# URBAN TRANSPORTATION: SECTIONS AT MINUS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

EZGİ EROL

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF ARCHITECTURE
IN
ARCHITECTURE

FEBRUARY 2010

Approval of the thesis:

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## ABSTRACT


**URBAN TRANSPORTATION: SECTIONS AT MINUS**



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February 2010, 122 pages



This thesis focuses on the underground transportation forms that began to emerge in city centers in the second half of the $20^{th}$ century. Besides providing an illustration and evaluation of the selected case projects, the notions of *speed* and *time* are opened for discussion as significant concepts that interact to affect the physical formations both of cities and transport policies. The developments in urban transport technologies after the 1960s are also examined as leading factors in the development of today's multimodal and multilayered urban transportation hubs.



**Keywords:** urban transportation, urban section, multimodal transportation, speed.

# ÖZ

## KENTSEL ULAŞIM: YERALTI KESİTLERİ



Erol, Ezgi

Yüksek Lisans, Mimarlık Bölümü

Tez Yöneticisi: Doç. Dr. Güven Arif Sargın



Şubat 2010, 122 sayfa



Bu çalışma, 20. Yüzyılın ikinci yarısından sonra inşa edilen kentsel yeraltı ulaşım yapılarına odaklanmaktadır. Seçilen örnek projelerin tanıtım ve değerlendirmelerinin yanı sıra, kentlerdeki fiziksel oluşumlar ve ulaşım politikaları ile karşılıklı etkileşim halinde olan *hız* ve *zaman* kavramları tartışmaya açılmıştır. 1960 sonrası kentsel ulaşım teknolojilerinde meydana gelen gelişmeler, günümüzün çok modlu ve çok katmanlı kentsel ulaşım merkezlerinin oluşmasına sebep olan diğer etmenler olarak incelenmiştir.



**Anahtar kelimeler:** kentsel ulaşım, kentsel kesit, çok modlu ulaşım, hız.

*To My Parents,*

*Lale and Mehmet Faik Erol*

# ACKNOWLEDGMENTS

I would like to express my profound gratitude to Assoc. Prof. Dr. Güven Arif Sargın for his professional guidance, support and patience throughout this study.

I would like to thank the members of the examining committee, Assoc. Prof. Dr. Cana Bilsel, Assoc. Prof. Dr. Ela Babalık Sutcliffe, Assist. Prof. Dr. Berin Gür, and Inst. Dr. Haluk Zelef for their valuable suggestions and comments.

I would like to thank Serdar Yeşilyurt, from the staff of the EGO General Management-Department of Rail Systems (EGO Genel Müdürlüğü-Raylı Sistemler Dairesi Başkanlığı), for his technical help in order to achieve the drawings of Ankaray-Metro Transfer Station. I offer sincere thanks to Arda Tarımcı, from the staff of the Ministry of Transportation-Department of Railways, Harbors and Airports (Ulaştırma Bakanlığı -DLH (Demiryolları, Limanlar, Hava Meydanları İnşaatı Genel Müdürlüğü)) for his technical support in achieving drawings of the Marmaray-Yenikapı Transfer Station.

I am thankful to all my friends, especially Beste Bayramoğlu and Mehmet Salih Yıldırım, for their continuous encouragement and support through the most difficult times. I would also like to thank Mücahit Erdem, who always shared my excitement during the study.

I owe my deepest appreciation and thanks to my parents, Lale and Mehmet Faik Erol, for their patience and trust throughout my life.

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# CHAPTER 1

# INTRODUCTION

## 1.1 The Definition of the Problem and the Objectives of the Study

This thesis explores the transformation of urban areas in terms of their expansions below ground, occurring as a result of changing economic, political, and architectural factors from the beginning of the 20$^{th}$ century up until the present day. Since the superimposition of urban transportation system corridors in metropolises has resulted in the formation of transportation nodes, new urban areas are being designed at a subterranean level in metropolises. The main argument addressed in this thesis is that the 21$^{st}$ century metropolises are opting to extend underground, in particular for transportation purposes. This new urban paradigm is the result of a number of diverse factors, such as an increase in the variety of transportation modes, urban congestion in historic city centers and environmental conditions. Focusing on this assumption, the physical effects of this new urban paradigm on public spaces are to be examined. The basic questions that are to be answered in the study are:

- What were the factors that lead to the expansion of urban forms underground in the second half of the 20$^{th}$ century?
- What were the architectural and urban space properties of the underground transportation sections that have been built after the second half of the 20$^{th}$ century?

## 1.2 Method of Analysis

The main resources used in this research are the architectural drawings of the selected multilayered transportation nodes from around the world. Since the underground spatial formations are to be analyzed in the study, the discussion is based mostly upon section drawings of the projects. One of the determining factors in the selection of the section drawings to be analyzed is their indication of the transportation modes and program elements they include; and that the section drawings of the case projects should give an indication of their urban contexts.

For the analysis in this study a categorization of these projects will be developed; and by analyzing of a wide range of cases, a general framework will be constituted. This will allow an understanding of the common factors that led to the emergence of these new urban areas around the world, and the processes that led to their respective formations. The cases will be studied in terms of their physical milieu, their underground-over ground space relations, how different spatial functions are connected and understandings of the urban space.

### 1.3 Structure of the Thesis

The argument of the thesis will be developed in three main chapters, covering the subject matters of: 'Speed and Time in the Post-Industrial Metropolises', 'The State of Urban Transportation in Post-Industrial Metropolises', and 'The Analysis of the Urban Underground Transportation Systems' respectively. In the second and third chapters of the study, a theoretical framework is to be developed; while the main discussion of the thesis will be introduced in the fourth chapter.

In the second chapter, the changing perceptions of *time* and *speed* in the 21$^{st}$ century are to be investigated and commented upon as important factors in the development of transport policies, and their affect on the physical environment of metropolises. The concept of speed is claimed to have affected the world socially, economically and architecturally in this chapter. The effect of the acceleration in socio-economic processes will be analyzed as a basic factor affecting the formation of the built environment in post-industrial metropolises. In terms of transportation, the desire for increased speeds led to the invention of faster modes and the acceleration of existing ones, which will also be introduced in this chapter. The invention of the railway and motorized transport in the industrial period will be analyzed with respect to their contribution to the changing perceptions of time and speed.

In the third chapter, the current status of urban transportation will be reviewed to allow a comprehension of the elements that constitute multilayered nodes. Urban transportation policies put in place by governments since the 1980s and their affects upon the urban form will also be discussed in this section. The competition between the car and other modes of transport is another matter that is going to be dealt with. The advances in high speed train technology in the post industrial period will be analyzed in their attempt to curb the popularity of car; and since this new mode of transport has changed the balance in transport policies since the 1980s, its development around the world is going to be discussed. The final issue opened for discussion in this chapter will be multimodal transportation.

The properties of programs that have been initiated to create multilayered urban underground architectures are going to be analyzed in the fourth chapter. Forming the main part of the study, the chapter will present examples of underground urban transportation systems, supported by general information and analytical readings. By using this comparative method, the contextual factors that have led to the formation of underground transportation systems in metropolises are aimed to be understood. In all, 19 examples of subterranean urban systems in different countries and on different continents have been selected for analysis. The catalyzing factors behind the formation of subsurface transportation hubs will be investigated under five main titles: ‘Congestion over Surface’, ‘The Arrival of the High Speed Rail Network’, ‘Ecological Aspects’, ‘Integrating New Transportation Layers into an Existing Station’, and ‘Underground Transportation Hubs of New Urban Centers’. Besides contextual leading factors, contents of the selected cases have also been analyzed due to the concepts *movement, form, process, and density*. The commonalities and differences among the projects will be discussed in terms of their transportation elements, qualities of architectural space, formation processes, and contributions to the urban density.

### 1.4 Assumptions and Limitations

Since the theoretical and technological basis for the subject matter has been formed in the second half of the 20$^{th}$ century, all of the analyzed case projects have been built or designed within this period. Besides their relevance to the thesis argument, another main criterion that has been used in the selection of the transportation node cases in this research is the level of development in the case locations. The cases covered in this study are taken from developed countries in Europe, the United States and Asia. Since the transportation policies of the developed countries are more dependent on the multimodal transportation demanded by metropolis life, the urban sections of these countries can be said to have been more affected by the technological developments of the modernization processes.

## CHAPTER 2

## SPEED and TIME IN the POST-INDUSTRIAL METROPOLISES

*'The spirit of the time shall teach me speed.'*
Shakespeare, a quote from the *King John*[1]

Daniel Bell describes the three levels of industrial development witnessed by cities as follows: the *pre-industrial level*, based on agriculture, fishing, timber and mining; the *industrial period*, concerned with fabrication and the conversion of raw materials into finished products; and finally the *post-industrial level,* in which the main activity is the processing of information and knowledge.[2] The contribution of the pre-industrial period to the formation of today's modern metropolises can be considered as quite limited; and it is the industrial period mentioned by Bell that have brought the most extensive transformation in the order of the world. The world has changed both physically and mentally as a result of the developments brought by the industrial revolution. It was inevitable that the way people live would undergo a rapid and revolutionary change due to the innovations of this era, which affected not only how people worked and produced things, but also how they lived and traveled between locations. The cities expanded into their surroundings, forming what are now today's metropolises. The economic and scientific breakthroughs of the industrial revolution also redefined the social systems of the human world, bringing about a transition from feudalism to capitalism. The working class as the labor power of the industrial production processes, and the capital, as the controller and owner of the economic power, became the two main poles of the world order in that period.

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[1] Epes Sargent. Ed. King John-A Tragedy by William Shakespeare. *Modern Standard Drama*. New York: Douglas, 1848. p 51 (source: www.googlebooks.com) > 09.03.2010
[2] Daniel Bell. *The coming of Post-industrial Society*. New York: Basic Books, 1976. pg. xii

It is generally accepted that the post-industrial period also brought about a radical change in the order of modern life. Countries strived to become stronger and show their power after World War II, resulting in rapid transformations. Cities and built environments, and the way people lived and perceived the world started to change, especially with the arrival of computer technologies and the invention of motorized vehicles. Among the factors that have deeply affected modern life, the concept of 'speed' can be said to have played a leading role. Although speed started to be a dominant element in the industrial period, it is still continuing to gain importance in the post-industrial world of today, affecting the world, socially, economically and architecturally.

The increasing speed in the world has changed the sense of space. Paul Virilio introduces his thoughts about the changing space perceptions affected by the increasing speed in the world using the martial terms *fleet in being* and *negation of space*. His term '*fleet in being'* relates to a state of existence eliminating the importance of position and time. He defines *fleet in being* as '*the art of movement of unseen bodies'* used as a strategy to eliminate the enemy's power. By creating a permanent insecure global zone, he suggests that the counter side's resistance is weakened in the *fleet in being* strategy. He points out that the *fleet in being* carries the idea of mobility, '*displacement without destination in space and time*'. [3] Another important issue introduced by Virilio related with the breakpoint in the perception of time-space is the '*negation of space'*. Virilio states that the reduction of distances in the world is a correspondent notion with the *negation of space*. He says that today the aim of gaining time has revolved into a vector problem that is independent from the *territory*, '*…the strategic value of the non-place of speed has definitively supplanted that of place'*. [4] Both of these concepts can be said to indicate a common change in the perceptions of space; that space and its boundaries have been blurring as speeds in the world increase. According to Virilio, geographical spaces have been shrinking as speeds increase in the world. Virilio continues his argument by defining the result of the subjected new conditions as *an artificial topological universe* formed due to time and speed. He states that every surface has a direct encounter in the newly formed topological form of the world. [5]

[3] Paul Virilio. *Speed and Politics*. New York: Columbia University Press, 1986. pg 38-40
[4] Ibid. 133
[5] Ibid. 133-135

As the world globalizes, so does it homogenize, and it is the developments in transportation and communications that have been the most effective factors catalyzing that process of homogenization. It is paradoxical that these two factors also cause an *uneven development* in their contributions to capitalism, as David Harvey states[6]. In other words the world becomes both homogenous and heterogeneous. In the light of these arguments, Virilio's assertion of the word *topological* may be very appropriate for describing the contemporary condition of the world. As a mathematical term, topology means '*The study of the properties of geometric figures or solids that are not changed by homeomorphisms, such as stretching or bending*'.[7] While the world moves faster, the more it extends beyond its physical borders. The distances between different locations have begun to be measured in terms of travel times rather than physical distances. Visual media and internet have also contributed to that effect of eliminating the physical borders in the world.

Harvey highlights the negative effect of the changing perceptions of time and space, saying that the increase in the speed of modern life has resulted in a faster way of living, which has created a pressure upon the human being. As a result of that shift, *space-oriented thinking* has been replaced by the *time-oriented* thinking. This change in understanding of the world has created a perceptual tension which Harvey defines as the '*time-space compression'*.[8]

The acceleration of economic processes is interactively affecting the speed of the world and spatial perceptions. According to the *annihilation of space by time* law in Marxist critical theory, the capitalist must go beyond his/her local market and broaden the limits of the *space* in which he/she could make sales in order to sustain the money-commodity-money circle.[9] Harvey mentions another aim of the capitalist as being to *speed up* the process to obtain maximum profit. In other words, the capitalist has to paradoxically *generate the space* by broadening his/her market, and *annihilate the space* by increasing the *speed*. To

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[6] David Harvey. *Spaces of Global Capitalism: Towards A Theory of Uneven Geographical Development*. New York-London: Verso, 2006. pg 100-101

[7] source: http://www.thefreedictionary.com/topological > 09.03.2010

[8] David Harvey. *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change.* Cambridge: Blackwell, 1989. 283.

[9] My ideas on this issue have profoundly influenced by the Architecture Theory and Design course, ARCH 613 Critical Theories on Urban Architecture, Spring 2009, lectured by Güven Arif Sargın.

*speed up* the processes of production, marketing and consumption, many technological developments have emerged according to Harvey. [10]

H. Savitch describes the shift in production activities that occurred between the industrial and post-industrial periods, stating that industrialism was based on blue-collar workers and their '*turning of the wheels of production',* whereas post-industrialism relied on the white-collar workforce to govern the information. This shift is defined as the transition to a '*service-oriented economy'* from a '*goods-producing economy'* by Savitch. The new order of production processes is represented by people who sustain business (such as managers), personal service professionals (doctors) and regulation engagers (legal workers).[11] All these changes can be claimed to have occurred with the help of increases in speed. The acceleration of information and production processes indicates a transformation from Marxism to post-Marxism. At this point, David Harvey's Marxist approach to the changing perceptions of speed, which he basically constructs upon the capitalist mode of production, may be discussed in tandem with Paul Virilio's post-Marxist ideas. Harvey introduces the invention of *Henry Ford's assembly line* as a development that has affected the experience of the concepts of *time* and *speed* deeply with the changes it brought to production processes and the economy: *'He fragmented tasks and distributed them in space so as to maximize the friction of flow in production. In effect, he used a certain form of spatial organization to accelerate the turnover time of capital in production. Time could then be speed up* [*sic*] *by the virtue of the control established through organizing and fragmenting the spatial order of production.'* [12]

Paul Virilio defines the fortified cities of feudal regimes as 'great immobile machines'. According to Virilio, the French Revolution in 1789 could be seen as a response to the constraints of the feudal serfdom system that aimed to immobilize people. He claims that the freedom of mobility gained in 1789 was replaced by *a dictatorship of mobility* following the mass uprising of 1793. Mobility has become a capitalized phenomenon as a result of these developments, says Virilio, claiming that the first appearance of the Marxist State was

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[10] David Harvey. *Spaces of Global Capitalism: Towards A Theory of Uneven Geographical Development*. New York-London: Verso, 2006. pg 100

[11] H. V. Savitch. Post-Industrial Cities: Politics and Planning in New York, Paris, and London. New Jersey: Princeton University Press, 1988. pg 4

[12] David Harvey. *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change.* Cambridge: Blackwell, 1989. pg 266

as 'a *dictatorship of motor functions,* a totalitarianism very carefully programming and exploiting every form of *mass movement.'* Virilio examined the relationship between political events and the revolutionary developments in transportation. After mentioning the rise of the Volkswagen automobile with the support of the Nazi government, Virilio claims that the reason why governments inoculated the motorized vehicle culture was to prevent people from engaging in revolutionary street rebellions. [13]

Developments in transportation technologies had a major effect on the acceleration of the world. John Urry suggests that the railway had a transformative consequence upon modern life in terms of its re-ordering of time-space perceptions. Before the mechanization of movement brought by the railway in 19th century Europe; late-19th century North America; and 20th century India, Africa and Latin America, speed was not such an important issue, says Urry. The difference between the fastest and the slowest was little, since the travel times between traveling by foot and traveling by horse were not so different.[14] Urry states that the mechanization of movement has initiated the faster train more valuable than the slower one. The increase in the importance of speed was a reflection of new social and economic parameters in the world, according to Urry: Faster transport helped with economic competitiveness and was an indicator of status. Another reason behind the increase in speed, as cited by Urry, is the notion that traveling is dead time; and this is why developments in technology or infrastructure that decrease the time spent traveling are taken so seriously. Another important effect of the mechanization of movement on the perception of time raised by Urry is *timetabling*. Both transport operators and their passengers were faced with a new and precise regime of time with the introduction of railways into daily life. '*The railway machine, accurate clock time, mass publication and scheduling across a national system'* all came together with the *timetable* in the 19th century, according to Urry.[15]

As Urry points out, the railway brought about changes in the perception of *time*. With the invention of the private car, *speed* started to have a profound effect on modern life; and Aldous Huxley claimed that speed was indeed the only pleasure of modern life. According

[13] Paul Virilio. *Speed and Politics. pg* 25-31
[14] John Urry. *Mobilities*. Cambridge: Polity Press, 2007. pg. 99
[15] Ibid 98-99

to Huxley, men had always enjoyed speed, even before the invention of car; however their enjoyment was limited due to the low velocity capacity of horses and trains. Describing trains as '*too large and steady*', and airplanes as '*too remote from the stationary surroundings'*, Huxley lauded the automobile as a very advantageous provider of speed, being on a human scale and more accessible. [16] Referring to Huxley's discourse, Enda Duffy interpreted the relation between speed, pleasure and automobiles as: *'The automobile was the promise, through technology, of an experience lived at a new level of intensity. In offering the new sensation of hurtling through space at speed, it gave car's driver a striking new level of personal power, both over the most minute manipulation of the new sensation and over its effect on others – most starkly, after the first car crash, the power of life or death.'*[17]

