Pork Barrels and Boondoggles: Lessons Learned from the era of Urban Automobile Infrastructure Development and Corresponding Implications for the Future of American Cities

by

Zachary Richard Kostura

B.S., Physics, Integrated Science and Technology (2002)

James Madison University

Submitted to the Department of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degree of Master of Engineering in High Performance Structures

at the

Massachusetts Institute of Technology

June 2003

Signature of Author.....
Zachary Richard Kostura
Department of Civil and Environmental Engineering
14 May 2003

Certified By.....
Dr. Jerome J. Connor
Professor, Civil and Environmental Engineering
Thesis Supervisor

Received By.....
Dr. Oral Buyukozturk
Professor, Civil and Environmental Engineering
Chairman, Committee for Graduate Studies

Pork Barrels and Boondoggles: Lessons Learned from the era of Urban Automobile Infrastructure Development and Corresponding Implications for the Future of American Cities

by

Zachary Richard Kostura

Submitted to the Department of Civil and Environmental Engineering on May 9th, 2003 in Partial Fulfillment of the Requirements for the Degree of Master of Engineering in High Performance Structures

Abstract

Development of modern urban transportation infrastructure places heavy emphasis on the automobile. Local roads and major highways permeate the cores of every American city. As such development persists, alternative modes of transportation are left in stagnation. As a result, city residents and local commuters grow increasingly dependent on the automobile. This dependence has proved unilaterally damaging to the urban landscape of every city in the nation, and more valuable land is sacrificed to roads and highways with each passing year. To understand why modern transportation engineering is so highway oriented, one must observe the history of the automobile and the modes of transportation that predated this vehicle. The legacies of the car and the highway continue to drive major municipal development, as observed in the massive Central Artery/Tunnel project in downtown Boston. This multibillion dollar megaproject promises to clean up the heart of the city, which is at present snarled with hundreds of thousands of vehicles each day. Yet the solutions put forth in the reconstruction continue to emphasize highway travel and largely neglect other transit forms that have proved more sustainable within the urban context. The reasons for the car-oriented plan stem from social and political forces that exist on local, national, and global levels. Only through the comprehension of these forces can feasible alternatives be developed. Implementation of these alternative modes is crucial to the deceleration of urban highway development, which has proven ineffective in solving modern transportation problems and has continued to inflict severe harm on virtually every aspect of life in the American city.

Thesis Supervisor: Dr. Jerome J. Connor
Professor, Department of Civil and Environmental Engineering
Massachusetts Institute of Technology

"The American city should be a collection of communities where every member has a right to belong. It should be a place where every man feels safe on his streets and in the house of his friends. It should be a place where each individual's dignity and self-respect is strengthened by the respect and affection of his neighbors. It should be a place where each of us can find the satisfaction and warmth which comes from being a member of the community of man. This is what man sought at the dawn of civilization. It is what we seek today."

-Lyndon Baines Johnson

Table of Contents

Table of Figures

Table of Abbreviations

BERY	Boston Elevated Railway Company
BRA	Boston Redevelopment Authority
BRT	Bus Rapid Transit
CA/T	Central Artery/Tunnel
CCIB	Cambridge Committee on the Inner Belt
CLF	Conservation Law Foundation
EIS	Environmental Impact Statement
FHWA	Federal Highway Administration
FSEIS/R	Final Supplemental Environmental Impact Statement/Report
GSD	Harvard Graduate School of Design
HOLC	Home Owners Loan Corporation
MBTA	Massachusetts Bay Transit Authority
MDPW	Massachusetts Department of Public Works
MIT	Massachusetts Institute of Technology
MTA	Massachusetts Turnpike Authority
NGMLP	National Growth Management Leadership Project
PWA	Public Works Administration
SOS	"Save our Cities"
TVA	Tennessee Valley Authority
WPA	Works Progress Administration

Acknowledgements

The completion of this work would not be possible without my advisor, Dr. Jerome Connor. His support and advice proved invaluable to the production of this paper. Along with Lisa Grebner, Dr. Connor arranged the site visits that permitted me to see construction of the Central Artery firsthand. Such visits were critical to the process of visualizing the future form of the artery.

I must extend gratitude to Professor Frederick P. Salvucci, who graced me with the opportunity to discuss his experiences throughout the long history of the Central Artery/Tunnel project. His dedication to the betterment of life in Boston is vividly clear, and serves as inspiration for myself and other students of the Institute that have had the opportunity to learn from him.

Finally, I would like to thank Robert Caro, whose biography of Robert Moses served as inspiration for this work.

Prologue

The task of maintaining and developing cities has grown increasingly complex. As such, the role of an individual is far more specialized. The role of the master builder – prominent in urban development until the twentieth century – has vanished. In its place, massive teams of policy makers, urban planners, architects and engineers are employed on even a modestly-sized civil project. An individual's level of specialization often grows at the expense of one's breadth of knowledge, and he or she must rely on a large number of other individuals to provide additional expertise. While such increased specialization is crucial in the technologically complex civil projects within today's cities, the creation of optimal designs is fundamentally reliant on the engineer's awareness of the underlying forces driving the project's delivery.

While attending MIT, I had the opportunity to perform several site visits to various portions of the Central Artery/Tunnel Project. The scale of the project is difficult to comprehend, even when one is within a portion of the developed system. As an engineer, my interest was immediately captured by the vast network of bridges and tunnels and I was compelled to study the project further. My preliminary focus involved purely structural aspects of the project, however I grew increasingly interested in the ambitious promises made by the MTA. I wanted to know why this highway was expected to meet traffic volume demands for decades, thereby succeeding where virtually every major urban highway to date has failed.

The resulting study centers on urban planning concepts and highlights social, economic, and political forces that do not commonly penetrate the consciousness of the civil engineer. It could be argued, however, that such forces play a larger role in the determination of a structure's ultimate form than either architect or engineer. The driving forces and ultimate aspirations of the project must be understood and valued by each individual participating in the delivery of the final structure. Only through this mutual understanding can true success of the project be realized.

The dense nature of the modern city results in an environment where small changes to the urban landscape can have major ramifications on numerous aspects of life within the surrounding areas. It is here where builders must be certain that development of any kind does not degrade the quality of life within the city during construction, or during the lifetime of the new structure. I believe that this responsibility rests in part on the engineers who design these new structures. This was the motivation behind the following composition.

I. Introduction

"The city is not a concrete jungle,
it is a human zoo."
-Desmond Morris

Throughout history, cities have been defined in the minds of many as geographical regions with dense human habitation. Indeed, the textbook definition of a city places heavy emphasis on the perspective of population density. Yet the complex urban fabric of American cities has led to their establishment as the fundamental epicenters of society, culture, politics and finance. Urban achievements have historically fueled human civilization, where the close proximity of diverse peoples has promoted progressive thought for millennia. Anthropologist Claude Levi-Strauss has likened cities with symphonies and poems. Strauss identifies a city as the "point where nature and artifice meet." They represent ongoing social and cultural experiments, whose outcomes reveal the intricate dynamics of human nature.

For centuries, cities have developed where geographic advantages exist. Historically, urban areas invariably grew concentrated due to primitive transportation modes, which did not facilitate quick movement over long distances. Even as recently as the eighteenth century, the one hundred mile trip between New York and Philadelphia required two days to complete. Inner city movement primarily involved pedestrian travel, requiring close proximity of work to home. Those who worked in the city typically lived in the city. The resulting development was dense and concentrated within a small geographical area. Streets served as pedestrian promenades and provided open space for recreation and community interaction.

As technological advancements in transportation facilitated faster movement, cities gradually broke free of the constraints that had established and maintained the outer limits of urban development. Horse-drawn and electric streetcars led to the widespread migration of residents to outer regions, labeled "streetcar suburbs" by city planners and anthropologists. The development of these early suburbs released pressure that was building within cities, and allowed for the reduction in

overcrowding within urban neighborhoods. Meanwhile streets and roadways remained largely dominated by those who traveled by foot.

This vivid picture of open, livable cities is a far cry from the urban cores of modern metropolitan areas. Automobiles dominate streets and thoroughfares, which are no longer considered open space for recreation and community development but rather a cold element of city transportation infrastructure. Where streetcars and pedestrians once traveled exist today paved arteries bursting with urban automobile traffic. The cars exist as a major source of urban noise and air pollution, and rob individuals of open space. Busy roads serve as barriers to movement by any mode other than automobile travel. Residents in and around cities continue to rely on these vehicles for movement in and around the downtown centers, despite their damaging effects on the urban fabric.

The American automobile dependency and its effect on downtown areas can be seen clearly in the City of Boston, which for centuries has taken a highly proactive approach to infrastructure development of all kinds. The existing urban landscape of downtown Boston includes a massive steel elevated highway that serves as an immense barrier to physical, social, and economic interaction in the surrounding regions. Aware of its damaging effects to the city fabric, numerous municipal agencies have undertaken a monumental effort to restore the precious land lost to the highway by depressing the artery into an underground passageway, which will continue to serve the urban automobile culture with better access ramps, more lanes, and intelligent highway operation technologies. Politicians and residents alike maintain an optimistic outlook on the potential of the project to improve the city, despite the increasing cost of its delivery. The project focuses on the development of the depressed highway however, and the conceptual and technical design of the underground network has preserved many ideals held by the designers of the elevated highway a half-century before, whose demise was discussed little more than a decade after its opening.

The ongoing delivery of this massive urban project has caught the focus of other major metropolitan areas such as Seattle, where the crumbling Alaska Viaduct poses as detrimental to the surrounding urban landscape as the elevated artery in Boston has. Many city planners have hailed the Central Artery/Tunnel project as an example of the future of urban infrastructure development, and have called for its imitation in countless American cities. Yet the CA/T project, called the "Big Dig" by locals, does not appear to enhance the sustainability of the transportation network. Nor does the future artery promise to alleviate traffic problems that have permeated every region of the downtown area. While efforts have been made to improve and beautify the area immediately above the highway, the widened artery threatens to carry more vehicles into the city, further robbing space from pedestrians and funds from alternative transit modes.

Will the depressed Central Artery solve the human movement problems faced by every city in America? Does the new system provide long-term solutions to urban transportation and trends in traffic growth? The establishment of a legitimate perspective on these quandaries begins with a reflection of urban transit achievements throughout the history of Boston. The history of the automobile must be compared to the rise of other dominant modes of transportation. The story of American automobile infrastructure development throughout the past century reveals several key characteristics that illustrate the potential of future urban roadway development. An objective analysis of the promises made by the agencies involved in the Big Dig reveals further realities of modern highway design paradigms. If highways are not a viable solution to urban transportation problems, other alternative modes must be assessed. Not only must alternative modes promise equivalent levels of comfort, speed and reliability, but their logical implementation into modern cities and suburbs must not violate parameters governing infrastructure financing, development, and use. Several deterring forces must be overcome, and a corresponding strategy must be developed.

Criticism of current paradigms alone is insufficient to cure the incompatibility between modern urban transportation infrastructure and the urban fabric that has sustained cities for centuries. New ideas and strategies must aim for the betterment of services and networks that move humans, but they must also sustain or enhance the quality of life throughout the surrounding regions. Only though a balanced approach to urban development can planners and builders ensure the prosperity and longevity of the social and cultural epicenter that they aim to improve.

II. From Riverboat to Railway: The Rise of Mass Transit in an American City

"Since then on many a car you'll see
A broomstick plain as plain can be;
On every stick there's a witch astride-
The string you see to her leg is tied.
She will do mischief if she can"
-Oliver Wendell Holmes

The settlement of the Trimountaine by John Winthrop and a small group of Puritans represented a reaction to the outbreak of disease within the original settlement in Charlestown, north of the Charles River. On September 17th, 1630, the city of Boston was born under the Court of Assistants, led by William Blackstone. The geography and coastal topography of the area led to immediate success on behalf of settlers in the development of the city. It was learned shortly thereafter however that the Trimountaine Peninsula, known as Mishawmut by Native Americans, did not provide sufficient room for urban expansion and evolution.

Early development quickly covered the spatially inadequate peninsula, which measured only three miles in length and one mile in width. This resulted in the need to create vast amounts of land for future expansion, in contrast to other urban areas where such outward movement could occur naturally. By 1775, all preexisting land on the Shawmut Peninsula had been acquired by individual owners or public entities. Before the city could grow, new land had to be realized.

This realization occurred through the execution of several massive municipal efforts aimed at converting wetlands and waterways into urban real estate. The first of such efforts began in 1804, when the city embarked on planning for the elevation of Mill Pond. Known thereafter as the Mill Pond Plan of 1808, this project involved the relocation of soil from Beacon Hill to the tidal wetlands on the northern shore of the Peninsula, resulting in the creation of 50 acres of land that would later house thirteen city blocks.

The execution and eventual success of the Mill Pond Plan of 1808 represented the inauguration of an era in which the progression of the city was inseparable from the major civil projects that facilitated its growth. The Mill Pond Plan led directly to the construction of the Mill Dam in 1814. In 1858, the city began an unprecedented forty-year project to fill and develop the Back Bay area, increasing the size of Boston by 550 acres. The eastern shoreline was extended three times between 1630 and 1916. To the south, the tidal causeway was greatly expanded to create a permanent link to the mainland. By the close of the 20th century, municipal land-making projects had more than doubled the original size of Trimountaine.

The extensive municipal development in the nineteenth century had a dual effect on the urban transportation paradigm. First, the creation of land in outlying areas resulted in the need for alternative modes of transit, in order to facilitate access to city centers. Additionally, the continued development of Trimountaine during this era helped establish Boston as a continually changing city. Built upon the legendary role of the city in the American Revolution was its role in the revolution of the city itself. Residents and leaders welcomed urban evolution and technological innovation, which affected every aspect of city life, particularly the infrastructure that moved goods and people.

Innovation in public transit in Boston can be traced back to 1631, when Thomas Williams received permission to operate a ferry between Chelsea, Charlestown and Boston from the Court of Assistants. The opening of ferry service in June of 1631 represented the establishment of the first chartered transportation service in the western hemisphere. Additionally, the efforts of the Court of Assistants illustrated the importance of mass transit early in the history of the city. The Winnisimmet Ferry, which remained a family business, maintained continued service for nearly three centuries.

The growth of the urban population and the expansion of city limits led to the need for land-based transportation, which would allow individuals to easily traverse the peninsula. The creation of South Boston resulted in the construction of a network of roads that connected Trimountaine to the mainland, and led to the invasion of the stagecoach. The first public coach service connected Boston and Cambridge by way of the West Boston Bridge in 1793. The stagecoach had limited effectiveness as a mode of mass transit however, due to the relatively low carrying capacity of the vehicle.

The city of Boston was quick to act when technological improvements brought about the omnibus, which was introduced in the early 1820's. This horse-drawn vehicle was longer than the traditional carriage in order to enhance carrying capacity. In contrast to the stagecoach, the new omnibuses made frequent stops along their designated routes. The resulting system delivered the first large-scale, land-based mass transit network in the city, and remained a staple of human movement for 150 years.

Another transportation milestone was met in 1870, when small rail portions were connected to form the first heavy rail link in the country. This freight and passenger connection provided easy rail access from Boston to the industrial hub of Lowell, Massachusetts to the North. Popularity of the new device, which was subsequently implemented nationwide, allowed the railroads to develop as a primary means of intercity and long distance travel. Goods and passengers were moved efficiently into and out of cities along the cast iron rails that continued to envelop both city and countryside. The widespread use of the railroad as a means of long distance travel gave rise to innovations that would prove to enhance travel within cities themselves.

Speed and comfort on the omnibus were enhanced through the invention and implementation of railway cars on city streets in 1856. Initial privatization of the light-rail omnibus led to the formation of more than twenty independent horsecar companies. Unregulated fares and duplicated services led to the union of all rail lines under the West End Consolidation Act of 1887. The reorganized network was placed under the control of the West End Street Railway. The consolidated system became one of the largest street railway operations in the United States during that period. By 1888, Boston had become home to one of the most effective mass transit systems in the world. Its greatest achievement in mass transit development however, had not yet been realized.

The horse-drawn streetcar industry faced fierce competition in many American cities in the 1880's from a precarious new vehicle that was propelled along a designated path by a mechanical cable embedded in the roadway. The cable car, which was used extensively in such cities as Kansas City, Los Angeles, New York City, and the nation's capitol, was perceived by many as the future in urban mass transit. Faced with the reality of associated installation costs, difficult maintenance, and vulnerability to harsh winter weather, the West End Street Rail Company chose not to pursue the implementation of cable cars. In order to keep pace with advances in other cities, which were witnessing the successful phase-out of animal-drawn vehicles, the West End Railway sent delegates to Richmond, Virginia to investigate the feasibility of railway electrification.

On January 1, 1889 the West End Railway began service on the first large-scale electric railway system on the continent. The immediate success of the electrified network prompted other American cities to follow suit, and led to the abrupt decline of the cable car. Development of the electric railway system in Boston was accelerated by the investment of bankers and land speculators, who witnessed the high demand for land within the vicinity of a new line. By the turn of the 20th century, Boston had more streetcar track per square mile of urban land than any other state in the union. Control of the extensive system was turned over to the Bay State Railway Company, which oversaw the development of an electric rail network that connected Nashua, New Hampshire to Newport, Rhode Island. The city maintained its dominance in the field of mass transit through the

creation of the Massachusetts Bay Transit Authority, which was the first combined regional transportation planning and operating agency in the United States.

The city of Boston and the West End Railway Company were quick to act on new, innovative transportation technologies. The elimination of obsolete vehicles however did not occur expeditiously. In 1889, city residents witnessed the convergence of pedestrians, conventional stagecoaches, horse-drawn omnibuses, and electric streetcars on narrow downtown streets. This effect resulted in chaos and congestion unlike any in the history of the city.

Acting in response to public dissatisfaction, the Governor of Massachusetts organized the Rapid Transit Commission in 1892. The primary objective of the Governor's commission involved the investigation of solutions to the traffic problems, including a feasibility assessment of elevated and underground rail systems. In 1894, the commission submitted a recommendation that called for the construction of four elevated railway lines through greater Boston, supplemented by a tunnel under Tremont Street for exclusive use by streetcars. The proposal was approved in its entirety by the Massachusetts State Legislature, which organized the privately owned Boston Elevated Railway Company and the state-run Transit Commission.

Following the reorganization of governing agencies, Boston became the first city in America to move electric mass transit underground. On September 1, 1897 the Tremont Street Subway began operation between the Public Garden and Park Street Station. This landmark achievement was complemented by more than four decades of aggressive infrastructure development and technological innovation, which led to the nation's first sub-aqueous mass transit tunnel and the invention of the articulated streetcar.

In 1930, Boston residents could look back on a mass transit system that was, at many times, the most effective and technologically advanced in the nation; one that had evolved over a period that was longer than American Independence. Early emphasis on mass transit in and around the city had led to the birth of the first chartered transportation service in the nation. Technological foresight in the 1880's had led to the implementation of the first large-scale electric railway system in the western hemisphere. Success of this electrified network resulted in the first combined regional transportation planning and operating agency in the country. The explosion of mass transit use required the construction of the nation's first electric subway system. Finally, expansion of this system had led to the implementation of the first sub-aqueous mass transit tunnel on the continent, and the invention of the articulated streetcar. The growth and evolution of a system dedicated to efficiently moving the masses in Boston had persisted for three centuries, and appeared to be gaining momentum. With the regional reorganization of governing bodies, rail companies were increasing their scope to include high speed rail. In the 1920's, a proposal was publicized that depicted the connection of North and South Stations with a one-mile length of heavy rail that would eliminate the

only remaining rail gap between Portland, Maine and New York City. The proposed corridor for the rail connection was drawn through downtown Boston, passing such sites as the Bulfinch Triangle, Haymarket Square, Quincy Market, and Chinatown. City officials and the public at large thereafter referred to this corridor as the "Central Artery".

The explosive growth of mass transit did not persist. Modernized railway and streetcar systems entered into a period of stagnation. Transit agencies abruptly found their development plans – such as the corridor rail link proposal – on the financial chopping block. Governmental funding and subsidies for such projects became scarce. It appeared as if the focus of state and federal powers on transportation had blurred. Their focus on transportation however was sharper than ever. Only now, they focused on the automobile.

III. The Invasion of the Automobile

"History is more or less bunk. It's tradition. We don't want tradition. We want to live in the present and the only history that is worth a tinker's damn is the history we made today."
-Henry Ford

In the closing years of the first decade in the twentieth century, city residents witnessed the introduction of the automobile to city streets. Almost immediately, urban reformers began looking beyond the awkward appearance of this new vehicle to see an object that could single-handedly reshape life within American cities. The widespread acceptance of the automobile led to its integration into the fundamental aspects of American life.

The rise of the automobile was accompanied by a drastic decline in the growth and development of railroads and urban mass transit. The convergence of cars on urban thoroughfares led to the displacement of electric streetcars and omnibuses, the veterans of the road in the early twentieth century. As personal vehicles became increasingly affordable, ridership on rail networks dropped. Reduced demand resulted in reduced service, which further promoted the widespread dependence on the automobile.

While technological advantages are generally cited for the dominance of the automobile over rail-based alternatives, a number of external factors directly contributed to the succession of the personal vehicle. The shift in urban priorities from rail to road was also driven by the involvement of corporate and governmental entities in the financing of transportation infrastructure development in America. The overall level of success experienced by these entities was compounded by the tarnished reputation of the heavy rail industry, which for decades had been owned and operated by several of the nation's most infamous robber barons.

The City Beautiful

It was in the year 1893 when, at the World's Columbian Exposition, the great American frontier was declared closed by historian Frederick Jackson Turner. The motivation and spirit that had guided Americans to explore the west had to be diverted to a new arena. For many, their focus shifted to the overcrowded city.

Throughout time, cities such as Boston could expand outwards only to the limits set by the transportation system within. As vehicles and transit networks grew, so too did the size of the city. Electrified rail had allowed cities such as Boston to encompass nearby pockets of dense residential housing called "streetcar suburbs". Advances in nineteenth century technology had not allowed the expansion of city limits to keep pace with rising population however, which had led to critical overcrowding in many urban areas. Dense residential tenements had consumed many parks and open spaces within the core of many American cities by the beginning of the twentieth century.

