tax rates because a large proportion of those tax revenues are being used for interstate highways (and some for non-highway uses) that only regularly serve a small portion of the population. Many people don't want to pay gasoline taxes to support these highways because they live in areas not well served by interstates. This is especially true for those living in rural and less densely populated areas. Consequently, they only have rare occasions to use an interstate highway. Yet they know that their gasoline tax dollars are being used to subsidize highway usage and benefits for other people.

Given the resistance to higher gasoline taxes, and the prospect of declining yields from such taxes, it seems pointless to pursue this avenue for increasing funding for maintenance of existing highway infrastructure, much less for the construction of new highways. Why search for a pot of gold at the end of a rainbow if the rainbow is fading faster than we can reach the end?

Comment on Usage Fees Versus Fixed Fees

Some suggest that the gasoline tax–"free" usage of roads by electric or other alternatively fueled vehicles can be dealt with by levying a substantial extra licensing fee and/or sales tax for such vehicles. This idea should be vigorously opposed, for at least two substantial reasons: First of all, electrics are coming to market at a high enough sales price premium over gasoline-powered vehicles that any additional ownership costs (costs not dependent on vehicle or road usage) that might be imposed could be detrimental to the development of electric vehicles, and impede their acceptance.

Second, and more importantly, the imposition of additional taxes or fees, such as licensing fees, sales taxes, or property taxes (in exceeds of the simple costs of the state's provision of the annual licensing service) has an impact on vehicle owners' behavior. In the case of a fixed fee for road usage, those who do not drive many miles would be forced to pay the same fee as drivers who uses the roadway often. Any driver who recognized this might be motivated to use the roads more, in order to get greater benefits from the fixed ownership costs already incurred and paid. Such a system would encourage waste instead of efficiency, making it harder to address the real problems of congestion and wear and tear of the roads. If an automobile owner's fixed costs, such as depreciation, sales or property taxes, licensing charges, and insurance are relatively low, the driver is more likely to pay attention to marginal costs, such as gasoline, electricity, and the variable costs of operation and maintenance of the vehicle. This would likely motivate drivers to use the roadways only to the extent that they are willing to pay.

It appears that the best solution to this conundrum is to keep ownership fixed costs as low as possible, in favor of gaining as much highway construction and maintenance revenue as necessary from usage fees levied upon actual highway users. Again, it should be recalled that PPPs often require user fees — that is to say, tolls.

There is another somewhat unrelated — but nonetheless relevant — reason, from the public policy point of view, to focus on user fees as a means of financing transportation infrastructure and maintenance. The United States has the largest consumer goods market in the world, combined with the lowest-cost distribution system — including the freight transportation system. We have eliminated a large proportion of the distributor/wholesaler layers in the distribution system. We are also bypassing a growing portion of the retail establishment, with catalog and Internet sales, and shipping services such as United Parcel Service (UPS) and FedEx. This has greatly reduced distribution costs.

This low-cost distribution system is available to foreign goods producers at virtually no cost to them. Yet U.S. manufacturers must face costly and arcane distribution systems in trying to get their products to consumers abroad. This enables foreign producers to sell their goods profitably in the U.S. market at the same price for which they retail in their home markets. Selling at the same price in both markets meets the anti-dumping requirement of the World Trade Organization (WTO). However, this price regime also enables foreign producers to achieve a higher unit profit than they could gain in their home markets. This is one example of the many ways that regulation of trade distorts real market forces, leading to suboptimal practices that take advantage of these distortions. The foreign producer faces a relatively more costly and inefficient distribution system in his or her home market. These foreign producers do not contribute to funding the U.S. distribution system from which they benefit. This situation could be more efficient if there were some mechanism in place for foreign producers to pay the true costs for the transportation of their goods throughout the United States.

This should not in any way be taken as an endorsement for tariffs, however; tolling would be a much more efficient way to ensure that those who use transportation infrastructure pay for their use. This is why it is misguided to introduce funds raised from general revenues into highways or railroads, airlines or waterways. True, such taxes serve the general public and reduce the transportation costs of both domestic and imported goods. However, such taxes disproportionately benefit the sale of goods by foreign producers into the U.S. market. General revenue taxes used to fund transportation routes have the effect of subsidizing foreign producers by reducing their U.S. distribution costs.