Duffy's introduction of 'death' as an outcome of *speed* is quite striking. In addition to all of the positive effects it has brought into the human life, speed has also emerged as a fatal factor that threatens the driver's and/or other people's rights to life. Duffy goes on to mention that the concept of speed started to gain a political meaning as a matter of national control. According to Duffy, governments have the compulsory duty to monitor and patrol speed, as they do with all of the other resources and pleasures of their citizens.[18] He also points out that a new vocabulary has emerged related to the measuring and policing of speed that includes such concepts such as *speed limits, acceleration* and *road rage.* [19]

David Harvey makes economy-based comments related to the effect of transportation and communication technologies on perceptions of time and space. He mentions that the excessive speculation in railroad construction caused the first European-wide crisis, resulting in needless material accumulation. According to Harvey, although the transportation industry was responsible for the over-accumulation, the solution to the crisis may also be found in the developments in spatial displacement techniques. Acceleration in the circulation between the capital mass markets had become possible as a result of the

[16] Aldous Huxley, 'Wanted, a New Pleasure' in *Aldous Huxley: Complete Essays*, vol. 3, 1930-1935, ed. Robert S. Baker and James Sexton (Chicago: Ivan R. Dee, 2001), pg 263-264
[17] Enda Duffy. *The speed Handbook*. Durham and London: Duke University Press, 2009. Pg 5
[18] Ibid. pg 7
[19] Ibid. pg 54

developments in transportation and communications. Harvey states that the perception of space and motion radically changed with the invention of the steam ship, automobile and telegraph.[20]

Paul Virilio uses contemporary military terms to explain his thoughts about the changing perceptions of speed and time in his book *Speed and Politics*. This may be deemed as quite appropriate, since it is for the benefit of the military that most technological developments in history have been made, and indeed technologies for war and the speed of the world have progressed at a parallel rate. The main concept introduced by Virilio in this regard is the concept of '*dromology*'[21], which he centralizes in his discourse given that the essence of war is to progress to the target as fast as it is possible. Virilio uses *dromology* to define the instinct of mobility that has become central to our lives with the increasing speed of the world. Since developments in transportation and communications have internalized the idea of progressing as fast as possible, constant mobility has become an internal law of life as claimed by Virilio.[22]

According to Virilio, it is not technology or politics, but 'speed' that is the only determining factor in understanding a country's development level: *'In fact, there was no "industrial revolution," but only a "dromocratic revolution;" there is no democracy, only dromocracy; there is no strategy, only dromology.'* [23] He introduces the 'practical war' term, which started to be applied as a new martial strategy due to the changing understanding of speed in the world. According to Virilio, this new method of defense rendered war '*easier to use*'. By introducing 'practical war' as an 'easier' mode, Virilio implies that today wars have become not only a subject of destruction, but also a matter of construction. He defines the first assault of the 'practical war' as the construction of '*new railroads and stations, telephone installations, enlargement of roads and tracks, the parallel lines of departure, evacuation routes, shelters, etc.'* [24]

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[20] David Harvey, *The Condition of Postmodernity*. pg 264
[21] Dromology is a Greek word which means 'the logic of speed' in English.
[22] Paul Virilio. *Speed and Politics*. pg 40
[23] Ibid. 45-46
[24] Ibid. 53-63

While Virilio introduces infrastructural investments as a mode of war strategy, Enda Duffy defines them rather as the duties of governments in capitalist growth; mentioning that the control of such infrastructure by the state is as crucial as their construction. According to him, the management of the roads, telephone lines, radio frequencies and airways is in fact control over the channels of movement and speed of a country. [25]

In his book *Speed and Politics*, Virilio mentions that every new engine will be superseded by a faster one due to the demands of the monopoly; and that that system causes *the threshold of speed* to be *in a state of constant shrinkage.* As a result of this shrinkage, the product literally becomes out of date before even entering operation, and that conceiving a faster engine becomes more difficult. [26] He claimed in an interview that this issue leads to *speed pollution* and '*reduces the world to nothing'*, while mentioning a mental disruption that affects directly the physical world. [27] He foresees a time when people will feel confined, being stuck in an enclosed and small environment due to the increasing speed of information and technology.[28]

Paul Virilio also comments on the relationship between speed and freedom in his book *Speed and Politics*. '*The more speed increases, the faster freedom decreases*', he says. In other words, as machines to transport people get faster, the role of the human in intervening, contributing and experiencing the processes of life disappear. We abandon our roles to machines voluntarily as we become more mechanized. The machines do not need to be operated by us, and we become more dependent on them and the speed they bring into our lives.[29] In the light of Virilio's arguments, it could be said that our freedom is being restrained at an increasing speed, and will be even more so in the future. Although new technologies bring ease to our lives, they render us addicted to speed.

In the 1990s, an international movement was launched against the acceleration of the world: The Slow Movement. The movement claims that the stress caused by the fast style of living is leading to health problems, and a slowing down in various areas of modern life

[25] Enda Duffy. *The speed Handbook*. pg 57
[26] Paul Virilio. *Speed and Politics.* p 46-47
[27] Interview with Paul Virilio by James Der Derian. *Wired magazine*, Issue 4.05 | May 1996, http://www.wired.com/wired/archive/4.05/virilio.html > 09.03.2010
[28] Ibid.
[29] Paul Virilio. *Speed and Politics* p 142

has been proposed by the group: Slow travel, food, schools, books, living, money and cities. The Slow Movement aims to address the issue of ‘time poverty’ by making connections, through which connections to people, food and places is aimed to be achieved. According to the movement, the desire for connectedness is an old issue that has been neglected in modern times. They claim the people were more connected to their traditional culture, their place and food in the past. With the introduction of labor saving technological advances, the connections of people with their lives have been weakened. The Slow Movement defenders question whether these advances have really given us more time to enjoy life, as was their claim, or whether this gained time is used to make people even busier. A fast-forward motion is prevailing in our home and work environments: we rush our food, family time and even our recreation. The Slow Movement opposes that acceleration in all areas of life, and supports a cultural shift towards slowing down[30].

Inspired by the popularity of the Slow Movement, an organization known as “The World Institute of Slowness” was established in 1999. This institute makes research into slowing down art, production and education; while also making more focused studies into the prevention of the uncontrolled acceleration of various subjects around the world. Slow design, slow family living, slow travel, slow TV, slow medicine and the slow bicycle movements can be highlighted among these efforts.[31]

As a part of the Slow Movement, and fired by the success and support of the Slow Food enterprise, the idea of the Slow City (CittaSlow) was introduced in 1999. The idea of a “slow city” was first introduced by Paolo Saturnini, who is the major of a small town called Greve Chianti in Italy.[32] The Cittaslow Movement today embraces 66 Italian towns, and is still continuing to develop around the world. A total of 59 cities out of Italy have been granted the status of Cittaslow, and have joined the association by signing a charter.[33]

The Slow Cities Movement developed a manifesto to set out the underlying principles behind their discourse. The basic characteristic of a Slow City is stated as inheriting ‘a way

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[30] The Official Website of the Slow Movement http://www.slowmovement.com/ > 09.03.2010
[31] The Website of the World Institute of Slowness http://www.theworldinstituteofslowness.com/page2/page2.html > 09.03.2010
[32] The Official Website of the Slow Cities http://www.cittaslow.net/index.php?method=section&id=2012&title=Association > 09.03.2010
[33] http://www.cittaslow.net/download/DocumentiUfficiali/2009/CITTASLOW_LIST.pdf > 09.03.2010

of life that supports people to live slow'[34]: "…*towns where men are still curious of the old times, towns rich of theatres, squares, cafes, workshops, restaurants and spiritual places, towns with untouched landscapes and charming craftsman where people are still able to recognize the slow course of the Seasons and their genuine products respecting tastes, health and spontaneous customs....*" (From the Cittaslow Manifesto)[35]

These cities are against fast lanes, in order to have less traffic, less noise and fewer crowds. Cities with more than 50,000 residents may not apply to become a Slow City. The Slow City manifesto contains 55 criteria and pledges under six categories: environmental policy, infrastructure, quality of urban fabric, encouragement of local produce and products, hospitality of community and CittaSlow awareness. In order to make sure they are fulfilling the standards of the conduct, the member cities are regularly checked and analyzed by inspectors. As long as they continue to fulfill the requirements of the movement, these cities may use the snail logo and be referred to as a Slow City. A Slow City offers and encourages the application of the philosophy through a combination of traditional elements and modern technologies. [36] The use of technology in Slow Cities is welcomed in selected cases, such as in improving the quality of the environment and the urban fabric. The safeguarding of the production of local foods and wine are encouraged to be provided through the use of technology. [37]

The changing meaning of the concept of speed and its increasing importance in modern life has various reflections in urban transportation. Faster transportation modes have been invented, and existing ones have been rendered faster in order to meet the demand for speed in metropolis life. To decrease the time lost by citizens, transport networks have been improved and the transition between different modes has become more of an issue. These developments, which have had a direct affect on spaces of transportation and urban forms, will be analyzed in the next chapter.

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[34] http://www.slowmovement.com/slow_cities.php > 09.03.2010
[35] http://www.cittaslow.net/index.php?method=section&id=2017&title=Philosophy > 09.03.2010
[36] The Official Website of the Citta Slow-United Kingdom Branch
http://www.cittaslow.org.uk/page.php?Pid1=2&Pid2=1&PLv=2 > 09.03.2010
[37] http://www.cittaslow.net/index.php?method=section&id=2017&title=Philosophy > 09.03.2010

# CHAPTER 3

# THE STATE OF URBAN TRANSPORTATION IN POST-INDUSTRIAL METROPOLISES

The statistical pocketbook published in 2009 by the Energy and Transport Directorate of the European Commission provides a good overview of the current status of urban transportation in the world.[38] Today, the car is the most popular method of passenger transportation throughout the world. As can be seen in the statistical data, private car usage is preferred over public transport modes, especially in Europe and the United States. (Table 3.1) Since the car is so popular, investments into infrastructure are mostly focused on road networks. (Table 3.2) The vast number of motorized vehicles on the road results in urban congestion and environmental pollution in metropolises; meaning that reducing car usage has become a priority issue in the transport policies of governments since the 1980s. To this end, policies have been developed and infrastructural investments have been carried out to make the other modes of transport more attractive to the general public.

## 3.1 The competition between passenger car and the other transportation modes

Finding a transport mode to surpass the popularity of car is difficult, given the advantages of privacy offered by the car, however the 1980s saw the advent of an inter-urban transport mode that could compete with the car in terms of speed – the High Speed Train (HST). This new mode of transport, while not able to pass the usage rates of motorized vehicles, has succeeded in stopping the rise in private car usage in interurban transportation.

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[38] European Commission, Directorate-General for Energy and Transport. EU Energy and Transport in Figures: Statistical Pocketbook. Luxembourg: Office for Official Publications of the European Communities, 2009.
(http://ec.europa.eu/energy/publications/statistics/doc/2009_energy_transport_figures.pdf)
> 09.03.2010

**Table 3.1** Comparison of the World Passenger Transportation between 2006 and 2007 years
(Source: European Commission Directorate-General for Energy and Transport Official Website www.ec.europa.eu. Last accessed on 09.03.2010)

| PASSENGER TRANSPORT | | | | | |
|---|---|---|---|---|---|
| | EU-27 | USA | JAPAN | CHINA | RUSSIA |
| billion pkm | 2007 | 2006 | 2006 | 2006 | 2007 |
| Passenger car | *4 688.0* | 7 317.1 (1) | 724.0 (2) | 1013.1 (3) | |
| Bus + trolley-bus + coach | *539.0* | 275.4 | 89.0 | | 127.9 |
| Railway | 394.6 | 23.7 | 396.0 | 662.2 | 174.1 |
| Tram + metro | *85.4* | 19.7 | | | 51.3 |
| Waterborne | *41.0* | 0.6 | 3.8 | 7.4 | 1.1 |
| Air (domestic / intra-EU-27) | *571.0* | 950.5 | 86.0 | 237.1 | 111.0 |

**Table 3.2** World transport infrastructure in 2006
(Source: European Commission Directorate-General for Energy and Transport Official Website www.ec.europa.eu. Last accessed on 09.03.2010)

| TRANSPORT INFRASTRUCTURE | | | | | |
|---|---|---|---|---|---|
| | EU-27 | USA | JAPAN | CHINA | RUSSIA |
| 1 000 km | 2006 | 2006 | 2006 | 2006 | 2006 |
| Road network (paved) | *5 000* | 6 463 | 1 190 | 2 283 | 755 |
| Motorway network | 63.4 | 95.3 (1) | 7.4 (2) | 45.3 | 29.0 |
| Railway network | 215.9 | 203.6 (3) | 27.6 | 77.1 | 85.5 |
| Electrified rail lines | 108.2 | | 15.7 | 23.4 | 42.3 |
| Navigable inland waterways | *43.0* | 41.8 | *1.8* | 123.4 | 102.0 |
| Oil Pipelines | *33.6* | 272.5 | *0.2* | 24.1 (4) | 46.7 (5) |

If the modal split graphic of Europe between 1995–2007 years is analyzed, it can be seen that the usage rate of cars has decreased from 73.0 to 72.4. This table also indicates that the second most preferred mode of transport in Europe is the airplane. (Table 3.3)

Hugo Priemus claims the development of European HST network is a solution that competes not only with the passenger car, but also the airplane. Priemus states that there was a modal split in urban transport between 1970–2000, when the usage ratios of the rail, tram, metro and bus modes decreased, while the popularity of the passenger car and the airplane increased. In response to these figures the HST network has started to be developed, according to the writer.[39] Priemus goes on the point out that there are three more factors which he claims to have been brought by the railway sector in response to the popularity of car and airplane. The first factor is the wave of privatization in the European railway sector, which started in 1985 in the UK, with many other countries following suit. The second factor is the construction of light rail connections and metro systems, aimed at improving local and regional transportation systems. Exemplifying the developed underground networks in London and Paris, Priemus states that many European countries have started to establish dense urban rail networks on varying scales. The final factor raised by Priemus is the rapid development of information and communication technologies, which raises the productivity of production processes and leads to more creative activities and knowledge development.[40]

John Urry compares the non-adaptive and public system of the train with the adaptive and private aspect of car. Mentioning that motorized traffic overshadowed railway transportation in the 20th century, Urry highlights the car as a transformative factor of the speed concept. Cars give the driver the opportunity to make his/her own timetable, which Urry refers to as its adaptability, while naming the privacy offered by the car as another reason for increased usage. Urry says that the railway system has developed three basic measures against the popularity of car: speed response, neo-liberal response and integrated transport response. The first issue the rail system has brought forward is the

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[39] Bruinsma, F, Eric Pels, Hugo Priemus, Piet Rietveld, Bert van Wee. Ed. 'Urban Dynamics and Transport Infrastructure: Towards greater synergy'. *Railway Development: Impacts on Urban Dynamics*. Germany: Physica-Verlag, 2008. p 20
[40] Ibid. 18

building of new high speed rail lines. '*To beat the car in the speed game*', very fast train systems have started to be developed, says Urry. The second response of the train to the car represents a neo-liberal restructuring in the rail system policies and station building facilities. Urry states that rail users have been renamed as 'customers', and new ticketing methods have started to be applied. Besides the marketing solutions in rail policies, the programmatic features in stations have transformed a great deal as a part of the neo-liberal responses of the train to the car. Retail, social and cultural facilities have emerged in stations as a part of that response according to Urry.[41] The third issue he mentions is the integration of multimodal transport with the railway. He points out that the bringing together of buses, light rail systems, trains and bicycles at stations in a new public structure has emerged in a bid to curb the popularity of the private car:[42] *'Where once the station was a transitional space through which travelers passed en route to the train, so now it is another urban venue, a post-industrial site of consumption, fluid functions and pastiched meanings.'*[43]

Martha Thorne refers also the new role of stations, stating that while they were considered as purely functional in the past, now, in addition to their main function, these buildings have taken on new roles, such as ticketing, waiting, shopping, and as transfer areas between transportation modes. Thorne mentions the most important concept of contemporary transportation as *seamlessness*. In her opinion, the contribution of architecture and urban planning in achieving seamless mobility is important.[44] The 'seamless' mobility that Martha Thorne states may be explained as the fluidity of transportation, meaning, less time loss and ease of transfer between different mobility modes.

