The Return of the Infrastructure
“Muti-Platform Clty”

by

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B.Arch Seoul National University (2014)

Submitted to the Department of Architecture in partial fulfillment of the requirements for the degree of Master of Science in Architecture Studies at the Massachusetts Institute of Technology

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ABSTRACT

“Corresponding to the form of the new means of production, which in the beginning is still ruled by
the form of the old, are images in the collective consciousness in which the new is permeated with the old.”
-Walter Benjamin

Cities, spaces that always coexist with the old and new, are similar to realms of production. Cities
have complex layers of construction over time, including all types of transport infrastructure –
roads, railways, highways, etc. This infrastructure reflects the city’s history and evolution.

The thesis studies the impact of infrastructural interventions on the urban environment, especially
in terms of its morphological changes during the 19th through the 21st centuries. By examining
this impact, the thesis shows that there is an important causal relationship between technology,
means of transportation, and infrastructure planning. The first half of the project is an analysis of
the development of transport infrastructure in general and the evolution of city form. With this as
a backdrop, the second half proposes a new urban transportation framework in an historic area
of Boston suggesting ways to improve urban environments by introducing transport infrastructure
that is more integrated into the urban fabric.

More specifically, this section takes a close look at Bulfinch Triangle in Boston, which has had
dramatic transport infrastructure changes. This small triangle-shaped area, created from landfill
in 1825, underwent changes that essentially buried major infrastructure underground. While this
minimized the impact of pollution, it also separated city life from the infrastructure below. This the-
sis proposes a shift in the relationship between the urban and pedestrian environment and a new,
integrated transport system – that is, above ground and using new technologies.

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1. INTRODUCTION

1.1 Transportation Development and Urbanism
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1.1 Transportation Development and Urbanism

The thesis is about the relationship between an urban environment and transportation development in general. As modern urbanization and transportation systems have begun after the industrial revolution, the thesis focuses on their development after the 19th century. After the 19th century, cities have grown along with the transport infrastructure in many ways. Transport infrastructure is usually understood as the means of passenger and freight traffic. Transport infrastructure is closely related to the urban pattern and architecture development. Also, the street activities and vitality of the cities are changed as to how the transport infrastructure is designed. This makes the transport infrastructure planning to be close with the politics. The following timeline shows a brief history with the significant events of each area including transport system, urbanism, politics and architecture in the United States. Before looking at the development from the 19th century, this section goes through an early stage of the transportation history in the United States.

THE HISTORY BEFORE 1800

The transportation development in the United States started from the wheelwright industry that came into Massachusetts early in the 17th century. However, they couldn’t achieve much progress in their period because the transportation infrastructure the country had was poor that there was limitation on the demand for transport vehicles. Only a few private coaches were imported from England by the upper class. Most of the work for the wheelwrights in the United States was just repairing the imported vehicles.

"Thomas Hooker from Newtown, Massachusetts, to a point near the present site of Hartford, Connecticut, a horse-litter was used and two weeks were required to make the trip. In the same year a woman rode on horseback and carried a baby from a point in New England to Philadelphia. When one of the first intercity mail transfers started between Boston and New York in 1673. A monthly trip on horseback met all requirements. The first post route between New York and Philadelphia, established in 1693, was covered only once a fortnight. In 1700 there were no public hacks in Philadelphia, and only three private coaches. The only public hack in New York in 1697 was run by a saloonkeeper in the Bowery chiefly for the purpose of delivering customers to his resort. Still, the use of vehicles was thought to be growing to such dangerous proportions that New York City imposed a tax on them, Albany forbade driving a horse at faster than a foot tap, and Massachusetts prohibited Sunday travel."

After the 18th century, the stages that had regular running schedule connected between Philadelphia, New York and Boston. It took several days to travel from New York to Boston until the 1770s. The time was significantly shortened in 1780s that it took only 10 hours from Boston to Providence. The most difficult things to fix for reducing travel time were the poor road condition and weak stagecoaches. Therefore the government tried to improve these problems from the end of 18th century.

“In 1790 the Federal Government controlled about two thousand miles of mail roads. These included the National or Cumberland Turnpike, which ran from Cumberland, Maryland, over the mountains into Ohio; the Lancaster Turnpike in Pennsylvania; the Daniel Boone Wilderness Trail into Kentucky; and a road north from New York, via Boston, to the Canadian border.”

Another issue to make the transportation development slow was the absence of hook-up between local roads that were constructed by the local government and the national routes. Horseback riding was still the main transportation to travel between towns. Private coaches were too expensive for the public but they were fascinated with the wheeled vehicles. The chairs with wheels were the alternative choice for them who couldn’t purchase private coaches. Here is the story about the chairs with the wheels in this period.

“They had two-shell cart frames and shafts, a spoon-shaped body, and a board top with painted cloth side-curtains. Linings and cushions were usually stuffed with salt hay. This was the original “one-hoss shay”.”

As the timeline from 1800 shows, there is a correlation between transportation development and politics because most of investments to transportation infrastructure are from government. The influence of government on transportation development was even stronger before the 19th century for few reasons. First, there were not enough transportation infrastructures in the country so that the new constructions from the government were important. Second, the power of the presidents was much stronger. The fact that George Washington was the greatest traveler made a big move for the national transportation development.

“George Washington was the nation’s greatest traveler. His famous carriage, the White Coach, had been built in England. It was in this coach -known as the Powell type of coach- that he made his 1889 miles presidential “swing around the circle” between March 21 and June 6, 1791. This first presidential tour in the history of the United Stated took him from Philadelphia south through Virginia, the Carolinas, into Georgia, and back to Mount Vernon. It was the longest continuous ride by private vehicle taken by any citizen of the country up to that time. Considering the wretched state of the roads, it was a most remarkable journey, and only Washington’s conviction that it was his duty to visit his official “family” to the fullest possible extent caused him to take it.”

After the long journeys the presidents enjoyed, the interest and the investment to the transportation infrastructure was increased. With the growth of interest in transportation, the urbanization started after 1800 in the United States. This accelerated the development of the transportation systems in the urban areas.

3 Ibid, page 55.
(Fig 1.1) Transportation Development and Urbanism in US
THE HISTORY AFTER 1800

The industrial urbanism in the United States started from the late 18th century. It evidently has been developed with modern transportation system such as railway. There were only 5 cities that had populations over 10,000 in 1800. It was rapidly increased with invention of steam engines in 1800s and an advent of railroads in 1830s. The urbanization related to the transport development was influential not only to cities but also to architectural styles. There was a transition of architectural styles between 1830s and 1840s because of rail system installations on streets. Street activities were changed and affected usage of buildings on streets. Buildings on streets were more opened to public in general as street activities were vitalized with an advance of public transportation like trolleys. It is interesting to see how rapid the urbanization in the United States were from 1800 to 1850 with transportation development.

From 1850 to 1900, it is railway generation in the transportation history of the United States. In many cases, Railways replaced a canal system that was a main form of transportation. The railway system completely settled down and it extended to 30,000 miles in 1860s. The number of cities over 10,000 populations reached 100 which means almost one fifth people in the United States were living an urban life. In 1870, the population in New York was a million. As the urbanization was proceeding, real estate increased constantly during the 19th century.
It is a very important period between 1900 and 1950 in terms of transportation changes because an automobile became popular. The private car generation had come in the United States. After 1920s, automobiles became important as a means of transportation. At the same time, a rail system was developed and the total length of new railways reached 100,000 miles in 1900. This progress in railway system led to an IND (Independent Subway System). The progress of the transportation development enabled high-rise buildings in cities such as Empire State Building in New York City. Interestingly, there was also a rise of suburbia from 1920s when private cars became popular.

As private cars became a main form of transportation, there were huge amounts of construction for highway system in the United States. The suburbia phenomenon was accelerated and a suburban life became a typical way to live. In 1950s, there was an appearance of suburban malls. This changed the life of the people and led to the decentralization of urban population after 1960s. As a result of the suburbia phenomenon and transport infrastructure change, the vitality of the central business districts of America's cities significantly declined.
1.2 Two Objectives

the urban morphology has close relationship with transport system and transport infrastructure determines the scale of urban geometry.

(Fig 1.2) Urban Morphology Change in Boston
The first objective of this thesis is related to urban morphology changes. The transportation development strongly affects urban forms. Complexity and size of streets are changed according to the types of main transportation in each generation. In Boston as an example, the urban fabric has been dramatically changed over the time especially after the industrial revolution impacted transportation systems.

Before the industrial revolution started in the United States, the configuration of urban fabrics and streets was simple and wide. The city started to be developed as an urban area with a water transportation system in 1700s. After 1800, the city was briskly developed and it was significantly expanded. The streets were still wide and simple because the main transportation was horse carriages or walking. The urbanization impacted the city center in terms of density. The increased density and horse carriages on streets made urban life chaotic and it required wider streets than before. The railway system was first introduced to the United States in 1830s and it accelerated urbanization. Public transportation was installed on streets in the city. There was an enormous progress of an urban movement in terms of efficiency. The urban form became complex and streets no longer had to be wide.

There were elevated railway infrastructure constructions as the public transit became popular and it expanded the city around late 19th century. The urban geometry became more complex and the center was filled with buildings. The railway dominated the city early in 1900. The city and its architectural environment was affected by elevated railway infrastructure. Because the railway was important as a means of transportation in this period, the city expanded and developed along with the railway lines.

After 1950s when private cars became popular in the United States, the urban geometry evolved in a different way. The elevated railways went underground or disappeared in some cases, and streets were filled with cars. The pattern of streets became simple and wide, returning back to the 18th century. Soon after private cars dominated the city, a lot of transportation infrastructure disappeared underground and were covered with the earth. The trace of disappeared transport infrastructure remained as green spaces in some cases.

Cities evolve with transportation development especially in terms of its morphological changes. Therefore, planning transportation system strongly affects city form. Exploring this relationship is the first objective of the thesis.
Urban Vitality: number of activated lots, urban employment, population density

(Fig 1.3) Urban Vitality Change in Boston
The second objective is about the relationship between urban vitality and transportation. Urban vitality, the pedestrian activity on streets in other words, is enlivened by the transportation facilities. This objective argues that urban vitality in cities considerably declined as the most of public transportation infrastructure was buried into underground.