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General revenue taxes used to fund transportation routes have the effect of subsidizing foreign producers by reducing their U.S. distribution costs.

Incidentally, the same situation arises when the government imposes environmental regulations on polluting industries, inducing them to move production to parts of the world where they do not have to incur extra costs. They can pollute the atmosphere as much as every other producer in that area of the world, and ship those more cheaply produced goods back to the United States. This is not an argument for relaxing environmental regulations, but for ensuring that if emission taxes are imposed on the production of goods, they aren't levied disproportionately on domestically produced goods, rather in proportion with the latent production of pollutants involved in their manufacture.

Of course, the notion that foreign manufacturers obtain a competitive advantage from their ability to impose higher external costs on others is only a theory, unable to be definitively proved or disproved because we have no way of gauging the unit costs of imported goods. We also can't generally transfer prices for goods sold to a foreign producer's U.S. distribution subsidiary, although foreign producers would likely be motivated to set high transfer prices so as to keep their U.S. profits (and U.S. corporate taxes) low, thereby allocating more of their profits to their home countries, where corporate profits tax rates are much lower.

Charging of Tolls for Highway Usage

In 2002, MoDOT published a "Missouri Toll Feasibility Study,"[28] which served as a good primer on the various aspects, methods, and issues involved in tolling of highways and bridges. It is today somewhat outdated, in that it does not provide a view of current advances in electronic tolling and billing technologies. Among those advances are open-road tolling, variable congestion relief tolling, and automatic billing. Nevertheless, the study is still a useful reference, with an obvious purpose of informing the public and moving public opinion toward greater acceptance of tolling as an alternative funding mechanism for highway and bridge construction and maintenance. The study has not yet been successful to the point of achieving the necessary amendments to the Missouri Constitution that would generally allow tolling, which is currently prohibited except in unusual circumstances.

This situation presents an opportunity for positive change, and there are signs that public opinion is changing. The Show-Me Institute's 2008 policy study "Missouri's Changing Transportation Paradigm" presents polling data from Rasmussen Reports, a respected national polling firm, indicating that 53 percent of 500 likely Missouri voters polled said that money for highway and bridge improvements should come from tolls rather than from higher state sales taxes.[29] Apparently, the polling did not ask about other possible sources of revenue, such as gasoline taxes. In view of this prospect, there is reason to hope that a properly structured proposal embodying adjustable rates (higher rates for heavy users of the interstate highways) could gain public acceptance.

As noted previously, many people resist, and justifiably so, paying broad-based taxes for provision of services, such as interstate highways, that they seldom use. On the other hand, there tends to be much less objection to the use of such taxes for local roads. People see themselves individually benefiting proportionately from local roads and streets, just as everyone else in the general public does. They do not see themselves benefiting proportionately from interstate highways, especially if they live at some distance from the highway or if the nearby interstate does not fit into their usual travel patterns. Finally, they find the older toll-collection practices (before the newer electronic, open-road tolling became available during the last couple of years) as being annoying, frustrating, an imposition, and possibly a privacy violation — all added to the toll fee itself.

Yet on the infrequent occasions when such people would need to use an interstate, they could be induced to pay a toll if need be. It is purely a question of how much they would be required to pay on those occasions when they needed to use the tolled highway (or bridge). As emphasized previously, people are willing to pay for what they use if and when they use it. They are not willing to pay for what they seldom use, or perceive others using more and obtaining differential benefit to their own disadvantage.

Fortunately, we have available to us today a wide variety of new electronic tolling technologies that enable a similarly wide variety of adjustable tolling and payment alternatives. It is quite possible to accommodate the public with a simultaneous variety of toll-charging alternatives, and to allow the individual to choose his or her preferred one. Further, it is possible to implement open-road tolling, largely, if not totally, obviating the necessity for tollbooths. Using electronic tolling, charges can be levied on a per-mile basis with different per-mile rates on various sections of the highway, or at various times of day, thus making provision for automatic congestion pricing and inducing drivers to shift their road usage to times of day when there is lighter traffic.