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[41] John Urry. *Mobilities*. Cambridge: Polity Press, 2007. p 110
[42] The multimodality issue that Urry mentions has been discussed under the 3.3 Multimodality titled part in this chapter.
[43] John Urry. *Mobilities*. Cambridge: Polity Press, 2007. p 110
[44] Martha Thorne. Ed. *Modern trains and Splendid Stations*. Chicago: Merrell-The Art Institute of Chicago, 2001. pg 21

**Table 3.3** Modal split in EU between 1995-2007 years
(Source: European Commission Directorate-General for Energy and Transport Official Website www.ec.europa.eu. Last accessed on 09.03.2010)

MODAL SPLIT

%

| | PASSEN-GER CARS | P2W | BUS AND COACH | RAILWAY | TRAM AND METRO | AIR | SEA |
|---|---|---|---|---|---|---|---|
| 1995 | 73.0 | 2.3 | 9.5 | 6.6 | 1.3 | 6.3 | 0.8 |
| 1996 | 73.0 | 2.3 | 9.4 | 6.5 | 1.3 | 6.5 | 0.8 |
| 1997 | 73.0 | 2.3 | 9.2 | 6.4 | 1.3 | 7.0 | 0.8 |
| 1998 | 73.0 | 2.3 | 9.1 | 6.2 | 1.3 | 7.3 | 0.8 |
| 1999 | 73.1 | 2.3 | 8.9 | 6.2 | 1.3 | 7.4 | 0.7 |
| 2000 | 72.9 | 2.3 | 8.8 | 6.3 | 1.3 | 7.7 | 0.7 |
| 2001 | 73.2 | 2.3 | 8.7 | 6.2 | 1.3 | 7.6 | 0.7 |
| 2002 | 73.7 | 2.3 | 8.6 | 6.1 | 1.3 | 7.4 | 0.7 |
| 2003 | 73.6 | 2.4 | 8.5 | 5.9 | 1.3 | 7.6 | 0.7 |
| 2004 | 73.3 | 2.4 | 8.5 | 5.9 | 1.3 | 8.0 | 0.7 |
| 2005 | 72.7 | 2.4 | 8.4 | 6.1 | 1.3 | 8.4 | 0.6 |
| 2006 | 72.8 | 2.4 | 8.2 | 6.1 | 1.3 | 8.6 | 0.6 |
| 2007 | 72.4 | 2.4 | 8.3 | 6.1 | 1.3 | 8.8 | 0.6 |

**Table 3.4** Modal split in USA between 1990-2006 years
(Source: European Commission Directorate-General for Energy and Transport Official Website www.ec.europa.eu. Last accessed on 09.03.2010)

MODAL SPLIT

%

| | PASSENGER CARS (*) | MOTOR-CYCLES | RAILWAY | BUS | LIGHT AND COMMUTER RAIL | AIR |
|---|---|---|---|---|---|---|
| 1990 | 86.3 | 0.3 | 0.3 | 3.7 | 0.2 | 9.1 |
| 1995 | 85.7 | 0.3 | 0.3 | 3.7 | 0.2 | 9.8 |
| 2000 | 84.5 | 0.2 | 0.3 | 3.8 | 0.2 | 10.9 |
| 2001 | 85.9 | 0.2 | 0.3 | 3.5 | 0.2 | 9.9 |
| 2002 | 86.2 | 0.2 | 0.3 | 3.4 | 0.2 | 9.7 |
| 2003 | 86.0 | 0.2 | 0.3 | 3.3 | 0.2 | 10.0 |
| 2004 | 85.4 | 0.2 | 0.3 | 3.2 | 0.2 | 10.7 |
| 2005 | 85.0 | 0.3 | 0.3 | 3.2 | 0.2 | 11.0 |
| 2006 | 85.0 | 0.3 | 0.3 | 3.2 | 0.2 | 11.0 |

**Notes:** (*) Passenger Cars (2006: 4 297 billion pkm) and other 2-axle 4-tyre vehicles (2006: 3 038 billion pkm).

As demonstrated in Table 3.3., the usage rate of the passenger car in Europe is around 72–73%. For the United States, this figure is significantly higher, at around 85–86%. (Table 3.4) This huge trend in car usage in the United States is claimed to be a natural outcome of the transport and urban planning policies of the country in late-20th century. Susan Hanson and Genevieve Giuliano blame the establishment of a motorized culture in the United States and its reflections on the urban patterns on the high speed, limited access highway networks that were completed in America in the 1960s and 1970s. This caused a structural reorganization of the US metropolis, as the advantage of the core-city central business district (CBD) was eliminated, and intra-metropolitan accessibility became easier. Another result of the new highway networks in the United States was that non-residential buildings started to spring up with significant density in the intra-urban areas. It was the areas at the peripheries of US metropolises that were favored as residential areas up until the 1980s; however with the development of a highway network in the 1960s and 1970s, various non-residential programs were launched in these areas. Thus, the peripheries of cities have become 'outer cities', hosting more than half of the industrial, service and business facilities in metropolises.[45]

The process that started with the intra-urban transportation innovations during the Industrial Revolution and their reflections on the American urban pattern are referred to as *suburbanization* by Hanson and Giuliano. The peripheries of urbanized areas started to grow during this suburbanization period. Comparing the intra-urban concentration tendencies of US and European metropolises, Hanson and Guiliano claim that the suburbanization culture is unique to some values in the United States which are completely opposite to those in Europe. The authors claim that European planning culture is based on making the already dense historical centers even more condensed.[46]

Hanson and Guiliano's deductions, which they derived from a comparison of the metropolises of the two continents, can be deemed to be quite appropriate. Most of the multilayered and dense underground urban forms studied in this thesis are located in the metropolises of Europe. The policy differences between the two continents may also be

[45] Susan Hanson and Genevieve Giuliano. Ed. 'Spatial Evolution of the American Metropolis'. *The Geography of Urban Transportation.* New York: The Guilford Press, 2004. p 60.
[46] Ibid. 61

down to their varying acreages and populations. In 2004, the total population of Europe is estimated at 815 million[47]; however the population of USA is 308 million in 2008.[48] The surface area of Europe is 4.32 million km square, while the United States has an area of 9.83 million km square; from which it may be assumed that the outward expansion has occurred in the United States due to the high acreage; while upwards and downwards development is preferred in Europe due of the lack of land. Consequently, most of the policies in Europe urban planning aim to make the historical city centers denser.

### 3.1.1 High Speed Train Developments around the World

The high speed train can be said to hold an advanced position in the competition between passenger car and other transportation modes. As mentioned in the studies of Priemus and Urry, this new technology definitely tipped the balance in transportation policies after the 1980s. According to Hugo Priemus, the stations through which the HST lines pass are expected to be used by more passengers. The socio-economic statuses of these stations are also foreseen to be raised on the strength of the high speed transportation network.[49] Besides the socio-economic benefits, as Priemus mentions, this new transportation mode has led to the planning of many new station projects around the world, and has caused a reintegration process in many existing station buildings in order to render their infrastructures suitable for HST.[50]

At this point, it becomes necessary to understand the development process of this new transportation mode. Although becoming efficient in the 1980s, the idea of the high speed train was born in 1958. The Japanese government decided to construct the 515-kilometer

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47 Recent demographic developments in Europe-2004. France: Council of Europe Publishing, 2005. p 11 http://www.coe.int/t/e/social_cohesion/population/Demo2004EN.pdf > 09.03.2010

48 U.S. Cencius Bureau Official Website. http://www.census.gov/ > 09.03.2010

49 Bruinsma, F, Eric Pels, Hugo Priemus, Piet Rietveld, Bert van Wee. Ed. 'Urban Dynamics and Transport Infrastructure: Towards greater synergy'. *Railway Development: Impacts on Urban Dynamics*. Germany: Physica-Verlag, 2008. p 20

50 Among the newly planned projects catalyzed by HST network, the Zuidas Dok in Amsterdam, Sagrera Station Area Master Plan in Barcelona and Euralille in Lille has been analyzed in the fourth chapter of this thesis. The Stuttgart Main Station Area Project has also been covered as an example of an existing transportation building to which a renovation project has been applied with the arrival of HST.

Tokaido Shinkansen high speed train system, which began commercial operation in 1964.[51] This line connected Tokyo, Nagoya, Kyoto and Osaka, with trains reaching speeds of around 200 kilometers per hour, and has now increased to 300 km/h.[52] Mitchell Strohl claims that the conditions in Japan were particularly suitable for the development of a high speed transport system. Providing the large population with a fast transportation infrastructure over a limited available space has led the invention of HST, as he mentions.[53] The Shinkansen Network has extended throughout Japan, and today records a high ridership rate. According to Central Japan Railway Company data[54], 151 million passengers used the high speed train in 2008. (Figure 3.1 and Table 3.5)

The lessons learned from the development process of the high speed rail in Japan were extremely useful in Europe and North America, according to Mitchell Strohl;[55] however Europe was only able to maximize on high speed rail technology nearly 20 years later. As a result of researches that started in 1966, Europe's first high speed train service, the TGV (Train a Grande Vitesse), started to operate in France in 1981;[56] and since then Europe has witnessed a rapid development of a high speed rail network. Between 1985 and 2008 the total length of High Speed rail lines in Europe increased almost nine-fold, according to European Commission data. (Table 3.6 and Figure 3.2) France leads the field in infrastructural investments into high speed railways today, as can be seen in Table 3.6, followed by Spain, Germany and Italy, respectively; resulting in a considerable amount of HST lines under construction in Europe.

America has a very backward position in HST infrastructure development when compared to Europe and Asia. The first high-speed rail service in the United States, known as the Acela Express, entered into service at the end of 2000[57] between Boston and Washington D.C., which is the most densely populated area of the country. Although it is a delayed effort, a significant HST network in the United States is foreseen in the future. (Figure 3.3)

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[51] Mitchell P. Strohl. Europe's High Speed Trains. London: Praeger, 1993. p 56-57
[52] http://www.japan-guide.com/e/e2018.html > 09.03.2010
[53] Mitchell P. Strohl. Europe's High Speed Trains. London: Praeger, 1993. p xii
[54] http://english.jr-central.co.jp/index.html > 09.03.2010
[55] Mitchell P. Strohl. Europe's High Speed Trains. London: Praeger, 1993. p xii
[56] Ibid. 69
[57] Martha Thorne. Ed. *Modern trains and Splendid Stations*. Chicago: Merrell-The Art Institute of Chicago, 2001. p 29


**Figure 3.1** Shinkansen High Speed Rail Line
(Source: Japan Railways Group Official Website http://www.japanrail.com/index.php?page=JR-Shinkansen-bullet-train. Last accessed on 09.03.2010)

**Table 3.5** Passenger Ridership of Japan Shinkansen High Speed Rail Line between 1988 and 2008 years
(Source: Central Japan Railway Company Official Website, http://english.jr-central.co.jp/ Last accessed on 09.03.2010)

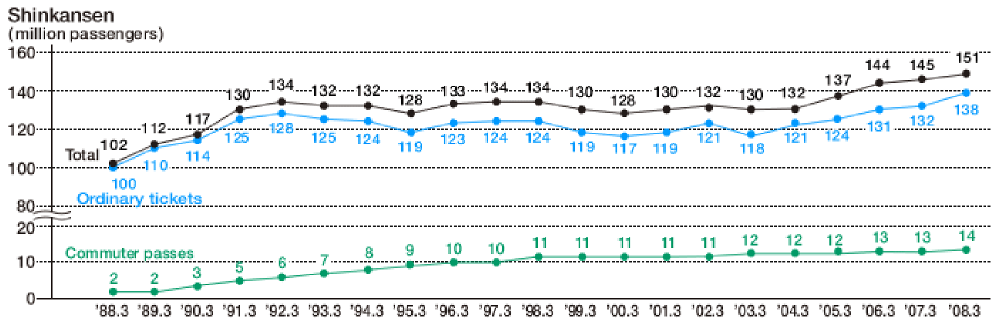

**Table 3.6** Length of High speed rail lines in EU between 1985 and 2008 years
(Source: European Commission Directorate-General for Energy and Transport Official Website www.ec.europa.eu. Last accessed on 09.03.2010)

LENGTH OF LINES (1)

km (at end of year)

| | BE | DE | ES | FR | IT | UK | EU |
|---|---|---|---|---|---|---|---|
| 1985 | - | - | - | 417 | 224 | - | 641 |
| 1990 | - | 90 | - | 699 | 224 | - | 1 013 |
| 1995 | - | 447 | 471 | 1 220 | 248 | - | 2 386 |
| 2000 | 58 | 636 | 471 | 1 278 | 248 | - | 2 691 |
| 2001 | 58 | 636 | 471 | 1 573 | 248 | - | 2 986 |
| 2002 | 120 | 833 | 471 | 1 573 | 248 | - | 3 245 |
| 2003 | 120 | 875 | 1 069 | 1 573 | 248 | 74 | 3 959 |
| 2004 | 120 | 1 202 | 1 069 | 1 573 | 248 | 74 | 4 286 |
| 2005 | 120 | 1 202 | 1 090 | 1 573 | 468 | 74 | 4 527 |
| 2006 | 120 | 1 291 | 1 272 | 1 573 | 562 | 74 | 4 892 |
| 2007 | 120 | 1 300 | 1 516 | 1 893 | 562 | 113 | 5 504 |
| 2008 | 120 | 1 300 | 1 594 | 1 893 | 744 | 113 | 5 764 |

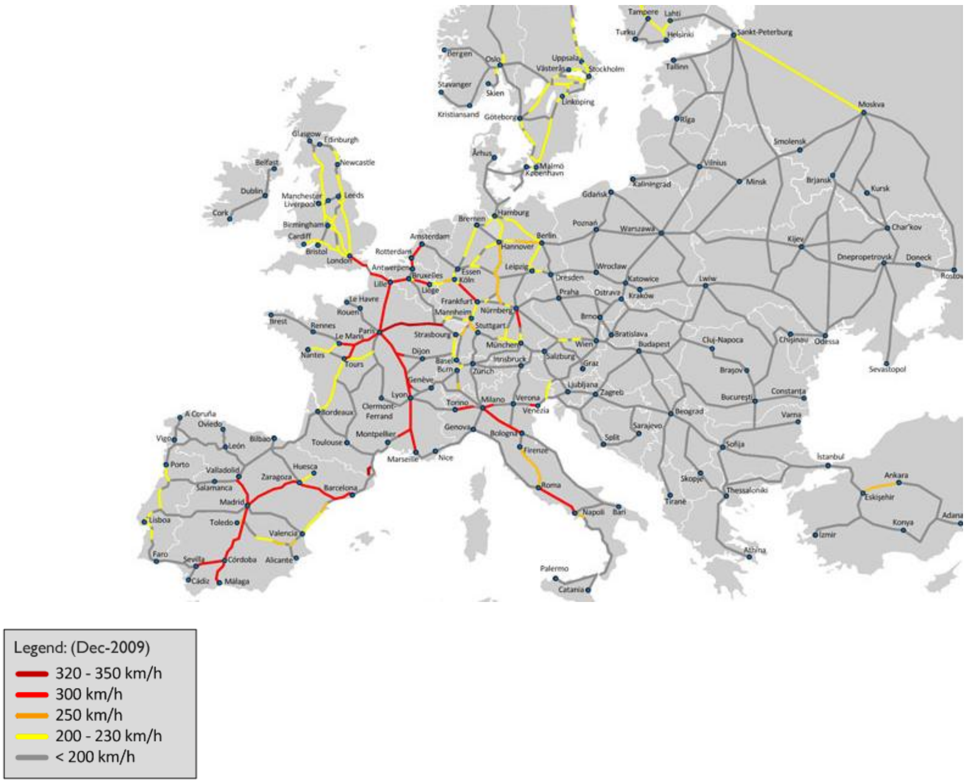


**Figure 3.2** European High Speed Rail Network in December 2009
(Source: PRI’s The World Official Website www.theworld.org. Last accessed on 09.03.2010)


**Figure 3.3** Figure showing the foreseen high speed rail network of USA in July 2009. (Source: Federal Railroad Administration Official Website www.fra.dot.gov. Last accessed on 09.03.2010)

### 3.2 The Interaction between Transportation and Urban Forms

It is certain that the formation of urban space is highly correlated with lines and networks of transportation. David Banister points out some key relationships between transport and urban forms, such as *settlement size*, *intensity of land use*, *the location and local accessibility to transport infrastructure* and *parking provision*. The first aspect Banister mentions is the influence of settlement sizes on transport services. Referring to data from National Travel Surveys in Great Britain, he claims there exists an inverse ratio between the travel distance and development level. Total travel distances are highest in the smallest settlements and lowest in metropolitan areas, according to Banister.[58] Another interesting point raised by the writer is the relation between population density and transportation

58 David Banister. *Unsustainable Transport: City Transport in the New Century*. Britain: Routledge, 2005. p 102

modes. He states that when population densities increase, the proportion of trips by public transport and foot both increase.[59] Speaking in terms of accessibility to transport infrastructure, he states that better access to major road and rail transport networks increases travel speeds, and thus increases the distance that can be covered in a designated time. He emphasizes the influence of proximity to major transport networks on the development of residential and employment areas.[60] The final aspect that Banister points out is the impact of parking policies on modal choices and the number of trips, claiming that as the availability of residential car parking increases the average number of trips per person. Banister also deals with *park and ride* schemes as a solution to the congestion and deterioration of city centers. The park and ride concept is a system that allows members of the public to leave their cars at designated areas and travel by public transport during the day.[61] Banister notes that the aim of the *park and ride* system is to decrease traffic congestion and encourage public transport use in city centers.[62]

Luca Bertolini and Tejo Spit also deal with the relation between transport and the urban form by analyzing the 'station' concept. They claim that a station has two basic identities: A *node* that is a point of access to transportation modes: '*As a node, or a point at which subsidiary parts originate or centre. Together with 'lines' or 'channels' (or 'arches' or 'links'), nodes (sometimes called 'points' or 'vertexes') are the basic components of a network – the points where the lines are 'knotted', 'secured', 'interconnected' or 'interrelated''*; and as a place where infrastructure concentrates in a specific part of the city. Bertolini and Spit state that such areas attract a diversified collection of buildings and open spaces. [63]

Camagni and Salone point out two basic meanings of the urban network concept raised by Bertolini and Tejo. According to Camagni and Salone, an urban network means both an infrastructure system (highway, railway networks, and drainage networks) and a spatial

[59] Ibid 106 (Referring to the data of ECOTEC-Emissions Control Optimization Technology)
[60] Ibid 117
[61] See the website www.parkandride.net for further information. > 09.03.2010
[62] David Banister. *Unsustainable Transport: City Transport in the New Century*. Britain: Routledge, 2005. p 119
[63] Luca Bertolini and Tejo Spit. *Cities on Rails: The Redevelopment of Railway Station Areas*. London: Spon Press, 2007. p 10

interaction among urban places, economic activities and people.[64] Referring to this definition, Bertolini and Tejo state the positive impacts of transportation networks on socio-economic networks are that a number of different facilities tend to be located around transportation nodes.[65]

Contemporary urban networks are characterized by three main criteria, according to Gabriel Dupuy. First is the *topological criterion,* which is the search for direct connections between points, and the ideal of being everywhere at once. The second is the *kinetic criterion,* representing instantaneousness, the homogeneity of speed, the importance of rapid transportation and flow without loss of time. The third aspect is the *adaptive criterion*, which Dupuy states as the notion of multiple connection choices, both in space and in time. According to Dupuy, such connections require infrastructure as a fixed support that can adapt to the user requirements.[66]

According to Hugo Priemus, around 25–30% of the population of Europe lives in metropolises, due to the need to be close to central urban facilities. Since such an important ration of European desire to live in metropolises, accessibility to urban centers is aimed to be improved in different ways. Priemus claims that the *network* pattern, which has become a frequently used strategy in Europe, is a result of this metropolitan dwelling. According to Priemus, transport networks develop so that one is able to reach every point of the urban tissue and its residents. He highlights the Netherlands as a good example of this, in that it has become a ‘network city’, with a high density of residential facilities.[67]

### 3.3 Multimodality

The need for transportation systems that not only provide rapid access to various points of the city, but also integrate different movement modes arose in post-industrial metropolises. Transportation corridors have started to be designed as mediums of urban movement modes, including metros (metropolitan railway), U-Bans (Short for *Undergrund*

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[64] Roberto P. Camagni and Carlo Salone. Network Urban Structures in Northern Italy: Elements for a Theoretical Framework. *Urban Studies*, Vol 30, No: 6. p 1053-1064
[65] Luca Bertolini and Tejo Spit. *Cities on Rails: The Redevelopment of Railway Station Areas*. p 11
[66] Gabriel Dupuy. *Urban Networks-Network Urbanism*. Netherlands: Techne Press, 2008. p 19-20
[67] Bruinsma, F, Eric Pels, Hugo Priemus, Piet Rietveld, Bert van Wee. Ed. *Railway Development: Impacts on Urban Dynamics*. Germany: Physica-Verlag, 2008. p 19

*Bahn*, means underground rail), S-Bans (Short for *Schnell Bahn*, means fast rail), high speed trains, buses, trams and taxis. Each of these transportation modes has their own network, diffused throughout the city, so as to allow connections between different parts of the metropolis. The urban transportation networks of varying modes of movement superimpose at some points of the city, allowing passengers to transfer to a different mode of transport. These juxtaposition points may be referred to as urban transportation nodes, and they have formed to provide multiplicity in urban movement modes.