Urban activities mostly take in place at stations and buildings that have connections to underground transportation systems. The period that had the most activated pedestrian life was when cities had above ground transportation infrastructure with connections to urban fabric. The diagram shows the degree of street activity has been changed over the time from the railway era to the recent times when the underground transport system became a main public transportation in cities.

The vitality of an urban activity depends on transportation system and infrastructure. Above ground transportation infrastructure and its connection to urban fabrics activates street life. Demonstrating this relationship is the second objective of the thesis.
1.3 Future Transport Infrastructure

(Fig 1.4) New Vision Diagram
With these two objectives, the design purpose of the thesis is based on technological advance in transportation systems. This is a belief that new technologies will change transport infrastructure in the future, and the change of transport infrastructure will affect city form and urban life.

"There are a lot of technologies and visions related to future transportation that are under the studies. The studies are based on the expected future transportation trends. There are several potential causes that affect on the future transport trends. First, economy is one of the important factors. General economic conditions in the past few years leading to lower incomes and lower levels of employment. Also, Higher fuel prices have discouraged car travel. Second, changes to relative quality travel options are more transport related factor. Improved public transport infrastructure and services have attracted modal shift away from private vehicles. Provision of cycle lanes and other infrastructure has attracted modal shift away from private vehicles. Parking conditions and policy have discouraged driving as well as congestions. Last, new social/technical patterns and preferences affect to the future transport with new mobile technologies. The driver license acquisition among young people is getting lower. The concerns about environmental and health impacts of private vehicle use become greater. Mobile technologies and social media enable social contact without traveling. Mobile technologies allow productive work on public transport."\(^5\)

The three future transportation trends in the thesis are based on these three potential causes. The thesis argues that the future transport infrastructure framework will be developed with these three trends; a decrease of infrastructure, an increase of pubic transport and a demand for green transportation. The details of these three trends will be discussed in the second section of the thesis.

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1.4 Boston - The Bulfinch Triangle

The Map of 1648. It was a pond with the canal connection, which called Mill Creek, before the 19th century. The dam generated the power for the Mills located the shoreline of the pond.

(Fig 1.5) Bulfinch Triangle Old Map 1
The geographical scope of the thesis is Boston and the thesis eventually proposes the future design of a transportation system in the Bulfinch Triangle. The Bulfinch Triangle that was created from landfill has experienced dynamic changes in terms of transportation infrastructure. The history of transportation system in this small urban fabric is important. Projecting a new urban transport design based on these studies will be very interesting.

“There are two kinds of cities, the most persistent, and crudest, analysis of urban form would have us accept. It is not hard to tell them apart. The first kind is the planned or designed or “created” city - Pierre Lavern's ville creee. It is set down at one moment, its pattern determined once and for all by some overseeing authority. Until the 19th century this pattern invariably registered as an orderly, geometric diagram. At its purest it would be a grid, or else a centrally planned scheme like a circle or a polygon with radial streets issuing from the center; but often the geometry is more complex, marrying the two pure formulas in modulated and refracted combinations. The other kind is the ville spontanee - the spontaneous city, also called “grown,” “chance-grown,” “generated” (as against “imposed”), or, to underline one of the evident determinants of its pattern, “geomorphic.” It is presumed to develop without benefit of designers, subject to no master plan but the passage of time, the lay of the land, and the daily life of the citizens. The resultant form is irregular, non-geometric, “organic,” with an incidence of crooked and curved streets and randomly defined open spaces. To stress process over time in the making of such icy-forms, one speaks of “unplanned evolution” or “instinctive growth.”

In this point of view, the Bulfinch triangle is one of the typical examples of the planned urban fabric that means this area was developed after the transport system was planned. Then this area became a center of the transportation in the city. The most new transport technologies were applied to this area as soon as they were introduced to the United States. This is not only because of its geological advantages for the transport infrastructure but also because it is totally planned area that was created just before the industrial revolution in the United States had begun. The transport transformation and its impact on the urban environment have evolved dramatically. Therefore, understanding the transportation changes is crucial to analyze this area.

The map of 1796. This area started to be filled up from the late 18th century. This map shows difference between the 1630 and 1796 shoreline as well as the location of the North and South Mills, the floodgates at the west end of the dam.
THE HISTORY OF THE BULFINCH TRIANGLE UNTIL THE INDUSTRIAL REVOLUTION

The Bulfinch Triangle was a part of the sea that shaped a large cove next to the Shawmut Peninsula surrounded by the North End and West End. It became a pond named the Mill Pond in 1630 just after Boston was founded as a city. The whole area near the Mill Pond was the private Mills from 1643. The dam was constructed at this cove to generate power in order to run the Mills around. However, as the route to the Mill Creek that was a part of the connection to the Middlesex Canal was needed, the gate was built at the corner of the dam so that boats could enter the cove.

The causeway Street where the North Station currently is located originated from this dam. The first transportation plan of the Bulfinch Triangle was to make the route for boats through the dam. After the first transportation plan, the Bulfinch Triangle developed as the center of transportation in the city. Since the surrounding area was mostly filled with Mills, the transportation plan in this area evolved to support industrial facilities in the beginning of its development. Maintaining the existing mills and building new ones were the main issues for the landowners of Mill Pond area.

"By 1670 they had erected four grist mills, two at the southern edge of the pond on the Mill Creek, a location later called South Mills, and two on the north east side at the mill dam, a location that came to be known as Center Haven and later North Mills, and were about to add a third mill at the west end of the mill dam, and evidently added two more grist mills at Center Haven in the early 1750s." 7

However, the mills in the Mill Pond area were not profitable. A lot of the mills were sold to new owners in 1800. Boston was rapidly expanding and urbanizing from the 19th century. Therefore, the city needed more land to catch up to its growing speed. The main interest of the new group of owners of the Mill Pond area was to fill up the Mill Pond as a speculative venture. They were not interested in maintaining the mills anymore. They started to shut off the gates at the dam so that there were no longer incoming tides into the pond.

"A fact noted in 1801 by a town committee that remarked on “the prosperous and flourishing state the town and the increasing scarcity and demand for vacant land for building lots.” But in the fall of 1803, after the Mill Pond proprietors had announced plans to sell lots on the edge of the pond and to lay out streets across it, the selectmen forbade them to proceed, claiming that the town owned the flats within the pond. In December 1803, however, a lawyer offered the opinion that the proprietors owned the cove and could erect houses on it and make other improvements as long as they observed the condition of maintaining a grist mill. So in early January 1804 the selectmen asked Peck to submit his proposals for filling up and selling the Mill Pond." 8

8 Ibid, page 76.
The map of 1807. This map shows Pond (now Endicott) Street that was built across the Mill Pond in 1806-1809.
This became an important controversy for the planners of the city. The argument from the people who wanted to fill up the Mill Pond was based on the sanitary problems caused by the contaminated water. This is the part of original petition from the landowners of the Mill Pond area.

“A ... capacious receptacle and reservoir of all the filth and putrescent substances of a considerable portion of said town; above ninety privies are emptied into said Pond; a great number of common sewers flow into it' the unwholesome draining of a number of sugar-houses, and the fetid returns of several distilleries and breweries are emptied into the same; the margin of the Pond is at all times covered with the putrid bodies of dogs, cats, and other animals; ... the exhalation from the pond is the most offensive and unhealthy ever emitted from any nuisance within the remembrance of your petitioners.”

Obviously, the solution they made for this issue was to make new land on the Mill Pond. They got agreements and supports from the town physicians certifying that the health issues such as infectious diseases would get solved.

“In 1806, another project was proposed for the Mill Pond which was the transportation extension. A group of Charles town and Boston residents was incorporated as the Pond Street Corporation to build a new street across the pond from the Charles River (now Charlestown) Bridge to Middle (now Hanover) Street, presumably to make it easier to get from Charles town to the center of Boston. The act of incorporation specified that the street was to be city feet wide (later changed to forty-five feet), to be made of solid earth or gravel, to have a stone facing on the southwest side (the side fronting the main body of the Mill Pond), a timber facing on the more protected northeast side. Pond (now Endicott) Street was laid out in May 1806 and was apparently under construction by August when the selectmen recommended that two sluices be made in the street to prevent the accumulation of filth on its east side.”

10 Ibid, page 78.
The map of 1829. The Bulfinch Triangle started from the landfill with the canal at the center in 1820s and evolved either as an industrial area or as a transportation center.

(Fig 1.8) Bulfinch Triangle Old Map 4
The plan for filling up the Mill Pond was approved in 1807. The committee had a conclusion that there were several reasons, such as sanitary problem, to fill the Mill Pond up. And it impacted transportation development of the surrounding area.

"Filling the Mill Pond began with the three streets, One street was to begin at the north end of the pond near Prince Street and to run parallel to Pond Street, creating the present North Margin Street, and the other two streets were to be at right angles, running from the new street to Pond Street - the present Cooper and Stallman Streets. Much of the town’s discussion of the Mill Pond project in 1808 concerned the plan of streets that were to be laid out across the pond. Bulfinch was designated to make a plan of streets and market square. He presented a plan that imposed a symmetrical grid of streets on the Mill Pond: a street parallel to Pond Street (now North Washington Street) on the east side of the pond was matched by a similar diagonal (now Merrimack Street) on the west side, forming a large inverted triangle and giving rise to the name “Bulfinch Triangle”. A market was to be located at the apex of the triangle and a street built across the pond at the base of the triangle (Causeway Street), replacing the old irregular causeway.”11

The plan of connection of the Mill Creek was required to keep the water route as the part of the Middlesex Canal. Therefore, the construction of the canal through the filled Mill Pond began as the Mill Pond was being filled. This made the Mill Pond area the center of transportation from its creation, which means the transportation infrastructure has been very important for the development of this part of the city. This is the description of how the Canal constructed in the Mill Pond.