It was at the World's Columbian Exhibition that an alternative to conventional urban development first surfaced. The "White City" was a model for future urban development that showed parks and public spaces as essential parts of downtown metropolitan areas. A new urban design paradigm immediately emerged that emphasized city beautification projects, and theorized that such projects could rejuvenate the quality of life in dense areas. The new paradigm was widely accepted, and gave birth to the "City Beautiful" movement.

Inspiration spread from the "White City" at the exhibition in Chicago to cities across the nation. Downtown civil improvement projects began emphasizing aesthetic enhancements. Public demand for promenades, vistas, and grand imperial gardens surged. Cities turned to a new breed of urban architects called "City Beautiful Designers" such as Daniel Burnham and Frederick Law Olmstead, Jr. for innovative new designs for open public spaces. Born from the movement was a need for drama in urban development. Under the 1909 improvement plan for Chicago, Burnham's credo became "Make no little plans; they have no magic to stir man's blood."

In tune with its historically bold approach to city improvements and municipal projects, Boston had embarked on such projects as early as 1879, when Frederick Law Olmstead, Jr. submitted a proposal for the development of a continuous park system throughout the city that would include more than 2,000 acres of open public space. With the success of the Emerald Necklace in Boston, cities such as New York, Chicago, and Washington, D.C. embarked on large-scale city beautification projects.

The public land and open space came at a price, however. Homes, businesses and industries had to be relocated in order to provide space for such beautification projects. The dense urban core had to be reorganized in order to accommodate the newfound openness.

Some relief came from the introduction of the electric elevator in 1880, which allowed buildings to reach heights that were previously unreasonable. But if the park lands and open spaces were to successfully coexist with a growing city, that city would have to continue growing outward. And if residents were going to venture out to land on the outskirts of the city, they would need a vehicle that could take them there.

A Farm Boy from Michigan and a Motorcar for the Masses

The vehicle that facilitated the unbounded expansion of the city and fueled the City Beautiful movement received its first patent on January 29, 1886 in Germany. Imitations of the self-propelled motorcar quickly appeared in the United States, however they were too expensive and fragile for widespread use. Although some automobiles had appeared on city streets by the turn of the twentieth century, they served as luxury rather than necessity, as most city residents continued to depend on electric streetcar for day-to-day travel.

The role of the automobile in American life began to change in 1908 when Henry Ford, a young man from rural Michigan, began production on the first fleet of affordable automobiles on the continent. By 1913, his robust, inexpensive line of Model T's was rolling off the assembly line at the rate of one every three minutes. By 1913, an individual could purchase a Model T for $425, half of what one would have paid five years prior. And while Henry Ford spent much of his life avoiding American cities, his vehicles did not.

As the barrage of motorcars hit the streets of America, state and federal transportation funds were almost instantaneously diverted from enhancements of light rail and interurbans to the development of infrastructure for the automobile. From big cities to small towns, sidewalks were narrowed to accommodate wider streets. This conversion of pedestrian space to automobile space immediately became the textbook solution to roadway congestion. In the cities, parking lots and parking decks replaced countless buildings.

Through the two decades immediately following the opening of Ford's first manufacturing plant in northern Michigan, the automobile took hold and grew fast. It was during the economic boom in the 1920's that the motorcar finally got its grip on society. As urban planners and city developers continued to emphasize infrastructure for the automobile, the consumption of automobiles surged. In 1929, the nation found its roads accommodating 26 million cars – more than one for every household.

The introduction of Ford's creation into American society could not have come at a more ideal time for the young entrepeneur. With the nation's great frontier declared closed and the focus of many shifting to the cities, reformers saw the automobile as the vessel through which the pressure of urban overcrowding could be released. The daily commute of the American worker rose from

several blocks to many miles as the rail-free motorcar allowed developers to push into the undeveloped land beyond streetcar suburbs.

As residents pushed out of the urban downtown areas, cities proceeded with urban renewal projects. Inspired by the widespread City Beautiful movement, cities began redeveloping their crowded cores and retrofitted them with promenades, vistas and elegant parks adorned with public gardens and manmade waterways. Soon, roads themselves became part of the City Beautiful movement, which celebrated the long-awaited liberation from animal-powered vehicles. The elimination of horses from city streets meant the dissipation of inherent urban odors resulting from decaying animal waste and carcasses.

The coinciding emergence of the automobile with the wildly popular urban beautification movement led to the fusion of these originally independent phenomena. Soon, the advancement of the automobile was inseparable from the beautification of inner cities. This occurrence was noted by historian James J. Flink, who called this pre-World War I era Consciousness I. Flink's label on this era reflected the newfound associations made by the American public, whose perspectives on the city beautiful movement incorporated the implementation of automobile infrastructure.

As City Beautiful Designers went to work on urban streets, European-style boulevards and thoroughfares began to appear. Tree-lined streets were designed to be appealing to the motorists, and facilitate leisurely drives around and outside the city. As driving developed as a recreational activity, transportation engineers began to push pavement past the suburbs toward parks and forests. These new, pedestrian-free arteries gained widespread popularity with motorists, and evolved quickly into the modern parkway.

The coincidence of the automobile with the desire for urban expansion had allowed the awkward, clumsy vehicle to survive through the second decade of the twentieth century. Economic prosperity had allowed the automobile to gain widespread acceptance in the 1920's, leading to large-scale infrastructure development within and between cities, and the establishment of driving as a recreational activity for the masses. While this prosperity had allowed the car culture to take shape, its role in society was solidified at a time when the nation's economy was at its weakest point in the twentieth century.

Automobile Prosperity During the Depression

Progress and prosperity came to a halt following the market crash of 1929, which sent the nation spiraling into the Great Depression. As homelessness and joblessness rose, the purchasing power of the public at large shriveled. Major commercial establishments throughout the country closed their door forever as a result of the depression.

This was not the case for the auto industry. Between 1929 and 1937, the number of cars increased by 3 million, until one half of Americans owned automobiles. One quarter of these Americans remained on installment plans throughout the depression, making regular payments to their auto dealers. It seemed that even in the hardest of times, Americans refused to give up their cars.

Development of automobile infrastructure also persisted throughout the depression. The pace of road construction in America continued to accelerate. Parkways from suburban, rural, and undeveloped lands carved wide concrete paths to cities, where they were increasingly greeted by long-span bridges such as the Triborough in New York and the Bay Bridge in San Francisco.

By the decade's end, more than 30 million Americans had registered vehicles. As the pace of road and highway development quickened, light and heavy rail continued to stagnate. With little expansion occurring to the rail network in urban areas despite continued urban outward movement, streetcar service no longer reached the homes of most Americans. As service declined, so too did ridership. Citizens continued to spend the money they had – and in many cases money they did not have – on automobiles.

Cars dominated travel between cities as well. Travelers traded in their train tickets for automobiles, as the ongoing development of America's parkways and highways continued. This development quickly caught the eyes of the freight industries, which had historically relied on heavy rail to transport such goods as agricultural produce to market. Auto makers responded to the demands of industry by turning out motorized trucks that would ultimately rob the railroads of their core competency.

The United States auto industry had emerged from the Great Depression bigger and more deeply rooted in American culture than when it was first forced into the era that brought widespread unemployment and poverty. While many features of the urban landscape fell into stagnation and disrepair, streets, highways, and parkways were constructed at unprecedented speed and size. As auto makers experienced widespread prosperity however, paucity descended on other transportation sectors.

In the same year as the market crash, more than 14 billion trips were made on the streetcar systems in America. By the close of the 1930's, ridership had been cut by half. Most cities were in the process of dismantling street-level light rail infrastructure in an effort to provide added travel lanes for motorcars. The disappearance of city transit in San Antonio in 1933 represented the first fall of a big city system. Many other urban lines, particularly in the southern United States, fell as well by the end of the decade. The disappearance of streetcar service in cities and suburbs left most residents with little recourse. Those who did not own a motorcar had to buy one.

Transit between cities suffered during the depression as well. Growing highways soon created a transportation network that dwarfed heavy rail. Passenger service on heavy rail lines failed to compete, and commuter service into and around cities began to disappear. Expanded highway infrastructure took its toll on the interurban system as well. Service on the staple of long-distance electrified transit was derailed as the national network fell into disrepair. As the network of intercity rail reduced its service, travelers turned to the motorcar to get them to their destination.

Major intercity railroad lines, which had historically relied on freight transport as a primary service, were devastated by the advent of the truck. As industry converted from rail to freight transport, railroads were deprived of revenue. The loss of such revenue led to further failures to maintain an extensive rail network. As towns and cities outgrew the static network of heavy rail in the nation, industry had no alternative but to move toward truck transport.

Searching for Answers

By the end of the first three decades of the twentieth century, widespread use of electric mass transit had been replaced by the automobile. The once superior network of light and heavy rail within and between cities in America had halted its expansion at a time when urban and suburban expansion was extreme. The role once filled by rail was now increasingly filled by roads and highways, which were appearing in a flurry of construction, even when the public was experiencing poverty unlike what most had seen in their lives.

How had this transformation taken place? Why was it so swift? How had the auto industry continued to grow at a time when most consumers could not afford to buy their products? To many, the answers may have rested in the technological superiority of the automobile. Yet European nations had maintained emphasis on an extensive rail network through this period. How had Europe developed so differently than America?

The answer to this question has numerous layers. While technological superiority can be cited as a powerful driving force behind the acceptance of the automobile, corporate involvement and governmental policy-making played a large role in not only advancing travel by road, but also in suppressing travel by rail.

New Wheels and the New Deal

"America was the only nation in the world that ever went to the poor house in an automobile," said Will Rogers about the nation's habits during the depression. As nationwide infrastructure networks sank into stagnation and disrepair, citizens found the continental web of car-carrying concrete growing furiously. But it was not the auto industry that paid for this growth. A distinct new trend in government spending would aid in the development of this infrastructure. This

shift in federal involvement in transportation represents the first major cause of the widespread acceptance of the automobile.

Faced with the results of the market crash of 1929, United States President Franklin Delano Roosevelt was left with the task of reviving the financial state of the nation. Known for his comfort with progressive ideals, Roosevelt set to work creating a plan to restore the prosperity of the 1920's. His efforts led to a series of ambitious programs, lumped together under a common effort known as the "New Deal".

While New Deal programs aimed at many sources of poverty, the major overriding theme of Roosevelt's first 100 days in office involved the reduction of unemployment throughout the country. One year after his election to office, Roosevelt appropriated $3,000,000,000 for the establishment of the emergency Public Works Administration.

The mission of this administration was two-fold. First, the PWA was to initiate and oversee the development of massive public works projects across the United States. More important than the projects however was the jobs that they created. This second focus of the administration led to the employment of more than 2 million jobless Americans.

The Public Works Administration and its successor, the Works Progress Administration placed heavy emphasis on the creation of jobs throughout the country, and sought labor-intensive projects. Through the PWA, WPA and other New Deal administrations, American laborers created dams, parks, and infrastructure for national forests. Most of the employed citizens however were sent to work on America's highways.

Between 1930 and 1940, the road mileage in America – which had been growing for more than 300 years– had doubled to nearly 1.4 million miles. The WPA had given birth to such regional entities as the Tennessee Valley Authority, known for its aggressive approach to dam construction. More than three quarters of the New Deal's expenditures however went to the construction of roads. Funding for highways and parkways dwarfed investment in every other mode of transportation, including light and heavy rail, which at that time represented the stiffest competition for the automobile.

The reason for such biased investment in automobile infrastructure rested in the core mission of the New Deal – to create jobs. Roosevelt and his administration emphasized the development of the most labor-intensive public works projects. On this list, roads and highways came in first. Priority was placed on infrastructure for the automobile not because of its technological superiority, but rather because of the labor-intensiveness involved in construction.

It was through such federal policy that the roads of America gained priority over rail. The New Deal had led to the creation of Administrations that stressed the construction of roads. This construction had led to the creation of jobs for the American people. Once these roads were

complete, they would carry Americans to the sites of new highway construction. And so the cycle continued throughout the depression. While Roosevelt's program had provided employment to the public at large, it had also led to the establishment of the automobile as the staple of American Travel.

While Roosevelt's New Deal program ushered in a period of increased employment across the country, it was the entrance of the United States into World War II that welcomed in a new era of prosperity. In this post-depression America, few accommodations could be made for railroad and streetcars, which received minimal support throughout the period of financial decline. The very network of roads that Roosevelt's programs had built had helped push the streetcar into obsolescence.

The Car as a Part of American Culture

While governmental policy had helped shape highways as an inseparable part of America, the mentality of the public at large had begun to associate the automobile with many aspects of the American Dream. With the advent of the automobile came independence from rail and overhead wire. Before the motorcar, most travelers were passengers. For many, the car represented the first vehicle that they could operate firsthand. With this newfound ability to control motion came an extreme sense of liberation, one that would push travelers to travel more than they ever had before. This sense of liberation, control and freedom quickly spread through popular culture, influencing music and films. Americans searched for new forms of media through which to express their appreciation of the motorcar. Meanwhile, their sentiments and perspectives were further fueled by the automobile industry. As the widespread use of the automobile continued to permeate society, fascination and awe gave way to love and admiration. "America's love affair with the automobile" had begun.

The age of the streetcar had represented an era during which virtually every traveler was a passenger. An individual on the move was at the mercy of the vehicle's agenda. Travel plans were based on the predetermined movement and direction of rail-based vehicles. As the cities in America continued to expand beyond the reach of urban light rail, freedom to travel by rail grew more limited.

The introduction of Henry Ford's motorcar into American society represented the birth of an era during which the traveler could set his own course. To drive an automobile was to adventure into the unknown. Drivers found freedom on the road that could not be provided by the rail service in America. The motorcar quickly became a symbol of independence and suburban adventure.

As the automobile grew as an icon of freedom, adventure and prosperity, Americans began to associate streetcar travel with restraint and mundane day-to-day travel. The perspectives of society were compounded by public figures in the auto industry that confirmed the inferiority of mass transit. Auto makers released statements associating mass transit not only with individual poverty, but with

massive failures in urban planning in general. This sentiment was repeatedly echoed by advocates of the automobile such as urban planner John Nolen, who continually noted that "Subways are evidence of an unsuccessfully planned city."

As time rolled on throughout the twentieth century, the automobile grew as an icon of speed and freedom, even as congestion in cities and on highways continued to worsen. The legacy of the automobile quickly surpassed the reality of the vehicle. The American devotion to the motorcar remained strong, however. As land was taken from sidewalks and other pedestrian and streetcar rights-of-way in the first half of the century, little resistance was encountered. Through the newfound American mentality, roads and parking lots had gained priority in the city over even the most sacred parcels, including parks and civic centers.

The introduction of the automobile into society had led to a transformation of the mentality of America. The freedom and control experienced by the driver of a motorcar had let to the establishment of the vehicle as an icon for personal adventure into the unknown. This mentality was fueled by public officials, urban developers, the media, and the auto industry, which continually validated the association of the car with freedom, independence and prosperity; and rail-based transit with restraint and poverty. This newfound devotion to the motorcar caused many Americans to shift support and patronage from mass transit to automobiles. The mentality resulted in a public willingness to relinquish vast tracts of land to the automobile, both in and out of the city. As a result, the auto-centric mentality of America in the early half of the twentieth century allowed automobile infrastructure to expand, and facilitated the establishment of the motorcar as a part of daily life throughout the country.

Hidden Agendas

While governmental policy and pro-auto mentality in America in the 1920's and 1930's were crucial in the solidification of the role of the motorcar in society, there existed a third factor that not only further ensured the continued prosperity of the auto industry, but also the decline of its competitors. As the auto-making industries bloomed in America, so too did supporting industries, such as steel, tire, and oil companies. These companies used a series of public and covert techniques to both ensure the permanence of their industry and facilitate the downfall of streetcars and railroads.

The public image of auto makers after 1910 was positive. Seen as companies in a new industry that provided growing numbers of jobs to skilled and unskilled laborers alike, Ford and General Motors quickly gained widespread public acceptance. The story of Henry Ford, a small-town country boy who invested his own savings into the first Ford plant in Michigan, provided citizens with the description of a man that they could connect with. As the factories grew, so did the small towns around them. The rise of the auto industry became synonymous with growth and

prosperity in small towns and cities, and the publicized leaders of firms such as Henry Ford and the presidents of General Motors and Studebaker were perceived as heroes to many.

Every hero needs a villain, and the owners of the railroad filled that role well. The railroad industry rose to prosperity during the previous century under leaders who prospered quickly through the use of manipulative Wall Street speculation and corporate coups. Many lines throughout the nation were owned and operated by some of the most infamous robber barons of the time, including Cornelius Vanderbilt, Jay Gould and Russell Sage. These individuals represented companies that repeatedly clashed with state and federal agencies in a flurry of anti-trust cases. Extortion and monopolization were overriding themes in the railroad business following the end of the Civil War. While the public at large continued to patronize the railroad freight and passenger services, approval of such barons and tycoons diminished. Attempts by railroad companies to gain illegitimate power had tarnished the image of the industry, and widespread disapproval of such corporate moves could be seen in public officials and politicians in the federal government. The poor public perception of railroad companies soon spread to the streetcar business, when tycoons of heavy rail began appropriating inner city transit lines. As streetcar patronage began to decline following the introduction of the motor car, cities and municipalities were left with the choice of taking over transit operations or allowing the service to halt entirely. Auto makers began persuading public officials to scrap streetcar service, and relinquish streetcar rights-of-way to automobiles.

The actions of the automobile industry grew more aggressive in 1936 when a handful of powerful American firms including General Motors, Firestone, Standard Oil, Mack Truck and Phillips Petroleum united in a joint venture called National City Lines. Over the two decades that followed, National City Lines would buy out more than 100 streetcar lines in over forty-five cities across the country. Once purchased, each line was scrapped and replaced with motorized bus transit. The omnibus service in Manhattan was purchased by General Motors who, in 1935, eliminated all rail from the streets of New York City and gave the associated right of way to the automobile.

By the 1940's, the automobile had overtaken America's city streets with a level of totality never before witnessed. Aided by changes in governmental policy and American mentality as well as the aftermath of a series of attacks on the streetcar and railroad industry, automobile manufacturers had succeeded in ensuring a place for their product in daily life throughout the country. Motorcars were quickly becoming the only way to travel, and Americans were responding to this change by buying automobiles in massive numbers. By the end of the depression, the results of this cultural shift had begun to emerge. What had replaced the streetcar-congested urban cores of 1890's America were the automobile-congested urban cores of the 1940's. Leisurely trips along parkways in the summer months had been replaced by rush hour traffic jams. The furious road-building efforts of the depression had succeeded in their mission to create jobs, and resulted in expanded automobile

infrastructure that had in turn enticed more Americans to buy cars. The end of the depression had not meant the end of fierce highway development. The intricate network of roads and highways that had resulted from Roosevelt's New Deal programs had left the country reliant on automobile infrastructure. As quickly as roads could be built, they were flooded with cars. With the vast majority of passengers and goods moving by car and truck, America depended on the movement of vehicles. It had no choice but to keep building.

IV. Aggressive Highways

"Speed is the cry of our era, and greater speed one of the goals of tomorrow"
-Norman Bel Geddes

With the deployment of atomic weapons over Hiroshima and Nagasaki, the Second World War drew to a close, and the automobile industry once again exploded in a fury of post-war prosperity. As fighters returned from the front, they returned with ambitions to realize the American dream. Guaranteed housing loans from the GI Bill of Rights, veterans fueled the suburban explosion of the late 1940's. As more and more individuals moved to the vast expanses of the suburbs, the demand for roads and highways continued to increase. The response from Washington was the intensification of a highway building policy that first emerged in the midst of World War II. Before long, the aggressive highway mentality had bled down through federal agencies. As "highway fever" began consuming state and local officials, roadways of unprecedented size and scope were proposed and, in many cases, constructed. If roads were considered a priority before, they were considered sacred during the 1940's. As highway plans grew more ambitious however, municipal groups grew more wary of the effects of highway development in cities, and the public began recognizing patterns in the buildings selected for demolition. By the close of the 1950's, highways would have a new reputation despite the untainted image of the automobile itself.

First Glimpses of the Interstate

Officials in Washington exuded concern about insufficiencies in post-war infrastructure long before the end of World War II. Three years before the United States resorted to atomic weapons over Japan, the National Resources Planning Board released a lengthy report detailing "a modern interregional highway system and urban express routes to accommodate the automobile of the future..." Two years later, congress enacted the Federal-Aid Highway Act, which called for the

creation of a National System of Interstate Highways. Plans for this network of roads were a far cry from the well-traveled interstates of today. Operating from a limited budget, the program primarily called for the widening of existing roads throughout the country. The most ambitious part of the initial project involved the elimination of limited access and toll roads from the system. While the enacted plan inspired cities throughout the nation to develop their own system of modern highways, it had limited effectiveness in actually linking states.

While the Federal-Aid Highway Act had little effect on many of the nation's cities, it foreshadowed a Massachusetts program that added a new chapter to Boston's History, which spoke of ambition, innovation, conflict, and compromise; and permanently reshaped the urban landscape. As the city of Boston had done many times before throughout its history, it experimented with the massive development of modern infrastructure.

"Highway Fever" Spreads to Massachusetts

In Boston, traffic problems developed during the opening years of the automobile era. By 1925, state legislature committees were releasing reports and proposals aimed at dealing with the "intolerable conditions" developing on city streets. While the committee made many proposals, most focused around the development of a major north-south thoroughfare through the city that would accommodate the damaging number of automobiles owned by one out of every five residents.

Automobile infrastructure development projects ushered in by the federal government during the depression and World War II gave priority to rural highway systems. For this reason, little funding could be found to support the development of these thoroughfares. In their place, the city engaged in the act of widening major downtown streets such as North Washington Street, which crossed the most heavily traveled bridge north of town and provided access by commuters to downtown areas. While the widening of such roads provided short term relief, traffic problems continued to grow within the city, and public officials and government agencies were soon on the task of upgrading city infrastructure.