Various associations, research centers in universities and organizations have been established to look into multi-modal transportation and fluidity between the different modes. Important associations dealing with intermodal transportation include LINK (The European Forum on Intermodal Passenger Travel) and KITE (A Knowledge Base for Intermodal Passenger Travel in Europe), both of which study multi-modal transportation in an interactive manner, drawing funding from the European Commission. Government policies related to urban forms can be said to have been affected significantly by academic studies and foundational attempts; while have also been a number of political studies aimed at increase awareness of multimodal transportation. For example the White Paper entitled **'**European Transport Policy for 2010: Time to Decide' was published by the European Commission to encourage long-term strategies for achieving sustainable transportation systems. This paper offers advice and presents several multi-modal transport cases. Following this study in 2001, the European Commission also published an analysis entitled 'Towards Passenger Intermodality in EU' in 2004, which focuses particularly on the association of different modes of transportation systems. These two papers, including analyses and suggestions related to intermodal transportation can be said to have played a catalyzing role for the future transport programs around the world.

The issues raised in this chapter have led to major changes in urban forms and station buildings in 21$^{st}$ century metropolises. Singling out one of these basic changes, it can be said that the increasing popularity of underground urban spaces has been catalyzed by a number of different factors, such as the development of transportation networks and congestion in the city centers, which have led to underground urban forms being constructed in the world's metropolises. The leading factors in that shift in urban policies will be dealt with by taking a look at a number of case studies in the next chapter.

# CHAPTER 4

## ANALYSIS of the URBAN UNDERGROUND TRANSPORTATION SYSTEMS

Underground urban formations were studied as architectural utopias in the 20th century; with one such futuristic underground city represented in an issue of *Popular Science Magazine* in the 1930s.[68] (Figure 4.1) As it can be seen from the figure 4.1, street level has been left for pedestrian use, while below ground has been designed to accommodate a number of different facilities. A high speed electric railway is located at the very lowest level, with other transportation modes layered towards the surface according to their speed, from fast to slow. Space is also given over for car parking, and each layer is connected with high-speed escalators. This idea of underground urban forms was taken up by a number of other architects. Avant-garde designer Paul Maymont produced a proposal for an underground city beneath the River Seine in 1963, which besides including different transportation mode layers, also includes areas for sports, recreation, and habitation. (Figure 4.2) Another example of 20th century underground utopias can be seen in the design of Peter Cook and Archigram. Cook's underground concrete box houses four floors of parking on one side, while the rest of the complex includes a theater, a restaurant, a performance hall, a railway station and storage facilities. (Figure 4.3) A further example was suggested by Architect Eugene Henard, who presented his proposals to resolve the traffic problems of metropolises at the Town Planning Conference held in 1910 in London (Figure 4.4), suggesting three or four superimposed subterranean traffic platforms:

> *'The first platform would be for pedestrians and carriage, the second for the tramways, the third for the various mains and pipes required for the removal of refuse, and the fourth for the transport of goods, etc. We should thus have*

[68]David Zondy Personal Archive Website http://davidszondy.com/future/city/underground.htm > 09.03.2010

*a many-storied street, as we have a many storied house; and the general problem of traffic could be solved, however heavy it might be. It is probable, however, that the duplicate streets I have just described would suffice, at least for a very long time, under the present conditions of urban life.'*[69]

Entering the 21st century, these 20th century utopias now have the chance of actually coming to fruition, as today the space below ground has become a major medium for urban transportation and infrastructure spaces, and a number of metropolises have started to extend downwards for under different motivations. Tim Paul, Fiona Chow and Oddvar Kjekstad list six benefits of utilizing underground: Firstly, *efficient land use and the improvement of the environment* is made possible by realizing the potential of subterranean space in congested urban areas. Street level then becomes available for other uses, such as parks and recreational areas. By taking the motorized traffic underground, surface routes become available for cyclists, pedestrians, emergency vehicles and public transport. The second aspect is related to *aesthetics*. The urban space becomes more aesthetic when unattractive structures such as car parks, roads and shopping malls are removed from the cityscape. The third benefit is tied to *sustainable development*. The writers claim that the removal of external cladding and finishes leads to an efficient use of materials and cost savings. The fourth factor is the *conservation of energy,* reminding of the ground's natural insulating properties in absorbing noise and heat, while heating and cooling systems and energy storage units become more efficient. The fifth and sixth aspects are the *protection of people,* against environmental factors such as extreme weather conditions, and the *security* to be protected from bombs.[70]

[69] The Official website of Cornell University Library
http://www.library.cornell.edu/Reps/DOCS/henard.htm > 09.03.2010

[70] Tim Paul, Fiona Chow, Oddvar Kjekstad. Ed. *Hidden Aspects of Urban Planning: Surface and Underground development*. London: Thomas Telford Publishing, 2002. p 35

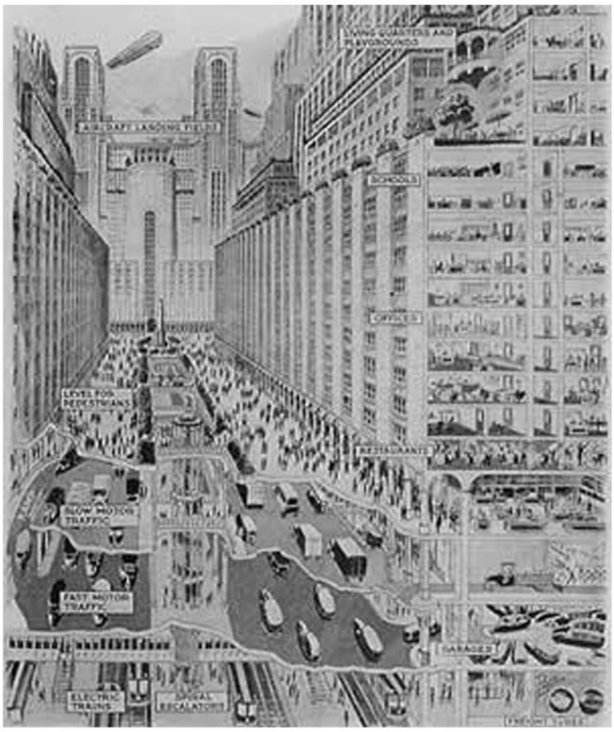


**Figure 4.1** An underground urban utopia representation in a 1930s *Popular Science Magazine issue* (Source: Personal Archive of David Zondy www.davidszondy.com. Last accessed on 09.03.2010)

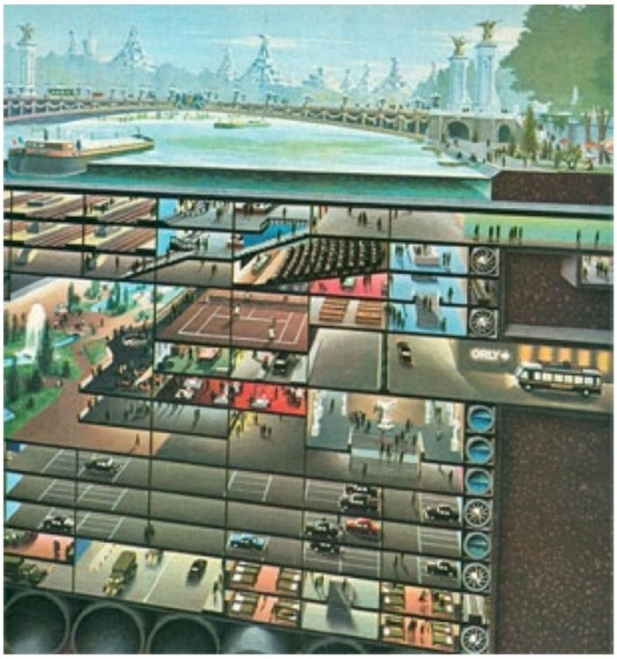

**Figure 4.2** Paul Maymont's proposal for a subterranean complex under River Seine (Source: International Tunneling and Underground Space Association Official website www.ita-aites.org. Last accessed on 09.03.2010)

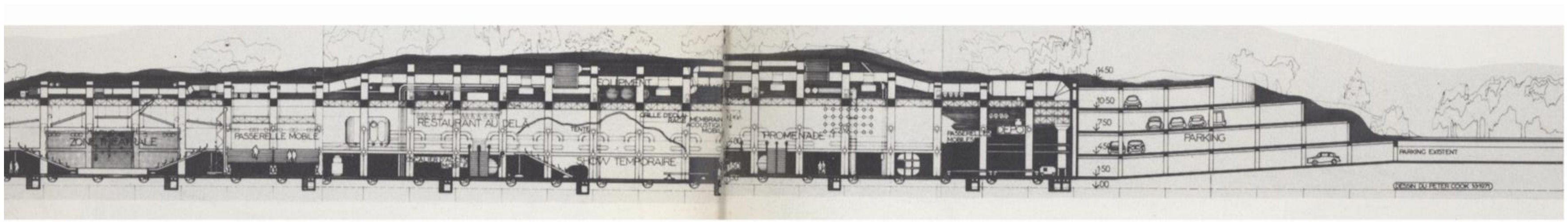


**Figure 4.3** The underground urban complex proposal designed by Peter Cook and Archigram.
(Source: Peter Cook. Ed. Archigram. New York: Praeger Publishers, 1973. P 108-109)

Various associations, university research centers and organizations have been established to look into multi-modal transportation and underground urban forms around the world – some of the most notable being COB (Netherlands Knowledge Centre for Underground Space and Underground Construction), ITA (The International Tunneling and Underground Space Association), ACUUS (Associated Research Centers for Urban Underground Space), the Urban Underground Space Center of Japan, the Chinese Society of Underground Engineering and Underground Space, UCA (American Underground Construction Association), Berliner Unterwelten (Society for Exploration and Documentation of Subterranean Architecture) and AFTES (French Tunneling and Underground Space Association).

There have been a number of publications and congresses aimed at increasing awareness of the underground space and creating a platform for innovation. For example, the ACUUS Research Center organizes an international underground space conference that raises different technical issues every year. The COB Center in the Netherlands also hosted an international congress entitled ‘Think Deep’ in 2008, during which the ‘National Underground Space Day of the Netherlands’ was celebrated. The subterranean urban space has also inspired artists, including the non-profit organization Art Souterrain, who put on exhibitions of contemporary art in subterranean Montreal, hoping to change the perception of the general public to the medium.[71]

Academic research centers dealing with urban underground space have also been established, with examples found in the National Technical University of Athens, the Louisiana Tech University, the University of Minnesota and the University of Montreal. The Observatoire de la ville intérieure (Observatory of the interior city) in the University of Montreal was established in September 2002 to bring together researchers and administrators for the development of underground spaces within urban landscapes. The research center focuses mainly on the development of underground Montreal, with the objective of monitoring underground Montreal and providing analysis related to the area.[72]

[71] For detailed information please visit http://artsouterrain.com/ > 09.03.2010
[72] See the Official Website of *The Observatoire de la ville intérieure* for further information: http://www.ovi.umontreal.ca/home.html > 09.03.2010

The underground urban system in Montreal is known as RESO (as in *réseau*, or *network* in French), and is one of the largest underground pedestrian networks in the world. The system comprises 33 kilometers of passageways beneath the city center, providing links to thousands of boutiques, hotels, restaurants, universities, office buildings and other areas of public interest.[73] There are nearly 200 entrance points connecting street level with the system,[74] while the Metro (subway), commuter train and bus networks converge at several different points. The passageways of RESO serve a leisure purpose by providing access to 40 entertainment venues. (Figure 4.5)[75]

Montreal's underground system was inaugurated in 1962 when the base of the office complex known as Place Ville Marie was decided to be linked to Central Station via pedestrian tunnels under a main roadway. The underground passageway gained an economic identity with the placement of a number of boutiques along its length; and besides providing an efficient way to traverse the busy city center the system also has the benefit of protecting its users from the extreme climate of Montreal. The second main development of the 'underground city' in Montreal came with the opening of the metro, comprising two lines that opened to the public in the downtown area, designed approximately 700 meters apart from each other. The development of the underground network of Montreal continued with a significant expansion in the 1970s when the multi-functional Complexe Desjardins center opened, containing government offices, a hotel, cinemas, retail stores and a very large indoor public atrium, all connected to the subterranean system. With this addition, underground Montreal gained an additional role as an area of recreation. The subsurface streets around the Complexe Desjardins have in time been appropriated for the hosting of several music and film festivals; and the system has continued to develop with the completion of the north-south axis between the Place des Art and the Place d'Armes Stations. In this period, the McGill and Peel Stations were also connected with a passageway forming an east-west axis. Multi-level shopping centers were constructed in the underground complex in 1980s, and several new development projects have been applied in the 1990s, including the World Trade Center, Les Promenades

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[73] http://www.tourisme-montreal.org/What-To-Do/Shopping/underground-pedestrian-network > 09.03.2010
[74] http://www.aviewoncities.com/montreal/reso.htm > 09.03.2010
[75] http://www.tourisme-montreal.org/What-To-Do/Shopping/underground-pedestrian-network > 09.03.2010

de la Cathedrale, the IBM Plaza and the 1000 de la Gauchetiere Center, which have also been connected to the underground network of the city. The 1000 de la Gauchetiere Center has contributed profoundly to the network, since it includes a major bus terminal and an indoor skating rink, and provides an alternative route between the Bonaventure Metro Station and Central Station. In this period, a western connection between the two metro lines has been completed with the construction of a link between Place Ville Marie and the Eaton Center.[76] (Figure 4.6) Today, the underground pedestrian network of Montreal is used by half a million people every day.[77]

Another extended underground network can be found in another city of Canada, Toronto, where the system is known as PATH. PATH is downtown Toronto's underground walkway, linking 27 kilometers of shopping, service, sports and cultural facilities. PATH does not follow the grid pattern of the streets above, but rather connects more than 50 buildings and office towers. It provides access to 20 parking garages, five subway stations, two major department stores, six hotels and a railway terminal, providing links to public transportation points that are used by more than 100000 commuters every day. This network also provides links to some of Toronto's major centers of attraction, such as the Hockey Hall of Fame, the Roy Thomson Hall, the Air Canada Centre, the Rogers Centre and the CN Tower, as well as City Hall and the Metro Hall. [78]

The first section of the underground form in Toronto was constructed in 1900, when a company called T. Eaton created a link between its main store and its bargain branch. With the opening of Union Station in 1927 an underground passageway was built to provide a connection to the Royal York Hotel, and the growth of PATH was accelerated rapidly in the 1970s when a further tunnel was built between the Richmond-Adelaide Center and the Sheraton Hotel. In 1987, the PATH network was brought under the coordination and financing of the Toronto City Council. Design companies Gottschalk, Ash International, and Keith Muller developed a signage system for PATH in 1988, making the system more user-friendly. Each letter in the signage system of PATH has been assigned a different color to

[76] Pieter Sijpkes, David Brown. *'Montreal's Indoor City - 35 Years of Development'.* Unpublished paper submitted at the 7th International Conference on Underground Space in 1997. (source: http://www.ovi.umontreal.ca/publications.html) > 09.03.2010

[77] http://www.tourisme-montreal.org/What-To-Do/Shopping/underground-pedestrian-network > 09.03.2010

[78] http://www.toronto.ca/path/ > 09.03.2010

represent a different direction: a red P for south, an orange A for west, a blue T for north, and a yellow H for east.[79]

As can be seen in the cases introduced above, the subterranean level has become a major medium in which metropolises can expand, especially in terms of urban transportation and infrastructure, at the beginning of the 21st century. Whether multi-functional or exclusively for transportation purposes, underground architecture has begun to be used incrementally in urban operations. One aspect that has led designers to begin planning below ground level can be said to be the accumulation of economic and social activities in city centers. Metropolises have become centers of attraction for people whom to be employed and/or dwelled. The design of subterranean structures that can decrease congestion and resolve problems originating from increasing density at ground level of the city have become a challenge for contemporary architecture; and it is the leading factors and the properties of the programs that have generated these large-scale multi-layered underground urban architectural forms that are going to be analyzed in this chapter.

A total of 19 subsurface urban systems in different countries and on different continents have been selected for this thesis. These case projects will be analyzed comparatively to establish points of commonality and difference between them. Using this comparative method, the programmatic factors that have led to the formation of underground transportation systems in metropolises are aimed to be understood.

### 4.1 An Analysis of Underground Transportation Forms According to their Leading Contextual Factors

In this section, it is intended to answer the research question: 'What were the factors that led to the expansion of urban transportation forms underground in the second half of the 20th century?' The reasons behind the advent of underground and multi-modal transportation systems will be investigated under five main headings: 'Congestion over Surface', 'The Arrival of the High Speed Train Network', 'Ecological Aspects', 'Integrating New Transportation layers into an Existing Station' and 'Underground Transportation Hubs of New Urban Centers'.