"The canal walls were to have a battered cross section, that is, to be wider at the base than at the top, and to be set on a foundation of timber “platforms” composed of alternating lengthwise and crosswise timbers. The walls were to be twenty feet apart from the south shore of the pond as far as the north line of Market Street and then forty feet apart from that point to the causeway. The entire canal was to be one thousand feet long. The last stage of building the canal was to top the stonewall with a timber cap, a common method of finishing stone seawalls in the early nineteenth century.”12

12 Ibid, page 84.
The map of 1835. Railway infrastructure started to be installed from 1830s, when the first railway came into the city.
Another seawall, which became Causeway Street, was built while the canal was being constructed. Those constructions were finished by 1815. The canal, which was constructed in the middle of the landfill, successfully kept the connection to the Middlesex Canal, which terminated in Charlestown and had provided the continuous route between Boston and the Merrimack River.

"From Boston Harbor boats went north through the Mill Pond into the Charles River and then to the Almshouse Wharf in the West End from where they were drawn across the river on a system of buoyed cables to the canal entrance were present Sullivan Square. From that point they could travel all the way to the Merrimack River and, via other canals, into New Hampshire."

The entire completion of the Mill Pond project was finally done in 1825. Even though some houses were built on the made land in the Mill Pond area, this land developed as an industrial area soon after the land was completely filled up.

"The next major transportation project in the Mill Pond was related to a major technological innovation of the 1830s - the introduction of railroads. Railroads were becoming a viable form of transportation by the late 1820s. Inspired by the example of the Granite Railway, a horse drawn railroad built in 1826 to bring granite for the Bunker Hill Monument from a quarry in Quincy to a tributary of the Neponset River, the Massachusetts legislature conducted surveys in the late 1820s for other horse-drawn railways from Boston to destinations such as the Hudson River and Providence. In the 1840s the canal that had been left open down the center of the former Mill Pond was filled in to make land for a railroad, a graphic demonstration of the way one form of transportation was being replaced by another. In 1845 the Boston & Maine Railroad opened, entering Boston on a route that crossed the Charles River and then went down through the former Mill Pond between Canal and Haverhill Streets to a passenger depot in Haymarket Square. This route was virtually on top of the canal that had been built in the 1810s, so during the summer of 1844 the canal was filled in to create land for the railroad."

The canal era didn't go long. Only 20 years after the construction of the canal, railways replaced the canal, which was located at the center of the triangle. And the north area of the triangle had begun to be filled up to make depots of railway companies. This influenced the adjacent buildings.

"In the 1880s five and six story brick furniture factories and ware houses replaced most of the original buildings, and in the first decade of the twentieth century an elevated railway was built down the center of the triangle over the site of the surface railroad. The Bulfinch Triangle was further divided when the elevated Central Artery was constructed through it in the 1950s, and today the land that was created by the Mill Pond project is now primarily a commercial area of nineteenth-century brick buildings."
The map of 1852. After 1850s, the railway completely replaced the canal and this area was developed as a railway depots and the urbanization was accelerated.
The introduction of the railway infrastructure generated several extra constructions for making landfill around the Bulfinch Triangle. As the railways settled down completely in this area and accelerated the industrialization and urbanization, there were much more places needed for transportation infrastructure.

“Railroads were also the reason for the land making projects that took place during the second half of the nineteenth century and first half of the twentieth north of Causeway Street in the area between the Warren and the Canal, or Craigie's, Bridges. There railroads that entered Boston from the north - the Boston & Lowell (1835) and Boston & Maine (1845) - were joined in 1845 by the Fitchburg Railroad and in 1854, after its route was moved from East Boston, by the Eastern Railroad. All these railroads crossed the Charles River to depots near Causeway Street. This concentration of railroads in the Causeway Street area resulted in some additional land making. By 1852, for example, the Boston & Lowell had filled in and straightened the shoreline of the land crated by Asa Sheldon in 1835 and the Fitchburg had made land just east of the Warren Bridge for its depot. And by the late 1850s the latter line had filled a tongue of land projecting from the Charlestown shore and the Boston & Maine had extended an island that it had created in the 1840s into a parallel strip of made land. There were the veritable networks of bridges then spanning this relatively short section of the river in 1866. By the late 1860s there was real concern about the degree to which these railroad bridges obstructed both the navigation and the flow of the river, so in 1869 the legislature passed acts requiring the railroads to widen the draws in their bridges. The result may have improved the channel but did not reduce the number of bridges. This proliferation of bridges continued to be a concern. By the early 1890s the railroad bridges were said to “fairly roof the river.” The situation was not improved when, in 1893, the Boston & Maine, which by then had absorbed most of the other railroads, opened a huge new Union Station on the future site of North Station. This new Union Station resulted in the building of even more tracks across the river. Despite recommendations that the railroad bridges be removed or rebuilt, the bridges remained and no more land making occurred north of Causeway Street for years - an aerial photograph of the area in 1925 shows it looking quite similar to the way it had in 1899. In 1928, however, the Boston & Main replaced Union Station with North Station and received permission to fill in a large area of flats behind the station so that passengers in the rear cars of trains could disembark on solid ground instead of on trestles. The land-making project, which also involved filling large areas on the Cambridge and Charlestown side of the river, began in 1927 and continued for several years.”

1.5 Outline of Thesis

(Fig. 1.11) Structure of Thesis
This thesis has two axes. One is about a future urban design framework with two conclusions regarding “urban morphology” and “urban vitality” drawn from the historic research. And that makes theoretical perspective of the new vision. Another axis is about Future transportation that leads to the design of the new urban transportation infrastructure through the new trends studies. And it builds the design perspective of the new vision. These two axes frame the new vision and finally the new vision will render the human scale environment in the city.
2. URBAN TRANSPORTATION VISIONS

2.1 Overview
2.2 Motopia: Jellicoe Geoffrey
2.3 Lower Manhattan Expressway: Paul Rudolph
2.4 Conclusion
2.1 Overview

(Fig 2.1) Urban Transportation Visions
Until early in the 19th century, transportation infrastructure and its influence on the city environment had been developed with horsepower mobility and walking. After G. Stevenson invented steam power in the end of the Industrial Revolution Era, the Railroad system was implanted in the city and the automobile infrastructure was followed. This result from the Industrial Revolution on the transportation environment strongly affected a new paradigm of city form. After the new paradigm of city form, the city has grown with the transportation development. The interest on the relationship between the urbanism and the transportation rapidly increased in the United States after the 19th century. A variety of proposals and new visions appeared, two of which are shown below.

**KING’S DREAM OF NEW YORK**

“King’s Dream of New York” shows an urban transportation vision with a high-density city. The drawing describes multi-layered transportation infrastructure, which makes strong intervention in an urban context. The infrastructure system that “King’s Dream of New York” illustrates looks very fast and efficient, however, it separates buildings where people live and infrastructure where people move. The idea of aircrafts over skyscrapers is interesting but there is no pedestrian consideration in the drawing.

**MIDTOWN MANHATTAN: LAYERED INFRASTRUCTURE**

Mr. Corbett’s idea was also making multi-layers in a high-density urban area to segregate transportation infrastructure from living area. Even though his approach to urban transportation issues was based on legislations that the New York City actually planned, the vision couldn’t make any connections between urban elements. The infrastructure he described in the drawing looks like a huge wall between buildings.

**CONTINUOUS TRANSIT SYSTEM**

Continuous Transit System, which proposed in 1924, has very interesting ideas on automated transit systems in city. This vision is different from others, which came out around the same time, in that it introduces transportation systems that were applied new technologies never been used before. Nonetheless, this vision also includes an idea that transportation infrastructure is separated from urban area by burying them into underground.

**CITY WITHIN A CITY**

“City within a City” approached transportation infrastructure planning with zoning ideas of the New York City. Therefore, transportation infrastructure, which “City within a City” describes in the drawings, is a part of elements that create a hierarchy in the city. It is interesting that this vision integrates buildings and infrastructure suggesting new types of architecture. At the same time, it makes strong separations between urban areas as a zoning system.
2.2 Motopia: Jellicoe Geoffrey

(Fig 2.2) Motopia
"Motopia" renders an infrastructural architecture in suburban area. Carchitecture was one of the trends in transportation related visions after 1950s, when private cars became a major means of transportation in cities. In this context, "Motopia" integrates streets and housings and this integrated building forms continuous huge blocks. The connected blocks create a city in a suburban area. "Motopia" designed not only a new type of integrated architecture but also a new type of city form. It has no relationship with existing urban elements because "Motopia" was planned on an empty space in a rural context.

"The search for an ideal city has fascinated men of all ages. First there must be the sociological study, and for clarity of idea and analysis none has equaled the Utopia of Sir Thomas More. Thereafter come the physical designs that have attracted such architects as the sixteenth century Vincenzo Scamozzi and the twentieth century Le Corbusier. The designer of the latest ideal city, Motopia, has found that the destructive force most likely to disintegrate human society is the motor car. His objective has been first to separate the two facets of mankind, the biological and the mechanical, and thereafter to put them together harmoniously and without confusion in a town of 30,000 persons. Physically he does this by placing the roads upon the roofs and thus leaving the ground wholly for pedestrians; philosophically he attempts to establish a man-to-man and a man-to-soil relationship that has stood the test of a long history."

2.3 Lower Manhattan Expressway: Paul Rudolph
"Lower Manhattan Expressway" is about the strong integration of buildings and transportation in the city. It designed a huge continuous layered transportation infrastructure, which is enclosed by buildings. The infrastructure itself became an endless linear block in the city. "Lower Manhattan Expressway" renders a high connectivity between transportation and living environment, however, huge blocks in the middle of the city described by "Lower Manhattan Expressway" create segregations in the city and make a poor environment for pedestrians.

“In 1967 the Ford Foundation commissioned Paul Rudolph to explore the feasibility of developing large mega-structures as part of a new urban regeneration program for the city of New York over the proposed Lower Manhattan Expressway. The construction of this important traffic route crossing the city would have created a wasteland in its immediate vicinity, rendering it unsuitable for other purposes while carving great swathes of derelict land through these valuable areas. The study was to explore how these prime parts of New York could be rejuvenated and transformed by providing new housing, offices, social and civic buildings over this expressway route. This interesting exercise in three-dimensional civic planning was presented when completed at an exhibition in 1972 under the project title 'New Forms of the Evolving City'.”