In 1948, the Massachusetts Department of Public Works released a comprehensive municipal works plan that, if implemented, would result in the creation of many miles of urban highway in metropolitan Boston. The plan was composed of two major highway projects. The first project called for the creation of a highway connecting the financial core of the city with the suburban outskirts to the north and the south. In order to do this, planners proposed the creation of an artery that ran through what was once the center of Trimountaine, and involved cutting a swath through such areas as the Bulfinch Triangle, Haymarket Square, Quincy Market, and Chinatown. Planners had resurrected the proposal for the rapid transit connection between North and South

Stations, and as a reflection of cultural changes over the past 20 years, had replaced rail with road in the design but kept the name. The proposed highway was named the Central Artery.

The second major project within the comprehensive plan called for the creation of an Inner Belt Expressway. Emerging from proposed expressways north of the Charles River, the planned Beltway was directed through Cambridge, through Boston's Back Bay toward the South End, where it would reconnect with the proposed Central Artery. Little came of the plan in the 1940's, and the proposals released by the Massachusetts Department of Public Works sank into the shadows. The story of the Central Artery and Inner Belt in Boston was far from over, however.

The Eisenhower Interstate System

Bold and ambitious plans leaped from the drawing boards of Washington and every state in the nation. Highway construction plans grew bigger and broader through the 1940's and 1950's. Yet inexperience with such massive infrastructure development had put a halt to the realization of countless individual highway projects. While activity in the nation's capitol had inspired the widespread design of highways between 1940 and 1950, few had been realized. Boston's massive highway building campaign had begun to fade after its proposals went public. Throughout the country, only five hundred miles of highways existed within cities. Cities were still connected with a network of limited access highways and toll roads.

The state of American highways would change forever in the year of President Dwight D. Eisenhower' reelection. On the 29th of June, 1956, Eisenhower approved plans for "the greatest peacetime public works project in the history of the world." His project involved the creation of more than forty-one thousand miles of road across the continental United States, uniting every town and city with one vast concrete web.

While the system boasted a network of public-access freeways, the Interstate Program fell under the guise of National Defense. With the proposal for Eisenhower's system came the promise that its total completion would ensure the safe evacuation of every city in the nation in the event of a nuclear attack. As the atomic era moved forward, the public grew more fearful of nuclear war. Eisenhower had identified this fear as a potentially useful tool, and used this tool to sell his roads. According to the original mission of the roads, the Eisenhower National System of Interstate Defense Highways meant protection from Communist Missiles. Its effect on American Car Culture, according to the plan, was secondary.

Eisenhower had succeeded in fulfilling the prophecy put forth by the Federal-Aid Highway Act more than a decade before. His massive civil works project was organized under a brilliant organizational and financial plan. Instead of receiving traditional federal funds as the National System had fourteen years prior, Eisenhower's Interstate system was funded through a tax on

automobile petroleum throughout the country. Absent from annual federal spending budgets, his gas tax system would supply $50,000,000,000 to the project every year. The President's now-rich Federal Highway Administration went right to work on spending their budget.

To cities, Eisenhower's plan meant cheap money for development. The new program provided massive subsidies for urban highway development. The prospect of "ten cent dollars" inspired cities to support the program by planning highways. For every dollar spent by city and state on urban highways, the Federal Highway Administration would refund all but ten cents. Cities leapt at the opportunity to develop such highly subsidized infrastructure. Cities began pulling ancient plans out of their archives that had been deemed too costly to be considered. Highway proposals became "pork barrel" projects, largely undertaken in order to bring federal money and construction jobs to a specific state or locale. Politics and municipal undertakings grew intertwined; the intention and purpose of the new civil superstructures became only a portion of the underlying forces that shaped the urban landscape. In Massachusetts, the state Department of Public Works brushed the dust off of their plans for a comprehensive urban highway development system and prepared them for federal approval. Before the submission was made however, the DPW had to decide exactly where the new highways would go.

How Cities Decided Where Highways Would Go

America did see many successful highway development plans during the 1940s. Cities such as New York City and Portland, Oregon had succeeded in developing massive new highways along city perimeters. As the decade wore on, urban highway development grew more aggressive. The demolition of individual houses gave way to the demolition of entire neighborhoods and communities, as was seen with the Cross Bronx Expressway in New York City. Trends began to surface in the demographics of residents housed in the neighborhoods to be demolished. In order to observe these trends in their entirety however, one had to look back to the era of the depression.

As America continued to glide helplessly into the depths of the Great Depression, homeowners became increasingly unable to meet mortgage payments. By 1932, banks across the country began foreclosing on thousands of homes each day. Acting quickly, President Roosevelt inaugurated the Home Owners Loan Corporation in 1933. The mission of this new government-financed entity was to oversee the refinancing of thousands of homes across America, in an effort to reduce foreclosures. Refinancing of American homes was done through mortgage loans issued through local branches of regional banks. Naturally, each loan carried with it an element of risk on behalf of the lender.

In a move to statistically enhance the odds of repayment, the Home Owners Loan Corporation began an effort to illustrate regions of elevated fiduciary risk within urban areas of

America. Documentation on property risk and value was maintained in the form of maps, encompassing high-risk regions with bright lines and annotations, giving birth to the infamous act of "redlining". In many cases, the HOLC concluded that any urban area with non-Caucasian demographics was a zone of high fiduciary risk. Because of redlining practices, government support to homeowners lost uniformity. These redlined neighborhoods – lacking in the government subsidies awarded to most suburban communities – experienced high rates of foreclosures throughout the depression, and found little protection under New Deal Programs. In an ironic twist, studies since the depression have shown that loan repayment rates were highest in areas that had been redlined. Nevertheless, as residents in dense urban neighborhoods were evicted from their homes, vacancies in these areas rose. Land owners became continually unable to afford repairs and maintenance to buildings in which few people could afford to live. As a result, buildings in these redlined areas sank into disrepair.

The act of redlining was intended to highlight areas of urban poverty and financial delinquency. The overgeneralization of criteria for high-risk areas led to the redlining of neighborhoods containing residents that were in fact financially equal to those found in the suburbs, albeit more ethnically diverse. The result of such redlining however was the impoverishment of these neighborhoods – fulfilling the redlining prophecy of Roosevelt's Home Owners Loan Corporation.

The neighborhoods made decadent by Roosevelt's homeowner's assistance programs were considered by many in the urban development community to be an aesthetic blight in the city. As the City Beautiful movement evolved into the urban renewal movement, these neighborhoods were denoted as "slums". With urban renewal came the process of "slum clearance", through which vast neighborhoods were labeled as slums. Their occupants evicted, these buildings were systematically razed in order to provide space for new municipal structures, including housing projects, open space, and highways.

Master builder Robert Moses repeatedly defended his approach to highway building through blighted areas. "You can draw any kind of picture you like on a clean slate and indulge your every whim in the wilderness and lay out a New Delhi, Canberra or Brasilia, but when you operate in an overbuilt metropolis you have to hack your way with a meat cleaver." And hack he did. The meat cleaver wielded by such builders across the country had an evident bias. More than two-thirds of the buildings that went under the knife in the middle of the twentieth century were historic buildings or buildings occupied by minority residents. By the end of the urban renewal era, government programs would be responsible for destroying 300,000 more households than were built to replace the "slums".

The combined failure to generate accurate criteria for slum declaration and the inability on behalf of the city to find new homes for displaced residents led to the failure of slum clearance. While the program succeeded in clearing large parcels of land for future city development, it had no success in reducing or eliminating urban regions that fell into their classification of "slums". As neighborhoods made destitute by urban zoning practices were demolished, impoverished residents sought shelter in other areas in the city. The dramatic influx of poor residents into new neighborhoods quickly led to the development of new slums. Instead of being eliminated or improved, these redlined regions were repeatedly shifted throughout the city, allowing developers to raze new tracts of land for housing projects and highways.

This "slum shifting" effect was observed in Boston during the city's urban renewal period. Between 1920 and 1990, more than one-quarter of the buildings in the metropolitan Boston region had fallen victim to the urban renewal machine. While many buildings were replaced by large-scale housing projects, most were cleared for highways.

Over time, many citizens and municipal groups began recognizing the patterns of redlining and slum clearance, and publicized the racial- and income-based biases in highway development. As such information was brought to the public, the image of highways began to shift from vessels of freedom and liberation to community doomsday devices. By 1960, urban highway development had grown more difficult. As builders planned, residents resisted. In many cases, only a few vocal opponents to a highway plan could be enough to sway public opinion away from approval of its delivery.

In the case of Boston's aggressive highway development, there was much opposition. However, it was one man in particular that acted as the voice of the opposition. When the Massachusetts Department of Public Works resurrected the inner belt proposal, many neighborhoods found themselves back under the meat cleaver that Moses spoke of. Residents and neighborhood committees attempted to voice their opposition to the plan, but received little response from city and state officials. In the end, it was a civil engineer from MIT that would play the biggest role in the organization of resistance to the second Inner Belt proposal, and his efforts would fuel an anti-highway movement that would slow aggressive highway development like no force in history had been able to do.

The Resurrection of Boston's Comprehensive Urban Highway Plan

The original intention of the Eisenhower Interstate System involved linking cities together, thereby enhancing travel between them. This point was clearly emphasized by the auto industry at the onset of the program in 1956.

> In laying out the general pattern of the 41,000 mile chain of national express routes the planners have steered away from the heavily built-up industrial and residential cores of the cities. Belt lines and bypasses are to allow through traffic on the new system to remain free of urban bottlenecks. Those drivers with destinations downtown will be able to reach them via access thoroughfares, but there is to be no dumping of Interstate traffic at city hall.

As the program progressed, the automotive industry began to rethink the consequences of limiting major arteries to the outskirts of cities. With the automotive industry came the industries responsible for constructing highways, which saw more profit per mile of road built in densely populated areas than in sparsely populated regions. By the 1960's, the national perspective on urban highway construction had changed. The shift in this paradigm was clearly echoed by General Louis J. Prentiss of the American Road Builders Association.

> Highway construction in urban areas is the most urgently needed part of our national highway program, and the most difficult. It is urgent because it will carry the greatest volume of traffic. Hence, they are the facilities which will serve the greatest number of people.

The Massachusetts Department of Public Works, however, had the opportunity to reverberate the newfound sentiment before General Prentiss had publicized the paradigm. The 1925 mission to create a major north-south downtown thoroughfare was resurrected by Governor Robert Bradford in 1948. In this year, the Governor requested the authorization of a bond issue from the state legislature that would allow construction of urban highways to commence. He outlined the first task of the highway plan, which involved the construction of the Central Artery expressway through downtown. He revealed the explicit intention of the new road, which was designed to assist in the distribution of automobiles attempting to enter various regions of Metropolitan Boston. The road was not to be constructed for traffic attempting to bypass the city. Following the November turnover of power in the legislature, the bond issue was approved. The $100,000,000 bond was delivered in cash, to be repaid through a gasoline tax that amounted to three cents per gallon. The quick approval of the bond and public support for the new highway represented the celebration of the city's history in bold and aggressive infrastructure development. At a time when many states were still unsuccessful at initiating rural highway development plans, Boston embarked on a bold plan to implant an elevated multilane highway through the center of the city's downtown, which would dump Interstate traffic fifteen hundred feet from the steps of City Hall.

Once approved, construction of the Central Artery began at once. By 1950, land condemnations and evictions became commonplace along the proposed route. At the close of 1951, the first building succumbed to the new roadway in the North End, at the corner of Beverly and North Washington Streets. The swath of destruction steadily proceeded southward, with the construction of the steel behemoth only shortly behind. By 1954, the elevated roadway was present

in its uncompleted form in the North End, and local residents quickly noticed the new structure. Most agreed that the new structure was an eyesore even before the roadway was completed. Boston locals, using an ironic contrast to their beloved baseball stadium, began to refer to the highway as "the other Green Monster."

The priority given to highways over other urban structures became abundantly clear during the demolition phase of the project. In the Bulfinch Triangle, historic buildings dating back to the completion of the Mill Pond Plan were razed. Haymarket Square, a centralized outdoor marketplace dating back to the eighteenth century that served as a community gathering place for several Boston neighborhoods was ravaged by highway construction. Demolition eliminated many of the buildings that had existed on the site for more than a century, and establishment of the overhead structure severed access to the square from many eastern neighborhoods.

Strong opposition to the plan began to emerge midway through project delivery from residents in the South End, who rested in the path of the oncoming demolition which had progressed deep into the city's downtown districts. These residents, who had witnessed how the expressway had torn the delicate urban fabric of the North End, appealed to MDPW Commissioner John Volpe for a reassessment of the plan for the highway south of downtown, which could still be spared from oncoming destruction. Volpe quickly succumbed to the strong political pressure, and ordered a redesign of the southern route which would push the highway underground at Congress Street, sparing Chinatown and the city's leather district.

The city's experiment with urban highway development and operation reached a new phase on June 25, 1959 when the southern tunnel was completed and the entire overhead structure began carrying through traffic. The new highway carried fluid traffic for three months, until a minor accident led to the first large-scale traffic jam. It was not long before congestion and delays began occurring without the instigation of automobile accidents, and the quick trip through Boston was replaced with a torturous crawl.

Over time, new technological features that were celebrated parts of the Artery were abandoned. The system of embedded pipes that carried warm slurry through the roadway to melt snow left operation only a year after the roadway opened, when it was determined that the costly system was insufficient at performing the desired task. Soon after, the command booth, equipped with sensors and cameras to observe and improve traffic flow within the southern tunnel, was abandoned when the absence of ventilation within the center rendered it uninhabitable by its human counterparts. Such technological failures served as catalysts for the declining morale of city residents and officials that surrounded the artery.

The design of traffic handling on the Artery met failure as well. In addition to heavy congestion that developed atop the roadway, the increased volume of traffic destined for downtown

areas faced delays and chaos at the foot of inner city exits, where interstate traffic converged on smaller thoroughfares with local traffic. Back atop the viaduct, exit ramps induced further problems as entering cars attempted to merge with through traffic. Studies in the early 1960's revealed that the ramp system connecting the Artery to Storrow Drive at the North End was the most complex and dangerous highway exit in the nation at that time.

Construction of the Artery and analysis of the resulting outcomes had shown public officials and highway developers that such urban undertakings were as costly as they were complex. Every year between 1950 and 1960, almost one quarter of all state funds set aside for highway development, maintenance and operation went to construction of the two linear miles of roadway that comprised the Central Artery. While highway budgets grew richer through federal highway subsidies and generous appropriations from the state, funds for rail dwindled. The once prosperous passenger rail services that had managed to float through the depression were by 1950 providing commuter rail service between suburbs and downtown Boston as an alternative to automobile travel. While many relied on such service, state funding for commuter rail service was systematically cut, resulting in the end of such services on the New Haven Railroad three weeks after the opening of the Central Artery expressway in 1959. Termination of commuter service was followed shortly by bankruptcy in the New Haven Railroad company, which had previously acted as the preferred means of freight transit into and out of Boston. Much of the land used for rail yards had been previously acquired by the state for assembly of the right of way for the Central Artery itself.

Construction of the elevated Central Artery expressway was similar in scale to many infrastructure projects undertaken by the city throughout its extended history. Yet the highway did not meet with the resounding success of so many urban infrastructure projects before it. Congestion and accidents on the roadway were complemented by early technological failure and abandonment of several chief structural features of the Artery. These outcomes of the first aggressive urban highway development project in the city had left a tarnished public perspective on arteries that cut through dense urban areas. This shifted perspective led to a change in the reaction of Boston residents to other highway project proposals from the Massachusetts Department of Public Works. While residents had grown wary of the effects of urban highway construction, the Public Works Department continued to push toward the complete realization of their highway development plan.

In 1960, the MDPW revealed the results of a completed study of possible Inner Belt routes updated for urban conditions of the new decade. The new study revealed a proposed route for the Belt which followed a path similar to that outlined in the 1948 plan. In addition, the new study results included three alternative routes that followed slightly augmented, yet highly destructive paths. Each path represented a semi-ring road that connected the existing Northeast Expressway to the Southeast Expressway, intersecting six other radial highways en route.

Outrage and opposition returned to Boston immediately, and grew most intense in the City of Cambridge, which was to feel the largest effect of the new highway. Citizen groups banded together to form the Neighbors United Against the Inner Belt, which later united with several student and faculty groups from the Massachusetts Institute of Technology and Harvard University under the coalition title of The Cambridge Committee on the Inner Belt. The CCIB was later joined by Area Four and the League of Women Voters. These groups voiced public opposition to the Inner Belt proposal. The opposition, which received widespread media coverage, successfully kept further feasibility studies of the highway at bay during campaign years. Advancement of the project continued however when city officials were not immediately facing reelection.

Struck by the reality that highway engineers and lawyers could undermine the city groups through the use of technical expertise, representatives of the opposition appealed for assistance from Cambridge residents that had experience with highway design and urban planning. This appeal led to their connection with an engineer from MIT who had experience in modern urban planning and finance, and an interest in helping the advance of the anti-highway movement. Fred Salvucci, the son of a local bricklayer, began his career in 1962 at the Boston Redevelopment Authority, which served as the urban planning and overseeing agency in the city. With the help of other BRA employees, Salvucci embarked on an intensive study into the effect and repercussions of the proposed Beltway.

By 1965, virtually all opposition groups within the city had banded together to form a single coalition of resistance against the delivery of the highway. The coalition organized under the name "Save our Cities", which received the loose yet appropriate abbreviation SOS. Citywide rallies and protests were later staged by the SOS coalition, which operated with an initial $1500 budget received entirely from the City Council.

In the Massachusetts Gubernatorial Election of 1969, Republican Frank Sargent beat out Kevin White for the next term. Both candidates opposed the Inner Belt. Governor Sargent quickly organized a blue-ribbon task force to study the MDPW proposals. The task force, chaired by Alan Altshuler of MIT, included Fred Salvucci. The task force returned their findings to the Governor, which were reflected by a statement that they released to the public.

> To be blunt, we perceive a great mindless system charging ahead. The interstate highways within Route 128 will be built as planned, it appears, not because they are the best public investment – or even the best highway investment – for the money. They will be built solely because they involve ten cent dollars from the state standpoint.

Ten cent dollars. The biting words left the desk of a state appointed task force and reverberated through the city. In the wake of this report, the Inner Belt Proposal had been left in

ruins. On the eleventh of February, 1970, the Governor went public to announce the unalterable opposition of the state to the Inner Belt Proposal.

The city of Boston had written another chapter in its story of bold and ambitious urban infrastructure development. This time however, the tone appeared inconsistent with others written throughout history about daring land creation and expansion, exploration into the realm of chartered mass transit and regular bus service built atop rails, and the electrification of the first widespread transit network on the continent. While these stories involved a sense of unilateral triumph, the new chapter involved designs that failed to achieve their stated goals, plans that contradicted the original sentiments of federal programs such as the Eisenhower Interstate System, and public and political conflict that would prove to impair the ability of the city to keep with the growing transit needs of its citizens. And while many individuals held the pen that had written this chapter, perhaps the most influential political figure was Governor Sargent himself, who acknowledged the grim state of inner city development during his televised statement in February of 1970.

> Four years ago, I was the commissioner of the Department of Public Works – our road building agency.
>
> Then, nearly everyone was sure highways were the only answer to transportation problems for years to come.
>
> We were wrong.

V. The Follies of Highway Design

"Today a magnificent instrument has ruptured the human environment in the name of progress. Its terror has been accepted as a fact of modern war – almost as if it were a sacrifice of war."
-Kenneth R. Schneider

"We were wrong." The Governor's biting words reverberated through the state of Massachusetts on the eleventh of February, 1970. His statement was not intended for the sole condemnation of the Inner Belt proposal, or any single highway for that matter. Governor Sargent had unearthed the follies associated with the entire highway movement as it stood at the beginning of the 1970's.

Looking back on the sixty-two years that had progressed since the first boxy, clumsy vehicles started rolling out of Henry Ford's plant, public officials and highway builders could see the progression of automobile infrastructure. They could see how governmental policy through the depression of the 1930's and following the close of World War II had given fierce momentum to highway development, and how many old ideals – such as the ideal that kept early Interstate highways out of the city – were compromised by public agencies and highway engineers. Master builders and power brokers alike had hidden behind the guise of urban renewal for decades in order to trade urban houses for urban highways. The evolution of road development in America was clear. The construction of a vast network of high speed arteries had been accomplished. But to what end?

The Interstate system alone had cost the nation more than fifty billion dollars every year of its first ten years of existence; a disproportionate amount of that money spent highway miles in the city. Yet as the highways grew, so too did congestion and delays. As the number of urban highway miles increased, so did public opposition. Enlarged urban arteries only seemed to result in enlarged

traffic jams, motivating critics and furious travelers to refer to these bewilderingly expensive undertakings as "boondoggles". What was wrong with the designs proposed by highway planners?

The failure of urban superhighways to serve traffic as they were intended can be traced to two underlying causes. These causes manifested themselves in fundamental highway design approaches as well as the basic logistics of the car culture, and how it reacted to new highways.

An Archaic Design Paradigm

In the development of an urban highway proposal, planners and engineers were forced to contend with a number of factors that would dominate the design of the new roadway. Builders determined who would be using the new road. They estimated how many would be traveling on that road. Identification of traffic sources and destinations followed. Such factors allowed planners to identify highway paths as well as the capacity of the artery.

Data was often collected in the form of origin-destination studies, which highlighted the number of travelers into and out of an urban core. Peak traffic hours were studied in particular and the resulting roadway design calibrated capacity to the dynamics of these peak hours. This approach to highway design resulted in the placement of major arteries to serve weekday commuters, who represented the bulk of travelers at peak traffic hours. This design approach placed priority on the weekday commuter. Such considerations were part of a primitive highway layout paradigm that failed to evolve as urban roadway design grew more complex. Planners gave little consideration for other travelers on the road, and did not design such roadways to facilitate other critical urban programs aimed at reducing poverty, inadequacies in urban education or segregation. The planners and engineers failed to augment their plans to minimize its impact on air quality, public health, and rates of automobile accidents throughout the city. Moreover, little recognition was often given to existing parallel transit networks, which could be enhanced to reduce the overall load on the proposed highway. Highways in cities had a tremendous effect on the growth of the nearby urban areas. Yet the layout of these highways suggested that builders were not concerned with how the urban areas would grow, and what effect such growth would have on other features of the urban landscape.

The inadequacies in the universal highway design approach were brought to light by the City of Cambridge during the Inner Belt Battle in the 1960's. Studies performed by the City revealed that the layout of the proposed semi-ring did not take the existing layout of Cambridge into consideration. A report released on the twelfth of June, 1967 revealed the results of their studies.