[79] Ibid

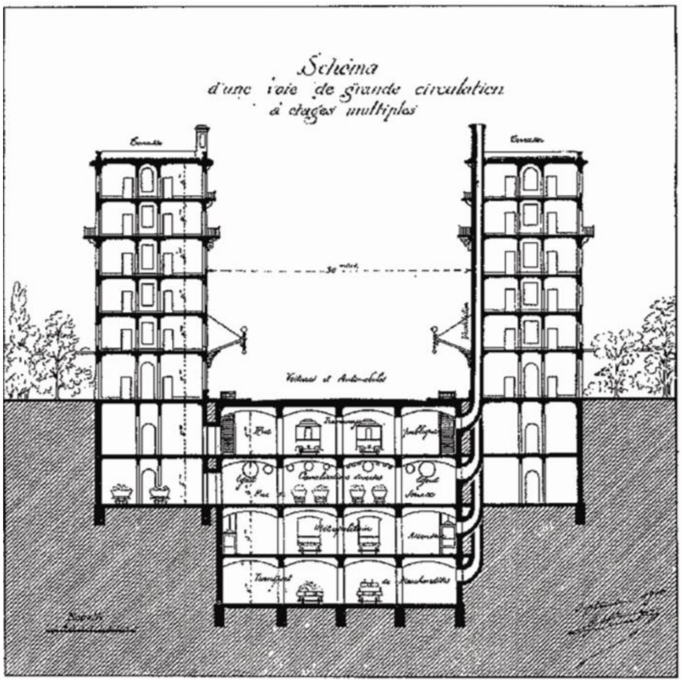


**Figure 4.4** Eugene Henard's proposal for an underground multimodal urban hub
(Source: http://www.library.cornell.edu. Last accessed on 09.03.2010)

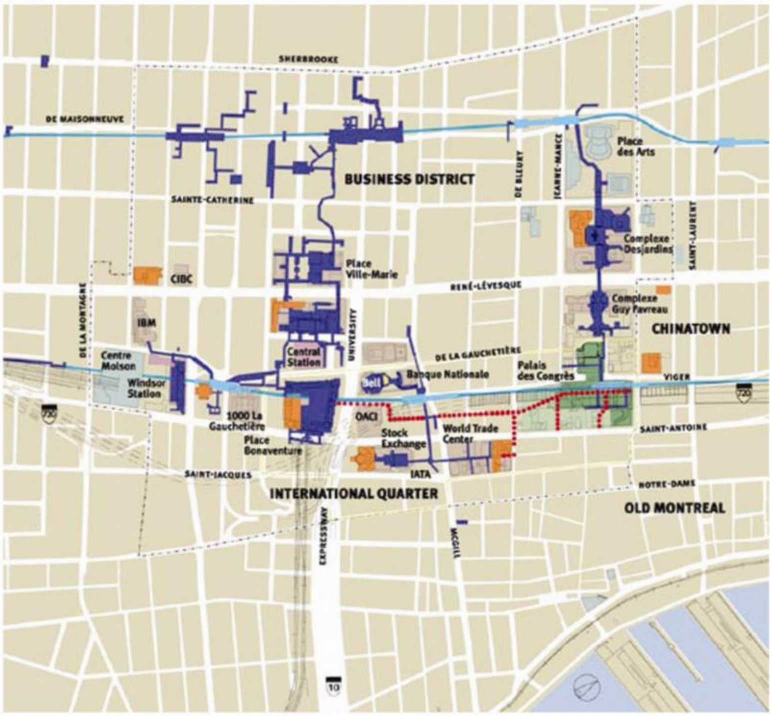


**Figure 4.5** The current situation of Montreal Underground
(Source: www.vieux.montreal.qc.ca. Last accessed on 09.03.2010)

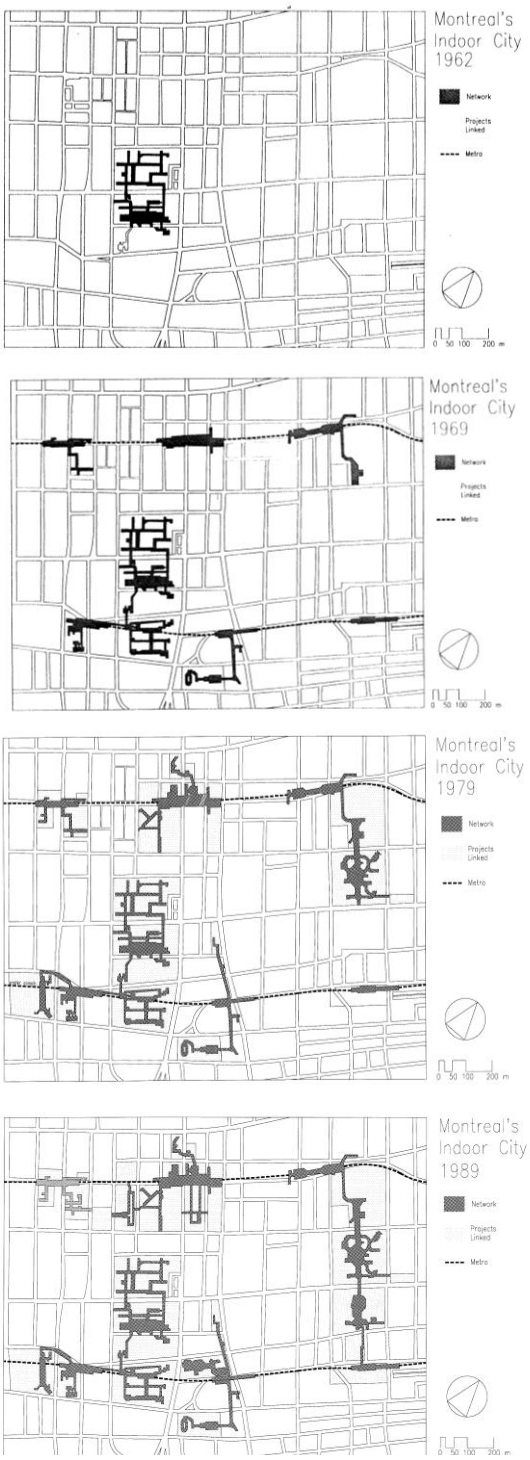


**Figure 4.6** The development of underground formation in Montreal city center between 1962-1989 years (source: *'Montreal's Indoor City- 35 Years of Development'.* Paper presented by Pieter Sijpkes, David Brown in 7th International Conference on Underground Space in 1997. http://www.ovi.umontreal.ca/publications.html. Last accessed on 09.03.2010)

#### 4.1.1 Contextual Factor 1: Congestion over Surface

The world's most advanced and pioneering projects in terms of underground multi-modal transportation architecture can be stated as having been developed in the Netherlands, resulting from the country's limited area (41,526 square kilometers) and high development level. Three of its most successful projects in this regard can be given as the Souterrain Tram Tunnel, the North-South Metro Line, and the AMFORA Project, all of which will be analyzed in this research. Of the three cases, two are located in the capital Amsterdam, which suffers from a distinct lack of space. Also in this chapter, two Paris cases, Les Halles and Haussmann-St. Lazare Station; and a Japanese case, Shibuya Station in Tokyo, will also be introduced.

In the early 1960s, the city of Amsterdam began to struggle with the inadequacy of its public transportation system, as the tramway network of the time was no longer able to meet the requirements of the growing population. Congestion in both the built environment and roads was resulting in a continuous decrease in the speed of the tram system; so in 1965 the Amsterdam municipality decided to replace the tram lines with an underground metro network, which was envisaged to span from beneath the historical city center out to the suburbs. The proposed network was planned to comprise four lines: The southeast-southwest line; the east-west line; a ring line around the pre-war built-up area of the city; and the north south line. Construction started with the southeastern line for two reasons: Firstly, it comprised the shortest underground section (3 km) of the four, meaning lower costs and easier construction. Secondly, it would connect the city center with a newly planned area known as Bijlmermeer. However, since its underground section passed through the built environment and many houses would have had to be demolished, public outcry caused construction to be stopped, and the south-east line under the city center was cancelled.[80]

For this reason, Amsterdam has just three metro lines, none of which passes through the city center, but with recent advances in civil engineering technologies it has now become possible to build a metro line without destroying the built environment, and so a north-south Metro Line, which was first planned 40 years ago, has started to be built. The new

[80] http://www.urbanrail.net/eu/ams/amsterdm.htm > 09.03.2010

line comprises 9.7 kilometers of track, serving eight stations. The project will form a connection between the northern and southern districts of Amsterdam, which currently are only served by buses or trams. The lack of space and the physical accumulation prohibits any further surface traffic in Amsterdam, and as such most of this metro line (6 km) will be built underground. When this metro line opens in 2015[81], travel times between the northern and southern districts will be decreased to 16 minutes.[82]

The Ceintuurban is the deepest station on the North-South Metro Line, which has been designed to depths of between 16.5 and 26.5 meters. The narrow, long and deep station is 230 meters in length, and since the station is very narrow, the station platforms will be located on top of one another.[83] A huge multi-layered and multi-modal transportation hub is to be constructed in Vijzelgracht below street level. (Figures 4.7 and 4.8) The construction of the metro line will result in an extreme downwards concentration difference in the urban tissue.

As mentioned above, the city of Amsterdam's overcrowded built environment and excessive traffic is hindering its economic growth, which in part depends upon good accessibility for the city. The municipality published its plans in the 'Action Plan Right of Way for a Healthy City 2008-2014'. As an answer to these evocations made by the municipality, the proposal project called AMFORA (Alternatieve Multifunctionele Ondergrondse Ruimte Amsterdam/Alternative Multi-functional Underground Space) has been developed through collaboration among architectural firm Zwarts-Jansma, Delft University of Technology and a group of engineering offices. Some 50 kilometers of tunnels beneath the canals in the town centre are proposed to be built to accommodate parking, transportation modes and sports and leisure facilities. (Figures 4.9 and 4.10) Approximately 1 million m2 of floor area will be acquired, which equates to around 50,000 parking places. The underground city in Amsterdam has been designed to increase livability above ground while addressing the existing urban congestion and air-sound pollution caused by heavy

[81] http://www.northsouthline.com/live/main.asp > 09.03.2010
[82] The North South Line Presentation Booklet
http://www.northsouthline.com/live/bijlagen/noordzuidlijn/documenten/corporate_brochureuk_2005.pdf > 09.03.2010
[83] Ibid

traffic. A project for a partial connection between the Groenmarkt and Amstel sites is currently being developed, and is expected to be completed in 2018.[84]

The initial idea was to rid the city center of the parked cars; however as the project developed, the plan was elaborated to include an underground network of urban spaces and infrastructure beneath the canals, creating space not only for parking, but also for commercial, cultural, leisure and sports activities, and various programs are underway or are planned to assess the potential of underground space. With all its varying programs, AMFORA has been defined as 'a city under the city'. The architecture of the project takes reference from the widths of the canal on the surface; with column-free spaces with a maximum span of 30 meters taken as the basic units of the design. For broader canals such as the Amstel, three segments of 30 meters are foreseen; while if the canal is less than 30 meters, this span will be diminished to fit the width.[85]

The boundary of the AMFORA project has been defined as the A-10 ring road that encircles central Amsterdam, from which vehicles will be able to enter the underground AMFORA network. By taking traffic below ground the interaction of the city center with the Oosterdok water front is also expected to be increased. Additionally, more space for squares and public spaces for pedestrians and cyclists will be obtained, and the existing rows of parked cars are to be replaced with shopping boulevards, thus contributing to Amsterdam's economy. The connection between the AMFORA network and street level will be through existing buildings, through pavilions on the quays, and from shafts that will come up through the water. [86]

Another example of an underground architecture that has been constructed to decrease congestion at street level is the Souterrain Tram Tunnel in Den Haag, the Netherlands. The tram tunnel was built between 1999 and 2004 by Rem Koolhaas and his architectural office OMA, which won the design competition in 1994. The 1,200 meter underground tunnel includes two tramway stations and parking spaces for 500 cars. The Grotemarkt and Spui tramway stations are located at opposite ends in the bottom level of the tunnel; while the

[84] The Presentation Booklet of AMFORA Project.
http://www.zwarts.jansma.nl/download.php?id=1593 > 09.03.2010
[85] Ibid
[86] Ibid p 11

two superior levels of Souterrain have been designed as car parks.[87] Cross-pedestrian bridges provide visual and spatial connections between these three layers of transportation. (Figure 4.11)

The Souterrain Tram Tunnel has undergone a very interesting design process in terms of the intersection of two different urban plans. The extending of a transportation network, the development strategy of the municipality and the architectural goals are all interactively reflected in the design of this underground transportation hub. The Souterrain Tunnel will form part of both the RandstadRail and The Hague Urban Plan; while forming also part of a larger-scale transportation network, known as *RandstadRail.* RandstadRail is planned to be constructed to the west of the Randstad Conurbation, established between The Hague, Amsterdam, Rotterdam and Utrecht; and will link the cities of The Hague, Rotterdam and Zootermeer. This hybrid rail system has been planned on the existing tram and train infrastructure in the region, meaning that the existing tram and train lines in Hague, and the existing metro and train lines in Rotterdam will be used to construct the rail network, while new lines will be built to complete the network.[88]

The Hague Municipality has a plan to increase the density of the city by way of an underground infrastructure network, and this will be the second urban project that the Souterrain will be an element of. As explained by OMA in the project description of the tram tunnel, The Hague suffers from an inadequacy of space being surrounded by the sea, the Amsterdam-Rotterdam highway and other neighboring cities, making lateral growth difficult.[89] The municipality's aim to decrease traffic in the busiest commercial center of the city was another factor that led to the construction of an underground transportation hub. Since growth means higher density for The Hague, it is underground that has become the preferred direction for urban development.

The location of the Souterrain Tram Tunnel is of very strategic importance in terms of the urban infrastructure planned by The Hague Municipality. The tram tunnel is to be

[87] http://www.oma.eu/index.php?option=com_projects&view=project&id=183&Itemid=10 > 09.03.2010
[88] www.connectedcities.eu > 09.03.2010
[89] http://www.oma.eu/index.php?option=com_projects&view=project&id=183&Itemid=10 > 09.03.2010

constructed at the center of an area that is closed to vehicular traffic at the end of 2009. In order to render the city center more attractive for shoppers, tourists, cyclists and pedestrians, The Hague municipality has defined an 'island' of 1 million m2 in which only trams and buses are allowed access. The loop-road, defining the boundary of the island will have various connections to large underground urban parking garages and an underground service road that will allow trucks access to the commercial center of the city. In other words, the Souterrain Tram Tunnel will work also as a connecting element between the foreseen underground urban infrastructural networks.

OMA has highlighted the main challenge of the Souterrain Tram Tunnel project as being '*to prove that architecture can have a positive effect when applied to the rigor of transport pragmatism*',[90] and Souterrain has succeeded in that challenge. In the light of the associated programs and the quality of the architectural space, the Souterrain should not only be defined as an infrastructural element, but should also be referred to as a building.

Les Halles in Paris is another example of an underground multi-layered transportation hub that has been constructed to decrease congestion at the surface. The name Les Halles, which means 'the markets' in English, originates from the marketplace located in the district in the 12th century that was the trading center of pre-industrial Paris. The crudely-built timber structures in Les Halles were replaced with 12 rectangular iron pavilions in the 19th century, designed by Victor Baltard. As Paris grew, Les Halles became overcrowded, with the population doubling between the time when the pavilions were constructed in the 1860s and the 1960s. Residential buildings in Les Halles were also developed in that time, and in the 1950s and 1960s the district was home to 21,000 people, causing congestion that turned Les Halles into an unhealthy environment where living conditions were well below standard. The streets in the district were choked each night by over 10,000 trucks carrying goods and vegetables; leading the government to decide to transfer the market to the outskirts of the city, leaving the pavilions empty, in 1959. Some nine years later a master plan was developed that led to the current situation of Les Halles that saw the demolition of the Baltard Pavilions in 1971, and a new design for a large-scale underground

[90] Ibid.

complex, containing shopping and transportation facilities.[91] Les Halles was selected as the convergence point of the underground transportation networks in the district. The catalyzing factor in integrating transportation into Les Halles can be said to be the opening of the RER (Regional Express Train Network) in 1960s in Paris. Today, Les Halles contains the Chatelet-Les Halles RER Station and an underground shopping mall called *Forum des Halles,* and features an urban park on the surface.[92] The existing underground urban area in Les Halles is in the form of five underground levels. The North-South transit road runs through the top two levels, served by car parking one level below. The RER network is housed in the lowest level, with the other rail system corridors located in the top three levels. (Figure 4.12)

An architectural design competition was opened for the renovation of the Les Halles district in 2004, in which four architectural companies were invited to compete: OMA, MVRDV, Jean Nouvel Architects and SEURA. The respective proposals were exhibited for six months, giving the general public the opportunity to state their opinions of each project. Taking into account public opinion, the mayor of the city decided to go with SEURA's proposal.[93] A second competition for the design of the wide glass roof covering the Forum des Halles, as proposed by SEURA, was won by Patrick Berger and Jaques Anziutti Architects.[94] The upgrade of the largest rapid transit station in Europe is scheduled to start in 2010 and finish in 2013.

It is worthwhile examining the four competition entries into the Les Halles project to gain an insight into the approaches of contemporary architects to an existing underground multi-layered and multi-functional urban hub. The four proposals can be separated into two categories in their approaches to underground forms. Interestingly, OMA's project proposes the largest amount of above-ground structure. In contrast to their designs of multi-layered and multi-functional underground buildings in Den Haag and Lille, OMA tried to place the programs with a dense cluster of small tower-like structures in Les Halles. In

[91] H. V. Savitch. Post-Industrial Cities-Politics and Planning in New York, Paris, and London. New Jersey: Princeton University Press, 1988. p 138-142
[92] www.connected cities.eu > 09.03.2010
[93] Ibid
[94] www.paris.fr > 09.03.2010

other words, OMA proposed surface constructions to connect the existing underground facilities with street level.