For those who would seldom use the toll highways, it would be possible to initiate charges only when their usage rose above a certain number of miles per month or per year, or higher than a certain dollar amount, or more than a certain number of days of toll-free usage of tolled highway per month. As an example, the first 10 dollars — or whatever amount might be settled upon — could be waived. This would address the objections to tolling raised by those who seldom have occasion to use the toll highways. That type of exemption proposal presupposes that vehicles would have an electronic tolling radio transponder box, about the size of a deck of cards, attached to the inside of the car owner's windshield or in some other part of the vehicle. The vehicle owner would normally have to establish an account and sign a contract with the toll system operator in order to have toll charges automatically debited to the vehicle owner's account. Because the electronic transponder would typically be assigned to a specific vehicle, it would be possible to have different tolling rates for different classes of vehicles.

For those unwilling to establish such an account, it would be possible to have unmanned credit or debit card readers at the entrances and exits of a toll highway, and automatically charge the owner's card account the appropriate amount when exiting the toll road. For those who do not like this arrangement, it would be possible to arrange for the sale of pre-paid, stored-value cards at service stations near the

People are willing to pay for what they use if and when they use it. They are not willing to pay for what they seldom use, or perceive others using more and obtaining differential benefit to their own disadvantage.

If tolls were widely implemented on the interstates, and were set at levels sufficient to cover construction and maintenance costs in full, it would become possible to devote a higher percentage of gasoline taxes to local roads and streets.

entrances to interstate highways. This would address the concerns of those who see the potential for privacy invasion from a charging system that could, if abused, yield tracking information on individuals. Of course, the latter objection could be overcome by providing manned tollbooths for collecting cash tolls, but the high costs of such a provision must be carefully considered.

It is possible to have multiple toll-charging plans, with individual vehicle operators choosing whichever one meets their needs. Just as mobile phone services offer multiple charging plans, vehicle owners could utilize an "anytime-use" plan at a higher charge rate than one that offers a lower rate if, for example, more than 60 percent of monthly usage were to fall outside of heavy congestion periods. Taking another cue from mobile phone companies, drivers could employ "roll-over miles," or roll-over dollars, if they failed to use their entire plan's prescribed monthly mileage or dollar quota.

All of this would involve a trade-off for those who have a greater desire for good highways, and are willing to pay more in tolls for them. They may effectively have to sign onto some scheme costing them higher tolling rates, in order to offer lower tolling rates to those who oppose tolling. Both sides might effectively have to sign onto a social contract that would bring majority acquiescence to the implementation of tolls for interstate usage. This is what is colorfully known in economics as "scooping out the consumer surplus."

If tolls were widely implemented on the interstates, and were set at levels sufficient to cover construction and maintenance costs in full, it would become possible to devote a higher percentage of gasoline taxes to local roads and streets. In this way, we could more gracefully adjust to the problems with decreasing gasoline tax revenue cited earlier in this paper. Because gasoline taxes would be devoted more to local road and street infrastructure, it might be easier to obtain public acceptance for increasing them — if necessary.

One can see a new paradigm taking shape here. As electric vehicles supplant gasoline-powered vehicles, an increasing amount of the revenue needed to finance construction and maintenance of all major roadways, including local roads and streets, would have to come from tolls on interstates and other major trunk roads. Drivers in London, England, faced a similar situation a few years ago. Any car passing from outer London into the inner city has to buy a one-day pass to bring the car into the inner city and use in the city that same day. Daily passes can be purchased at local gasoline service stations and automatic teller machines (ATMs).

In the face of rising gasoline taxes and increasingly congested roadways, tolling is the wave of the future. We should grasp the concept and implement the wide variety of methods for setting tolling rates in ways that best serve our individual and collective interests and needs.