> ...the Council has become convinced that the whole federally aided transportation system currently being superimposed on top of the City of Cambridge and the Boston metropolitan area – rapid transit as well as highways – is based on archaic (pre-World War II) assumptions and outmoded policies. Specifically, the system is being designed

only for metropolitan peak hour journey-to-work travel movements and does not reflect in any substantial manner the legitimate needs or goals of the people of Cambridge.

As urban expansion grew more complex and technologically challenging through the twentieth century, the design of urban highways continued to follow a primitive approach developed early on in the history of the automobile. City highways continued to provide primary service to individuals that worked in the city but lived in the surrounding suburbs. Existing transportation systems – such as light rail – dedicated to serving commuters along these routes were neglected during highway planning, and the insertion of the new artery into the urban landscape often displaced the alternative transit systems. The progression of such development therefore may explain the upsurge of opposition to urban highway expansion within the city, where such highways did little for residents in downtown areas such as metropolitan Boston and nearby streetcar suburbs, such as the City of Cambridge.

While the antiquated design approaches retained by planners and highway developers may explain the failure of urban highways to enhance life within the city, it does not explain why the highways failed in their goal to facilitate travel into and out of the urban core, particularly during peak travel hours. The underlying cause for this failure did not rest in outdated design practices or inadequate priorities in highway layout, but rather an effect ingrained in the dynamics of the American car culture.

The Lesson that Every City had to learn for Itself

Planners in New York City learned of traffic generation during the great depression. As outlying townships progressed deeper into the forests and fields on Long Island, travel into the city from the east continued to increase. The existing bridges that crossed the East River grew incapable of carrying the automobile traffic during peak hours in the early 1930's. To ease congestion on the bridges, master builder Robert Moses resurrected the plan to build the Triborough Bridge, connecting the Bronx and Manhattan with Queens to the east. Opened in 1936, it was anticipated that this new structure would carry the surplus of vehicles attempting to enter the city during rush hours. The surplus of automobiles, which had been determined through the use of origin-destination studies, had been the primary factor in the design of the new bridge. Yet only weeks after Triborough's ribbon cutting, congestion returned to the East River bridges. Further attempts to eliminate overcrowding on existing routes led to the creation of new bridges. Construction continued for decades and led to the creation of a vast network of bridges and tunnels between Manhattan and Long Island. Each time however, traffic levels surpassed bridge capacity soon after the ribbon cutting. The effect occurring on New York City bridges was documented by Biographer Robert Caro in *The Power Broker*.

> Watching Moses open the Triborough Bridge to ease congestion on the Queensborough Bridge, open the Bronx-Whitestone Bridge to ease congestion on the Triborough Bridge and then watching traffic counts on all three bridges mount until all three were as congested as one had been before, planners could hardly avoid the conclusion that "traffic generation" was no longer a theory but a proven fact: the more highways were built to alleviate congestion, the more automobiles would pour onto them.
>
> Force the building of more highways – which would generate more traffic and become congested in their turn in an inexorably widening spiral that contained the most awesome implications for the future of New York and all urban areas…Pour public investment into the improvement of highways while doing nothing to improve mass transit lines, and there could be only one outcome. Failure.

New York City had witnessed traffic generation. A newly opened bridge or highway led to the convergence of cars that had not appeared in origin-destination studies. It seemed that the highways were breeding cars, and therefore more congestion. Why were highways causing traffic problems instead of alleviating them?

In his book *Stuck in Traffic*, author Anthony Downs discusses generated traffic and suggests that its cause can be linked to a phenomenon called "triple convergence". When a highway is opened, new traffic will be generated for three reasons. Spatial convergence is caused by the improved roadway. Drivers who appear on the new highway because of the prospect of a more efficient trip in less time contribute to temporal convergence. Finally, the new highway will succeed in drawing some travelers from mass transit and other alternative modes of transportation. This cause is called modal convergence. The triple convergence theory suggests why an expanded network of roads may actually lead to more traffic and less efficient travel.

The theory discussed in Downs' book also illustrates the effect of disproportionate spending on highways and mass transit. When highway development leads to neglect of public transit services, traffic generation will be compounded through modal convergence as a higher number of travelers trade in their monthly rail passes for new automobiles.

The study of traffic logistics involved in new highway development has cast an unfavorable light on the expansion of automobile infrastructure. Identification of the generated traffic phenomena has led to the establishment of Braess' paradox, which states that "by adding capacity to a crowded network you could actually slow things down." The application of this dour theory to highway development leads to a sense of futility in future expansion projects.

The lesson was ultimately learned in New York City. The final bridge across the East River was built in 1961, during the autumn years of Moses' era of power and influence in the city. The lesson learned by planners in New York City would not spread quickly to other American cities however, which continued with their efforts to eliminate congestion on urban highways by supplementing existing roads with more roads. Such was the case in Boston during its era of

aggressive highway development which began with the release of the MDPW Comprehensive Highway Development Plan, and continued for decades until Governor Sargent's public declaration on February 11th, 1970.

The phenomenon of generated traffic coupled with outdated highway design practices had led to a network of roadways in 1970 that was as traffic-snarled as it had been in 1948. More roadways had not been the answer. Wider roadways had not been the answer. With these newfound realizations, the City of Boston moved into the modern era of infrastructure development.

VI. Finding Salvation in a Big Ditch

"Boston's a city that people have built. It's not quite like some of the Dutch cities, but it's close in terms of the intrinsic nature of major construction to making the city what it is."
-Frederick Salvucci

In 1970, the age of aggressive highways was drawing to an end across the country. Boston residents needed to look no further than downtown to observe the urban scars left by the era. The elevated Central Artery blocked view of the sea from beyond its western side, and had severed a significant portion of aesthetic, economic, and social characteristics by virtually dividing the city in two. With the realization of the impact of such a structure combined with the newfound public opposition to urban highway expansion projects such as the Inner Belt, public officials and the public at large had been cured of their "highway fever". The sentiment was largely solidified when State of Massachusetts Legislature and public officials declared a moratorium on all new highway construction in the commonwealth.

There was still a mess to clean up, however. That mess developed as a result of the scar in the urban landscape that ran north-south from Bulfinch Triangle to Chinatown. The elevated Central Artery expressway had induced a plague into Boston's downtown, and led to decreased economic and social activity, spiraling property values, visual blight, and noise, air and light pollution. With these surrounding externalities came the direct symptoms of overwhelming automobile congestion on the expressway and at street level, as well as elevated incidences of automobile accidents and injury to what few pedestrians remained. Atop the expressway, the accident rate rose to four times the national average for urban highways.

Despite the newfound downtown ailments, the expressway had become a permanent fixture to the physical realm of downtown Boston. Caused in part by triple convergence on the new

highway, the artery was carrying more than twice the amount of traffic that builders had anticipated. Public officials had learned long ago that to pave a plot of land for the automobile was to make it sacred. Once land was lost to the car, it could not be reclaimed by any conventional approach.

To facilitate the exploration of solutions to the downtown problems, Governor Frank Sargent assembled a multidisciplinary study group led by newly appointed Secretary of Transportation and Construction Alan Altshuler, which included representatives from such intellectual fields as architecture, engineering, law, public policy, and economics. In 1970, this group undertook the task of uncovering a series of possible solutions, assessing the feasibility of each solution, and compiling the results of the study into a proposal for consideration by the State. In 1972 the group, which included engineer Fred Salvucci, unveiled the results of their study in a publication for the State Government called the Boston Transportation Planning Review. While several alternatives were proposed, the most emphasized – and most ambitious – solution contained in the report involved the combination of three large scale municipal projects. First, the Review proposed the creation of a third automobile tunnel under Boston Harbor. Second, a transit link extension was proposed, which involved the development of transit lines running parallel to the existing expressway. Finally, the study group advocated the depression of the entire highway, leading to the reclamation of virtually all surface land lost to the original artery.

Getting the Green Light

The Review was submitted to Sargent, who favored the proposal for the depressed artery. In addition, he provided backing to the creation of a third harbor tunnel, which he stipulated would serve as a managed-traffic artery. This stipulation meant that traffic in the third tunnel would be restricted to multioccupancy and approved commercial vehicles. Finally, Sargent endorsed the diversion of highway funds to the development and expansion of urban transit, following the moratorium on highway development in the Commonwealth. It was through this final endorsement that Sargent played the largest role in the modern era of infrastructure development.

Coordinating with other governors that favored public transit, Sargent induced a massive change in federal highway funding legislation. Historically, states that were issued funding and subsidies for highway development were faced with the risk of losing such financial assistance if the project was not undertaken and completed. Through new amendments in federal highway assistance, states could redirect these funds to urban transit programs. The timing of this shift in federal funding was advantageous for Massachusetts, which had already appropriated funds for the recently discontinued Inner Belt project. Through Sargent's efforts, these funds were appropriated by transit authorities and were used in subsequent years to expand the urban transit system in Boston.

Sargent's success with federal highway reform failed to help him win his reelection in 1974, when he was replaced with future presidential candidate and avid highway opponent Michael Dukakis. Under Dukakis, Transportation Secretary Alan Altshuler was ousted from office, and Salvucci was brought in to fill his place. Transportation had become a major issue in the new Governor's campaign. During his term, Dukakis intended to largely enhance urban transit in Boston at the expense of highways. It was a combination of these development plans and his inherent distaste for automobiles that led to his firm opposition to the proposal to depress the Central Artery. Those around the Governor noted that such transportation issues were the only topics that induced noticeable emotion in him.

Despite his firm opposition, Dukakis ultimately succumbed to pressure from the public and his Transportation Secretary. The plan approved by the Governor, which had been reformed in order to appeal to his progressive stance on mass transit, involved such stipulations as a ceiling on downtown parking construction in order to promote alternative means of transportation such as light rail. The new plan also reflected Salvucci's distaste for condemning residential land – an approach taken by other Massachusetts highway builders that had led to the eviction of his own grandmother years earlier.

While negotiations between Salvucci and Dukakis had led to a long list of ideals that were to be represented in the new Central Artery plan, a conceptual design had not yet been developed. Salvucci began that design in the early part of the decade following 1970 with a survey of land needed for the new transportation system. As word of the proposal spread, so too did the number of public and state groups working on the design. By 1977, detailed origin-destination studies of downtown Boston had begun to return traffic data to assist design of the automobile elements within the plan. Preliminary reports on the potential social and economic impact of a depressed artery were published by 1978. These reports also included detailed land use proposals for the reclaimed parcels. These proposals reflected work by such entities as the Massachusetts Department of Public Works and The Harvard Graduate School of Design, even before federal funding had been successfully approved.

Approval of the federal funds was a critical step in the State's plan. In 1983, it became immediately apparent that acquisition of such funds represented a formidable task. In order to achieve their goals of federal financial support, Salvucci confided in Massachusetts Representative and House Speaker Thomas Phillip "Tip" O'Neill, Jr. for help in Washington. Opposition in Congress came early from many constituents, including O'Neill himself because of the prospect of lost homes in downtown and East Boston neighborhoods. This opposition led to the realignment of the third harbor tunnel in order to prevent the condemnation of residential property. Following Salvucci's assurance that homes would not be taken for the project, O'Neill endorsed the project, and provided support for movements toward federal funding in Congress. Resistance rose soon

thereafter from the Reagan administration and the Federal Highway Administration, which opposed the project because such funding would violate the Transportation Act of 1981. This Act served as the closing milestone of the Eisenhower Interstate Project of 1956, and stipulated that any further highway funding could be used only for construction of pre-approved projects. The Federal Highway Administration, concerned only with the project's benefits to urban automobile transportation, felt that the costs of such a project would overwhelm the advantages of the resulting road network. This declaration led the Reagan Administration to label any federal financing of the project as "pork-barrel spending".

Personally satisfied with the potential of the project, O'Neill contacted his associates with high-ranking positions in the President's Administration. His lengthy stay in Washington had led to the development of a power base that influenced the decisions of even the President himself. As a result, the opposition of the Reagan Administration and the FHWA was dissolved. O'Neill's retirement in 1986 inspired House Public Works Committee Chairman James Howard to declare federal funding for the project as "a going away present."

Salvucci grew confident of forthcoming federal support in 1985. He began selecting state departments that would participate in the delivery of the massive downtown project. Concerned with the declining state of the Public Works Department, he delegated primary project management responsibility to the MDPW. Salvucci ruled that the MDPW was required to hire a private contractor that could provide the project management experience that the department lacked. As a result, the MDPW contracted a joint-venture group from Bechtel Civil, Inc. and Parsons Brinckerhoff Quade & Douglass of New York. Agreements between the MDPW and the joint-venture group were finalized in August of 1986, and development of "the largest, most complex and technologically challenging highway project in American history" went underway.

The acquisition of State approval and federal funding represented an enormous triumph in the course of the Central Artery project; however many more challenges lurked ahead. With the new era of infrastructure design came a new list of considerations. Largely neglected in highway designs of the 1940's and 1950's, effects of the new roadway on the environment were tantamount. Before construction could commence on a new project, environmental effects had to be studied and thoroughly documented. The subsequent report, called an Environmental Impact Statement, must consider potential changes in such features as air, water and other natural habitats, and human conditions including sunlight and living conditions.

Sargent's study group had created one of the country's first Environmental Impact Statements in 1972, and was included with the Transportation Planning Review that rallied support from the Governor. A more detailed report was needed for a project of such magnitude as the Central Artery reconstruction. Development of the updated and expanded EIS began in 1982. Due

to the project's complexity, the statement remained in development for nearly a decade. In 1990, the MDPW released the Final Supplemental Environmental Impact Statement/Report (FSEIS/R). Not final in the true sense of the word, the FSEIS/R was kept updated with design changes implemented throughout the project. While many Environmental Impact Statements are created and maintained for agencies overseeing environmental quality and protection, the FSEIS/R was widely circulated throughout Boston by the MDPW. Wary of public opposition to modern urban highway projects, the Public Works Department publicized the FSEIS/R to boost public approval to the project. In addition to noting the inherent environmental improvements to air quality, pedestrian and vehicular safety, and downtown visual aesthetics, the report stated that no residential lots would be condemned for the project's right of way, and only 134 businesses would be forced to relocate. The release of the FSEIS/R was followed by a period of encouraged public participation in the artery design process.

Final approval for the commencement of construction came from Massachusetts Secretary of Environmental Affairs John DeVillars, following his conditional approval of the FSEIS/R. DeVillars requested a revised FSEIS/R that included details on mitigation agreed upon following the period of public involvement. The mitigation involved the compensation of individuals or groups for the exposure to negative environmental effects due to construction and the long-term existence of the new network. A second condition to DeVillars' construction approval was the creation of an aesthetically pleasing bridge structure over the Charles River. DeVillars called for the formation of a community task force, including community representatives, architects, engineers, and environmentalists to participate in the design of the bridge. While not a stipulation on his approval, the Environmental Affairs Secretary urged designers and project managers to consider "creative strategies" for implementing alternative transportation as well as minimizing downtown traffic. Such strategies, according to DeVillars, included the integration of the highway with mass transit facilities, the limitation of downtown parking spaces, and the creation of dedicated managed-traffic highway lanes for multioccupancy vehicles and busses.

Breaking Ground and Breaking Records

Construction of the new artery began in the closing months of 1991 following State approval of the EIS. The elevated expressway was kept in operation throughout development of the new artery tunnels in an effort to minimize the impact on existing vehicular traffic. The technological complexity of the project has led to the need for design reform and innovation throughout construction, as new logistical issues have surfaced.

Innovation in design and problem resolution has led to the evolution of a transportation network that is virtually unparalleled in complexity. With complexity however comes financial cost.

As construction problems led to design change orders, the highway's price tag continued to climb. Project delays resulted in additional costs through inflation. A decade after construction began, the projected cost at project completion had increased five-fold from $2,600,000,000 to over $14,000,000,000.

One of the most troublesome change orders came as a result of massive design revisions for the Charles River Crossing, due in part to stipulations in DeVillars approval of the Environmental Impact Statement. The FSEIS/R included an impact analysis for a cable-stay highway bridge across the river, nicknamed "Scheme Z" because it represented the twenty-sixth original bridge design. Public opposition to Scheme Z arose in late 1990 following an artists' rendering of the proposed ramp system appeared in the Charlestown Patriot. Nicknamed the "wall of viaducts", the visualization of the system sent local residents into an uproar over the proposal that left the design team with little choice but to work with DeVillars' community task force to resolve the issue through a new bridge design. The urgency of the resolution was emphasized by the need for the surface road design to be included in the reauthorization package for Congress in 1991. A tunnel alternative, while minimizing the aesthetic impact on the surrounding region, promised to add unreasonable cost to the overall project. While Salvucci was successful at developing a redesign for the bridge and ramp system that met with public approval, delays and change orders led to an additional $1,300,000,000 needed to complete the project.

Creating a Beautiful Downtown

While project leaders such as Salvucci encountered frequent resistance from public groups, overall support from Boston residents was fueled by the prospect of reclaiming thirty acres lost to the elevated expressway. Citizens anticipated the realization of the largest land development project since the elevation of the Back Bay more than a century before. Detailed land use design proposals began to appear as early as 1978, and were developed by several organizations independent of the Central Artery/Tunnel Project. Even as frequent change orders continued to change the ultimate form of the underground system, groups such as the Harvard Graduate School of Design began developing detailed plans for structures on the reclaimed land above.

By 1990, the Boston Redevelopment Authority had compiled a series of design concepts for the downtown area. A progress report released in that year highlighted four concepts that illustrated a wide variety of possible land uses. The selected scenarios represented the work of local architects Ricardo Bofill and Alex Krieger, as well as the Boston Society of Architects and original plans by the BRA. Parks, botanical gardens, arboretums, and city squares were represented by the scenarios. Open space within the designs ranged wildly from as little as twelve percent to almost seventy percent of total reclaimed land. From these four scenarios, the BRA developed the Artery District

Plan. The plan illustrated the division of the reclaimed land into twenty six individual parcels. Each parcel was classified as land for future development as open space, residential, community, transportation, retail and office, hotel, or mixed use. The resulting zoning plan was released for review by the public through a series of community meetings facilitated by the MDPW.

As construction of the artery continued, so too did development of the Artery District Plan. Citizen involvement and participation has led to the evolution of land use plans that involve long-lost city features such as gardens, vistas and promenades. According to the 1990 report, the BRA concept for downtown land use was inspired by Frederick Law Olmstead's Emerald Necklace. Following the release of the Artery District Plan, Boston residents participated in the design of a parks plan unprecedented since the completion of the expansive green arc a century before.

Forward Funding and a Decade of Neglect

The decade that followed the 1990 BRA report witnessed the culmination of design, and the breaking of ground that would not be sealed for almost fifteen years. Boston residents and visitors could for the first time view the physical realization of the elaborate plans and illustrations published in newspapers, reports, and environmental impact statements. While the massive structure began to take physical form, many intangible changes continued to occur that would further tarnish the image and future potential of the once superior public transit system.

Federal and state political forces continued to influence the final design and realization of the Central Artery/Tunnel project throughout the last decade in the twentieth century. Dominant political constituencies present at many levels of project control persistently exerted highway-oriented alterations that led to further highway capital investment and transit disinvestment. The MBTA, which had historically received relatively lucrative funding through a share of the gas tax, was placed under a new forward funding program. Supported instead by a portion of state-collected sales tax, the budget for the MBTA and its services was left to compete with such other vital city aspects as health care and education. The rearrangement of funding sources left the department unable to maintain the existing service, let alone continue with capital and service improvements.

Within the massive Central Artery Project plan, improvements for public transit continued to vanish. The planned and financed fleet of new surface buses did not show up. Capital improvements to the Blue Line station at Logan Airport disappeared. Extensions to the Green Line in the outskirts of the city failed to manifest. Analogous to the legendary Bermuda Triangle, politicians had set up an equally infamous "Boston Triangle." And they were furiously feeding approved transit improvement projects right into the heart of it.

As these "green" components of the CA/T project began to vanish, influential public entities began to challenge the apparent alterations to the original plan. The Conservation Law

Foundation instigated numerous legal battles to retain transit improvements, and reinstate additional improvements that had been lost. The CLF was at best only moderately successful. The decade persisted with a cycle of what Fred Salvucci calls "slippage and delay," where transit improvements would slip from the final plans, and legal battles with the CLF would only result in further planning and construction delays. Little progress was made by transit minded organizations, which saw their efforts prove futile as transit improvement plans continued to deteriorate.

The Promise of a New Era

The Central Artery/Tunnel Project of the late twentieth century represents the most recent massive civil undertaking of the City of Boston. From the massive land development programs that created the Bulfinch Triangle and the Back Bay to the first electrification of a streetcar system on the continent and through the construction of the first underground light rail system in the nation, municipal projects have ushered in new eras of life within the city. Completion of the CA/T holds the promise to carry the city into a new era of life and movement.

The new era is characterized by the Massachusetts Turnpike Authority as one of salvation from a variety of ailments caused by the original elevated artery. Through a series of public documents, the MTA has illustrated a set of predictions about this new period in Boston's history. These predictions reflect a sense of unwavering optimism on behalf of the authority, which anticipates significant and widespread improvement in both life and movement throughout the city.

Improvements in movement by car are emphasized in documents published by the MTA. The authority states as fact that the new artery will carry upwards of 245,000 vehicles daily, in contrast to the 190,000 found each day on the elevated highway. Under these conditions, the MTA anticipates the elimination of automobile congestion even during peak traffic hours. The reduction in on- and off-ramps is expected by the authority to reduce risk of collision on and around the highway, making the high-speed roadways safer for both local and through traffic.

As for life in the city, the Massachusetts Turnpike Authority anticipates noticeable improvements as well. The elimination of congestion on the roadway is expected to reduce carbon monoxide emissions by twelve percent, thereby improving air quality downtown. Cross streets that were severed by the elevated expressway will be reconnected, enhancing interaction between downtown districts and improving street level automobile travel.

Beautification of the downtown area will begin with the demolition of the elevated artery, according to the authority. Subsequent reclaimed land will amount to almost thirty acres, much of which will be converted into open space for general public use. Open space within the city will be further enhanced by the creation of five parks within the Charles River Basin, adding an additional two hundred acres of public land.