2.4 Conclusion

The transportation visions in this section strongly influenced later works of transportation plan. However, they made the perception that transportation should be separated from city. In the most cases, the drawings show huge barriers in cities. They create separated super blocks. They only focused on connectivity between different areas enhancing efficient in terms of traffic flows. The considerations of pedestrians were barely included. Cars are dominating cities in their drawings. However, it turned out that infrastructure for cars, which are intensely constructed in urban area caused various problems. They expected harmonious cities with new types of described made negative interventions in cities. The next generation should more focus on creating pedestrian friendly urban environment.

"Super-block projects are apt to have all the disabilities of long blocks, frequently in exaggerated form, and this is true even when they are laced with promenades and malls, and thus, in theory, possess streets at reasonable intervals through which people can make their way. These streets are meaningless because there is seldom any active reason for a good cross-section of people can make their way. These streets are meaningless because there is seldom any active reason for a good cross-section of people to use them. Even in passive terms, simply as various alternative changes of scene in getting from that the New Yorker reporter noticed in the blocks between Fifth and Sixth avenues. There people try to hunt out streets which they need but which are missing. In projects, people are apt to avoid malls and cross-malls which are there, but are pointless. I bring up this problem not merely to berate the anomalies of project planning again, but to indicate that frequent streets and short blocks are valuable because of the fabric of intricate cross use that they permit among the users of a city neighborhood. Frequent streets are not an end in themselves. They are a means toward an end. If that end – generating diversity and catalyzing the plans of many people besides planners – is thwarted by too repressive zoning, or by regimented construction that precludes the flexible growth of diversity, nothing significant can be accomplished by short blocks. Like mixtures of primary use, frequent streets are effective in helping to generate diversity only because of the way they perform. The means by which they work (attracting mixtures of users along them) and the results they can help accomplish (the growth of diversity) are inextricably related. The relationship is reciprocal." 19

As a context of these historic visions and, at the same time, to overcome their limitations, the thesis proposes the new urban transportation vision.

3. PAST: TRANSPORT DEVELOPMENT & URBAN ENVIRONMENT

3.1 Transportation Evolution and Urban Morphology Development
3.2 The Relationships: Transport Infrastructure, City form
3.3 Conclusion
### 3.1 Transportation Evolution and Urban Morphology Development

**Relationship Between Transportation and Urban Morphology**

<table>
<thead>
<tr>
<th>Infrastructure Type</th>
<th>Composition</th>
<th>Configuration</th>
<th>Main Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>17C</td>
<td>Mixture of configurational properties</td>
<td>Grid with cross roads</td>
<td>Pedestrian</td>
</tr>
<tr>
<td>18C</td>
<td>Grid with cross roads</td>
<td>Mixed configuration</td>
<td>Horse / carriage</td>
</tr>
<tr>
<td>19C</td>
<td>Mixture of configurational properties</td>
<td>Loop roads with branches</td>
<td>Public transit</td>
</tr>
<tr>
<td>20C</td>
<td>Loop roads with branches</td>
<td>Car</td>
<td></td>
</tr>
</tbody>
</table>

(Fig 3.1) Transportation and Urban Form History
(Fig 3.2) Urban Form History of Boston
This section explores the relationship between the transport development and the urban form changes. From the study of the relationships, the section concludes that transportation system greatly affects on the urban morphology. And it finds out the period that had satisfying street patterns and transportation infrastructure in terms of urban vitality.

Research on the history of transportation types is relevant to this section because the transport type affects the urban form such as street size, length, configuration, etc. New types of transportation make new shapes of transport infrastructure, and the new shapes of transport infrastructure change the structure of cities. The following story is a history from the very beginning of transport inventions to the advent of railway system.

1. FOOT AND HORSE ERA

TRANSPORTATION

"As the Greek developed the wheel more than any other countries after it had invented, the superior Greeks would seem to have been the natural race to assume early highway leadership, but they failed because they did not appreciate the necessity for good road. They only paved road in Greece was that between Athens and Eleusis. The Romans knew road values. Over a period of five hundred years, from 305 B.C. Until about A.D. 200, road building was one of their chief aims and accomplishments. Their highways were constructed primarily for military reasons; but good roads also brought traders and other persons who were influential in adding to the strength of the Roman state. More than 48,000 miles of Roman highways, consisting of 372 different thoroughfares, were built. Twenty main highways centered in Rome, and it has been declared that by virtue of them her people could sit on her Seven Hills and rule the world. The main roads were straight and strong. The pavement often was four feet thick and from thirteen to seventeen feet wide. Some of the highways lasted for eight hundred years. Wagon ruts on a Naples road outside Pompeii are deep today, apparently little changed since the city was buried in A.D. 79. All available men, including Roman soldiers not on active duty and many conquered persons, were put on road work. One method of raising highway funds was to name mileposts after prominent cash contributors. Caesar often melted his golden presents, cashed the metal, and turned the proceeds into highway funds.

Vehicle building became a profitable trade. The chariot predominated but many types of carriages and wagons were made for rich and poor. A notable move toward comfortable individual transit was the invention of the post birotum, a chariot with the open part of the body facing the horse, a leather-covered seat, and a place for baggage behind. For some unknown reason this vehicle was never adopted for private use but -during the time of Constantine- was held at post stations, largely for the use of government couriers. Ambulances were numerous, as well as wagons for carrying wine, hay, freight, and the merchandise. Transportation was making real advances."

**URBAN MORPHOLOGY**

Street patterns before 18th century are very different from the present because they were designed for pedestrians. Urban experience in this period is based on small size of streets and markets located at the center of city in most cases. The general morphology of cities was evolved with pedestrian activity.

"The typology introduced here has been developed with the intention of reflecting typical street patterns that are encountered in different kinds of urban analysis. The four types are best introduced by considering different patterns featuring at different stages of growth of towns and cities, arranged as if stretching outwards from the historic core of a settlement to its outskirts.

The urban pattern before the 17th century was developed with pedestrian and horseback transportation. It is typical of the core area of old cities, especially walled cities. The angularity of routes, oriented in a variety of directions, generates a rudimentary radiality, where such a pattern is located at the core of a settlement.

Typical of planned extensions or newly founded settlements in the era of horse and carriage transportation started from the 18th century. The prevalence of four-way perpendicular junctions naturally gives rise to bilateral directionality, with the implication of a grid form at the wider scale."

2. WHEELS ERA

TRANSPORTATION

Development of the transportations, which have wheels on them changed everything related to human life. Especially urbanism in European countries started with wheel transportation evolution. Based on the development of wheeled vehicles, steam engine was invented in 19th century and wheeled transportation enormously advanced.

"After the wheel was invented, the first signs of new transportation development came in the form of heavy, crude, two-wheeled carts in Germany. These had wheels either of solid wood or made from a few strips of wood fastened across a rim. The bodies were rough boxes. From these undoubtedly came the idea for the first coach in the world, owned by Emperor Frederick 3. He first journeyed to Frankfort in it during a rainstorm in 1474 and repeated the trip in 1475. The vehicle was a heavy, covered wagon with for wheels, pulled by two horses, The Emperor sat on a chair inside, behind drawn curtains. When this type of vehicle came into common use -almost two centuries after Frederick made his historic trip- various countries, including France, Spain, Italy, and Hungary, claimed that the original coach had been made within their borders. Most of them sought to prove their contention by showing early words in their own languages which can be translated into the English world coach. Individual vehicles began to occupy the attention in 1700s. A sedan-cart for one horse appeared in 1720, and in 1754 came a gig which was the forerunner of all British single carriages. The "high-flier," a four-wheeled phaeton with a light body and seat mounted on thin iron braces some ten or twelve feet above the ground, was offered to sportingly inclined young men in 1760 and had a temporary vogue. The brouette, an enclosed, tow-wheeled, one-passenger carriage drawn by a man, came and departed suddenly in 1770."

URBAN MORPHOLOGY

Street types begun to be changed as wheel transportation rapidly developed after 18th century. Street patterns designed with simple configuration and their sizes became larger to accommodate traffics.

"The transportation infrastructure type in the 19th century is the urban structure of the era of public transport and car. It is the perhaps the most general type which may be found at various positions in a settlement, but most characteristically astride an arterial route, whether constituting the central armature of a village, a whole settlement or a suburban extension along a radial route. Typical of modern hierarchical layout in the era of the car is often associated with curvilinear layouts of distributor roads, forming looping or branching patterns."

3.2 The Relationships: Transport infrastructure, City form

The urban morphology has been changed over time along with the transport development. This section shows the relationship between them. City form is framed by transport infrastructure plans in most of cases. Transportation infrastructure is not just an object that creates urban intervention and traffic congestion. It actually influence life of people living in urban environment.

“All sorts of urban activities have taken place on the main streets: they were not just for through passage, but for meeting, trading, hawking, busking, bear-baiting, public speaking and pillorying. If anything, there seemed to be a natural relationship between the busiest, most vital streets and the most significant urban places. The transport development after the industrial revolution not only broke this relationship between movement and urban place: it reversed it. It proposed an inverse relationship between movement and urban place. The movement would now be the movement of fast motor traffic; the urban places would become tranquil precincts. The diagram table is about the difference between the historic urban structure and the modern urban structure. The historic structure shows that the market square is center stage, and the intensity of circulation dissipates outward from this core. The routes out of town are of a relatively low standard. And the modern structure shows the main flows and highest standard routes are on the national network outside the town. The relationship between notional center and main routes is reversed.”