IX. SUMMARY AND CONCLUSION

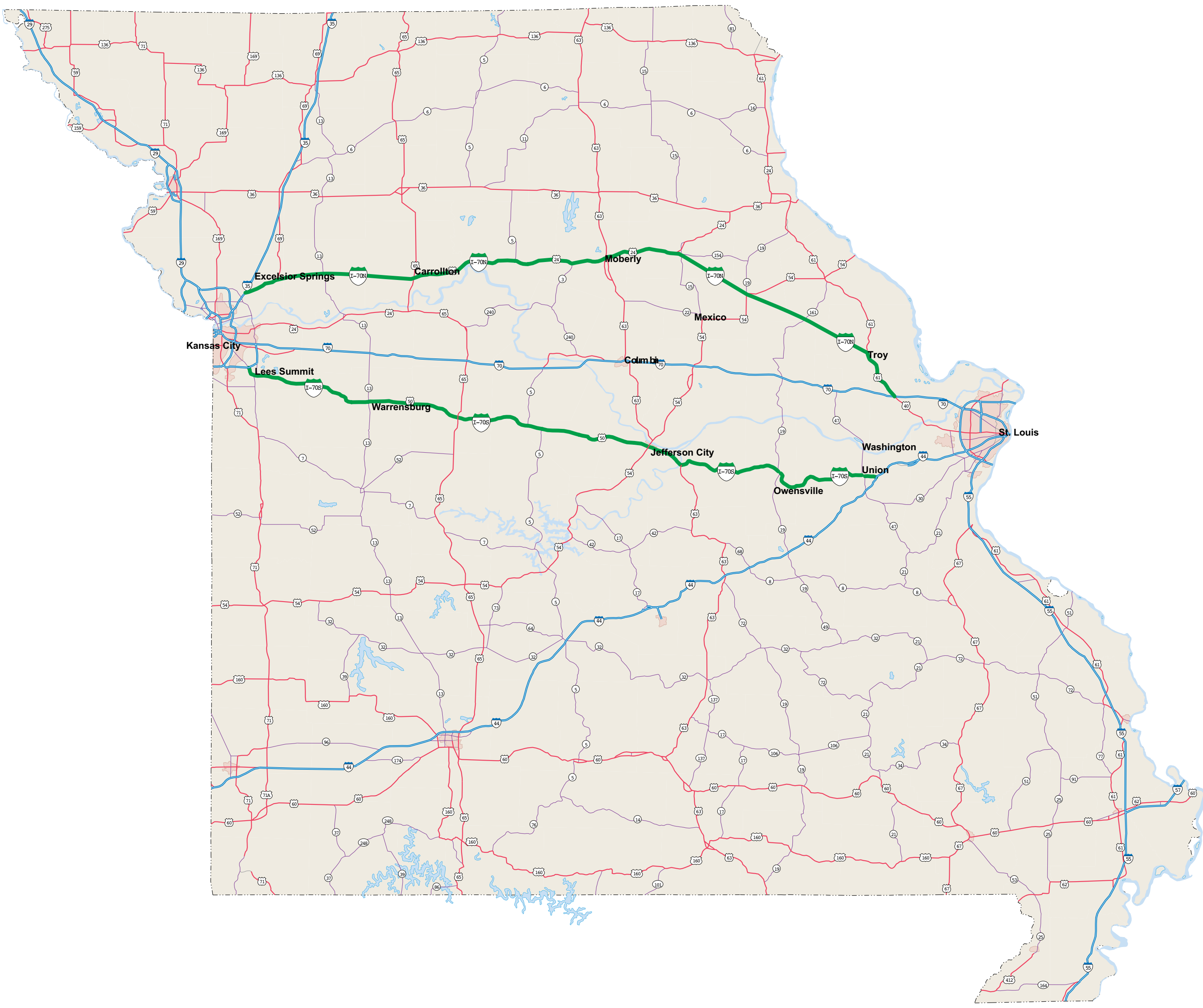
The bottom line is that we need to ask key Missouri leaders and policymakers to consider what kind of urban and economic future they want for Missouri. The urban corridor and a new I-70 North are options well worth considering, as they seem to offer the most environmentally sensitive, most cost-effective, and most investment-efficient way to achieve that future.

If we have the will and determination to achieve that better future, along with a viable plan, then a way will surely be found to overcome the largest obstacles — the financial issues. To quote "Transportation, Invest in America: Freight-Rail Bottom Line Report":[30]

> The value of this analysis is less in its specific numbers, and more in its overall message — namely, that relatively small investments in the nation's freight railroads can be leveraged into relatively large public benefits for the nation's highway infrastructure, highway users, and freight shippers.

In the face of rising gasoline taxes and increasingly congested roadways, tolling is the wave of the future.

Potential Routes Of Expanded I-70 System



NOTES

[1] The names BosWash, Chipitts, and SanSan are attributed to Jean Gottman, an urban, political, economic, and regional geographer. His 1961 book *Megalopolis* is regarded as the seminal work on urbanization.