The promises for the future given by the Central Artery/Tunnel Project extend to a vast number of aspects of life and movement downtown. The public has been repeatedly reminded of these promises by state agencies involved in the project, particularly the Massachusetts Turnpike Authority. The Boston residents now share a common vision of the city in the near future. With the completion of the multibillion dollar project comes with the expectation on behalf of public agencies and the general public alike of superior traffic movement, improved quality of life, and an urban downtown free of scarring remnants from the aggressive highway era. But will these expectations be met?

VII. Digging Deeper

"If we are an automobile-riding, we are also an automobile-ridden people. Despite the daily offerings that Americans insert in parking meters, and the grand new parking temples rising in the centers of our cities, we seem unable to appease the motor goddess...The yearly births of automobiles have for some time now been exceeding those of the human population."
-Daniel J. Boorstin

The Massachusetts Turnpike Authority has made some big promises. Not surprisingly, the expectations of the MTA reflect a wholly optimistic approach to the outcomes of the Big Dig. Through a broad and powerful public relations campaign, the authority and the city have left the public with a similar mindset. Despite political controversy, repeated publicized design changes, and cost and schedule overruns, many Boston residents believe that the project will single-handedly revitalize much of downtown.

While many groups such as the MTA maintain high expectations for the project's effectiveness, other involved groups foreshadowed a more ominous outcome. The appeal for federal funding of the project had driven the FHWA and Reagan Administration to label the effort as "pork barrel spending." Other local community groups have predicted that the new system will bring more harm than good to the downtown area. Many disapprove of the design, while others object to the project entirely. Local newspapers have picked up the uneasy feeling held by a noticeable minority of groups and individuals. Headlines such as "Will the Big Dig Serve Boston – or Bury it in Debt?" and "Boston's Money Pit, the Big Dig" have littered the front page of newspapers like the Boston Globe for years, eluding to the massive cost of the project which has further necessitated the need for the broad public relations campaign of the MTA.

The true outcome of the multibillion dollar project lies beyond the headlines in the local papers. It lies outside of the "facts" presented by the Massachusetts Turnpike Authority and other city agencies. Total success of the Central Artery/Tunnel project involves the achievement of each of the predetermined goals. In order to objectively assess the potential success of the project, these goals must be identified. While many individual project goals are voiced, each can be classified as either an improvement made for the traveler or an improvement made to the city.

The Promise of Improvements Made for the Traveler

From its initial conception in the Boston Transportation Planning Review, the ambitious project has been sold as a solution to traffic ailments downtown. A number of factors exist that play a critical role in the success of the design to facilitate travel downtown. In general, these factors manifest as considerations that are critical to an effective design. In order to accurately assess the potential effectiveness of the project, each factor is identified, and evidence is sought to prove the inclusion of the consideration in the final design.

Service Priorities

Design of a highway begins in part with the task of deciding who the new road will primarily serve. Traditionally, urban arteries are designed to serve the weekday commuter. This factor represents a key consideration that directly affects the layout and location of the highway. While the orientation of a highway to serve the needs of the commuter will likely lead to the minimization of peak hour congestion, it often results in a highway design that places little importance on the well-being of surrounding communities.

The layout of the depressed Central Artery and its core services were predetermined by the elevated highway it is intended to supplant. In order to replace the existing roadway, the new system must serve the traffic that already exists, leading to the design of an artery that primarily serves the journey-to-work traveler. The highway layout of the Central Artery therefore reflects the archaic paradigms of earlier roadways, including the Inner Belt in the 1950's.

Traffic Capacity

Consistent with past paradigms, the design strategy of the Central Artery/Tunnel involved design for peak hour commuter travel. The subsequent highway was designed to accommodate as many as 245,000 vehicles per day. In the eight-lane system, this leads to an individual lane capacity of 30,625 vehicles per day or 1,276 vehicles per hour. Current estimates place more than 190,000 vehicles on the existing artery each day. Distributed uniformly, this amounts to 990 vehicles per lane on an hourly basis. Due to the convergence of peak traffic hours for commuters who represent the

bulk of artery traffic, this hourly figure is noticeably larger for several hours daily. As a consequence, current traffic conditions already place peak hour traffic volume near the capacity of the highway.

This potentially alarming situation is aggravated by the near-certainty that traffic volume will continue to rise throughout the lifetime of the roadway network. Nominal traffic growth has historically led to an increase of more than 2.5 percent annually in the Boston area. This continual trend in nominal growth suggests that the widened Central Artery will reach daily capacity within its first decade of existence. Moreover, this growth fails to account for the triple convergence effect resulting in substantial traffic generation. This effect, which has historically affected the traffic volume on nearly every major highway project in the nation's history, is likely to result in spatial, temporal and modal convergence on the Central Artery and third harbor tunnel. The effect of traffic generation will likely be compounded by the lengthy duration of the project as well as its widespread publicity.

The carrying capacity of the new artery will also be affected by the frequency of accidents along the roadway and the efficiency associated with the removal of unavoidable disabled vehicles. Artery advocates and designers stressed the need for the new highway in order to improve vehicular safety downtown. The depressed roadway features a new ramp system that is significantly less vexing than its predecessor, and involves fewer entrances and exits thereby minimizing the need for merging and lane changing within the tunnel. While this factor will reduce the likelihood of collisions along the roadway, several newly-integrated characteristics may reduce the overall improvement to traffic safety and minimization of associated delays. By depressing the entire highway into a two-mile long tunnel, builders have created a roadway length that may have adverse psychological effects on drivers. High-speed underground merging may prove more daunting than similar maneuvers made on the previous artery. The spectacle of the new tunnel may also result in a distracting effect that would deter the alertness of the driver. For these reasons, collision rates along the artery may not be reduced to the extent predicted by builders and engineers.

The new design fails to minimize the effects of disabled vehicles on surrounding traffic. The absence of shoulders and breakdown lanes within the tunnel may lead to lengthy delays within the tunnel. Disabled vehicles will consequently occupy active lanes, which will lead to congestion within the tunnel, especially when such breakdowns affect peak hour traffic volumes.

Thorough analysis of the stated capacity of the new artery suggests that several expectations put forth by the Massachusetts Turnpike Authority may cease to exist on the newly opened highway. Moreover, the laws of traffic growth and traffic generation that have affected virtually every major roadway in America threaten to make any successfully met expectations short lived. Within a decade, the fluid movement of automobiles predicted by the MTA will likely fall victim to Braess' Paradox.

Alternative Transit

While much of the publicity surrounding the new Central Artery/Tunnel Project focuses on the new roadway, it is critical to note that this highway is only one part of the massive effort. While in its infancy, the project centered on a new depressed highway. Over time however, the efforts of public officials such as Sargent, Dukakis and DeVillars have led to the thorough integration of efforts to provide alternatives to conventional highway travel. These efforts manifested as conditions for environmental, executive, and legislative approval of the project. Many public officials saw the inclusion of transit expansion as critical in order to avoid increased dependence of commuters on the automobile, which would result in associated problems downtown including parking and traffic congestion on urban thoroughfares.

The final design of the new transportation network lacks the spirit of alternative transit that the progressive officials exuded years earlier. Extensions to existing light rail lines are absent in final plans, which promise little more than the refurbishment of several downtown transit stations. Early design proposals included the plan to develop a fifth underground line running parallel to the artery, in order to promote alternative use of transportation for short-distance trips. Plans for the parallel transit line evaporated. An existing MBTA fifth-line proposal was later integrated into the project in order to revitalize transit expansion efforts. The new transit line, nicknamed the "Silver Line" remains present in the final plan, the design calls for the use of Bus Rapid Transit (BRT) technology instead of rapid transit technology. Moreover, the Silver Line does not run parallel to the Central Artery, and therefore does not provide direct alternatives to travelers on the new highway.

Beyond light rail solutions, Environmental Affairs Secretary John DeVillars described several other traffic cutting measures. DeVillars proposed the implementation of managed access lanes within the tunnel that would remain open only to public buses and multioccupancy vehicles. Such design features would further promote the use of alternative transportation measures, namely public transit and carpooling. The final design of the artery lacks such lane designations however. Instead, the entire highway remains general access, allowing single-occupancy vehicles to travel in every lane. Such conditions provide no logical repercussions to the commuter who makes the daily trip into Boston with four empty seats in his or her automobile. While many modern highway designs boast one or more managed access lanes, other designs incorporate flexibility that will allow for the conversion of general access lanes to managed access in the future. The Central Artery Tunnel however incorporates a series of ramps that merge with the left lane. As a result, the tunnel design lacks flexibility that would allow the future designation of existing general access lanes for public bus and multioccupancy travel.

The design of the new Central Artery includes virtually total emphasis on automobile travel. Efforts to expand existing infrastructure to promote use of light rail, public transit, and carpooling

have been lackluster throughout final design of the project. The resulting design leads to a transportation network that strongly promotes automobile travel, and may lead to further increases in automobile dependency within the downtown areas. The likelihood of future rates of growth in traffic volume on the new artery suggest that peak hour automobile congestion will return within a decade of the opening of the highway. Congestion may be compounded by delays caused by collisions and disabled vehicles, which will be forced to occupy active lanes of the tunnel due to the lack of emergency shoulders. If such scenarios become frequent, commuters will have few alternatives but to sit in traffic. Failure to expand alternative transportation infrastructure and promote its use will leave drivers with few incentives to leave their cars at home.

The Promise of Improvements Made to the City

Beyond infrastructure redevelopment, the Central Artery/Tunnel project represents a major stride in urban improvements. Beyond promises to ease traffic woes and integrate several forms of transportation along a single corridor, the Big Dig is an effort to remove blight, and restore the urban landscape of the early twentieth century. While much of the public participated in the design of the highway artery, most active public participants have played a larger role in the debate over land use above the highway. The Central Artery land use debate represented an element that most urban development projects lacked: the physical creation of open space within the city. Whereas most infrastructure enhancement programs led to the further cluttering of the urban core, the city of Boston is spending billions of dollars to make the clutter disappear.

The expectations of the Massachusetts Turnpike Authority involve the improvement in the urban environment surrounding the artery. Air quality, for example, is expected to improve significantly in and around the downtown corridor. The depression and covering of the artery prevents automobile emissions from directly contaminating the air at the surface. Eight large ventilation buildings are expected to disperse the emissions into the air high above street level, causing a dramatic reduction in the contamination of the air downtown. Additionally, the MTA insists that the elimination of congestion on the artery will reduce carbon monoxide emissions by twelve percent. This assurance is of course based on the assumption that traffic will indeed be eliminated.

Beyond air quality improvements, elimination of the elevated artery is expected to result in the reconnection of thoroughfares that once traversed the corridor. The reestablishment of a regular network of roads is expected to result in a safer environment for pedestrians and cyclists, enhancing the attractiveness of the downtown walking trails, including the Freedom Trail and the Walk to the Sea.

The Central Artery/Tunnel project promises to return almost 30 acres of land to Boston for public use through the elimination of the overhead artery. The removal of the expressway will restore a downtown aesthetic that was lost in the 1950's. Throughout the lengthy development of the artery below, debate has raged over the use of land on the surface. Regardless of its detailed form, the returned parcels promise to boast parks, botanical gardens, vistas, promenades and civic space reminiscent of the "City Beautiful" era.

The MTA promises the removal of blight downtown. Realization of this assurance is nearly certain, as plans involve the replacement of the visually obscene six-lane viaduct with public facilities dedicated to urban aesthetics and recreation. It is through this objective that the project stands most likely to succeed. Not only will the project revitalize the visual landscape downtown, but the effects of this visual landscape may reemphasize the importance of aesthetic considerations in urban municipal projects. This paradigm – which served as the staple of the City Beautiful movement a century ago – disappeared by the end of the depression of the 1930's, leaving many urban downtowns with immense structural blight. Through this effect, the Central Artery/Tunnel project may in fact deliver more than what is promised by the Massachusetts Turnpike Authority.

Evaluating the Project's Potential

The goals of the Central Artery/Tunnel project are consistent with the promises made by the Massachusetts Turnpike Authority. The diverse set of goals derived from such assurances made by the overseeing parties generally involves attempts at improving travel within the city and improving the city itself. The level of potential success of these goals has been shown to be as diverse as the goals themselves. By categorizing the improvements however, it becomes clear what effects the project will truly have on the city as a whole.

With a traffic capacity increase resulting from the addition of only two lanes, the proposed highway holds little potential for eliminating the woes of the typical weekday commuter. Moreover, any success that the highway attains in reducing traffic congestion will only lead to higher traffic volumes as a result of triple convergence. Even without the effects of traffic generation, increasing trends in the volume of cars on the roads in America suggest that the highway will reach capacity once again within a decade of opening.

By reviewing the history of the automobile and highway development in the United States, it becomes readily apparent that the Central Artery/Tunnel is just another highway. The "largest, most complex and technologically challenging highway project in American history" has been designed at its most basic level according to the same archaic paradigms used by highway engineers for the past eighty years. The roadway still caters primarily to the journey-to-work commuter. It is still designed for peak traffic conditions. It includes few mechanisms for promoting alternative travel, including

carpooling and public transit. And most importantly, the ideals behind the roadway still involve the naïve belief that engineers can create a vehicular artery that Americans can not fill to capacity. From an exclusively transportation-minded perspective, it is a boondoggle.

The project does not only seek to improve transportation however. Beyond benefit to the traveler, the Central Artery/Tunnel project represents a massive effort to restore a downtown that was torn apart by the highways of the 1950's. Analysis of the designs and intentions of the builders leads to the conclusion that the effort will be well rewarded. While countless American cities are surrounded by asphalt beltways, the City of Boston has long boasted its green beltway – the sequential system of parks including the Commons and the Muddy River Basin that make up the Emerald Necklace. Boston residents will be graced with another thirty acres of public space in the heart of downtown. Current development calls for the realization of a new economic and social epicenter that promises to spark new development in surrounding regions. Further park development elsewhere will result in additional openness and aesthetics throughout the city.

The above analysis has led to the visualization of an elaborate, multibillion dollar urban beautification project. A resurrection of the long lost City Beautiful movement, the depression of the Central Artery promises to drastically improve life in the immediate vicinity of the corridor, yet embodies no revolutionary approach to urban transportation. With the anticipated achievement of a selection of preset goals, it is difficult to arrive at a solid conclusion of the project's success.

The success of the Central Artery/Tunnel project lies in the eye of the beholder. The Federal Highway Administration argued that the artery would not provide transportation benefits commensurate with costs. The prediction of the FHWA appears in line with the results from analysis of the posed transportation improvements. Yet many would argue that the project's true mission lies within its power to beautify and rejuvenate the downtown area of the city. The question of the project's success therefore has no easy answer. The goal of improving and beautifying the city represents a long-term investment in the prosperity of the area. The applied transit solutions however appear to have manifested through a short-sighted approach based primarily on highway widening.

After observing the possible failure of the project to provide long-term solutions to transportation problems downtown, it is important to determine if its shortcomings could have been averted. Indeed, transit alternatives are important in any modern urban transportation system. Whereas a single general access highway lane will carry less than 1,500 vehicles per hour, a single rapid transit line can transport as many as 40,000 passengers in the same time span. An artery design that placed more emphasis on mass transit would surely represent a system that is more efficient at moving people. Why did the final Central Artery/Tunnel design allocate such a disproportionate amount of resources to highways over its alternatives?

The answer to this puzzling characteristic in the new artery design is an indicator of a fundamental urban development paradigm that persists within American culture. It is impossible to solve the puzzle of the Big Dig without studying the trends in urban infrastructure development across the country. Not only do these trends explain the auto-centric design of the highway, they foreshadow the potentially ominous future of the American city.

VIII. The Bigger Picture: Automobiles and the Fate of the American City

"As soon as people become tributaries of transportation...the contradictions between social justice and motorized power, between effective movement and higher speed, between personal freedom and engineered routing, become poignantly clear."
-Ivan Illich

Despite lessons learned from the era of aggressive highways, the bulk of infrastructure expansion in the country is still within the realm of highway construction. Although cities like Boston and New York watched traffic volume on their highways skyrocket after massive increases in carrying capacity, the overriding mindset still dictates that further widening will solve transportation issues. Such proposed solutions frequently dominate plans to expand mass transit in and around cities. And as land such as the downtown corridor in Boston is further developed with highways, it grows less likely that such transit expansion will ever occur.

Identifying the Fuel of Automobile Dominance

The modern emphasis placed on highways in urban infrastructure can be linked to a number of underlying social and political forces. These forces, which have continually fueled the development of urban highways despite their destructive nature within the urban landscape, are similar to the forces that gave rise to the automobile in the 1920's. While the technological complexity of highway development has continually evolved through the past century, the forces that drive the advancement of urban transportation have not.

Government Policy

The immensely disproportionate funding policies of Roosevelt's New Deal programs had allowed the automobile industry to prosper while the railroads continued to sink into bankruptcy. As cities and suburbs continued to grow, automobile infrastructure was built and funded through a series of state and federal programs and administrations. The task of expanding and modernizing America's rail network however was left with the streetcar and railroad companies.

While several public officials such as Governor Sargent have succeeded in advancing federal funding for public transit, financial support for road and rail remain substantially uneven. Federal highway dollars provide funding for nearly 90 percent of urban highway project costs. The concept of "ten cent dollars" remains alive through the Central Artery/Tunnel project, for which the federal government if funding a vast majority. Government funding for the expansion of the nation's rail network is sporadic at best. While highway funding in the United States is repeatedly viewed as glamorous, funding of light and heavy rail appears almost taboo. The perspective is illustrated clearly when federal support for domestic rail is compared to financial support given to the rail networks of Europe. Germany and France routinely allocate 22 and 21 percent of their annual transportation capital on rail, respectively. In the United States, the equivalent value resides at four tenths of a percent.

In order to win the hearts of the voting public, state and city officials continually work to acquire federal funding for municipal projects. By appropriating the bulk of funding to roads, the national government entices such officials to appeal for highway projects over urban rail projects. The seemingly bottomless budget of federal highway programs continue to perpetuate this political effect, motivating officials to seek highway dollars in order to fulfill the expectations of the voters.

Popular political nomenclature often aggravates the discontinuity between highway and rail funding. Federal support for highway development is often viewed by politicians as an investment in infrastructure. Political response to rail funding is often in contrast to this viewpoint. Officials continually declare financial support for rail as "subsidies" and "bail outs", expressing an expectation for the railroad to break even or turn a profit from the allocated funds. Such expectations rarely accompany federal funding for urban highways.

The Same Old American Mentality

Working in conjunction with government policy of the 1930's to fuel the advancement of the automobile was a new facet of the American psyche which has nostalgically been referred to as the "American love affair with the automobile." Glamour was integrated early on in the lifetime of the automobile by the national media, portraying the simple act of driving as an exciting and liberating experience. The car became a sacred symbol in American music and movies. The public

flocked to see movies portraying a young James Dean who preached the ideology of living fast and dying young. The man and his message were only further immortalized following his death at the age of twenty four when his Porsche Spyder collided with an oncoming vehicle – a consequence of the vehicle that his following continually chose to ignore.

As the role of the automobile grew more fundamental in American society, the symbol of excitement and liberation became a symbol of status. In Fink's model, this phenomenon signaled the onset of Consciousness II, when the automobile itself became an icon. Public transit began to represent financial deficiency, as its riders were assumed to be living in the same poverty that the transit companies were experiencing. To take the train was to state one's lack of the means necessary to own and operate an automobile. As the transit lines suffered continued financial loss, their vehicles grew increasingly decrepit.

As rail service became the symbol of poverty, the automobile grew into the symbol of prosperity. This evolution further solidified the perceived necessity of the automobile in American culture. This growing perception of necessity has infiltrated every level of city and state government, and officials continually act under the belief that Americans will not widely use public transit. This mentality results in the further expansion of highways and the continued neglect of existing transit facilities. As a consequence of the actions by public officials, journey-to-work commuters remain faced with no alternative that provides the same level of service, speed, and comfort as their automobile. The commuters continue to use their automobile, thereby fulfilling the prophecy of the public officials. The perpetuation of this cycle in urban areas has led to the establishment of highway development as this quintessential solution to transportation ailments.

The Damaging Effects of Highways in Cities

The combination of city, state, and federal public policy and the perpetually auto-centric mentality of America has allowed for the continued dominance of highways over alternative modes of transit. Urban highway development has repeatedly proved socially, economically, environmentally, and aesthetically destructive to the cities in which they are built, yet these transportation solutions continue to receive vast amounts of federal funding while alternative transit solutions receive little to no support. Examination of the elevated Central Artery has revealed several ways in which such highways have proven unilaterally destructive to the urban landscape. Such roadways serve as physical, social, and economic barriers as communities are detached from adjacent communities. Sunlight, airflow, and pedestrian movement are often greatly deterred by the structures, which often appear as steel walls or concrete trenches more than a hundred feet wide.

Other externalities introduced into the city from the highway include degradation in air quality as well as the elevation of noise and light pollution. Salt, oils, and volatile chemicals left by

cars on the roadway often spread to nearby structures, which experience accelerated aging, corrosion and disintegration. Such materials are deposited in nearby parks and gardens, adversely affecting the growth of urban vegetation.

The construction or expansion of urban highways leads to a higher volume of traffic deposited on city streets. While many projects consider such deposition through the redesign of adjacent ramp-end intersections, the elevated traffic levels permeate the city, leading to accentuated traffic and parking problems throughout downtown regions. Increased traffic levels not only endanger drivers, but also pedestrians and cyclists. Many projects such as the Central Artery/Tunnel in Boston show consideration for pedestrians near the project site itself yet show little consideration for pedestrians facing elevated traffic volume in other areas as a result of increased highway capacity.

Conversion of America's "walking cities" into "driving cities" has led to an awkward transition with many consequences. The widening of thoroughfares and construction of parking garages has transferred countless acres of city land from the local resident to the commuter. Cities grow less enjoyable for individuals on the streets and on the sidewalks. The narrow streets of cities developed before the age of the automobile provide little room for expansion and capacity increase. Modern solutions involve the elimination of oncoming traffic and the development of a complex network of one-way streets that confuse and irritate unfamiliar motorists. The social, economic, environmental and aesthetic consequences of automobile infrastructure enhancement within cities have grown noticeable from virtually every angle of the urban landscape. As ever-expanding highways dump ever-growing numbers of cars in the hearts of American cities, life and movement within those cities will almost certainly continue to decay.