3.3 Conclusion

There are various urban elements that can change urban environment such as architecture, public space, green space, etc. However, transportation infrastructure is the most powerful element that impact urban morphology and its quality. City form has evolved with transportation development. They are not just closely related each other. Types of transportation change transport infrastructure, especially in term of its scale and configuration. And it impacts city form – street patterns, side walk types. The way that transport infrastructure installed in city makes difference in quality of urban life. Street activity types have been changing as main transportation types shifted over time. Historic analysis on transportation and urban environment in this section reveals that there are more than morphological relationships between them. Transportation development builds different types of infrastructure and transport infrastructure shape city forms. City forms change connectivity and public space. Connectivity and public space impact people living in city. Therefore, taking new technologies in transportation field serious for urban designers, planners and even architects is very important. Every design process in cities has to be based on understanding role of transportation in urban environment.
“The ancient Romans called their urban blocks insulae, or islands, reflecting the topological containment of buildings and land parcels – howsoever nested or subdivided – within an all-embracing common continuum of public space. This public space is primarily constituted by the system of public streets. This contiguity is a basic topological property which sets apart the access network – the ‘transport land use’ – from other land uses. This makes transport a fundamental organizing feature, and gives it an importance that transcends the direct travel or traffic function of routes. In effect, transport topology has an importance and influence that goes beyond the concerns of transport policy. To say that transport is key to urban structuring does not imply that ‘transport’ as an urban function or land use is more important than ‘housing’ or ‘open space’. Nor does it mean that transport is the only influence on the pattern of streets and land ownership, land value and other social, economic and physical factors. However, it does mean that close attention to the structural logic of the access network is important for understanding how existing cities are structured and how new ones may be designed. So, although a transport infrastructure is much more than an urban road, the movement function is in a sense central to the street function from the point of view of spatial organization. Consequently, those responsible for catering for the movement of people and vehicles – of whatever profession – will necessarily have a strong influence on the design of transport infrastructure and street patterns.

This is why the transport infrastructure may be regarded as a fundamental building-block of urban structure. The public street system forms the principal part of the urban transport system. This explains why a change in transport mode (from horse power to the internal combustion engine) was more than just a technological regime change, but more like an urban revolution – and why it might seem to need a ‘counter revolution’ to put it right.”

4. FUTURE: THE RETURN OF HUMAN SCALE CITY

4.1 Three Transportation Trends
4.2 Multi-Platform City
4.1 Three New Transportation Trends

TREND 1

(Fig 4.1) Transportation Trend 1
Continued from the introduction, this thesis picked three major trends in the transportation field, which shape this vision of future transport infrastructure. All three trends are related each other in many ways. They are listed here and described in more detail below. First, “the devolution of Infrastructure” means that the transportation infrastructure area in cities is shrinking mainly because of technological advance in public transport system and environmental issues. Second, “the evolution of public transport” is a very strong trend in which people start to use public transportation much more than before. And third, “the green transportation” is a public interest in environmental issues and sustainability. Those three trends are actually happening over much of the world. Consideration of the new trends is important to render the new vision of transport infrastructure because the means of transportation has strong correlation with transport infrastructure development as we see from the previous section. The scope of this thesis is not to explore these technological advances in transportation but to use them to propose a future transport infrastructure as a new framework of urban design. There are no doubt more trends and issues in the new transportation systems; however, this thesis focuses on these three trends to support the design proposal. Let’s take a close look at these three trends with actual data.

1. THE DEVOLUTION OF TRANSPORT INFRASTRUCTURE

This graph is about the real growth in vehicles and traffic volume as well as percent change in road length in the United States case. It shows the number of private vehicles had been rapidly increased until 2009 but the growth turned significantly slows after then. The highway length stopped to grow from 2011 while the regular road stopped from 2006. Most importantly, the traffic volume has been actually decreasing from 2005. These data indicate that the transport infrastructure and private transportation stopped to grow more. The future transportation system has to reflect this infrastructural change.

“\textit{In existing European city centers attempts to alleviate road congestion through building more roads or through road widening have largely ceased, partly because land values are too high, partly because of public opposition. Traffic engineers too – at least the more enlightened ones – now accept that widening only brings in more traffic, although they are still averse to closing a road or reducing a road width in the unshakeable belief that ‘traffic must have somewhere to go’. Today road building and road widening in Europe is largely confined to the suburbs and regions where land is cheap to acquire. This attempts to cater for the rise in cross-city trips although in practice rarely meets the demand for additional road space. This is partly due to development being allowed in areas without consideration being given to the proximity of good public transport.}”\textsuperscript{26}

TREND 2
2. THE EVOLUTION OF PUBLIC TRANSIT
The increase of public transportation was already in progress from around 2000. As public transportation use started to rapidly increase from 2005, growth of road traffic slowed. This is because of the technological development in transportation and the heavy congestion that made people to use private cars not as much as before. Also, the way of commuting is changing. People used to drive by themselves to go to work; however, there was a significant change in the portion of public transport users in recent years. The number of people who used public transportation for commuting in 2007 is almost more than four times the number that appeared in 1998. Those data show that there is a strong trend of using public transportation during the 21st century. The future transportation will be developed mainly as a public system.
TREND 3

(Fig 4.3) Transportation Trend 3
3. THE GREEN TRANSPORTATION

The last trend is “Green Transportation”. The interest in environmental issues became greater than in any other era. Not only organizations for environment give attention to this but also the public and their governments started to demonstrate concern about the environment. Therefore, the regulations have been created to the pollutions and they are stronger as time goes. Transportation is not an exception. Actually, transportation is one major source of pollution. Therefore, the transportation in these days is evolving in a way not to make pollution by adopting new technologies. These efforts and the regulations by the governments result in the decrease of percentage change in the gas emission. As the graph is showing, every state started decreasing in CO2 emissions since 2007. This trend is much more strong in the northeast region. The northeast region reached almost 20% decrease in 2011 compared to 2005. The future transport system must be eco-friendly.

“By 1995, global warming had become a focal concern of the United Nations and the international environmental movement, and sustainability had become a watch word in the debate over national energy policy, automobile dependence, and the future of personal transportation by automobile. In 1997, UN conferees reached consensus on the Kyoto accord on global warming, an international treaty that pledged the advanced industrial nations to adopt policies sufficiently aggressive to roll back their CO2 emissions by an average of 5.2 percent by the year 2012. The United States was initially assigned a 7 percent reduction target because it was – and is – the nation that accounts for the largest share of the world’s greenhouse gas emissions.”27

4.2 "Multi-Platform" City

MULTI-PURPOSE "MULTI-PLATFORM"

(Fig4.4) "Multi-Platform" Unit 1
There are 3 key trends that will strongly affect the future transportation as we see in the previous section: “Infrastructure decrease”, “Public transportation increase”, and “Green transportation”. Their influence on the transportation field is already happening all over the world. This thesis proposes a new type of transportation based on the 3 trends. It is a vision of a future transportation system from an architecture and urban design perspective. The future transportation system that will be eventually applied to urban design framework should reflect these trends in order to be realized one day. This section introduces the new type of transportation called “Multi-Platform”.

The Multi-Platform unit can go together with the "decreased infrastructure" in cities. This is a matter of decision-making on the size of future transportation infrastructure. The Multi-Platform has a 3-dimensional rail 10 feet in width, which is multi-layered. It can move above ground level. Therefore, this new system can share spaces with existing transport infrastructure, such as existing roads, even if existing infrastructure will be shrunk in the future.
This shows the Multi-Platform unit in a means of public transportation. The occupancy of one unit is up to 8 people and this unit can group together in every four way. The unit of Multi-Platform finds another units that have same direction as passengers put information of their destination into the system by smartphones. This is a new type of public transportation with the information sharing technology.

(Fig4.6) "Multi-Platform" Unit 3
REFLECTION OF 3RD TRANSPORT TREND
“GREEN TRANSPORTATION”

(Fig4.7) “Multi-Platform” Unit 4
The unit uses electronic power to operate its motor and this electronic system may ultimately be charged by wireless system. The wireless charging can be done because the Multi-Platform system has a 3 dimensional rail. The rail is connected to electronic power source with its underground structure. And the unit has a diagonal wheel that is saw-tooth shape. There are 8 diagonal wheels coming outside each corner of the unit and they are connected to the rail on all four sides. Therefore it is very stable when it moves. When the unit turns the angle to left or right, the wheels in the other side of edge come out to make the turn. It is easy to convert the direction for the unit because the plan of unit is square and it has completely symmetrical form. Also, it can move vertically by taking out the wheels at the vertical edge of unit. It has 24 small wheels in total. Each group of 8 wheels shifts if the unit wants to change directions.
5. THE BULFINCH TRIANGLE

5.1 History after the Industrial Revolution
5.2 The Transportation Development
5.3 City Form Changes
5.4 “Multi-Platform” in the Bulfinch Triangle
5.1 History after the Industrial Revolution

This section is about an application of the new transportation unit into the specific urban area of the Bulfinch Triangle. As continuing from the introduction, this section goes through the history of the Bulfinch Triangle after the industrial revolution was done. And it argues for the importance of introducing a new transportation system to the Bulfinch Triangle from this historical analysis.
This is a satellite photograph of the Bulfinch Triangle in 1995. There was the central artery that went through the Bulfinch Triangle. It separated the left and right side of this area. There was elevated transit that was the Green line next to the Canal Street. This period had the most complex and big transport infrastructure in history. The central artery construction in the 1950s erased a lot of urban structure and it became a huge transport system in the city. It connected the areas in efficient way. However, it caused a lot of problems, including pollution.

(Fig 5.1) Satellite Pic Bulfinch Triangle 1
In the late 1990s, the elevated transit line started to be demolished and the station above ground was replaced by new constructions. The old Boston Garden that was located on the Causeway Street started to be demolished as well. The replacement of the old Boston Garden changed a lot of the transport infrastructure in the Bulfinch Triangle because it created the underground connection between the railway system and the transit lines. The big portion of the activities happening in the transportation infrastructure went to the underground.
The 2001 satellite photograph shows the new Boston Garden with a huge ground parking space on the Causeway street. The blocks between the Canal street and the central artery where the elevated transit station was located turned into an empty space and were ready to be developed. The Bulfinch Triangle had a connection to the central artery at its bottom and the most places in the Bulfinch Triangle had enough parking spaces that enabled people to come this area with their private cars. However, the central artery also started to be demolished as the big dig project progressed.
The central artery was completely gone in 2004. The space that the central artery was located became a big parking space. The rest of elevated transit line started to be demolished as well. The era of minimized transport infrastructure had come. The construction for new buildings on the blocks that used to be the elevated transit lines started.