In the other three projects above ground elements have been kept to a minimum. Although their methods differ, the proposals of MVRDV, SEURA and Nouvel all evaluated the existing urban park as a constant element. In the SEURA and Nouvel designs there are re-interpretations of the existing urban park, whereas the MVRDV proposal suggests an additional translucent layer in the park to increase the interaction between above ground and below ground.

The SEURA project claims to increase the dialogue between the monuments surrounding Les Halles: The Georges Pompidou Center in west, the Les Halles stock exchange building in the east and the Eustache Church in north. Besides the rearrangement of the urban park above Les Halles, SEURA proposes a ceremonial axis dividing symmetrically the area and connecting the stock exchange building to the Forum des Halles. SEURA's winning proposal can be claimed as being the most conservative and traditional of the three, as it does not differ much from the existing building, either programmatically or infrastructural. (Figure 4.13) SEURA's approach to transportation is based on the idea of reducing motorized traffic passing through Les Halles, with the existing five entrances and six exits reduced to two entrances and three exits.

While an urban network spreading towards the whole city center is tried to be integrated into projects such as AMFORA, half of the vehicular entrances to the existing underground transportation hub are being removed in the Les Halles district, which could be interpreted as a paradoxical situation. In the case of Les Halles, the disadvantages associated with deciding upon the winning project though a public vote should be mentioned. The Parisians' reasons for selecting a proposal that reduces underground transportation probably originates from a fear of negative conditions related to waste, air pollution and petty crime below the surface;[95] however focusing on the improvement of an existing urban infrastructure would have been a more appropriate approach, rather than just discarding it due to its deficiencies. With multi-modal and multi-layered transportation hub projects being constructed all over the world, the people of Paris public could have been

[95] http://www.citymayors.com/development/leshalles_paris.html > 09.03.2010

made aware of improvements in mechanical systems, better maintenance and increased security, which are just some of the interventions into the urban infrastructure in Les Halles.

The fifth project that is going to be introduced as an example of underground forms resulting from urban congestion is the Haussmann-St Lazare Station in Paris. The Haussmann-St Lazare Station is built as a part of the EOLE Regional Express Line, which has led the construction of major transportation facilities in the north of Paris (Figure 4.14). The creation of the Regional Express Network (RER) in France was one of the most important developments proposed among the urban development plans of 1965. The first RER Line, RER A was constructed to link the eastern and western suburbs from the new town of Marne la Vallee to another new town, Cergy Pontoised serving also the Central Business District (CBD) of Paris and the site of La Defense. The strategic positioning of the line has made it one of the most crowded urban public transport lines in the world, and by the 1980s the line had become extremely congested, serving 60,000 passengers in the morning peak hours.[96]

The overcrowding on RER A led the two public transport services of metropolitan Paris, the SNCF (the French National Railway Company) and RATP (The service that operates subway and bus lines within Paris and its near suburbs) to propose new projects as a solution. RATP developed the Meteor (Metro Est Ouest Raide) Subway Line, linking many railway stations in Paris and providing new services to the rest of the city; while SNCF proposed the EOLE (Est Oust Ligne Express) to connect the railway lines in the center of Paris through the construction of a section of tunnel. The French government accepted both projects, and scheduled them for completion in 1989. Laurence Debrincat claims that the underlying reason behind French government’s acceptance of both projects was to overcome the deficiency of a previous policy of the 1970s and 80s, when the government invested more into the road network than public transport infrastructure.[97]

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[96] Laurence Debrincat. *New Public Transport Lines in the Ile de France Region- Meteor and EOLE: Are they worth the money?* Unpublished paper submitted at the European Transport Conference. p 33. (The official website of the European Transport Conference. http://etcproceedings.org/)
[97] Ibid 33-34

Accordingly, The EOLE started operation in 1999 as the 5th RER Line in Paris, providing a connection between Gare du Nord, Gare de l'Est and Gare Saint Lazare and the CBD.[98] Located on the EOLE Line, the Haussmann-St. Lazare Station provides interchanges between metro and long-distance train stations. Designed by Jean-Marie Duthilleul, Etienne Tricaud and Rolan Legrand from the French architectural firm AREP, the underground Haussmann-St Lazare Station is located in the 8th and 9th arrondissements of Paris, where a number of landmarks and facilities, such as offices, department stores, the opera building and the Gare St. Lazare are located. The construction of the station was competed in 1999, and has been built to serve the city on four metro lines, the regional express line (RER), the Meteor Metro Line, and travelers from Gare St. Lazare. The exchange points of the new station are two large halls, called the Caumartin Hall and the Le Havre Hall. [99]

The final project to be analyzed in this section is the Shibuya Station in Tokyo, which opened in June 2008 in the shopping district of Shibuya. The station provides a connection to the two other neighboring shopping precincts of Ikebukuro and Saitama, and is expected to be used by 400,000 commuters and a total of 2.4 million visitors each week. The Shibuya Station is located under the Meijidori (Meiji Street) near the site of the old Tokyo Cultural Center. The choice of location for the new transportation building is an outcome of a larger development plan by Tokyo Metropolitan Government that will see Shibuya turned into a cultural center. The station has been constructed as a part of the new 20.2-kilometer Fukutoshin Subway Line, which is the 13th subway line in Tokyo and has been created to decrease congestion on the Yamanote Line.[100]

The Canary Wharf Jubilee Line Station, the Canary Wharf Crossrail Station, Westminster Station and Fulton Street Station are other cases that can be listed under this heading, since all have resulted from congestion in dense urban centers; however these projects will all be introduced in later sections.

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[98] Ibid 34

[99] Martha Thorne. Ed. *Modern trains and Splendid Stations*. Chicago: Merrell-The Art Institute of Chicago, 2001. pg 74-77

[100] http://www.designbuild-network.com/projects/shibuya-station/ > 09.03.2010


**Figure 4.7** The existing situation of the Vijzelgracht
(Source: www.ivv.amsterdam.nl. Last accessed on 09.03.2010)


**Figure 4.8** The situation after the construction of the Vijzelgracht Station
(Source: www.ivv.amsterdam.nl. Last accessed on 09.03.2010)


**Figure 4.9** The sectional relations between the proposed program elements in the AMFORA Project (Source: www.zwarts.jansma.nl. Last accessed on 09.03.2010)

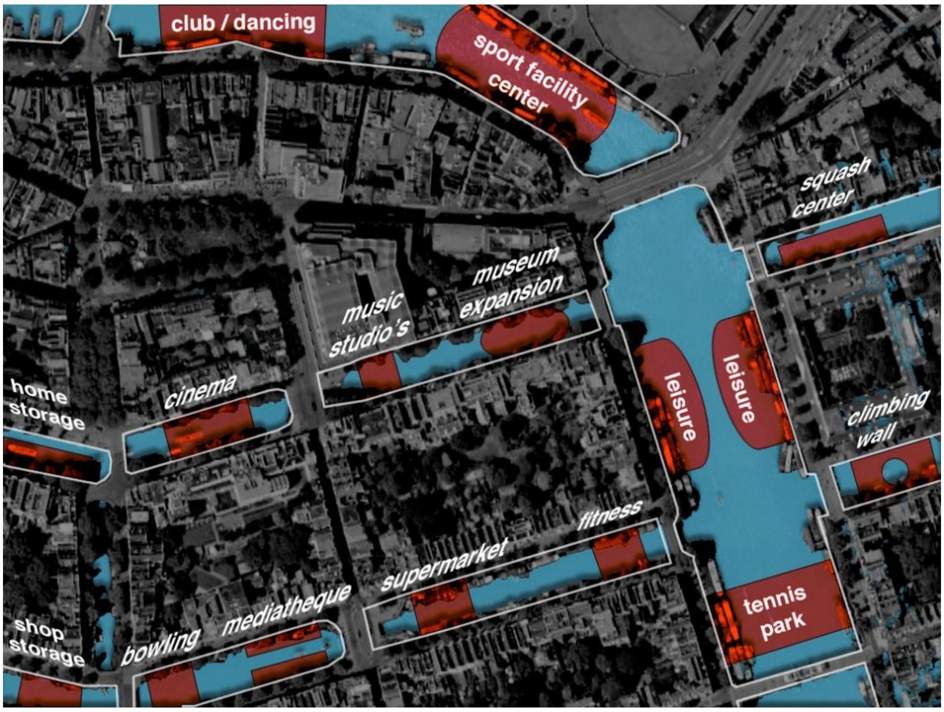


**Figure 4.10** The planimetric relations between the proposed program elements in the AMFORA Project (Source: www.zwarts.jansma.nl. Last accessed on 09.03.2010)

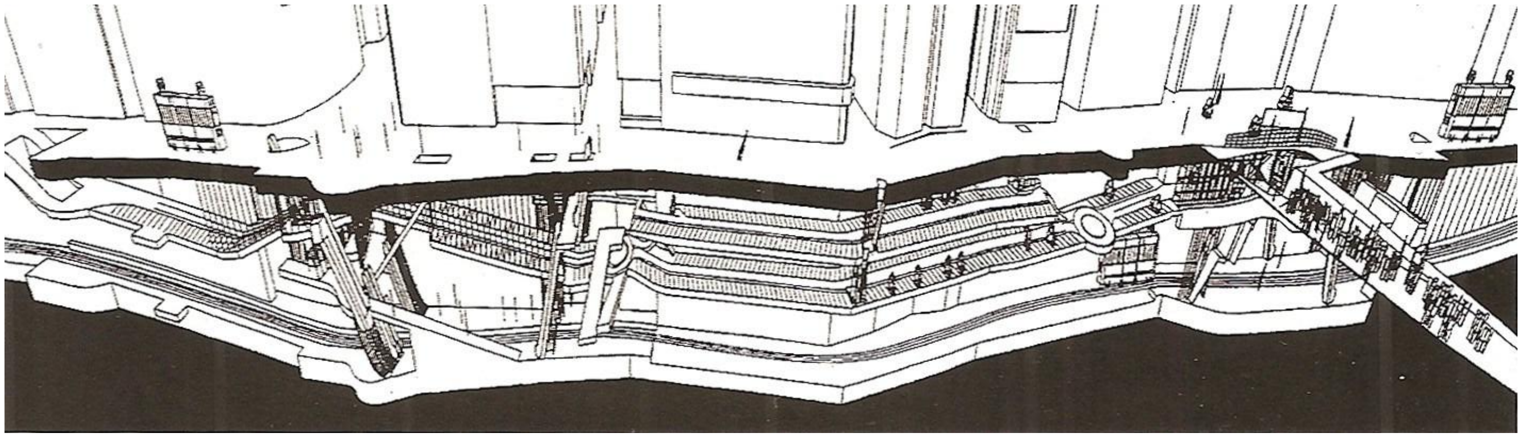

**Figure 4.11** The section-perspective of the Souterrain Tram Tunnel showing the different layers in the station (source: www.oma.nl. Last accessed on 09.03.2010)

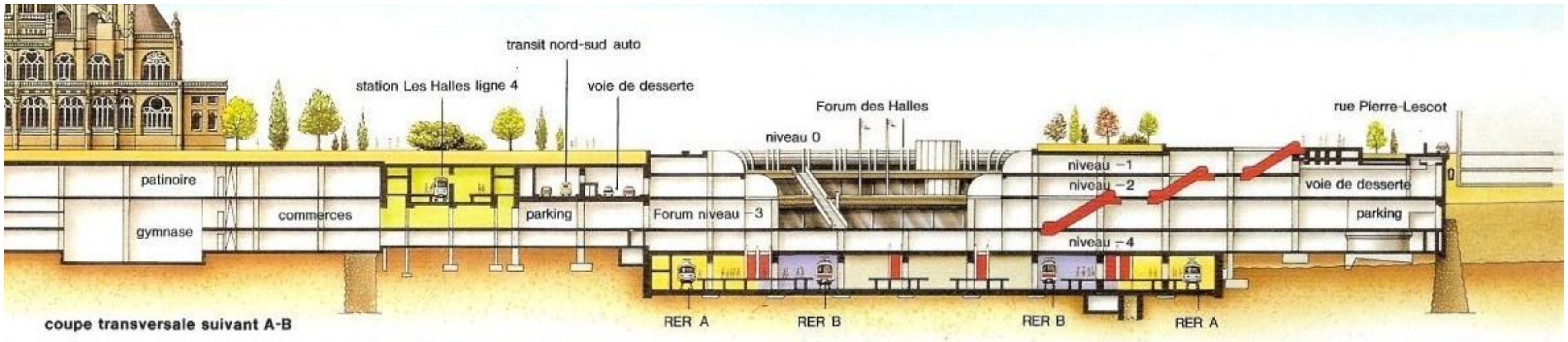


**Figure 4.12** The section of the Les Halles in Paris (source: http://grandparis.free.fr/chatelet-les-halles.jpg. Last accessed on 09.03.2010)

**Figure 4.13** The model of the Seura Architects's proposal for the Les Halles
(Source: http://connectedcities.eu/images/conferences/paris_les_halles_mangin_1.jpg. Last accessed on 09.03.2010)

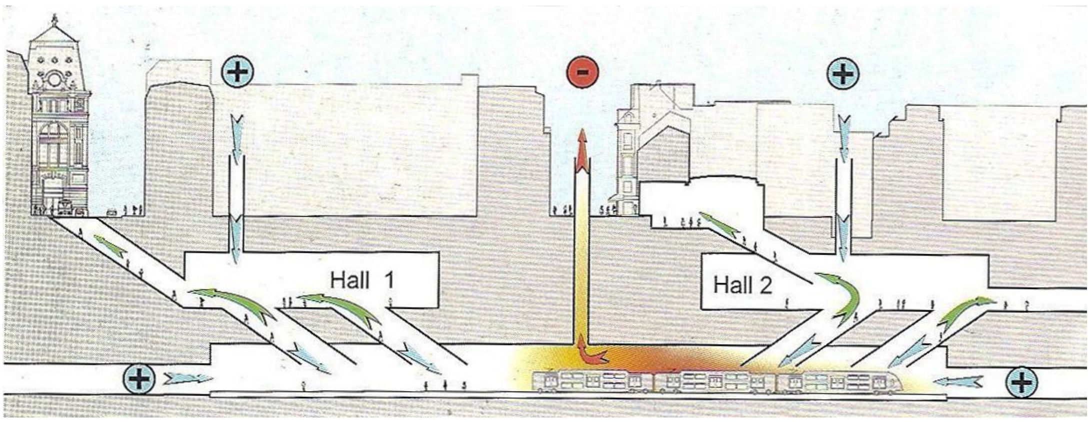


**Figure 4.14** The section of the Haussmann-St Lazare Station
(Source: Martha Thorne. Ed. *Modern trains and Splendid Stations*. Chicago: Merrell-The Art Institute of Chicago, 2001. p 74)

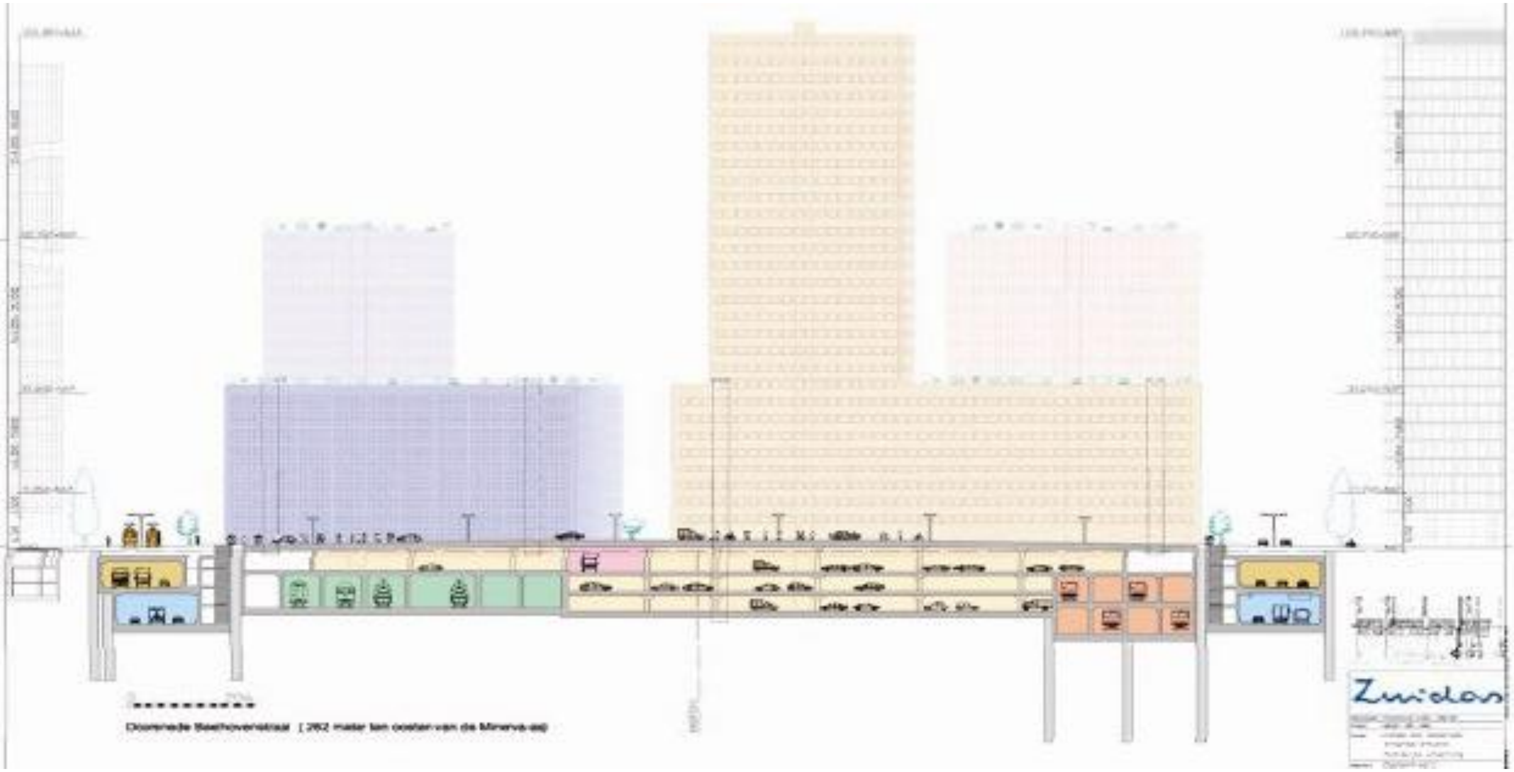


**Figure 4.15** The architectural section of the proposed project for Zuidas Dok (image: www.thinkdeep.nl Last accessed on 09.03.2010)