Securing the Future of American Cities

From the colonial cities of Boston and New York to the post-automobile boom cities of Houston and Los Angeles, no downtown has been spared from the wholly destructive effects of modern automobile traffic. City limits are marked with massive highway interchanges, often termed "spaghetti bowls" because of their chaotic appearance. As the size and intricacy of the nation's highway network grows, so too does the dependence of the public on the infrastructure of the automobile. It has been shown that alternatives to the automobile exist, and that their failure to dominate modern transportation is not due to technological inferiority but a series of social and political forces that have aided in the perpetuation of the nation's roadways. If cities are to be saved from the ever-expanding highway network, such alternative modes must be cultivated. The forces that continue to suppress these modes must be eliminated. While society's dependence on transportation will inevitably remain a permanent fixture in human civilization, the urban highway need not be.

IX. Seeking Alternatives

"You're not stuck in a traffic jam, you are the jam."
-German public transportation campaign

In order to ensure the long-term future of American cities, corresponding long-term solutions to transportation issues must be developed. As cities continue to grow, the corresponding infrastructure must remain flexible to grow as well. Current infrastructure projects do not embody any long term considerations. The complete dedication of the Central Artery to highway travel, for example, means that future expansion to the network must involve the implementation of added lanes. The cost associated with the depression of the Central Artery suggests that such future subterranean expansion is unfeasible. However if an alternative to highways is to be implemented, it must provide a level of service comparable to that of the automobile. Successful transcendence from the highway to the system of the future must involve no substantial reduction in associated levels of convenience, reliability, speed, or comfort.

Exploring the Options

Realization of future urban transportation does not hinge on the development of a yet unknown system of mass movement. Indeed, some of the most effective modern alternatives to highway travel are based on systems and technologies that predate the automobile. A revolution in urban movement may not be technological; however the occurrence of such transcendence inevitably involves the widespread implementation of alternative technologies. But what alternative mode could feasibly supplant the automobile and its extensive infrastructure? To answer this, it is important to closely study the potential alternatives and assess the technological, economic, social and political benefits and roadblocks involved in their implementation.

Rail

While most surface and elevated rail lines in America's cities disappeared during the twentieth century, many urban areas still boast a stable light rail network, often operating primarily underground with several elements remaining at or above street level. Very often, these lines are directly tied into existing heavy rail networks that provide intercity and suburban commuter passenger services. The preexistence of light rail within cities is a major advantage to this alternative, as future development involves rehabilitation and expansion of the existing infrastructure rather than the complete development of a yet unseen urban system.

While automobile-dominated surface streets have forced most urban rail underground, the potential exists to place more rail at or above the street level, and represents an inexpensive alternative to further subterranean development. By creating an urban rail network that combines underground lines with surface lines, most urban areas could provide an extensive system that facilitates convenient and efficient travel in and around cities.

One of the most significant benefits of a rail network is its capacity. Calculations of the highway capacity within the Central Artery/Tunnel reveal an estimated volume of 1,276 vehicles per hour, most of which carry only a single individual. Modern traffic design strategies allow for the accommodation of up to 1,500 autos per hour. If appropriated by rail however, a similar lane-width could accommodate up to 40,000 passengers per hour. To reach such a capacity, a single urban highway would require upwards of fifty-three lanes to accommodate a volume of single-occupancy vehicles equivalent to a single multidirectional line of light rail. Even if dual occupancy policy was mandated on all drivers, twenty-six lanes would be required to provide enough volume for vehicles containing a driver and one passenger.

Design for high-volume travel by rail, therefore involves a much simpler and less costly process. Subterranean arteries such as Boston's Central Artery/Tunnel would involve fewer lanes and therefore a smaller tunnel. Construction of such facilities would be far less costly, and significantly less potentially detrimental to surrounding structures. Indeed, the original rail-based Central Artery proposal of the 1920's, which envisioned the development of a rail line through the downtown corridor, could provide nearly four times the carrying capacity of today's modern depressed tunnel.

It has been shown by projects such as the Central Artery/Tunnel that large infrastructure projects become increasingly costly when conducted in an urban setting. The widening of highways – a simple and inexpensive task in rural America – grows in cost and complexity almost exponentially as the surrounding land grows more densely populated. Urban rail networks involve a combined investment on infrastructure and service. The capital cost of developing the structural systems is dramatically lower over equivalent highway counterparts. These reduced structural costs are

complemented by service costs, covering such post-development factors as maintenance and repair, and management and operation. The focus on service in urban rail provides a number of advantages over highways, which instead dominate in infrastructure costs. Initial development of a rail line is significantly less costly than a highway in urban areas, as fewer lanes are needed. The reduced demand for line width necessitates the condemnation of less land for the system right-of-way. Additionally, a reduction in line width facilitates the submergence of the network underground, where it results in minimal impedance on the surrounding urban landscape.

The substitution of service costs over infrastructure costs also results in greater system flexibility. Rail infrastructure can be designed with long-term volume demand in mind. Service on those lines can be designed to meet current passenger levels. As these levels grow, growth of network capacity involves the increase of service investment instead of further infrastructure development. Operators and vehicles can be added to existing lines to increase service. Service frequency and daily hours can also be tweaked to meet current passenger demands. Such flexibility allows for the one-time development of transportation infrastructure in order to meet long-term needs.

Primary drawbacks to intensified investment in rail revolve around the reluctance of the public to largely utilize such transit over the automobile. Government policy and the public mentality result in the reduced patronage on most rapid transit lines. The victim of a century-old self-fulfilling prophecy, the establishment of mass transit as a symbol of filth and poverty has led to the actualization of these qualities. Many urban lines have acquired a widespread reputation of being dirty and crime-ridden. Intermittent and unreliable service has risen due to reduced maintenance and upgrade budgets. The lack of consistent federal support has made the urban rail lines of America completely dependent on their patrons. The cycle of mass transit negligence persists throughout the nation's cities. Federal investment and active participation in the rehabilitation of these aging lines is essential for the reestablishment of rail as the dominant mode of urban transportation.

Motorized Public Transit

As the public image of urban light rail has grown tarnished, so too has the reputation of city bus systems. Originally imposed as high-tech substitutes for preexisting streetcar lines, busses were thought of as the future of street-level public transit. Indeed, they continue to serve as mass transit solutions that work not only in cities but in rural America as well. Forced to share the clogged city thoroughfares with urban automobile traffic, public busses face the same vulnerabilities that cars do. A bus system that relies on major roads provides little to no incentive for drivers, whose smaller and more maneuverable cars often navigate such traffic jams far faster than their cumbersome bus counterparts.

The underfunding of public bus systems again leads to the establishment of a system that is notorious for being dirty and unreliable. Like rapid transit, the label of the bus system had become one of poverty and destitution. Poorly publicized urban bus systems remain unnoticed or baffling to residents, who are provided no incentive to utilize such public services.

The poor image of the bus system can be attributed to the weak funding of urban transit programs. Many vehicles in use have succumbed to filth and disrepair due to weak state and federal investment. In most cases, no effort is made to provide infrastructure dedicated to public bus systems.

The primary advantage of a large-scale urban bus system is its cost. The infrastructure for such systems largely exists today in the form of modern automobile lanes, which can be shared with busses or designated as managed access lanes for exclusive bus use. Whereas rapid transit costs are mixed between infrastructure and service, costs for comparable bus systems are almost entirely service-based. The enlargement of system capacity affects service costs, and bus system capacities can be continually adjusted to meet current passenger demands.

Large scale investment in public bus infrastructure can provide significant incentives resulting in increased ridership. Elevated funding would allow for the integration of added comfort and convenience associated with transit by bus. Reliability is improved through the dedication of bus lanes for exclusive transit use. The establishment and enforcement of dedicated bus lanes results in the enhancement of speed and timeliness. The attractiveness of such an alternative becomes clear during peak traffic hours, when busses can navigate congested arteries, undeterred by the presence of automobiles. Investment in infrastructure for urban bus systems could lead to the development of dedicated bus tunnels, as seen in such cities as Providence. Bus tunnels provide quick access between otherwise distant communities, enhancing speed and convenience associated with public transit. By providing such incentives, motorized public transit can embody incentives not currently seen in most urban bus systems. The funding needed for such service improvements is virtually negligible when compared to automobile infrastructure development. The annual cost of the Boston Night Owl service – a series of bus lines operating during late night hours – reached $2,800,000. This figure represents a cost equivalent to less than a single day's spending on the Big Dig. Public motorized transit represents a flexible, inexpensive alternative to automobile transit. The poor public image of urban bus systems is a direct result of weak funding on behalf of state and federal governments. The minimal investment in service and infrastructure could lead to a system that is flexible and effective, and facilitates faster movement between urban neighborhoods than automobiles.

Low-Tech Solutions

Historian Kenneth Jackson has referred to American cities of the early nineteenth century as "walking cities". Before the explosive influx of streetcars, the dominant mode of short-distance transportation was walking. Pedestrian movements remain significant in cities, however the invasion of the automobile has deterred many for walking more than is absolutely necessary. Fast-paced, busy thoroughfares remain dangerous for pedestrians, who continually lose ground to the automobile. While projects such as the Central Artery/Tunnel seek to restore land to the walking public, these new structures facilitate a greater influx of automobiles into city centers. By doing so, they deter pedestrian movement throughout the urban core. The reduction or elimination of traffic within the city is likely to largely restore residents' propensity to walk to nearby destinations. The creation of pedestrian infrastructure, which includes sidewalks, and pedestrian tunnels and overpasses requires minimal financial investment. The nature of pedestrian travel is significantly less destructive to such infrastructure, requiring minimal maintenance when compared to roadways or rail lines.

A large contingency of the urban public expresses a willingness to use bicycles for urban travel. Many individuals who would otherwise use bicycles are often deterred by the lack of infrastructure and service provided to them. While urban trails and walkways can be designed to serve both pedestrians and cyclists, the addition of bike lanes to surface roadways is often an inexpensive feature that promotes the use of alternative modes of transportation. Many cities exhibit an extreme lack of bicycle racks along sidewalks and streets, making it difficult for cyclists to safely park their bike downtown. The implementation of bicycle racks and lanes represents one of the most inexpensive solutions to urban transportation problems.

The promotion of pedestrian and bicycle transportation not only represents an inexpensive solution to costly urban traffic problems. By promoting walking and cycling, public officials and city planners also facilitate community interaction and communication. An individual on the sidewalk interacts with one's surroundings far more than an automobile driver. Community development, exercise, and an emphasis on aesthetics in the surrounding environment are all positive effects of increased pedestrian traffic.

Future Alternatives

In the study of possible sustainable transportation modes in future American cities, it is important to include consideration for future transportation technologies. While most of the current automobile alternatives have existed in a variety of forms since the nineteenth century, many new technologies may result in additional alternatives that may aid in the reduction of America's car dependence. It is of extreme importance to maintain a liberal approach to potential future solutions, as most new technologies sustain an initial awkward appearance.

One such potential solution lies in the realm of telecommuting. The advent of computers and high-speed communication networks has allowed a small number of today's employees to work from home. Instead of commuting to a cubicle and desk in the middle of a dense urban core, these employees obtain high-speed linkups to company networks, and experience equivalent levels of productivity from their home offices. The expansion of such technologies may facilitate a reduction in the overall level of journey-to-work commuters attempting to simultaneously reach their downtown offices. While the number of current telecommuters is negligible in comparison to the vast number of commuters stuck in rush hour traffic, future advances in telecommunication technology may provide further incentives for firms to utilize this alternative to daily downtown journeys.

While technological innovations such as telecommuting may provide alternatives to travel, what future advancements will result in new vehicles and transportation modes? Popular science fiction media has left much of the American public familiar with such concepts as jetpacks and teleportation. Are such transit modes a fantasy, or could the one day be reality?

"It is not likely in a thousand years, much less a hundred," is the response to the possibility of teleportation from Dr. Frank Wilczek, Herman Feshbach Professor of Theoretical Physics at the Massachusetts Institute of Technology. "There are far too many obstacles," adds the professor, whose recent achievements include the discovery of asymptotic freedom and the development of quantum chromodynamics. For now, it appears that such modes are not likely to dominate the urban landscape of the twenty first century. While this fact remains, it serves as an important reminder that planners and engineers must keep future technological possibilities in mind when designing the infrastructure of the future.

Reexamining Transit Alternatives

Analysis of existing and possible future alternatives has provided insight into the true technological and logistic realities of long-term urban infrastructure planning and development. As highways grow wider and more costly, these alternatives will inevitably gain attractiveness to public officials and city planners, who today face the daunting task of obtaining countless billions of dollars in order to add minimal volume capacity to existing arteries. Indeed, the course of social and political progress remains within the realm of the automobile, and corresponding driving forces have gained significant momentum. Yet beyond the social and political obstacles standing in the way of an urban transportation revolution lies a logistic and technological reality. Alternatives to highways must be considered. But what alternative transportation mode can adequately supplant automobile travel in and around cities? Which single option provides equivalent convenience, reliability, speed and comfort?

The resulting answer is, "none of the above." There exists no alternative that is clearly superior to all others. Each mode of transportation inherently embodies both advantages over and disadvantages to other options. It is therefore clear that no single mode of transportation should dominate in an urban setting. An effective solution to the looming urban transportation crisis involves balanced investment in a series of alternative technologies.

The seeds of sustainable urban infrastructure already exist in American cities. Subways, trolleys, elevated rail, rapid transit, public bus and tram, bike lanes and pedestrian walkways all exist in varying forms in virtually every major city in the country. These seeds must be cultivated by state and federal funding. In order to provide solutions to long-term transportation problems, investment in urban transportation infrastructure and services must be evenly distributed in order to facilitate growth and prosperity on each available service.

A similar response is illustrated by a model proposed by the National Growth Management Leadership Project. In this model, transit modes are assessed according to the three "Ds": density, designation, and design. The NGMLP stresses that mass is indeed required for the success of mass transit. Density therefore plays a dominant role in the design of a balanced transportation system. Within urban areas, population densities stress the importance of mass transit. It is also important to ensure that the land surrounding an existing mass transit line is permitted to acquire such needed densities. Designation refers to these nearby zones, and stresses the importance of designing land to work with the available modes of transit. In order to promote such dense residential accumulation, good design practices must be invoked. As transit often requires residents to endure a short walk to a nearby transportation hub such as a bus or subway terminal, surface design practices should promote aesthetics and comfort for pedestrians.

While such alternatives provide solutions to movement within the city, a major revolution in transportation must center on the arteries that carry goods and people into and out of the cities. Highways and beltways must be complemented with direct and visible alternatives, such as rapid transit lines and managed access lanes for busses and multioccupancy vehicles. The response to increases in highway volume must no longer focus on the addition of more general access lanes. The pressure on America's arteries must be eased through the implementation of transit alternatives that result in spatial, temporal and modal convergence away from automobiles and back on more manageable urban vehicles.

A Balanced Approach to the Central Artery/Tunnel

An analysis of the multibillion dollar project underway in downtown Boston has revealed its likely success as a massive urban beautification project, and has suggested that the enhancements of the artery will prove largely fruitless as additional capacity is quickly engulfed by growing volume on

America's highways. The realized design for the new transportation system represents an unbalanced transportation model. The new highway provides no incentive for modal convergence on alternative transportation systems. As a result, commuters are likely to grow more dependent on automobiles, and further stimulate the social and political forces that fuel the dominance of highway development over other forms of infrastructure.

Conceptual development of a design alternative for the Central Artery begins with the acknowledgement that individual modes of transportation are ideal for regions with a unique population density. While automobiles prove inefficient in dense urban areas, they represent an effective mode of transportation in suburban areas, where the relatively sparse populations prohibit the implementation of extensive public transit. A balanced transit system would therefore emphasize fluid automobile traffic in suburban areas, while promoting the use of mass transit in dense urban areas. This strategy leads to the development of a system that motivates the journey-to-work commuter to drive from home to a facility where he or she can quickly and easily transfer to a mass transit line that provides levels of service equal or superior to automobile travel.

In most areas, a popular alternative to highway travel involves rail-based rapid transit. To maximize effectiveness, such transit networks should be placed along the shoulders of existing highways or along the median between opposing lanes. Multiple networks running parallel through the Central Artery would provide visible options for the commuter, who would interact on a daily basis with other forms of transit. As the inevitable buildup of automobiles continues to reduce the speed and efficiency of such vehicular travel, convergence is likely to occur on alternative modes. Within the Central Artery tunnel itself, the sacrifice of one car lane in each direction could facilitate the implementation of a rapid transit system that could move up to 40,000 passengers per hour. Such a system could be used to connect the rail stations to the north and south of downtown – closing the one-mile rail gap along the central corridor. The connection between North and South Stations would enhance journey-to-work travel by commuter rail, and would facilitate the simple transfer from northern rail lines to southern rail lines. This single one-mile line would not only link the two commuter terminals, but all four subway lines along its route, optimizing the speed and simplicity associated with rail transfers.

Transfer facilities would occur frequently along major highways such as Interstate 93, providing the driver with numerous opportunities to switch to rail. Many commuters may be reluctant to utilize local transfer facilities, however propensity to transfer is increased when delays and congestion is encountered. By providing frequent transfer stations, the driver is likely to encounter an opportunity to switch transportation modes in the midst of traffic delays. This design strategy takes advantage of temporal convergence, as drivers seek faster alternatives to sitting in traffic.

Implementation of rapid transit within the Central Artery tunnel would reduce the highway width from eight lanes to six, similar to the elevated expressway that predated the new roadway. As a consequence, this alternative design involves no physical expansion of the roadway. The MTA has repeatedly assured residents that higher traffic volumes will be accommodated in part due to the improvement of highway conditions, resulting in reduced merging and lane changing. This design perspective could be used to assure drivers that the new tunnel will represent increased traffic capacity despite the absence of highway widening. The new highway would accommodate existing traffic levels in a safer and more efficient manner while resulting in reduced traffic generation from highway capacity improvements. Over time, significant numbers of journey-to-work drivers would adopt the rapid transit alternatives, providing increased revenues for mass transit networks while simultaneously easing traffic problems on the corresponding highway.

To further combat automobile congestion, the left lane in each direction would be designated as managed access; dedicated to public transit and multioccupancy vehicles. Integration of managed access lanes would lead to reduced traffic volume by motivating drivers to fill the empty seats in their vehicles in order to bypass congestion in general access lanes. Moreover, by providing dedicated lanes for public transit, the design leads to quicker intercity movement by bus than in an automobile. By allowing individuals to travel faster by bus than by automobile, the design enhances the attractiveness of the service, and further motivates urban residents to utilize alternative modes of transit.

The alternative design illustrated above involves little investment over existing plans. Yet the development of this balanced transit system results in the extensive integration of single-occupancy automobiles with rapid transit, public bus systems, and multioccupancy vehicles. By placing these modes in close proximity, the design promotes the use of transportation networks that can be designed for long-term capacities. While service on rapid transit and bus systems must always remain at levels that are competitive to highway travel, specific service levels – including number, size, and frequency of transit vehicles – can be continually adjusted to meet current passenger demands. An increase in passenger volume can be quickly and easily accommodated through the enhancement of service on alternative transit lines. Such service enhancements have minimal effect on the urban landscape, which loses no additional land to future capacity improvements.

While this alternative design results in a virtually self-regulating transportation network that provides long-term urban transit solutions, its implementation in today's American cities is a logistical impossibility. Unbalanced state and federal transportation funding and the American mindset are two of the mounting obstacles that continually render such transit improvements unfeasible. Overcoming these obstacles represents a massive and radical task in today's society. A transportation revolution in present-day civilization will not be abrupt, and may occur over the

course of many years. However just as the perpetuation of the automobile has occurred through persisting economic, social and political cycles, so too can a transit revolution that could save cities from the ever-expanding highways.

X. A Call for Action

"It is a quest for the connecting of lives released from mobile steel cages and a questioning of the notion that the American existence is 'I move, therefore I am'."
-Jane Holtz Kay

The designs, ideals and criticisms illustrated thus far are indeed radical. The sacrifice of available automobile lane miles for public transit violates the social, political and economic norms of present society. Disinvesting in highways for the sake of busses, light rail, pedestrians and cyclists represents a political move with high associated risk. Urban progressives that seek to undermine automobile infrastructure swim against a strong current. Yet every fiscal year brings added car capacity on urban highways, carrying greater numbers of automobiles into cities unequipped to handle them. While designers and planners can widen highways, enlarge intersections and traffic circles and transform simple bi-directional thoroughfares into one way streets, they cannot shelter the city from the detrimental affects posed by automobiles on urban aesthetics, air quality, noise and light levels, open space along street medians and sidewalks, and overall space in the city. These ominous trends require immediate attention.

It is human nature to resist lifestyle changes of this nature. Historically, unsustainable human behavior has only been stopped by the depletion of the resources needed to maintain the associated activities. In the case of urban automobile infrastructure, this depletion point may occur only when the developing car glut has consumed all open space in the city, saturating local and express arteries which would prove too costly to widen. In rural and suburban America, the automobile promotes life and movement. Within the city, unregulated automobile use and growth is a cancer. Its escalation to dominance on the streets has pitted the very act of improving transit in a battle against air quality, parks and open spaces, aesthetics of the urban landscape, and alternative forms of transit.

A Realistic Approach

While abrupt and drastic action would inevitably prove fruitless to public officials, city planners, engineers, and public servants; subtle changes in the current planning and design paradigms can serve as a seed from which change in urban infrastructure can grow. Much as the seeds of automobile infrastructure were nurtured by federal policy and American social propensities, so too can the seeds of transit growth be cultivated. These changes are applicable to virtually every stage of project delivery, including conceptual design, acquisition of land and finances, permitting and approval, technical design, project construction and lifetime operation and maintenance.

Planning for the Future: The Right of Way for Rail

In most instances, new urban highway design projects do not involve the integration of parallel rail lines. Beyond construction, social and political logistics, current trends in project funding often do not facilitate such alternate mode integration. While the infrastructure needed for rapid transit may not appear in an artery design, land along the shoulders or within the median can be reserved as right-of-way for rail. By reserving a strip of land no wider than forty feet, highway planners reserve the opportunity to provide tremendous modal alternatives in the future.