(Fig5.4) Satellite Pic Bulfinch Triangle 4
In 2006, the new residential building replaced the elevated transit line next to the Canal street. And the rest of area where the transport infrastructure was located turned into green spaces. The Bulfinch Triangle recovered its grids that were erased by the transport infrastructure after the 1950s. However, the accessibility from the highway became lower. Moreover, the activities related to the public transportation such as transit lines were all disappeared on the ground. The intention of the plans that buried transportation infrastructure was to make the environment above ground better, but ironically it caused a reduction in pedestrian activities on the ground.

(Fig5.5) Satellite Pic Bulfinch Triangle 5
The new urban form after transport infrastructure demolition completely settled down in 2010. Except the one block where a residential building was built, the spaces that used to be the transport infrastructure became parks. This photograph shows the completion of the residential building on the Canal Street. This new residential building is not just an apartment but a complex building that has connections to transit lines in its underground. Even though the large amount of area in Bulfinch Triangle turned to be green spaces, the use of the green spaces stayed low. The most pedestrian activities were placed underground.

(Fig 5.6) Satellite Pic Bulfinch Triangle 6
After 2010, the green spaces started to be filled with new residential buildings. And the satellite photograph in 2013 shows that the use of parking spaces in the Bulfinch Triangle was significantly decreased compared to the satellite photographs before 2000 when the central artery was there.

(Fig5.7) Satellite Pic Bulfinch Triangle 7
In 2015 satellite photograph, the rest of the green space was developed as residential buildings. Only a small piece of block remained as green space. The parking spaces still stayed empty as this area lost clusters of activities after the demolition of the on ground transport infrastructure.
5.2 Transportation Development

In this section, the thesis focuses on the development of transportation in the Bulfinch Triangle. The transportation history of the Bulfinch Triangle is very dynamic. This small area used to have all different types of transportation infrastructure over the generations. The canal was the first transportation infrastructure around 1800s. Then the railways replaced the canal as soon as it was first introduced to the United States. The elevated transit lines were added early in 1900s. The huge highway called the central artery was built after 1950. And the biggest infrastructure project in the United States, which is called the Big Dig, demolished the central artery and moves it into the underground. Eventually every transport infrastructure except the streets went underground in the Bulfinch Triangle.
TRANSPORT DEVELOPMENT:
THE CANAL ERA

(Fig 5.9) Transport Infrastructure History Bulfinch Triangle 1
The history of transportation development in the Bulfinch Triangle started with the canal. The Bulfinch Triangle used to be water before the 19th century and there was a water route called Mill Creek, which was connected to the Middlesex Canal. The landfill was planned with the construction of the canal. Therefore, this area didn’t lose the Middlesex Canal connection after the landfill. The beginning of the Bulfinch Triangle was developed as an industrial area with the canal infrastructure.
TRANSPORT DEVELOPMENT:
THE RAILWAY ERA

(Fig 5.10) Transport Infrastructure History Bulfinch Triangle 2
After the railway system first came in the United States, the railways replaced the canal. This railway system was used for freight in most of cases at the beginning. Then the Union Station was opened as a passenger terminal. The North Station replaced the Union Station late in the 19th century. In 1900s, the elevated railway on the Canal Street was constructed. And the streets started to be paved after the 1910s. In the 1920s, the Boston Garden was opened. The Atlantic Avenue elevated railway was closed in the 1930s.
TRANSPORT DEVELOPMENT: THE CAR ERA

(Fig 5.11) Transport Infrastructure History Bulfinch Triangle 3
This diagram shows the underground transport infrastructure generation. It began by removing the central artery. One of the most destructive transport infrastructure plans, the Central Artery, was built in 1950s. In 1980s, the Big Dig project was planned which was a replacement of the Central Artery. The Big Dig project started to construct and the new Boston Garden was completed in 1990s. Finally, every elevated transport infrastructure went to the underground. All over the history, the Canal Street has been a center of the transportation infrastructure change in the Bulfinch Triangle.

"In the Bulfinch Triangle scheme, a canal dutifully followed Canal Street, connecting the markets at the apex of the triangle to the harbor at the base. The canal has long since disappeared and the street now leads forthrightly to nowhere. It is terminated at one end by the hulk of North Station and the elevated, and blocked at the other by wide new roads circumventing the Government Center Garage. Parallel and to the east are rail lines and highway bridges. This long, low set of buildings remains committed to the street, following it with eye-catching terra-cotta ornament, asking to be reconsidered as the inception of some more lively future for this enclave of streets. The first steps would include new construction that would fill out the boundaries of the street, confining the space of Canal Street to something of more limited size. At present these buildings bring a slim suggestion of human scale to the edges of that special, awful emptiness that is often found next to a transportation corridor." 

5.3 City Form Changes

(Fig 5.12) Transportation and Urban Form Bulfinch Triangle
THE NORTH STATION OPEN
WASHINGTON TUNNEL OPENED
ELEVATED RAILWAY CONSTRUCTED

1800 1875 1880 1895

URBAN UTILITY LOT NUMBER
DEVELOPMENT
The city form in the Bulfinch Triangle, including the street patterns and the lot configuration, has been changed along with the transportation development and transport infrastructure transformation.

In the canal infrastructure period, the Bulfinch Triangle was developed as an industrial area. It was totally vacant at the beginning. Then the vacant spaces started being filled up with industrial use buildings such as manufacturing factories. From the 1800s to 1840s, the complexity of the lot configuration and the number of the activated lots were rapidly increased while the total vacant space was decreased.

"The first notable American canal was the Middlesex, 27 miles, linking the Charles River at Boston and the Merrimack at Chelmsford. The superintendent of construction, Loammi Baldwin, had experience as a surveyor but had never seen a canal lock. As costs escalated dagerously, he had to seek advice from an Englishman, William Weston, who immediately discovered that the original surveys for ascent and descent were awry. The first lock “broak and failed” as soon as it was filled with water. After nearly a decade, the canal finally opened in 1803 at a cost of more than a half-million dollars, a huge sum for the day. There were 8 aqueducts, 20 locks, and 48 bridges, all in all the most elaborate construction project yet completed in the new nation. Disappointing returns discouraged other projects of the same sort in New England for two decades. Enthusiasm would revive, but only briefly, for railways provided devastating competition. The Middlesex Canal was out of service by 1852, crushed by the Boston & Lowell Railroad."  

The period from 1860 to early in the 1900s was the railway generation. This area was a center of the transportation in the city was developed very fast with the railway infrastructure. The total vacant area and was increased between 1860s and 1870s in a rise of need to store industrial freight. However, the total vacant space turned to be decreasing after 1890 as the density of the city and the land value was increased. After the railway infrastructure completely settled down in the Bulfinch Triangle, the passenger terminal that was the Union Station became the North Station. Then the elevated railway was constructed in 1900s. This means that the public railway transportation was very popular around 1900.

The land use in the Bulfinch Triangle changed early in the 20th century. There are both industrial buildings and commercial buildings in this area, and the railway system started to have a function of passenger transport. Before 1900, most of the railway system was dedicated to industrial freight. As the commercial use rapidly increased around the 1920s, most vacant spaces were filled with buildings. After 1930, private cars became the major transportation. Consequently, there is a strong need for parking spaces in the Bulfinch Triangle, and some of the buildings were demolished to make parking lots. It is the reason that the total vacant space was increased from the 1930s. Around 1950s, the Central Artery was constructed and it totally erased a large amount of urban fabric. Not long after its construction, the Central Artery was dismantled, and the highway went underground. The blocks that the Central Artery destroyed were recreated and filled with residential buildings. Land use from the 1920s to the present dramatically changed. It used to be an industrial area at first. Then the commercial land uses came to the area. It was totally commercialized after 1950. After the Big Dig project, the Bulfinch Triangle is becoming a residential area. Overall, from 1920s to the present, the urban vitality has been steadily decreased while the total vacant area increased until 1990s when it started to decrease.
5.4 *Infrastructural Interventions in the Bulfinch Triangle*

Finally the thesis is ready to propose a new transportation infrastructure design as a new urban design framework in this section. Before looking at the details of design, this section analyzes the relationship between the urban form and the transportation infrastructure in the Bulfinch Triangle, and figures out the best urban form and transport infrastructure for urban activities. Then it points out the current problems that the Bulfinch Triangle has in order to provide reasons why the new transportation system is needed in this area.
(Fig. 5.13) Urban Form History Bullfinch Triangle 1
**CANAL: 1800 - 1830**
The Bulfinch Triangle used to be a Pond called Mill Pond and the surrounding land was used for the mills. The dam was built to create power and it had a boat route to connect this area to the Middlesex canal. The surrounding land was not urbanized yet. Therefore, the streets look very simple and wide.

After the Mill Pond was completely filled around 1920s, the city started growing as an urban area and the Bulfinch Triangle became a transportation center of the city soon after it was created.

As the canal transportation was settled down into the area, the surrounding land started developing and the urbanism begun. Until 1840s, a lot of spaces were not developed because this area was just filled. Also, the needs of spaces to store industrial freight made some spaces remained as empty.
(Fig. 5.14) Urban Form History Bulfinch Triangle 2
RAILWAY: 1850 - 1930

“The introduction of railroads in the 1830s not only revolutionized transportation but also created a need for yet more land in Boston. The first three railroads to enter the city were all completed in 1835 and all had depots on made land. In addition, two of them, the Boston & Providence and Boston & Worcester, crossed the receiving basin in Back Bay on embankments that had been built up above the water. The Boston and Providence depot was on made land about where the Park Plaza Hotel is today. The Boston and Lowell depots were on land that had been created for that purpose by filling flats north of Causeway Street.” 30

The railway system was introduced into this area in 1830s. From 1830s, the landfill was extended to make the terminal spaces. The street pattern in this area was fixed. The empty spaces were increased than before because the industrialization hit the peak in this period.

After 1850s, the empty spaces were shrunk because of the urbanization and commercialization. The urban form became more complex than before.

Not only the empty spaces but also the streets were shrunk as the railway system was developed around 1900s. The railway public transport became the major means of transportation. There were a main transit station on the Canal Street and the train terminal was located on the Causeway Street called the union station. The trolleys can stop a lot of spaces on the streets.