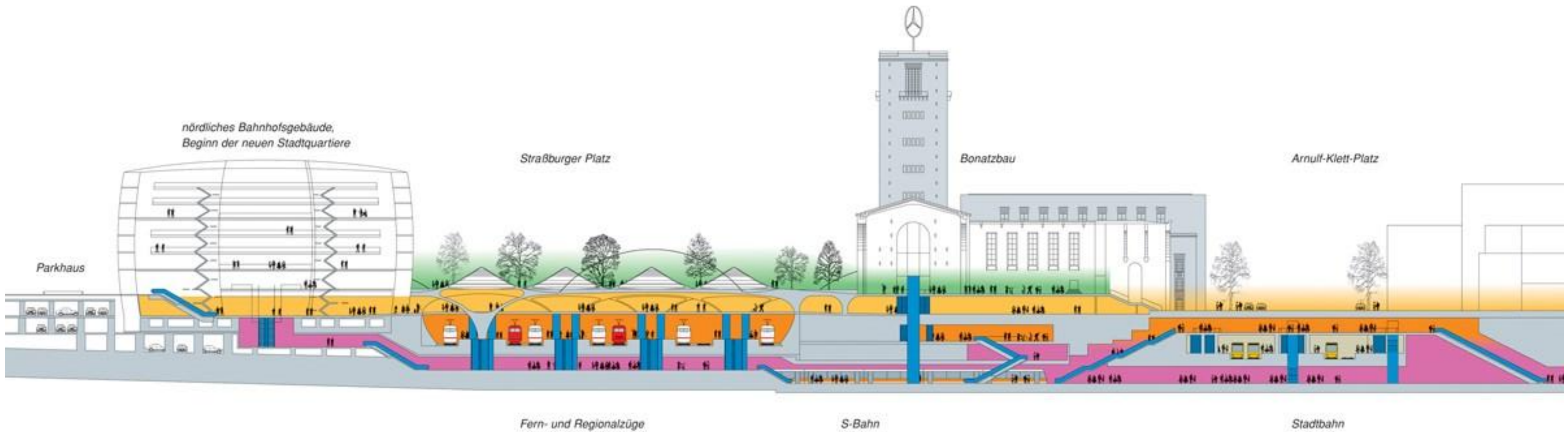


**Figure 4.16** The section of the proposed design for the Stuttgart Main Station (Source: www.das-neue-herz-europas.de. Last accessed on 09.03.2010)

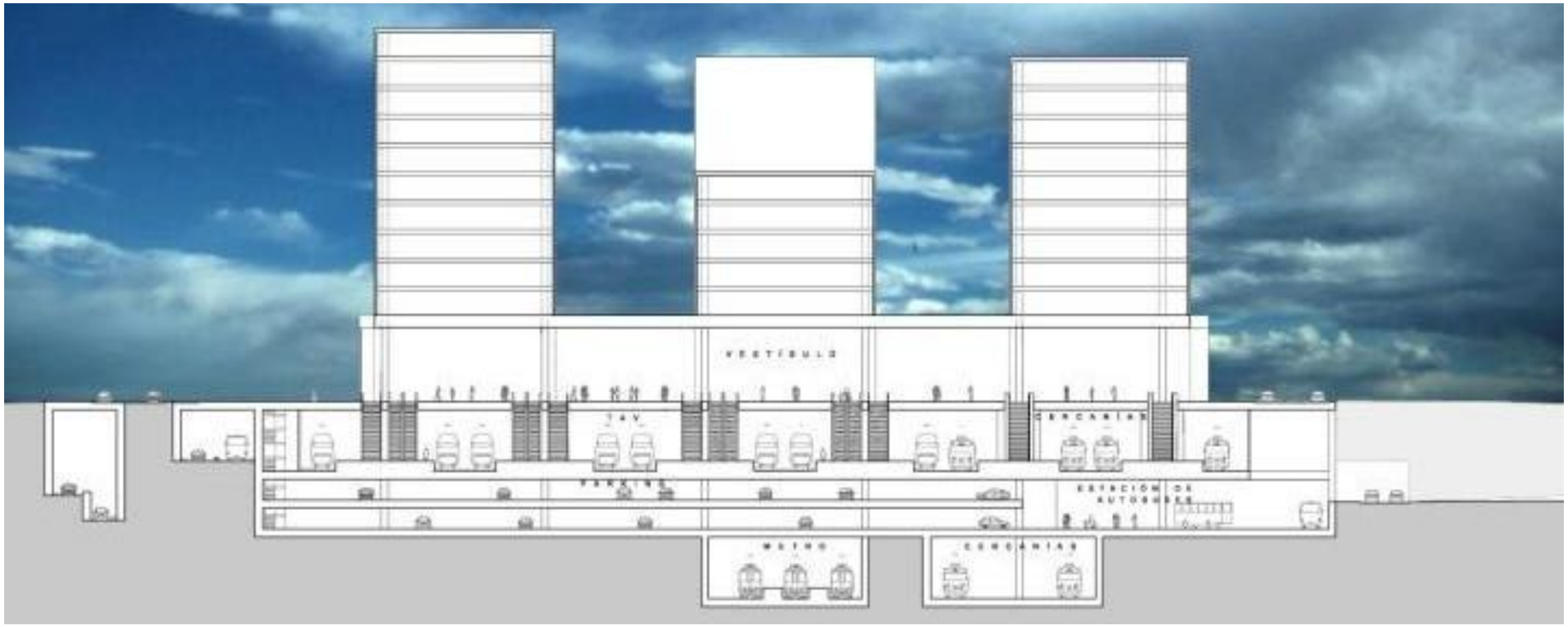


Figure 4.17 A cross section of the Sagrera Station in Barcelona (image: www.acturban.org. Last accessed on 09.03.2010)

**4.1.2 Contextual Factor 2:** The Arrival of the High Speed Rail Network

As introduced in the third chapter, high speed technology emerged with the launch of the Tokaido Express in Japan, and has since developed rapidly in many countries around the world. France has played a leading role in developing a high speed network in Europe with the TGV (Train a Grande Vitesse), which today connects countries in Western Europe. Another high speed rail service, known as Eurostar runs through the Channel Tunnel between London, Paris and Brussels, and links to the TGV network in Lille, France. The Eurostar can claim to have attracted 63 percent of the air traffic between those cities.[101] Brian Richards points out that the success of these high speed services has led governments to make important investments into new stations and the upgrade of existing stations to raise standards. He goes on to say that the arrival of high speed services to cities like Lille gives them a modern image and facilitates a socio-economic upgrading. According to Richards, the original TGV route was planned to pass through the city, but as a result of political pressure it was decided to be integrated into a new station, a policy change that resulted in the construction of the Euralille complex in Lille-France.[102]

The Euralille master plan has been designed with the aim of superimposing the rail lines from London, Paris, Brussels and Belgium as four neighboring cities of Lille. Besides the high speed train network, tram, bus and automobile routes run through Euralille. Besides being a multi-modal transportation hub, Euralille includes a wealth of other facilities, including offices, shops, 700 apartments, three hotels, 6,000 parking places, and an Exposition/Congress Center, an Expo Center, amphitheaters, the rock hall 'Zenith' and parking for 1,230 cars. The characteristic triangular form of Euralille has been designed as a commercial plaza between the old and new stations,[103] and each building in the complex has been designed by a different architect. The general master plan of Euralille has been created by Rem Koolhaas and his architectural firm OMA, and construction was completed in 1994.[104]

[101] Brian Richards. Future Transport in Cities. London: Spon Press, 2001. p 20
[102] Ibid
[103] Koolhaas, Rem, Bruce Mau, Hans Werlemann. S,M,L,XL. New York: The Monacelli Press, 1997. p 1166.
[104] Ibid

Another example of an underground form that arose out of the arrival of a high speed rail service is the Zuidas Project in Amsterdam; for which a letter of intent was signed by the central government and the city of Amsterdam in January 2005.[105] Zuidas is located on the south side of Amsterdam, close to the historical city center, Schipol Airport, the Zuid/WTC railway station, the A10 ring road, residential districts Zuid and Buitenveldert, and the green areas formed by the Amstel and Schinkel waterways. Briefly, Zuidas' potential for further development in terms of national and international development comes from its strategic position, as the project is not a static end product, but is rather part of a development strategy that draws a vision for the district. The plans have been extended over time as the realization of the total project is expected to take decades; with the continuously changing urban and infrastructural conditions becoming fully effective in the final detailed plan.[106]

The Zuidas Project has gained more importance with the introduction of the High-Speed Railway Line (HSL) and the North-South Metro Line for Amsterdam, with both transportation axes converging at the Zuid/WTC (World Trade Center) Station. Zuid/WTC is expected to become a major transportation hub, being a meeting point for the HSL (shuttles and international traffic), train, metro, tram, buses, taxis and cyclists.[107] In Zuidas there has been no placement of non-transportational facilities below the surface, with all other facilities proposed to be located above ground. (Figure 4.15)

The third example falling under this title is the Stuttgart Main Station. The idea to reconstruct Stuttgart Main Station emerged as one of a series of planned projects known as the Stuttgart 21 Project. Stuttgart 21 is a project for the capital of the South-West German state of Baden Wuerttemberg, aimed at integrating a high speed rail service into the city and improving its global importance through the development of its infrastructure. The Stuttgart Main Station is planned to become 'the central traffic junction of the city in the 21$^{st}$ century,[108] for which the renovation has begun, and is set to continue until 2019. Deutsche Bahn, the German rail company, the State of Baden-Wüttenberg, and the City of

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105 The 2004 Vision of the Zuidas, City of Amsterdam. p 10
http://connectedcities.eu/downloads/showcases/nsp_zuidas_visie_2004_uk.pdf > 09.03.2010
106 Ibid p 2-4.
107 Ibid p 7.
108 www.das-neue-herz-europas.de > 09.03.2010

Stuttgart held a European-wide competition for the design of station, with the winning proposal coming from Ingenhoven, Overdiek, Kahlen and Partners from among 126 submissions. Their design was found to be the best solution in terms of integrating new transportation layers into the existing station building, the creation of a landmark and satisfaction of the design criteria.[109] (Figure 4.16)

Besides integrating high speed rail services, the Stuttgart project has three other aims: the connection of the city centre with the southern region, where the airport and the business center is located; the conversion of the main station from a terminal into an underground through station; and the development of the city center through the transfer of rail lines to below ground level. Around 100 ha of land formerly occupied by railway infrastructure is planned to be allocated for housing, business and commercial facilities with the project,[110] and with the help of these improvements the city of Stuttgart is aimed to develop both economically and socially.

The Euralille and Stuttgart Main Station are both cases in which transportation corridors have been rerouted below the surface. In Euralille, the highway has been rerouted underground to run parallel to the existing TGV; whereas it is the railway lines that have been rerouted below the surface in Stuttgart Station. There has been an attempt to integrate with an existing transportation network in Euralille; while in Stuttgart the aim has been to release the surface level for the creation of new functions.

The Sagrera HST Station Area Master Plan will also be introduced under this part of the thesis. The awarding of the 1992 Olympic Games to Barcelona brought about a series of urban renovation projects in the city, including five main projects that were all developed with different objectives: Diagonal-Poblenou, Sant-Andreau-La Sagrera, Front Maritim, Diagonal Mar and a renovation plan for the industrial areas. A number of factors contributed to the decision of the municipality to launch such urban renovations. For instance, the Diagonal Mar District Project was developed in order to balance the urban

[109] Martha Thorne. Ed. *Modern trains and Splendid Stations*. Chicago: Merrell-The Art Institute of Chicago, 2001. p 91
[110] www.hstintegration.net > 09.03.2010

congestion and create a healthy environment for metropolitan housing in Barcelona.[111] The catalyzing factor behind the urban transformation in the Sagrera, Sant Andreu and Sant Marti areas of the city was the need to integrate the High Speed Rail Network into the city of Barcelona. An agreement was made between the Ministry of Development, the Government of Catalonia and Barcelona City Council in 2002 in order to manage the project.[112] This integration will be made possible through a series of renovations, and the addition of new infrastructure, to the area. Construction of the project began in 2009 and is scheduled for completion in 2012. The transformations of the Sant Andreu and Sagrera areas are part of a series of urban renovations that have been carried out in the east of Barcelona in recent years. The Sagrera district is aimed to be developed as a business and economic center, with an urban plan that includes hotels, offices, residential areas, urban parks and commercial activities, as well as transportation facilities.[113] (Figure 4.17)

**4.1.3 Contextual Factor 3:** Ecological Aspects

**4.1.3.1 Contextual Factor 3.1:** Reclaiming the green over surface

The desire to allocate above ground spaces as parks, or to maintain existing natural environmental conditions are other factors that have led to the creation of underground forms. To exemplify, in the AMFORA Project in Amsterdam, the existing canals are targeted to be retained in their current state; however the project aims to take up the challenge of improving environmental conditions in Amsterdam, including a program to clean the canals to make them suitable for swimming. The air quality is also targeted for improvement, with a plan in place to filter out $CO_2$, $NO_x$ and other hazardous gases from exhaust emissions before being discharged at the surface. The third environmental aspect of the project is its subterranean heat storage potential. No additional energy will be required for the cooling and heating of the underground space, as these functions will be made available with the help of water pipes located in the side walls of the tunnels.[114]

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[111] Tim Marshall. Ed. Transforming Barcelona. New York: Routledge, 2004. p 140-146
[112] The Barcelona-Sagrera Alta Velocitat Presentation Booklet, p 2-3. (www.barcelonasagrera.com) > 09.03.2010
[113] Ibid p 5.
[114] The Presentation Booklet of AMFORA Project, p 15

The area above the 5.6 km underground tunnel between the Sant Andreau and La Sagrera Stations[115] is going to be arranged as a linear urban park. (Figure 4.18) This landscaped area has an interesting background in terms of its design process. Commissioned by a private developer, Norman Foster prepared a proposal project for the region in 1993 that included an artificial river stretching from Trinitat to Glories. The river idea was later transformed into an urban park, which has now become the key element in the current master plan of the area.[116] In other words, the twisting linear form of the green area in the project, which resembles a water element, has been inherited from an idea of an artificial river.

Another example of an underground formation that has resulted from a desire to reclaim the green over surface for recreational functions is the Canary Wharf-Jubilee Line Station, built in London in 1999. Canary Wharf station was built as a part of the Jubilee Line of the London Underground. The creation of this underground form is very interesting, since it was built in a void vacated by the former West India Docks,[117] built between 1799 and 1806 in the Isle of Dogs district of East London.[118] For the new station, a 300 meter-long concrete box was built using the cut and cover method, the roof of which has been arranged as a landscaped park. (Figure 4.19) The only visible elements of the station at the surface are the glass canopies that cover the entrances to the underground station. Designed by Norman Foster Architects, orientation has been enhanced and the need for signage has been minimized through the use of huge glass canopies on Canary Wharf.

Another station in the Canary Wharf district has been designed to house a station on the newest major railway project in London, Crossrail. Like the Canary Wharf station, this station will also be built in the one of the West India Docks, being North Dock; however the water in the dock will not be drained as the building will rather be created as an island in the dock. The station will be six stories high, four of which will be under water. Covered by a semi-open-air timber lattice roof, the two levels above ground have been designed as landscaped recreational areas containing cafes and restaurants. (Figure 4.20) The Canary Wharf Crossrail Station box will be 260 meters long and between 27 meters and 30 meters

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[115] Detailed information about this project is going to be stated in the 'Contextual Factor 5: Underground Transportation Hubs of New Urban Centers' titled section of this chapter.
[116] Tim Marshall. Ed. *Transforming Barcelona*. New York: Routledge, 2004. p 142
[117] Arian Mostaedi. *Urban spaces*. Spain: Carles Broto&Josep Minguet, 2002. p 110
[118] Please visit http://www.british-history.ac.uk/report.aspx?compid=46494 for further information. > 09.03.2010

wide. The retail scheme in the station has been designed by Foster and Partners, who also designed the Canary Wharf Jubilee Line Station. The architectural design of the building is by Tony Meadows and Associates; with the park above the station designed by Gillespies. The station is expected to open for operation in 2017.[119]

The fifth project that is going to be exemplified in this section is the Kowloon Station in China. A new transportation corridor for Hong Kong between the city center and the new airport has been planned by the Mass Transit Railway Corporation (MTRC), and the Kowloon Station is a part of that extended project. The new rail link is 34 kilometers long, with Kowloon Station, which was completed in 1997, being the largest station on the route. This transportation hub is part of the master plan designed by British company Terry Farrell and Partners, which aims to turn the west of Kowloon into a transportation center. The 13.5-hectare development area will contain 1 million m2 of hotel, office, retail and residential space, is located around a main square and the Kowloon Station, meaning that the station is planned to serve not only the transportation needs of public, but also as an urban focus area. Above the underground hub in this station, open air walkways covered with curved canopies have been built. [120] (Figure 4.21)

Other examples of subterranean forms with urban parks at street level include the Les Halles, the North-South Metro Line, Stuttgart Main Station and La Defense. Firstly, the surface level of Les Halles is currently an urban park, which is a function that has been retained in the winning design proposed by SEURA. (Figure 4.22) Secondly, with construction of the North-South metro line and the underground car parks in Amsterdam, it will be possible to re-assign areas at street level as urban squares. Thirdly, the area over the Stuttgart Main Station's subterranean complex is going to be arranged as an urban park, (Figure 4.23) and in this respect the Stuttgart Main Station Project may be stated to be taking a balanced approach to the urban tissue density. Finally, above the surface level in La Defense has been designed with avenues and covered walkways by landscape architect Dan Kiley. (Figure 4.24)

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[119] http://www.crossrail.co.uk/company/communications-centre/press-releases/construction-of-crossrail-begins-as-foundations-laid-for-new-canary-wharf-station > 09.03.2010

[120] Martha Thorne. Ed. *Modern trains and Splendid Stations*. Chicago: Merrell-The Art Institute of Chicago, 2001. pg 67-68