The potential benefits of this situation were illustrated after the construction of the Van Wyck Expressway in 1945, which provided direct access to New York city's Idlewild Airport on Long Island. Initial proposals were made that stipulated the reservation of an additional forty feet for future rapid transit. During construction, the foundation under the reserved right-of-way would have been fortified and prepared for future light rail use. At that time, the cost associated with the reservation of the additional land and enlargement of foundations was estimated at $1,875,000. This forward-thinking plan was scrapped in the final stages of planning, and the additional forty feet was not acquired and fortified. Growing trends in traffic and the effect of triple convergence led to the clogging of this artery within ten years of opening. When planners in the middle of the 1950's sought to acquire this additional forty feet for the rail link to correct the ten year old mistake, they found that acquisition of the land alone would cost $15,000,000 for each of the eighty-five miles along the expressway.

The astounding increase in land value is a result of spurred development that occurs alongside new highways. This growth creates obstacles that sometimes prove insurmountable for highway widening efforts. While rapid transit efforts rarely involve the political power necessary to succeed in the acquisition of land for the right-of-way, highway widening projects often prove more effective. By integrating land for future rapid transit into current highway projects, the social, political and financial forces that fuel highway expansion can be used to eliminate the deterring costs of land acquisition that render many transit projects unfeasible.

Celebrating Transit Achievement

The opening of a new automobile artery is often viewed as a tremendous symbol of achievement. City officials, planners and developers often promote and advertise city works projects that facilitate automobile use. Transit works projects often receive less coverage. The unbalanced promotion of road and transit projects perpetuates the mindset of the driver, who often values the automobile above other means of getting around. Beyond the solidification of this mental state, unbalanced publicity fails to fully inform the public of their transportation options.

This phenomenon can be observed with the Central Artery/Tunnel project ongoing in Boston. Publicity on behalf of city and state administrations and authorities centers on the depressed highway which, in the words of Fred Salvucci, "is the tip of the iceberg." While most of the efforts made with the funding for the project have been directed at highway enlargement and urban beautification, attempts were made at the rekindling of the once mighty railroad network around Boston before the first spade was laid in the soil of the central corridor. Under Governors King and Dukakis, new equipment was purchased for transit lines in and around the city. Currently, the project involves an enhancement of the public bus system downtown and the inclusion of the new Silver Line into the transit fleet. Yet publicity continues to focus on the roadway, causing residents and visitors to conclude that bus and rail improvements are less important than highway development.

Regardless of the realities of uneven transportation funding, public support of transit projects can be generated through a reaffirmation of their achievement. Promotion of such projects by public officials and builders would lead to intensified media coverage, which would improve both the general awareness and perception of public transit. This strategy requires little to no added financial investment over existing project costs, but would likely prove effective at reviving the once glamorous image of public transit during the rail era.

Managing Access on Highways

Most municipalities have begun to realize that traffic volume can be decreased by elevating the number of travelers in each vehicle. Reaction to this realization has led to the establishment of managed access lanes, which are designated for use by vehicles containing multiple individuals. As congestion continually causes delays in general access lanes, drivers become motivated to organize carpools, which in turn reduce the volume of traffic on the highway as a whole. While many cities and municipalities have dedicated lanes to vehicles with two or more persons, several urban regions have progressed to the designation of lanes for cars with three or more.

The success of this approach has been documented on the Washington, D.C. Beltway, which for years has remained one of the most congested arteries in the country. The incentive to carpool

has led to a unique social culture originating from the numerous park and ride facilities along the interstate. At these facilities, drivers pick up fellow commuters who are referred to as "slugs" to fill empty car seats. Those who participate in this ridesharing program observe the travel time of daily commutes plunging from over two hours to under thirty minutes. Those who do not participate in carpooling programs along the Beltway are left in a traffic snarl, observing to their left the multioccupancy vehicles traveling expeditiously to their destination. The visibility of this alternative to the single occupancy driver serves as an indicator to the reality of one's options on the road, resulting in a mindset that is more open to the consideration of different modes of transportation.

Integrated managed access lanes serve as infrastructure for a unique form of movement – one that is dependent on the automobile, yet operates as a form of mass transit. The designation of managed access lanes requires little capital investment, generally only necessitating new paint and signage. Yet by integrating this infrastructure into journey-to-work arteries, planners and builders provide auto-dependent commuters with a chance to participate in mass transit.

Building A Lane for the Bus

While managed access lanes generally promote carpooling activities, they are also designated for use by local bus systems. By creating lanes for buses, planners and builders allow public transit to traverse regions of the city faster than single-occupancy automobiles. The capability of buses to reach destinations faster than cars leads to an improvement in the attractiveness of public transit.

This effect is observed in the city of Providence, Rhode Island. Bus lanes exist in busy downtown areas, allowing public transit vehicles to bypass traffic snarls that delay automobile movement during rush hours. To promote citywide use of the bus as a means of movement within the city, bus tunnels have been developed that allow designated public transit buses to bypass steep, narrow streets that add time to travel by automobile. Those that regularly traverse the city are motivated to utilize public transit, which provides a speedy trip across town. While bus tunnels represent infrastructure that requires significant financial resources, bus lanes along many city streets provide similar benefits to public transit vehicles, and represent little added financial investment required for city projects.

Enhancement of public transit infrastructure can be accomplished in most areas with minimal financial investment. The designation of bus lanes along major thoroughfares can often occur with little impact on automobile traffic. Added financial investment could be used to upgrade bus interiors, providing cleanliness and comfort levels not observed on current public transit vehicles. By upgrading interior conditions, public planners and city officials could succeed in improving the reputation of motorized transit, thereby attracting more repeat riders. The combination of these

improvements with improved transit publicity measures could lead to successful ridership campaigns, which may begin to alter the American perspective of local bus services.

Establishing Modal Consciousness

While the implementation of alternatives such as public transit and managed access lanes can succeed in altering daily travel patterns into and out of cities, the effectiveness of these services is greatly dependent on their orientation with respect to competing highways. In order to enhance modal convergence on alternative transit networks, these systems must appeal to drivers at their most vulnerable point – the traffic jam.

A commuter whose lifestyle revolves around automobile travel gives little to no consideration to modal alternatives while in the driveway before their journey-to-work commute in the morning. Access, comfort and simplicity compel the traveler to depend on the automobile. The apparent benefits of the automobile begin to fade only when the driver encounters traffic congestion and repeated delays on urban arteries. At this point, the traveler is faced with the logical reality of automobile dependence. It is under these circumstances that the driver is most open to alternative modes of transportation.

Alternative transit networks such as commuter rail lines have been implemented along existing highway corridors, however few of these lines run immediately adjacent to existing highways. To the driver stuck in traffic, a rail line that is not immediately visible is not a viable alternative. While an individual may be conscious of alternatives, these alternatives must often be readily visible in order to significantly impact their decisions on urban travel.

The presence of a managed access lane or a rapid transit line along the median or shoulder of a highway injects this alternative into the reality of the driver. By observing the alternative modes traveling efficiently along the shoulder of the road on which he or she is rendered motionless, the advantages of mass transit over automobiles become clear. The drivers are directly faced with the choice of traveling by car or traveling quickly.

The exercising of modal consciousness techniques can be observed again outside of Washington, D.C. along Interstate 66, which carries journey-to-work commuters into and out of the city on a daily basis. Rush hour traffic invariably pushes the volume of automobiles to the limits of the highway's capacity. Short distance travel that would otherwise consume only minutes requires as much as several hours to complete by single occupancy automobile. Along the median of the highway however runs the Orange Line of the Metro Rail System, which transports passengers along the artery at a brisk pace even at peak hours. The presence of the rail system is constant in the mind of the driver, who sits alongside the network in peak hour traffic each day. Frequent stations are made immediately accessible from the highway, and exit signs remind the driver of the opportunity

to trade road for rail. The effective and balanced transportation system along Interstate 66 involves the generation of modal consciousness, as drivers grow increasingly aware of not only the presence of alternative transit, but of its benefits over the automobile.

Paying the Cost of the Car

While all drivers pay tax at the pump, few acknowledge this financial transaction. Even fewer can explain where that money goes. While patrons of bus and rail networks repeatedly pay fairs on a daily, monthly, or yearly basis, the costs of automobile use are obfuscated by a nebulous program of taxation that actually only begins at the pump. Externalities of automobile use that include environmental and medical mitigation, snow removal and street upkeep and repair consume state and federal funds that are appropriated from all taxpayers, even those that do not own a car.

The financial system as it stands today gives many drivers the impression that automobile infrastructure represents a system that exists at no cost to the public. Economists refer to this scenario as the illusion of a "free lunch," where drivers reap the benefits of the car culture without paying for it. This is indeed not the case. Alteration of this mindset begins with the instigation of programs to force drivers to pay fees that are overtly intended for the maintenance and upkeep of the infrastructure. In most cases, these fees can appear as highway tolls collected on urban arteries that are traveled at no expense to the driver.

The establishment of toll collection facilities is a legitimate move to reap financial compensation that can be used to operate and maintain the roadway. While tolls may serve as a general inconvenience to drivers, modern technologies permit fee collection without traffic buildup. The collection of tolls along urban arteries would result in a number of benefits. Fees collected could be used for roadway maintenance, including repaving and snow removal. To the driver, these tolls would symbolize the external costs of repeatedly utilizing the road; eliminating the illusion of a "free lunch" and making alternative transportation systems more financially competitive. The existence of toll facilities would eliminate superfluous trips downtown by drivers, and would promote the use of carpooling techniques. Finally, such toll collection facilities would motivate through traffic to seek alternate routes around dense urban cores, such as beltways and bypasses. The elimination of this traffic would result in a reduction of traffic capacity, making it possible to designate additional lanes for managed access use.

This technique would likely prove effective in Boston's new Central Artery tunnel, where commuters and through traffic alike are provided unlimited use at no cost. Public awareness of the immense cost further permits implementation of toll collection facilities. As revenue builds from such collection facilities, funds can be diverted to mass transit programs that can improve the competitiveness of alternative modes of urban movement.

Elevated and uniform toll collection along urban arteries would result in the establishment of secure funding for future maintenance and operation of the roadways as well as enhancement projects for mass transit alternatives. While the revenue would prove beneficial to urban transportation improvements, the true benefit of fee collection lies in its effect on the mentality of the American driver. Devoid of the "free lunch" illusion, the driver is forced to pay for the costs associated with frequent automobile use. Alternative modes of transit would grow more financially competitive with the highways that today serve as free alternative to mass transportation.

Starting the Cycle

Changes in human lifestyles and alterations to the urban landscape occur over lengthy periods of time. Even the automobile, which has arguably become the most critical gadget of the modern era, took time to develop permanence within society. The dominance of the automobile occurred through a perpetuating cycle that was sparked by Ford in 1908, and fueled by individuals with corporate, financial and political power. Political support and investment led to the enhancement of automobile infrastructure, which resulted in increased dependence and ridership. Increased dependence and ridership led to the need for more highway infrastructure, and fueled the cycle that has continued for nearly a century. The cycle has proved effective to an extent never before witnessed, however such cycles can be implemented elsewhere – including the fight against the swelling automobile dependence in modern culture.

Under the small tricks and methods aimed at igniting a transit revolution is the same underlying tactic used by automakers, politicians and industrialists throughout the twentieth century to sell cars. The tactic involves the realization and perpetuation of a progressive cycle. The subtle approaches to enhancement of modal alternatives institute a cycle that is fueled by a progressive mentality maintained by city and local officials.

An approach must be brought about that will bring an end to Consciousness II, and instate a third era of consciousness. The modal mentality of the American public must be balanced just as federal funding must be. Consciousness III must mark an era of decline for the automobile as a societal icon, and the removal of stereotypes currently synonymous with public transit.

A cyclic model for urban renewal has been developed and implemented by Dennis Frenchman, head of the City Design and Development Program at the Massachusetts Institute of Technology. His cyclic model involves the interplay of investment, quality control, image and incentives. While this model has been successfully implemented in the overall realm of urban renewal and improvements, it represents a highly effective approach to transforming the modes of human movement within cities. Applied to mass transit, the model implies that initial investment in infrastructure or service directly leads to improved quality control. Elevated quality control levels in

turn result in the enhancement of the modal image – slightly reversing negative stereotypes applied to mass transit over the past century. Creation of a better image provides travelers greater incentives to utilize the improved services. This inevitably leads to increased ridership, which ultimately justifies further investment. The cycle begins small with investment in features such as managed access highway, bus and bicycle lanes, improved promotional coverage of transit enhancements, and the establishment of toll collection facilities on urban arteries. Proper initiation of these improvements coupled with a continual effort to promote and enhance further transit projects can over time lead to substantially elevated investment, quality control, image and ridership on alternative transit systems.

The establishment of balanced transit systems in the cities of America is a difficult, yet not insurmountable task. The goals of many transit activists involve the immediate removal of automobile infrastructure implementation of large scale modern transit networks. True progress will be made through actions that are far slower and more complex, however. Transformations in human movement must not impede such movement, even in the interim of construction. The associated complexities result in levels of cost and effort that overshadow current capabilities. By implementing a perpetual transit enhancement cycle, such as the one modeled by Frenchman for urban renewal, large scale transformations can occur over time.

XI. Conclusion

"When a planner speaks of implementing goals rationally, he implies that it is possible to demonstrate logically and experimentally the relationship between the proposed means and the ends they are intended to further"
-Alan Altshuler

Throughout the past century, the physical landscape of virtually every city has been largely decimated by the introduction of the automobile. Highways carry millions of cars into and out of dense urban cores each day, unloading vehicles on inner city thoroughfares that are ill equipped for such traffic. With the vehicles come congestion, noise, and pollution of the air, water and land. Local residents continually lose land to the automobile, including buildings that are razed for new highways and highway expansion projects as well as the loss of pedestrian and public space throughout the city. The modern paradigm of urban transportation enhancement has led to a tragic conflict between infrastructure development and other critical qualities of the downtown fabric, including purity of air and water, and the aesthetic use of land. Improvements in automobile infrastructure almost inevitably occur at the expense of such critical qualities.

The enhancement of automobile infrastructure within cities generally involves the development and widening of highways that infiltrate the very heart of urban America. While these projects are aimed at reducing congestion that has developed on virtually every urban highway in the country, the result is quite often the opposite. Highway expansion inevitably leads to increased dependence on the automobile within the regions surrounding the new or improved artery. The resulting "traffic generation" is a result of triple convergence effects that include traffic volume swelling due to spatial, temporal and modal advantages linked with the roadway. Resulting arteries

that have been designed to carry traffic efficiently for decades often reach capacity within only several years or, in some cases, several months.

While this documented phenomenon has been illustrated repeatedly in virtually every city in America, highway development continues to serve as the primary form of urban transportation enhancement. Such infrastructure enlargements often result only in further congestion on the road and damage to surrounding regions of the city, yet development of highways remains the primary investment by most cities. The reasons for such continued investment involve social and political forces that have fueled automobile dominance for almost a century. Unbalanced federal funding and support for transportation alternatives have allowed many public transit services to wither, while unwavering support for highway systems has persisted since the first New Deal programs implemented by Roosevelt more than seventy years ago. Such support has allowed the roadways of America to dwarf the railroads, which were continually forced into bankruptcy by constituencies from the auto industry, who purchased and dismantled more than one hundred competing rail services in the first half of the twentieth century. With no substantial modal alternative, Americans grew dependant on the automobile.

Federal financial support allowed for further investment in quality control and development of automobile infrastructure. Enhanced development and quality control repeatedly improved the image of the automobile, which took a glamorous role in American pop culture by the middle of the twentieth century and induced the "American love affair with the automobile." The improved image led to increased ridership and use, which further justified overwhelming financial support from Washington. This perpetual cycle fueled automobile dependence for more than nine decades, and allowed for the decimation of alternative transportation modes, such as streetcars and railroads. The seed of automobile dominance in American society was first planted by Henry Ford and cultivated by nearly a century of heavy federal financial and political investment. This dominance has led to widespread dependence of automobile infrastructure, which continues to fuel the development of highways over railways and other alternatives in cities.

The damaging effects of urban highway development can be seen in the City of Boston, which instituted a comprehensive urban highway development policy in the late 1940s. Construction of the elevated Central Artery occurred in the 1950s, which tore a swath of destruction through the very heart of the city, and left in this swath a structural blight that ultimately failed to improve human movement throughout the city. The consequences of such undertakings fueled an anti-highway movement that led to the declaration of a moratorium on further highway development within Boston.

To reverse the damage done to the city throughout this era of aggressive highways, the City initiated an ambitious project that was aimed at eliminating the traffic-snarled Central Artery from

the downtown landscape. Throughout the thirty-year delivery process, the project has repeatedly rejected opportunities for large scale enhancement of alternative transit. The CA/T Project, which held the promise of accomplishing such monumental tasks as eliminating the rail gap between North and South Stations, became a predominantly highway-oriented project. While early tasks of the transportation enhancement program included the procurement of new equipment for city rail lines and the attempted reclamation of several abandoned rail services, the project has been portrayed by the city and the media as a highway project. As a result, overwhelming focus has been directed at the depressed roadway, which the MTA has assured will provide adequate automobile capacity for decades. The project promises to do little more to urban transportation than intensify the dependence on the automobile as a means of entering and exiting the city. Triple convergence and growing traffic volume trends will likely eliminate the fluid motion of vehicles during peak travel hours soon after the highway is opened. While the multibillion dollar project will very likely succeed at beautifying the downtown area, the associated traffic problems will almost certainly grow worse.

The failure of the Central Artery design reflects the unbalanced federal support for alternative modes of transportation. By providing "ten cent dollars" to cities, the government has deterred investigation into better modal alternatives; as such alternatives would invariably lead to less federal funding. While recent policy changes such as the Intermodal Surface Transportation Efficiency Act of 1991 has led to the reduction of frivolous federal highway spending, transportation support is still far from balanced. Such unbalanced spending further fuels the anti-transit mentality public officials, builders, and residents.

As unbalanced transportation development persists, American cities continue to suffer. Added traffic volume permeates every region of an urban area, robbing residents and visitors alike of open space for movement, recreation and congregation. Air quality continues to worsen, and cities invest further dollars in cleanup programs and public smog level warning systems. Highways, thoroughfares, intersections and parking structures continue to introduce blight into downtown areas, robbing land that could otherwise be used for worthwhile development.

The introduction of a highway represents a short term solution to transportation problems. New high-capacity arteries will invariably grow insufficient for future traffic volumes. As cities increase in density, the widening of urban arterial highways becomes a financial impossibility. In order to ensure transportation solutions for future generations, human movement systems within cities must allow for an increase in ridership capacity without the consumption of more land.

Such accommodations can only be made through mass transit systems such as underground and surface light rail, where capacity enhancements are made through investment in service and equipment, and not infrastructure. One-time investments in mass transit infrastructure can result in the establishment of a network with the ability to accommodate ridership levels for centuries.

Cities and highways cannot coexist. Highways result in the continual consumption of land, which is scarce and precious in urban areas. While the automobile serves as an ideal mode of transportation in sparse areas such as rural and suburban regions, urban automobile infrastructure is not sustainable. Transportation plans today that involve the development or widening of roadways represent short term solutions, with stated lifetimes of only fifty years, and proven lifetimes that are far shorter.

The transformation of urban human movement systems must begin. While the immediate replacement of urban automobile infrastructure is unrealistic, city officials and builders are faced with the opportunity to institute and fuel cycles of funding, quality control and image enhancement that results in increased public support. Such political moves involve little financial investment and political risk. Managed access highway lanes on highways, bus and bicycle lanes on thoroughfares, secured right-of-way for future rail enlargements along major arteries, and the implementation of urban highway toll collection are all moves that have been used successfully on small scales by cities around the country. By continuing and enhancing such progressive solutions to urban transit problems, builders and city officials invest in the long-term life of their city.

American cities such as Boston have gained ambition and innovation toward municipal projects, which have allowed urban areas to continually grow and prosper for centuries. Like any other ecosystem, the ecosystem of the city relies on balance. The growth and betterment of the urban ecosystem involves progress in community development, maintenance of environmental quality, enhancement of aesthetics, and establishment of open space and life-sustaining resources. The prosperity of a city hinges on continued growth in each of these areas. The integration of a balanced transportation system can simultaneously facilitate human movement while preserving these other critical aspects of the human fabric. By acknowledging the necessary balance between transportation infrastructure and these aspects, urban communities can aspire for a future landscape that is free of pork barrels and boondoggles.