INFRASTRUCTURE/URBAN FORM
: 20THC

(Fig 5.15) Urban Form History Bulfinch Triangle 3
RAILWAY AND CAR: 1900 - 1950

“By the 1920s and 1930s, the insurance maps of Boston and neighboring cities began to show gaps in their tidy blocks of building footprints. The parking lot and parking garage, the gas station, and the auto repair shop began to leave their mark on the downtown. The automobile had arrived.”

In 1900s, private cars started to be introduced to the public. The streets used to be utilized mostly for railways and horse carriage but the streets had to accommodate cars as well.

At the beginning of the private car period, the streets were used by both trolleys or trains and cars. It caused some congestion but the city had enough access to the transportation and it made a lot of people to walk on streets.

After 1920s, the city paved the streets for cars. And the railways on the street were retreating fast as private car became a major means of transportation. The vacant spaces in the Bulfinch Triangle mostly disappeared at the end of the railway system dominated period.

INFRASTRUCTURE/URBAN FORM
: 20\textsuperscript{th}C-21\textsuperscript{st}C

(Fig 5.16) Urban Form History Bulfinch Triangle 4
CAR: 1940 -
“Report of a Thoroughfare Plan for Boston in 1930 recommended the construction of a tunnel to East Boston and a system of radial highways. It also presented a central artery connecting North and South Stations, originally proposed in 1911 as a “business thoroughfare.” Except for the construction of the Sumner Tunnel in 1934, the forward-looking 1930 concept languished in the face of the Great Depression and subsequent world war until Governor Bradford incorporated many of its recommendations in his 1948 Master Highway Plan. That plan included the outlines of two beltways around Boston – routes 128 and 495 – and the extension of I-95 northward into the city to be intercepted by an inner belt highway. Citizen opposition but not before large portions of the proposed rights-of-way had been cleared would eventually stop the I-95 extension and the inner belt. The first segment of the inner belt – the Central Artery – was completed, however.”

At the beginning of the private car generation, the streets were narrow to accommodate the rapid increase of cars. The streets had been optimized for the railway system for a long time. There was still a lot of railway infrastructure such as elevated railways. As private cars became the major transportation in the city, the elevated railways were dismantled and the railway infrastructure went to the underground.

After 1950s, the city built huge infrastructure for cars. The central artery was built in this period. Some of railway infrastructure above ground still remained. This period had the largest amount of transport infrastructure ever in the history. The size of existing transport infrastructure was enlarged and new transportation infrastructure were built.

After 1990s, every elevated transport infrastructure including the central artery and the elevated transit lines were buried. The transportation infrastructure started to be shrunk. The “road diet” which is one of the recent trends of transportation started.

(Fig5.17) Urban Vitality and Population Bulfinch Triangle
CONCLUSION
As we see from the city form analysis with the transportation infrastructure maps, the period that had the most number of activated lots is around 1900s when the railway transportation and the private cars were coexisted. This period had the most popularized public transportation. The population of the city also hit the peak during 1900s through 1950s. This analysis tells us that making clean environment on the ground does not activate the pedestrian movement in the city. The most important to vitalize the pedestrian activity is accessibility to the transportation system.
(Fig.5.18) Building Uses and Clusters 1950/2015
1950 VS 2015
To support the argument that the most important to vitalize the pedestrian activity is an accessibility to the transportation system not just making a good environment, this section takes a look at the program changes and the cluster changes between the 1950s and the present.

The first diagram shows the program of buildings in the Bulfinch Triangle. The programs in 1950s were very diverse. The wholesaling represented in blue color and the retailing in dark brown color and the office in red color are the three major programs in this period.

The programs in the Bulfinch Triangle in recent days were totally changed from the 1950s. The most areas are the retailing or office and the residential buildings were newly built. Therefore, we can understand that this area has been commercialized over the last few decades.

In the third diagram, we can see the most areas created clusters as the similar programs were bunched together. This diagram shows the most area in the Bulfinch Triangle was very activated following the programs.

The last diagram shows that the Bulfinch Triangle lost most of the clusters in recent days even though this area was commercialized. There are just few clusters next to the canal street.

With this phenomenon as a backdrop, the thesis proposes a new urban design framework into this area to re-vitalize it. Returning back transportation infrastructure in a new way is the only answer. The thesis applies the Multi-Platform system into the Bulfinch Triangle.
6. THE BULFINCH TRIANGLE AND ITS FUTURE: *THE RETURN OF HUMAN SCALE CITY*
The application of the “Multi-Platform” design to the site, the Bulfinch Triangle, is based on historical studies that concluded that transportation infrastructure is once again required for this area. These diagrams, which show the scenario from the past to the present and future framework of infrastructure installation, are about changes of the relationships between the transportation infrastructure and urban activities over time.

SCENARIO
The “Multi-Platform” is not only the extension of the transportation system. The “Multi-Platform” goes into the urban area and can attach to buildings. This is also an extension of the existing architecture. Therefore, this system can completely integrate the entire city. It links the transportation area and the pedestrian area by its structure, so the pedestrians can feel safe in the public spaces, and it generates more activities on streets. As the “Multi-Platform” system consists of small units, which are 10ft by 10ft, every place in the system can be a stop for people to get off and on, or connect with other units.
A past model of the modern urban transportation infrastructure is when the elevated transportation infrastructure was intensely constructed in the city. It had a lot of defects, even though it activated the city. First of all, it segregated the infrastructure and the city, separated neighborhoods, and made severe pollution. And it caused heavy traffic congestion. Paradoxically, the more the construction of the transportation infrastructure progresses, the worse the traffic is congested on the roads. Accessibility to urban fabrics was good, however, it was not an ideal condition for pedestrians. The elevated infrastructure blocked the sunlight on the city streets.

(Fig6.1) Design Scenario 1
Elevated transportation infrastructure were buried underground. These constructions had begun in 1950s, specifically in Boston, and the elevated railway and transit lines were buried first. Then the elevated highways for cars were constructed to satisfy the demands for more roads. These demands for new roads were caused by the rapid growth of private cars after the 1950s. However, elevated highways also went underground for several projects including the Big Dig, which buried the Central Artery. After these infrastructural constructions underground, accessibility to the urban street area became very limited. A lot of pedestrian activities take place in underground transportation facilities.

(Fig6.2) Design Scenario 2
One of the most recent trends is “road diet”, which means the road lanes will be reduced. Owing to the advance of traffic control technologies and the decrease of private car use, the size of transportation infrastructure can be decreased.
The proposed new transportation system, "Multi-Platform", integrates transportation and the city with a human scale structure and creates much more pedestrian activity than before. The "Multi-Platform" system, which is fit with the decreasing transportation infrastructure can share the road with existing cars.
"MULTI-PLATFORM" INSTALLATION
AND URBAN MORPHOLOGY CHANGES

(Fig 6.5) Future Urban Morphology
URBAN MORPHOLOGY WITH “MULTI-PLATFORM”

“A city sidewalk by itself is nothing. It is an abstraction. It means something only in conjunction with the buildings and other uses that border it, or border other sidewalks very near it. The same might be said of streets, in the sense that they serve other purposes besides carrying wheeled traffic in their middles. Streets and their sidewalks, the main public places of a city, are its most vital organs. Think of a city and what comes to mind? Its streets. If a city’s streets look interesting, the city looks interesting; if they look dull, the city looks dull.”

Application of the system to the city will progress as the urban morphology changes. As new trends of transportation such as “road diet” impact the city, the transportation infrastructure shrinks. Indeed, some roads will disappear completely. This decrease in transportation infrastructure brings loss of pedestrian activities on the streets.

The loss of transportation infrastructure on the urban fabric and the loss of accessibility to the buildings will be restored by installing the new transportation system, the “Multi-Platform”. This system comes out of the existing underground subway from North Station as a part of the subway lines, and the extended transportation infrastructure will then be installed into the urban fabric. Then the system will connect the existing buildings as a means of transportation and, as it does, the units can transform the architectural spaces, as they become extensions of existing buildings. This system will begin by occupying and connecting vacant spaces and by creating independent spaces. These independent spaces become new buildings and can replace the existing buildings later, as it expands. The space created by the “Multi-Platform” system makes more public space with its structure and creates pedestrian friendly spaces. This new configuration of the street morphology will give new breath of life to this area.

(Fig 6.6) Section of 'Multi-Platform' City
THE MULTI-PURPOSE “MULTI-PLATFORM”
This section drawing describes the implementation of the new system into the city, including both its transportation and architectural functions. It creates pedestrian friendly spaces and vertical movement in the city. This model integrates the transportation into the city, while also protecting pedestrians from the transportation system. This is very important to activate the pedestrian activities.

“What makes a sidewalk safe is not its width, but whether it is protected by a line of parked cars that form a barrier of steel between the pedestrian and the roadway. Have you ever tried sidewalk dining on a sidewalk without curbside parking? Those sorry little table installations rarely last long. Whether they are two feet away or ten feet away, nobody wants to sit – or walk – directly against a line of cars traveling at sixty feet per second. On-street parking also slows traffic down, since drivers are wary of other cars potentially pulling into the roadway” 34

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TRANSFORMATION OF GROUP OF UNITS

(Fig 6.7) Unit Matrix of "Multi-Platform"
THE UNIT MATRIX
A unit can group together in each case – transportation, architectural extension, public space.

If the system works in a single unit as a transportation use, the unit becomes a private vehicle. A single unit has 8-person occupancy for a group of people. A group of people can use this unit as their private means of transportation. A single unit in architectural use, by comparison, could temporarily stay attached on a building as a transportation dock or office, which means that people can use this system from inside of buildings. A single unit could also be used as a temporary lobby for buildings when it is on the street.

If the system works in two units for transportation purposes, it can be a transportation sharing system. Two different units, which have same direction, can be attached. This sharing system can save energy because grouped units can share power. Two units, which are grouped for architectural purposes, can create a temporary extension of space that is 10 by 20 feet in dimension. This temporary extension is very useful, especially for places which have small areas. This system provides extremely flexible space use. In public space, a group of two can make a rooftop space through its rail structure. It can give not only provide an extended semi-public space but also an entrance to a second floor from outside. It can generate more pedestrian activities on streets.