[2] Dalmia, Shikha, and Leonard Gilroy, "Going Protectionist Over a Fantasy Highway," *Los Angeles Times*, Sept. 20, 2007. Online here: tinyurl.com/2cgwvoa. The "fantasy highway" refers to a separate, supposed "secret federal project called the NAFTA Superhighway, a four-football-field wide monstrosity that would run from Mexico's Yucatan to Canada's Yukon." The explicit purpose of the article is to identify this fantasy highway as quite different from the real-world I-69 and the Trans-Texas Corridor projects. One of its authors, Leonard Gilroy, is a senior policy analyst at the Reason Foundation, which has produced many worthwhile transportation policy studies.

[3] "Future Options for the National System of Interstate and Defense Highways," National Cooperative Highway Research Program, Project 20-24 (52), Technical Memorandum #2, 2006. This paper presents a representative survey of studies of highway investment returns. The Economic Impact of the Interstate Highway System, at www.interstate50th.org. The quoted 35-percent rate of return is found on p. 45 of the Memorandum, and pp. 56–62 in the "Accompanying Tables" contain the survey of studies.

[4] "Corridors of the Future Phase II Application," produced by the Missouri Department of Transportation, the Illinois Department of Transportation, the Indiana Department of Transportation, and the Ohio Department of Transportation, May 24, 2007. Online here: tinyurl.com/48zafpg

[5] Ibid., p. i-1.

[6] Ibid., p. 2-20.

[7] Ibid., p. 1-1.

[8] Ibid., p. 1-1.

[9] Ibid., p. 2-6.

[10] Pisarski, Alan E., and Kevin E. Heanue, "Future Options for the National System of Interstate and Defense Highways Task 10 Final Report," prepared for National Cooperative Highway Research Program Transportation Research Board of The National Academies, by PB Consult, Inc., with Cambridge Systematics, Inc., May 2007. Note that the Transportation Research Board has issued a disclaimer: "The opinion and conclusions expressed or implied in the report are those of the research agency. They are not necessarily those of the TRB, The National Research Council, AASHTO or the U. S. Government." Online here: tinyurl.com/4hoph36

[11] "Transportation, Invest in America: Freight-Rail Bottom Line Report," American Association of State Highway and Transportation Officials (AASHTO), prepared by Cambridge Systematics, Inc. Online here: tinyurl.com/6kmve3w

[12] Ibid., p. 94.

[13] Ibid., p. 29.

[14] Ibid., p. 29.

[15] Coefficients of friction are experimentally determined and will vary somewhat from one experimental measurement to another. The data cited are taken from: tinyurl.com/dqtfz

[16] "Corridors of the Future Phase II Application," pp. 2-7–2-8.

[17] "Corridors of the Future Phase II Application," pp. 2-7–2-8.

[18] Advertisement appears in *The Economist*, Jan. 24–30, 2009, p. 103. Online here: indianrailways.gov.in

[19] "Corridors of the Future Phase II Application," p. 1-32.

[20] "Corridors of the Future Phase II Application," p. 2-6.

[21] "Corridors of the Future Phase II Application," p. 1-1.

[22] Pisarski, Alan E., and Kevin E. Heanue, "Future Options for the National System of Interstate and Defense Highways Task 10 Final Report," pp. 10–11.

[23] National Council for Public Private Partnerships. Online here: ncppp.org/howpart

[24] Samuel, Peter, and Robert W. Poole, Jr., "The Role of Tolls in Financing 21st Century Highways," Reason Foundation, Policy Study 359, May 2007. Online here: tinyurl.com/5wq65qs

[25] Samuel, Peter, and Robert W. Poole, Jr., "The Role of Tolls in Financing 21st Century Highways," Reason Foundation, Policy Summary of Study 359, May 2007. Online here: tinyurl.com/4zm424a

[26] Stokes, David C., Leonard Gilroy, and Samuel R. Staley, "Missouri's Changing Transportation Paradigm," Show-Me Institute Policy Study No. 14, Feb. 27, 2008. Online here: tinyurl.com/4ojfkc2

[27] American Petroleum Institute, motor fuel taxes summary report, January 2008. Online here: tinyurl.com/28c3w2

[28] "Missouri Toll Feasibility Study: Phase I," Missouri Department of Transportation, May 2002. Online here: tinyurl.com/4w53te9

[29] Rasmussen Reports, Missouri Toplines, Oct. 10, 2007. Online here: tinyurl.com/ywqwv

[30] "Transportation, Invest in America: Freight-Rail Bottom Line Report," p. 62.

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