Appendix A
Maps of the Central Artery

Figure 1. Boston Highways Prior to Central Artery/Tunnel Project (Courtesy BigDig.com)

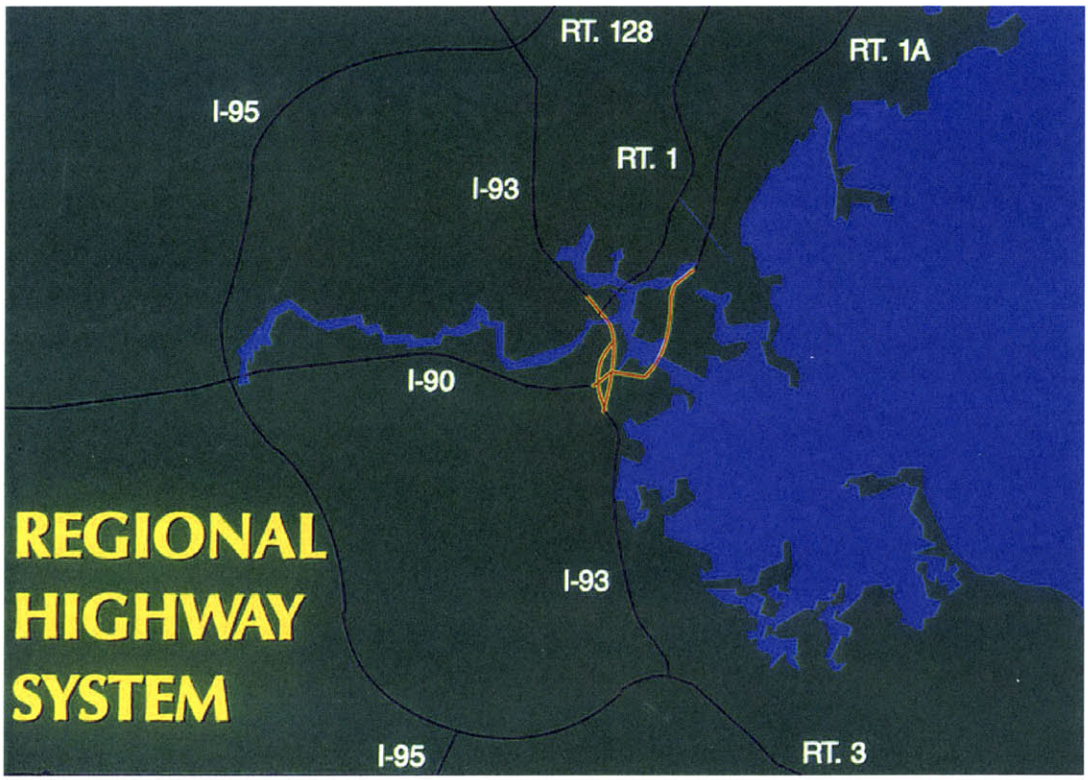

Figure 2. Regional Highway Map (Courtesy BigDig.com)

Figure 3. Map of Completed Central Artery/Tunnel Project (Courtesy BigDig.com)

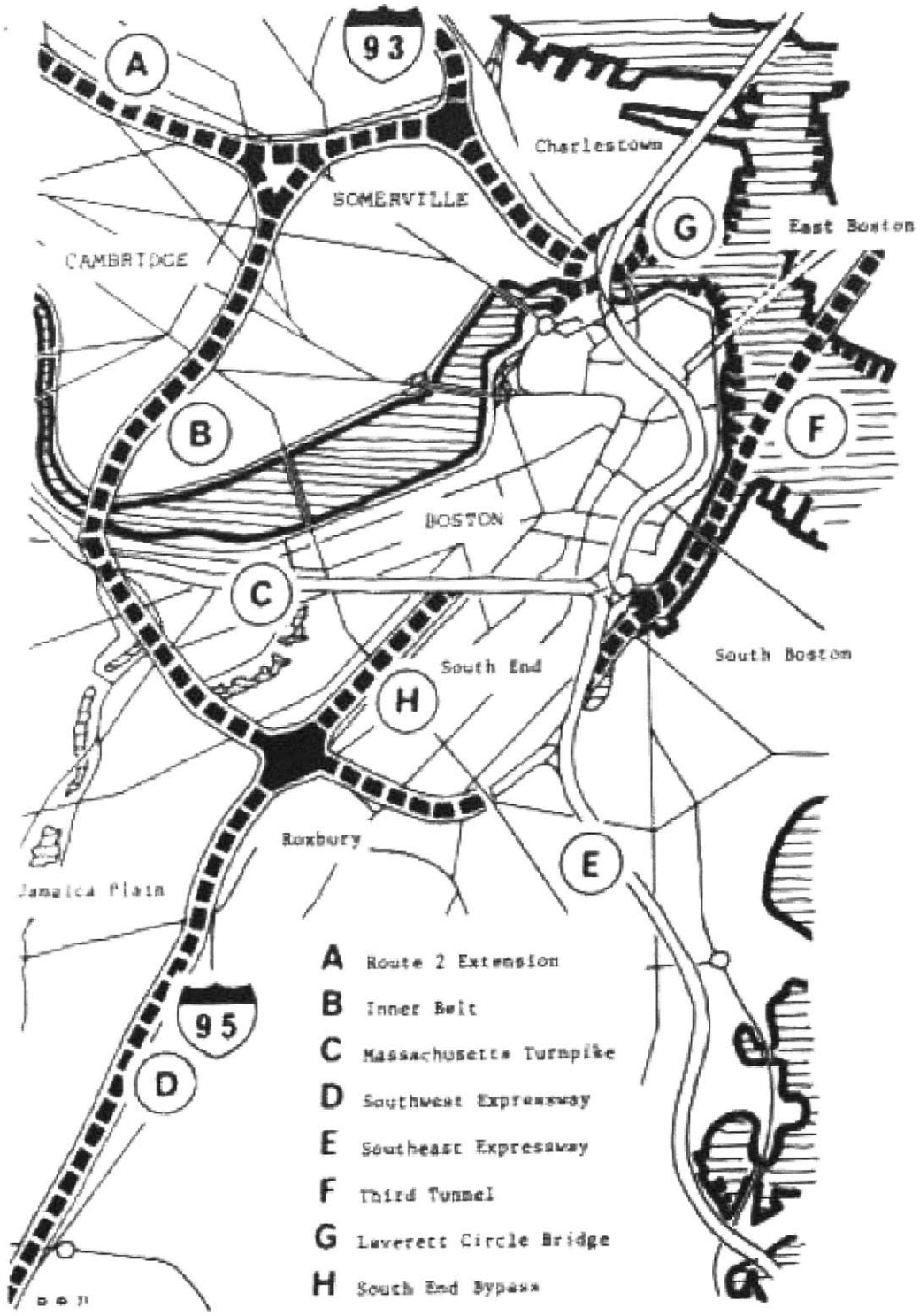

Figure 4. The Proposed Inner Belt Expressway (Courtesy Boston Redevelopment Authority)

Appendix B
Maps of Boston Rapid Transit Systems

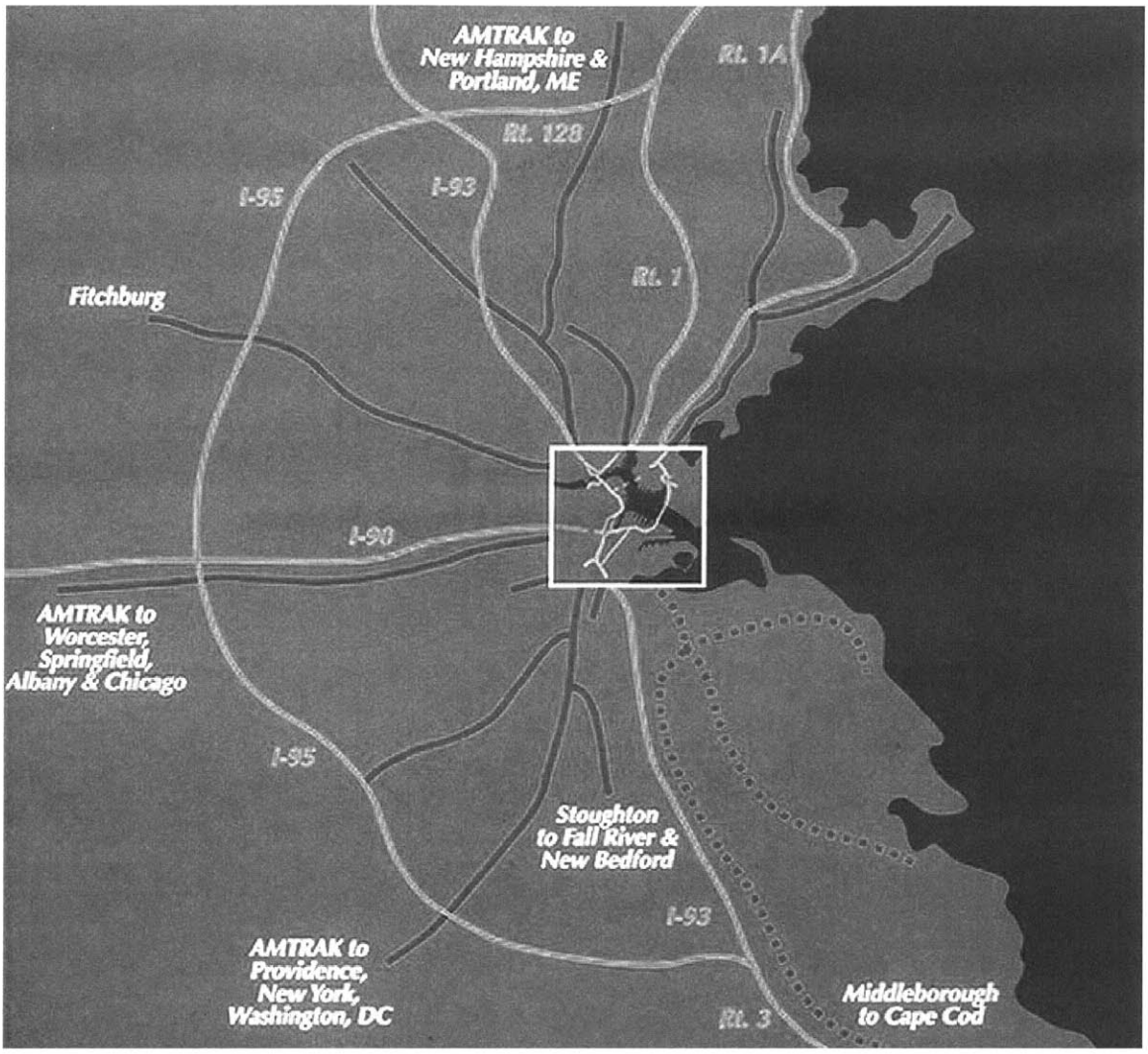

Figure 5. Amtrak Regional Map (Courtesy BigDig.com)

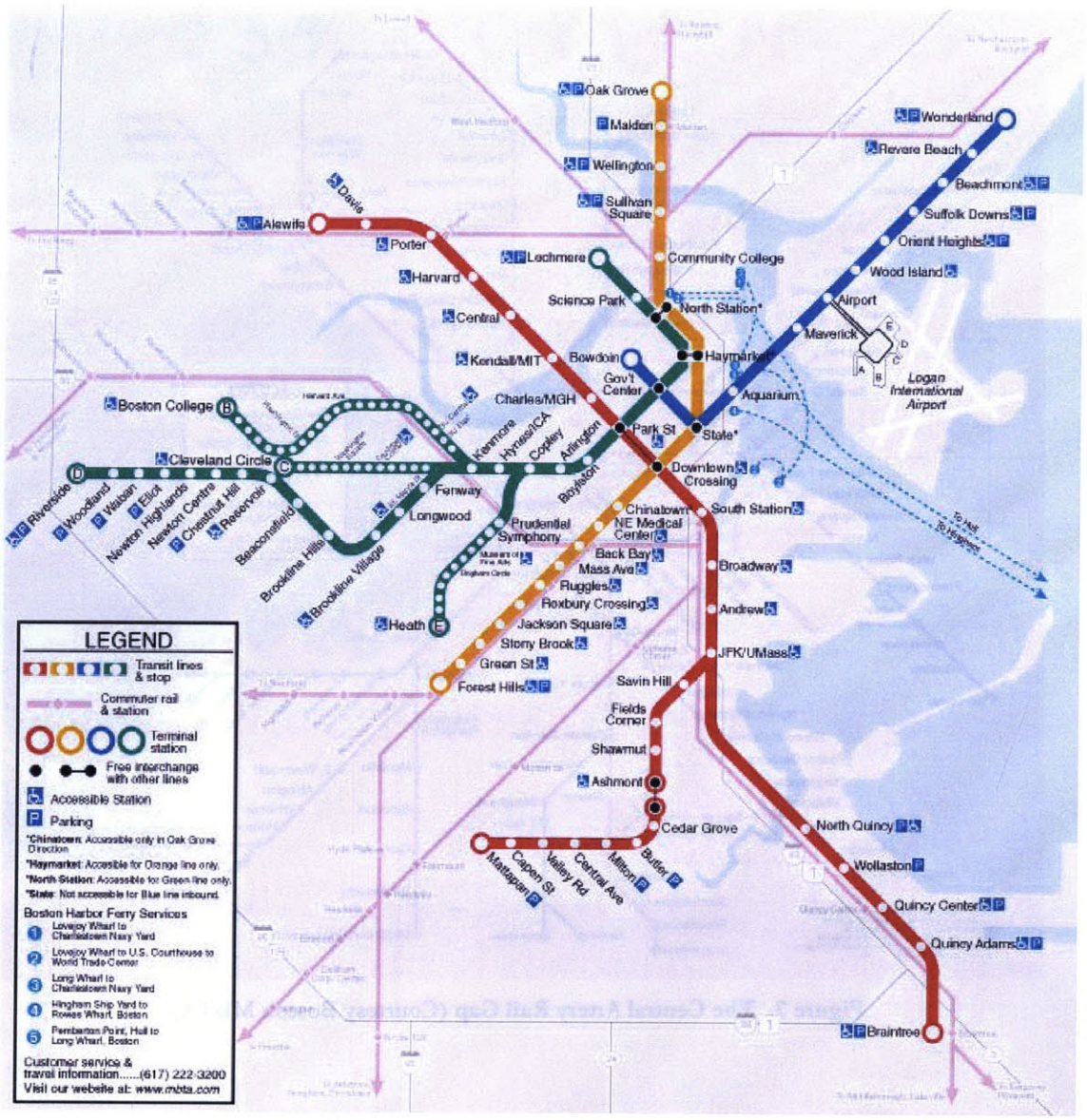

Figure 6. Boston MBTA Subway Map (Courtesy MBTA)

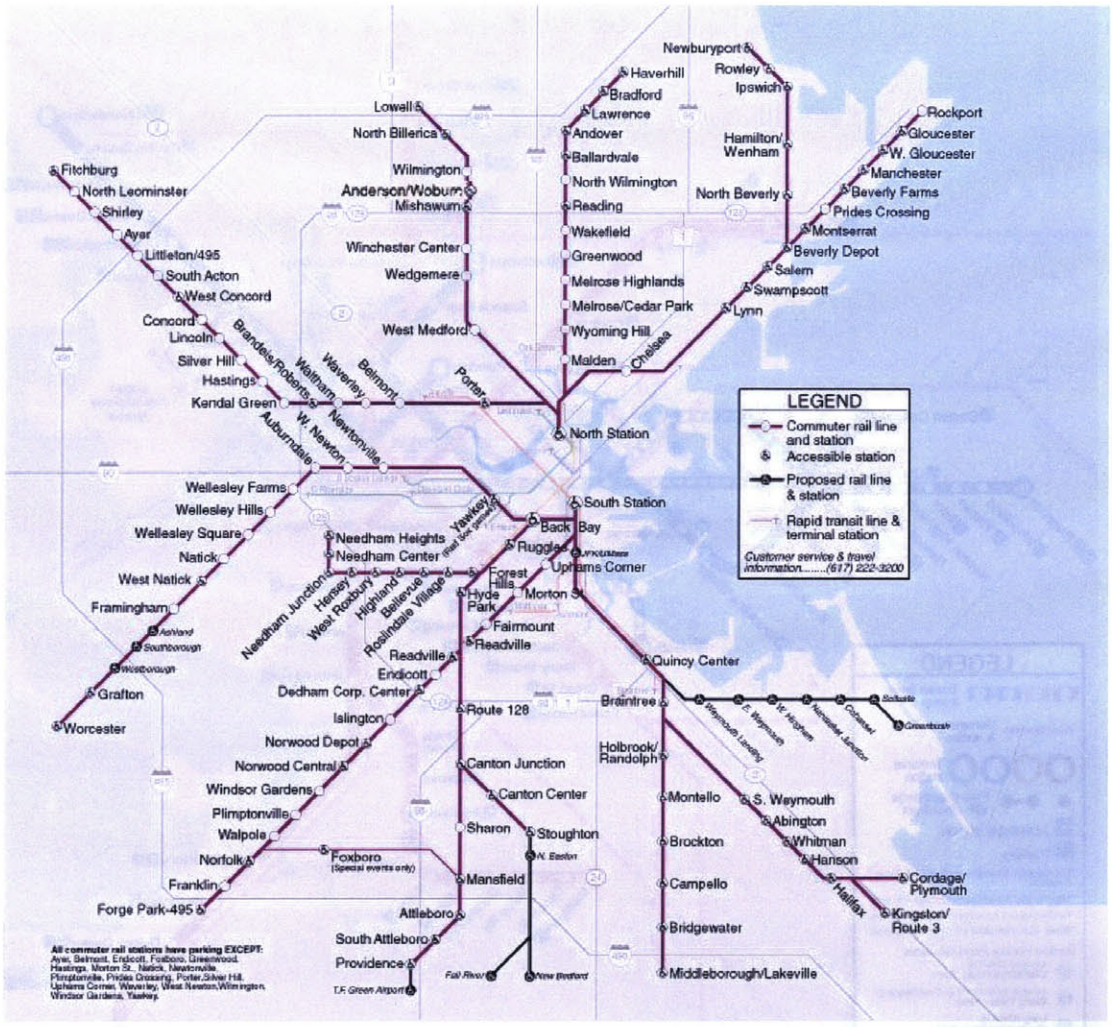

Figure 7. The Central Artery Rail Gap (Courtesy Boston MBTA)

References

Chapter 1

1. Salvucci, Frederick P. "The Big Dig." Management of Technology (MOT) Program. Sloan School of Business, Massachusetts Institute of Technology, Boston. 28 Apr. 2003.
2. Spirn, Anne Whitson. The Granite Garden. Boston: Basic Books, 1984.
3. Wright, Paul H. Highway Engineering. New York: John Wiley & Sons, 1996. 6th ed.

Chapter 2

1. Boston and the Environs. Map. Boston: BRA Archives, 1775.
2. Herlihy, Elizabeth M. From Trimountaine to Boston. Boston: City of Boston Printing Department, 1930.
3. Kirker, Harold and James. Bulfinch's Boston, 1787-1817. New York: Oxford University Press, 1964.

Chapter 3

1. Gramling, Robert. Oil on the Edge. New York: State University of New York Press, 1996.
2. Jackson, Kenneth T. Crabgrass Frontier. New York: Oxford University Press, 1985.
3. Kay, Jane Holtz. Asphalt Nation. Los Angeles: University of California Press, 1997.
4. Sanborn, George. A Chronicle of the Boston Transit System. Boston: State Transportation Library, 1993.
5. Spirn, Anne Whitson. The Granite Garden. Boston: Basic Books, 1984.
6. Warner, Sam Bass. Streetcar Suburbs: The Process of Growth in Boston, 1870-1900. Boston: Harvard University Press, 1978.

Chapter 4

1. Caro, Robert A. The Power Broker. New York: Random House, 1974.
2. Hixson, John R. Citizen Participation in Transportation Planning: Hero and Villain. Thesis. Boston: Massachusetts Institute of Technology, 1974.
3. Hughes, Thomas P. Rescuing Promethius. New York: Panthenon Books, 1998.
4. Jackson, Kenneth T. Crabgrass Frontier. New York: Oxford University Press, 1985.
5. Kay, Jane Holtz. Asphalt Nation. Los Angeles: University of California Press, 1997.
6. Tsipis, Yanni. Boston's Central Artery. Charleston, SC: Arcadia Publishing: 2001.

Chapter 5

1. Caro, Robert A. The Power Broker. New York: Random House, 1974.
2. City of Cambridge. "Inner Belt Highway (I-695)." Published Letter. 12 June, 1967.
3. Kay, Jane Holtz. Asphalt Nation. Los Angeles: University of California Press, 1997.

Chapter 6

1. Bailey, Faulk, Jandura, Robitz, Wu and Field. Reconstruction of the Central Artery. Cambridge: Harvard Graduate School of Design, 1978.
2. Boston Redevelopment Authority. Boston 2000. Boston: Boston Redevelopment Authority, 1990.
3. Hughes, Thomas P. Rescuing Promethius. New York: Panthenon Books, 1998.
4. Luberoff, David and Altshuler, Alan. Mega-Project. Cambridge: John F. Kennedy School of Government, 1996.
5. Massachusetts Turnpike Authority. "The Big Dig Website." Online Posting. Central Artery/Tunnel Program. 4 Apr. 2003.
6. Tippetts-Abbett-McCarthy-Stratton. Boston Central Artery 1977 Origin-Destination Study. Boston: Department of Public Works, 1978.
7. Salvucci, Frederick P. Personal Interview. 13 May 2003.

Chapter 7

1. Boston Redevelopment Authority. Boston 2000. Boston: Boston Redevelopment Authority, 1990.
2. Caro, Robert A. The Power Broker. New York: Random House, 1974.
3. City of Cambridge. "Inner Belt Highway (I-695)." Published Letter. 12 June, 1967.
4. Massachusetts Bay Transportation Authority. "MBTA Silverline." Online Posting. Massachusetts Bay Transportation Authority. 30 Mar. 2003.
5. Massachusetts Turnpike Authority. "The Big Dig Website." Online Posting. Central Artery/Tunnel Program. 12 Mar. 2003.

Chapter 8

1. European Conference of Ministers of Transport. "ECMT Home Page." Online Posting. Organization for Economic Cooperation and Development. 8 Mar. 2003.
2. Hughes, Thomas P. Rescuing Promethius. New York: Panthenon Books, 1998.

Chapter 9

1. Caro, Robert A. The Power Broker. New York: Random House, 1974.
2. Jackson, Kenneth T. Crabgrass Frontier. New York: Oxford University Press, 1985.
3. Kay, Jane Holtz. Asphalt Nation. Los Angeles: University of California Press, 1997.
4. Massachusetts Turnpike Authority. "The Big Dig Website." Online Posting. Central Artery/Tunnel Program. 12 Mar. 2003.
5. Sarisky, Amy. "Is Night Owl Service an Endangered Species?" The Weekly Dig 26 May 2002.
6. Wilczek, Frank. Personal Interview. 13 May 2003.

Chapter 10

1. Caro, Robert A. The Power Broker. New York: Random House, 1974.
2. Frenchman, Dennis. "Urban Renewal Strategies in the Town of Lowell, Massachusetts." Department of Urban Studies and Planning. Massachusetts Institute of Technology, Boston. 28 Apr. 2003.
3. Kilborn, Peter T. "To Commute to Capitol, Early Bird Gets 'Slugs'." New York Times 29 Apr. 2003. Online Edition.
4. Salvucci, Frederick P. "The Big Dig." Management of Technology (MOT) Program. Sloan School of Business, Massachusetts Institute of Technology, Boston. 28 Apr. 2003.
5. Washington Metropolitan Area Transit Authority. "Metrorail System Map." Online Posting. Washington Metropolitan Area Transit Authority. 26 Apr. 2003.

Chapter 11

1. Bureau of Transportation Statistics. "Intermodal Surface Transportation Efficiency Act of 1991." Online Posting. National Transportation Library. 1 May 2003.

2607
5