A group of four units becomes a form of public transit on streets and replaces buses. It is very efficient because it can be easily detached or attached depending on situations. In architectural use, four units can be a connection between adjacent buildings (20 by 20 feet). It can be not only space extensions but also hallways (10 by 40 feet). And as this extended hallway is a temporary space, efficiency of space use can be increased. On streets, four units can also make an entry courtyard as a transitory public space.

More than four units can replace subways. It can move like a subway train and some of them could be detached at a station for people who need to get off. However, different from existing subways, people do not have to take off from vehicles because each units can be detached and they will move to final destinations as a part of the system. Also, a group of more than four can make an independent space and create semi-permanent areas. These units can replace existing buildings in the future. New spaces created by this system are significantly flexible. In public areas, the units can make a plaza with its structure and it can eventually replace existing public spaces.
CONFIGURATION OF UNITS IN URBAN SITUATIONS

(Fig 6.6) Urban Situations of "Multi-Platform"
THE URBAN SITUATIONS
The “Multi-Platform” transforms its configuration and use in different urban situations.

On the street, it is a transportation rail but it also creates pedestrian areas. It can be temporarily attached to buildings as a transport dock. The system works either as a transportation line or as temporary or semi-permanent extensions of existing buildings. In the urban context, this system works as connections between the streets.

In small vacant spaces, it can be temporary extensions of architectural space, giving connections between the buildings. Temporary extensions of buildings create public places in vacant areas. It makes physical connections to surrounding buildings with its rail structures.

In large vacant areas, it frames semi-permanent spaces, which will be eventually replacing existing buildings. This system also helps outdoor activities by making open space on rail structures. In the urban context, this system makes connections between new architectural spaces created by units and transportation lines.

At intersections, the system makes the connections between corridors so that this system can expand to other areas in the city.
(Fig6.9) "Multi-Platform" City Situation 1
SITUATION 1
This image shows temporary extensions of the buildings and how rail structures create pedestrian space. Also, this image describes how vertical connections work with existing buildings. And rail structures enclose vacant space and make connections between buildings and vacant space. This new “zone” made by rail structures, between public space and private space, can create outdoor activities in public realm satisfying the three main qualities of the public place that Jane Jacobs mentioned.

“A city street equipped to handle strangers, and to make a safety asset, in itself, out of the presence of strangers, as the streets of successful city neighborhoods always do, must have three main qualities: First, there must be a clear demarcation between what is public space and what is private space, Public and private spaces can not ooze into each other as they do typically in suburban settings or in projects. Second, there must be eyes upon the street, eyes belonging to those we might call the natural proprietors of the street. The buildings on a street equipped to handle strangers and to insure the safety of both residents and strangers, must be oriented to the street. They cannot turn their backs or blank sides on it and leave it blind. And third, the sidewalk must have users on it fairly continuously, both to add to the number of effective eyes on the street and to induce the people in buildings along the street to watch the sidewalks in sufficient numbers. Nobody enjoys sitting on a stoop or looking out a window at an empty street. Almost nobody does such a thing. Large numbers of people entertain themselves, off and on, by watching street activity.”

Rail Structures can create decks in some places and they can become entrances to buildings from outside. This enhances accessibility to buildings and save space inside of them. Therefore, this new system not only changes ideas of urban transportation planning but also transforms architecture.

"Multi-Platform" City Situation 2

(Fig. 6.10) "Multi-Platform" City Situation 2
SITUATION 2
This drawing shows how groups of units create independent architecture. Groups of units can replace existing buildings. Structures of the system can expand as much as buildings require. Extensions that are attached to buildings can be temporary but some of groups create their own architectural space and they can be semi-permanent. This means that the system has extremely flexible space use. Spaces can transform anytime. Also, structures will provide connections between buildings by bridging them with decks. Structures, which go up to a roof of building, will give easy accessibility to a roof from outside while, in current situations, people have to go inside of buildings passing through private space in order to get to a roof. This system will help activating rooftop uses, linked with private spaces.
THE RETURN OF HUMAN SCALE CITY

(Fig 6.11) "Multi-Platform" City Situation 3
**SITUATION 3**

This image shows a street with the new system. It is basically the transportation line but it will build more active walking environment. The units work as temporary extensions of buildings as well as transportation docks. The new system will help pedestrian activities on the street. The new system, “Multi-Platform”, provides transportation system to the urban environment in a close distance. And it does not make pollution to the city. Moreover, it is very safe because it protects pedestrians from transportation by their structure.

“The relationship between transit and walking is borne out by the data, which clearly show that American cities with larger numbers of rail and bus commuters also have more pedestrian commuters. When more than a quarter of workers take transit, more than 10 percent go on foot. When fewer than 5 percent take transit, fewer than 3 percent go on foot. It isn’t just that transit users walk more, but that non-transit users also walk more in cities that are shaped around transit. For the most part, cities support either driving or everything else. Most American cities are driving cities and will remain so for years to come. For these cities, transit can still play an important role, by enhancing the walkability of the few walkable places and by connecting these places – more on that below. In contrast, a number of American cities, like Boston, are resolutely car-optimal, and more than a few others may be on the verge of becoming so. ... With rare exceptions, every transit trip begins and ends with a walk. As a result, while walkability benefits from good transit, good transit relies absolutely on walkability." 36

Also, this image describes the possibility of sharing the new infrastructure with existing cars. This sharing idea is very interesting in that the system could be developed as private car parking space. Private cars in the future will be more minimalized. Then they can be stored in a unit of this system and stacked on structures.

36 Speck, Jeff. Walkable City: How Downtown Can Save America, One Step at a Time. Macmillan, 2013, page 139-140.
THE 1ST PHASE: 2040
This is the 1st phase of the new transportation system in the city. The system will build connections between the areas. The system originated from underground transport infrastructure at North Station. The system will start as an extension of underground transportation to urban fabrics, and ultimately extend to Haymarket Station, beyond the Bulfinch Triangle.
THE 2ND PHASE: 2060
This is the 2nd phase: 2060. This image shows extensions of the new system started to cover existing buildings, and fill vacant lots. This will make space in the city much more flexible. This system is not just extensions of the transportation infrastructure but it is also extensions of existing architecture.
THE 3RD PHASE: 2080
The 3rd phase is about replacing existing buildings. This system can replace old buildings. And the system will make even more spaces than before with flexibility in terms of space use and size. This is the future of the Bulfinch Triangle in 2080.
6. CONCLUSIONS & REFLECTIONS
Transportation infrastructure is not just pathways that provide connections between places. It has close relationship with the urban environment. It has developed with urbanization, and it has impacted on urban forms and uses over time. This strong relationship became evident after the Industrial Revolution, which led to transportation innovations such as the railway system. The technologies related to transportation were rapidly developed and it really changed the urban design framework. However, not enough studies on the relationship between the transportation development and the urban environment were done. Especially, historical analysis of these two factors is hard to find. In this context, the thesis addresses the transportation and urban issues together. Even though the thesis limits its geographical scope to within the Bulfinch Triangle, which is only a small part of the city, the thesis successfully determined the causal relationships between the two. This area of Boston, a center of transportation in the city, has evolved with transportation changes.

The transitions of the transportation infrastructure in the Bulfinch Triangle obviously impacted the land use and the urban vitality. To measure the urban vitality over the history was one of the challenging steps in the research. It is hard to measure the urban vitality of the past objectively. In the research, the urban vitality was determined by the number of activated lots and the employment or population density. The thesis tries to maintain objectivity by measuring the urban vitality with the measurable factors; however, at the same time this methodology makes a limitation because it cannot represent every aspect of urban vitality. To find out the scientific and objective way to measure urban environmental factors of the past can be a further research issue of this thesis. Historic data, which the research mostly referenced, were the Sanborn maps. One of the important tasks in the research was to find the Sanborn maps and combine them together. The combined Sanborn maps are attached in the appendix of the thesis.
In the design process of the thesis, the design of a new vision in the future was based on the historic research. The design of the transportation unit reflects new trends of transportation. And the implementation of the new urban design framework into urban areas comes from academic studies of transportation history and urban form. Making connections between the design principles and the historic studies is very important for the urban design framework. It is very interesting to predict the future phases of urban forms with the historical context. The reason for the installation of the new transportation system into the urban fabric is from historical research on the relationship between the transportation infrastructure and the urban vitality. However, there might be some questions about the way the Multi-Platform framework was constructed. Indeed, this plan requires a heavy infrastructural construction. It might be a very demanding work, especially in terms of costs. As drawn, the materials would be heavy, but this is just the schematic design phase. Moreover, the grid structure might not fit with the existing urban/architectural environment. The new system needs to be developed to make people take this idea serious. But considering that the idea of new transportation is coming from the urban design frontier as a future vision of the city, let’s set aside the realization issue of the design at this stage. The new vision of this thesis gives ideas and imagination to people who might wonder how cities could evolve in the future. It can provide opportunities not only for engineers to make design innovations and algorithms for this system, but for policy makers to think about new legislation for the new transportation framework. It is a reality that new technologies are already changing transportation ideas, and they transform the urban environment.
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(Fig1.3) Photos from "Cityscapes of Boston"
(Fig2.1) Drawings from "Ecotransology: Integrated Design for Urban Mobility."
(Fig2.2) Photo from "Motopia"
(Fig2.2) Drawing from "The Architecture of Paul Rudolph"
(Fig3.1) Urban Form Configuration from "Streets & Patterns"
(Fig4.1) Data Source FHWA
(Fig4.2) Data Source Metlink, DOT
(Fig4.3) Data Source USDOT
(Fig5.1) Photo from Google Map
(Fig5.2) Photo from Google Map
(Fig5.3) Photo from Google Map
(Fig5.4) Photo from Google Map
(Fig5.5) Photo from Google Map
(Fig5.6) Photo from Google Map
(Fig5.7) Photo from Google Map
(Fig5.8) Photo from Google Map
(Fig5.17) Data Source Bureau of Labor Statistics
(Fig5.18) Data Source Sanborn Maps
1950

2015

OFF STREET PARKING
1950/2015 BULFINCH TRIANGLE
FLOOR SPACE UTILIZATION
1950/2015 BULFINCH TRIANGLE