**4.1.3.2 Contextual Factor 3.2:** Climatic factors

As has been mentioned before, an extended underground network was constructed in Montreal in the second half of the 20th century, and one of the leading motivations behind this was the Montreal climate, and the desire to protect the network's users from the extreme cold. McGill Station, which can be exemplified as a key underground form in the city, has been affected greatly by the decision to move public transportation layers underground. Designed by Crevier, Lemieux, Mercier and Caron Architects and inaugurated in 1966, the McGill Metro Station in Montreal is the busiest on the network, with over 10 million passengers using the station each year. Located at the heart of the city center, McGill Station provides a connection to many shopping malls, office blocks and McGill College via underground passageways. The station is arranged around a large volume that houses the metro platforms. The two concourses are connected by two corridors that encircle the platform area. Besides accesses from the underground network of Montreal, there are six entrances to McGill Station at street level that are accessed from the interiors of surrounding buildings, indicated by signage on their facades. [121]

The new transportation layers in the Stuttgart Main Station have been located underground in part to maintain a comfortable temperature inside the station below 25 degrees Celsius in summer and over 14 degrees Celsius in winter, without the need for additional heating or cooling. This has partly been achieved by covering the roof of the structure with soil, which also helps to reduce the noise level of station activities.[122] A comfortable climate in the AMFORA formation is able to be maintained as a benefit of being underground. While the outside temperature changes between -10 and +25 degrees, the interior temperature of AMFORA will be stable at +18.[123] (Figure 4.25)

The Shibuya Station constituted a world's-first in subway ventilation design. The central atrium allows hot air produced by the trains to flow out into the open air above; while cool air flows down into the station's atrium. In other words, natural ventilation has been

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[121] http://www.metrodemontreal.com/green/mcgill/index.html > 09.03.2010
[122] Martha Thorne. Ed. *Modern trains and Splendid Stations*. Chicago: Merrell-The Art Institute of Chicago, 2001. p 92
[123] The Presentation Booklet of AMFORA Project.
http://www.zwarts.jansma.nl/download.php?id=1593 > 09.03.2010

achieved with the help of the cut-out space in the station. The cooling of the station is achieved through water pipes passing through the outer shell of the 'spaceship' and underneath the platforms. Another interesting aspect about the Shibuya Station is that the use of indoor trees, which provide additional cooling facilities, and has also been added as aesthetic elements.[124]

**4.1.4 Contextual Factor 4**: Integrating New Transportation Layers into an Existing Station

During the earlier construction of an 18 m deep underground car park beneath Parliament Square, the Clock Tower of the Houses of Parliament, housing the famous Big Ben bell, tilted 23 millimeters from the perpendicular towards the car park. Construction of Westminster Station as a part of the London Underground's Jubilee Line Extension Project in 1996 was also predicted to produce significant movement in the adjacent clock tower and the Palace of Westminster unless protective measures were taken. During the 21 months of excavation and construction, movements of the historical buildings on the site were constantly monitored. The Westminster Station excavation was 39 m deep, and was the deepest in London up until that time. As a precaution against the movement of the historical buildings, the area underwent an application of compensation grouting. The combined efforts to protect the historical built environment were successful, and the observed tilt was reduced to within 100 millimeters of safe limits. [125]

After the problematic construction, Westminster Underground Station opened in 1999 in a very strategic location, neighboring the Portcullis House office block, the new Parliamentary Building, the Big Ben Clock Tower and the River Thames. The Jubilee Line platform in the 7.4 m diameter tunnel was constructed below the existing District and Circle Line platforms, and connected to the newly built box formed hub (Figure 4.26), while an open escalator hall provides a point of interchange between the platforms of the three lines.[126]

The District and Circle railway lines cut across the site at an angle of 45 degrees, which deeply influenced the architects in the planning phase. All of the construction elements,

[124] Ibid

[125] Tim Paul, Fiona Chow, Oddvar Kjekstad. Ed. Hidden Aspects of Urban Planning: Surface and Underground development. London: Thomas Telford Publishing, 2002. p 45

[126] http://www.hopkins.co.uk/projects/_8,109/ > 09.03.2010

such as the walls, escalators and ticket barriers, are designed to follow either the diagonal grid of the railway lines or the orthogonal grid of the building above. The ticket hall of the Jubilee Line in Westminster Station is entered through Portcullis House and via the lower levels of the District and Circle Line platforms. The beams and buttresses of the station form the foundations of Portcullis House.[127]

The North-South Metro Line in Amsterdam is also a case where new transportation layers have been integrated into an existing station. While continuing through Amsterdam, the North-South metro line crosses the historical train station located at the IJ Bay. (Figure 4.27) With the juxtaposition of the existing train and bus networks and the newly built metro line, the IJ Hall will become a multi-modal and multi-functional transport hub.[128]

The third example project that falls under this category is the Stuttgart Main Station. As a part of the Stuttgart 21 Project, the Stuttgart Main Station building is planned to be renovated to bring it up to date with the multi-modal transportation needs of 21st century. The existing Stuttgart Main Station was designed by architects Paul Bonatz and Friedrich Eugen Scholer in 1927, and currently the station serves the S-Bahn and U-Bahn lines. With the latest project, the railway lines will be integrated with automobile, bus and bicycle transport modes; while some of the railway lines that currently terminate in the station are to be extended. The existing station, which contains 16 platforms, will be converted into an underground station with eight through platforms. The entire transformation is expected to increase the capacity of the station by over 50 percent.[129]

The new underground form of Stuttgart Station has been designed as a projection of the existing terminal building, but rotated 90 degrees. (Figure 4.28) In other words, the layouts of the old and new stations are orthogonal to each other, intersecting to form a multi-modal transportation hub. In the Stuttgart case, downwards, upwards and outwards density concentration is targeted, with a variety of different land uses earmarked for the area once the rail tracks are taken below the surface. This will include housing, as well as business and commercial units that will constitute the upward and outward development.

[127] Ibid
[128] The North South Line Presentation Booklet. p 5.
[129] www.hstintegration.net > 09.03.2010

The new underground station corresponds to both downward and outward expansion.

The fourth case study to be introduced as an example of the integration of new underground layers into an existing station is Fulton Street Station in New York. The Metropolitan Transportation Authority of New York (MTA) has developed an improvement plan for the underground transportation network of downtown New York. This project includes the reconstruction of the Fulton Street Transit Center, which is one of the busiest interchanges on the city subway system, and is currently used by 275,000 passengers every day. The former Fulton Street and Broadway-Nassau Stations were originally built in 1905 and 1933, respectively, with no direct connection between the two. Under public pressure, attempts were made to remedy the situation that resulted in dark and narrow entrances and passageways, complex transfer routes and crowded platforms.[130] (Figure 4.29)

The Fulton Street/Broadway Complex Project includes the reconnection of six individual stations in the district, modernization of the subway network, and an increase in capacity from nine to twelve lines. Besides being accessible to people with disabilities, MTA has targeted the design of an underground complex that is easily recognizable from street level and directly connected to the World Trade Center (WTC) site. An entrance building at the corner of Fulton Street and Broadway has been planned as a part of this transportation project; and a pedestrian concourse under Dey Street will also be constructed to connect Fulton Street and the WTC.[131]

To realize the project, all the buildings on the east side of Broadway between John and Fulton Streets will be demolished, however the historical Corbin Building is to be preserved and integrated into the project. Adjacent to the new Fulton Transit Center, the Corbin Building is a nine-storey office block designed by Frances Kimball and built in 1889. Preserved by the Historic Preservation Commission of New York, this ornamental building is decorated with arches and large arcades. The restored arches in the basement of the Corbin Building will form one of the entrances of the Fulton Street Station, through which travelers will pass when entering the station.[132]

[130] http://www.designbuild-network.com/projects/Fulton/ > 09.03.2010
[131] Ibid
[132] Ibid

**Figure 4.18** An aerial view of the proposed urban park between the Sagrera and Sant Andreu Stations (Source: www.barcelonasagrera.com. Last accessed on 09.03.2010)

**Figure 4.19** An aerial view of the proposed urban park above the Canary Wharf – Jubilee Line Station (Source: www. skyscraperpage.com. Last accessed on 09.03.2010)

**Figure 4.20** The section showing the sub-surface mobility layers and the proposed urban park above the Canary Wharf – Crossrail Line Station (Source: www.nce.co.uk. Last accessed on 09.03.2010)

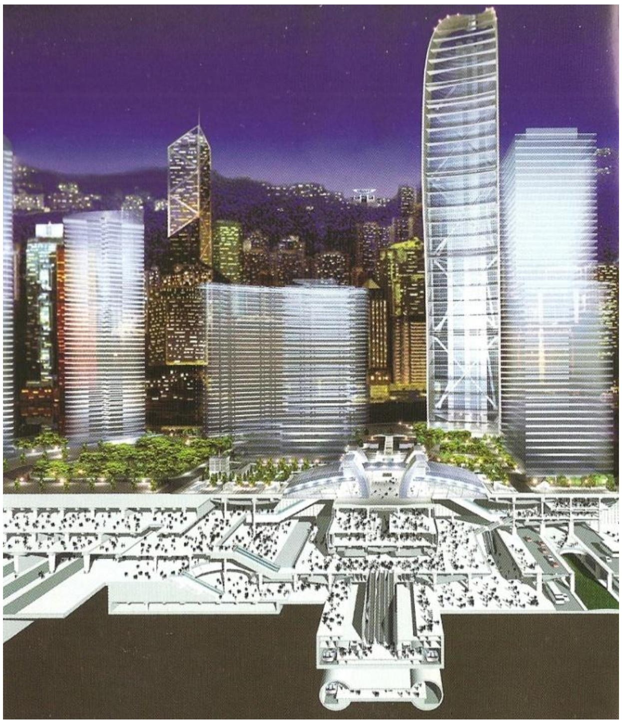

**Figure 4.21** A section perspective drawing showing the sub-surface mobility layers and the urban park at the street level in the Kowloon Station.
(Source: Martha Thorne. Ed. *Modern trains and Splendid Stations*. Chicago: Merrell-The Art Institute of Chicago, 2001. pg 68)


**Figure 4.22** The urban park that is proposed for the area over Les Halles underground transportation hub (Source: www.mzelle-fraise.fr. Last accessed on 09.03.2010)

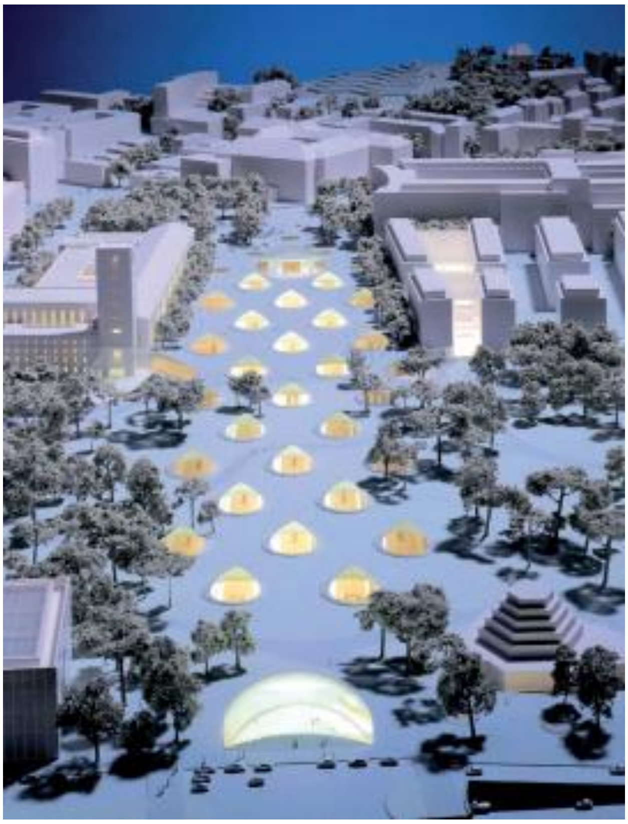

**Figure 4.23** The proposed ground level of the underground Stuttgart Main Station which is left as a green area for the citizens (Source: www.ssb-ag.de. Last accessed on 09.03.2010)

**Figure 4.24** The urban park over the sub-surface mobility hub in La Defense
(Source: http://www.gardenvisit.com/garden/la_defense_paris. Last accessed on 09.03.2010)

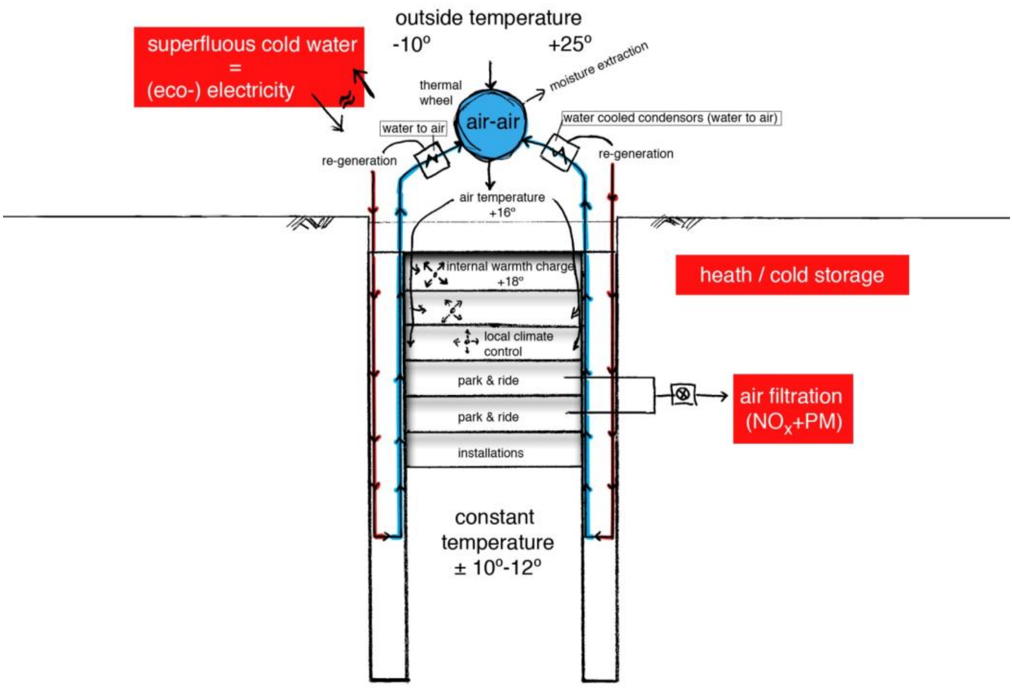


**Figure 4.25** The diagram showing the proposed climatic conditions in the AMFORA Project.

(Source: http://www.zwarts.jansma.nl. Last accessed on 09.03.2010)

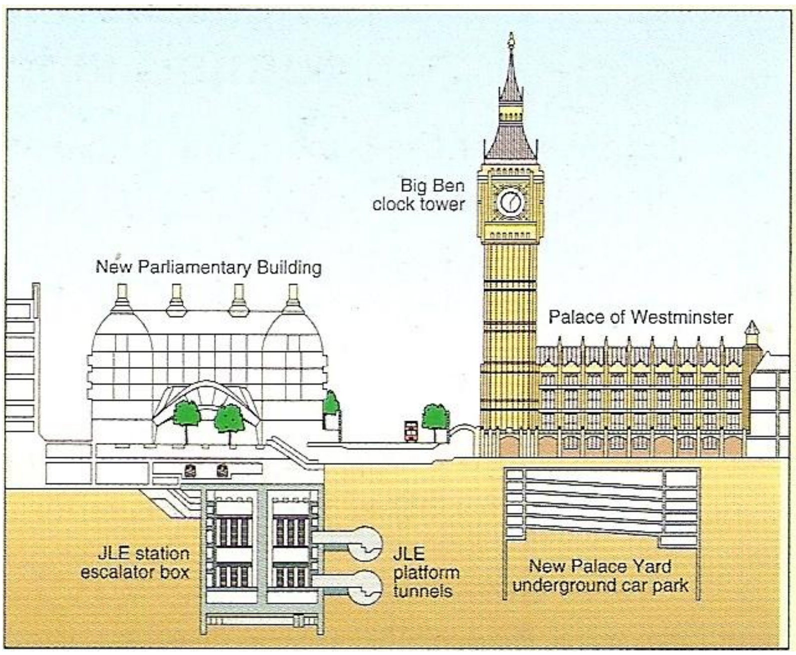


**Figure 4.26** Cross section through Westminster Station showing the Jubilee Line Tunnels and their proximity to Big Ben Clock Tower
(Source: Tim Paul, Fiona Chow, Oddvar Kjekstad. Ed. Hidden Aspects of Urban Planning: Surface and Underground development. London: Thomas Telford Publishing, 2002)

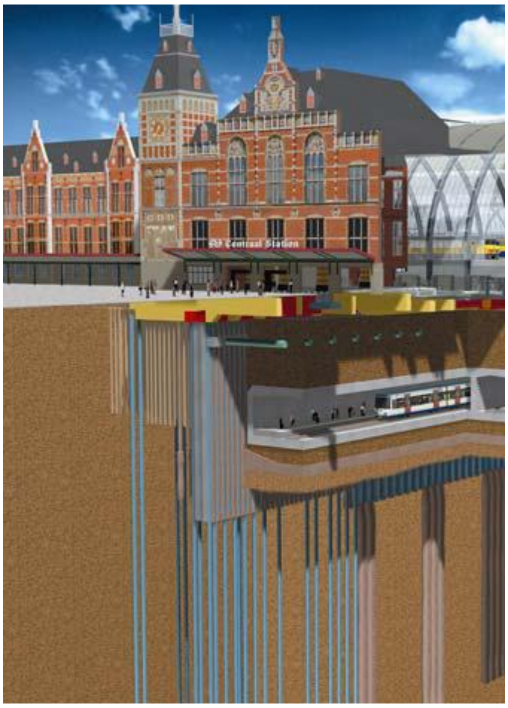

**Figure 4.27** The section showing the superposition of the former and new transportation layers in IJ Hall
(Source: www.arcadisgmi.com. Last accessed on 09.03.2010)

**Figure 4.28** The proposed expansion area for the Stuttgart station
(Source: www.das-neue-herz-europas.de. Last accessed on 09.03.2010)

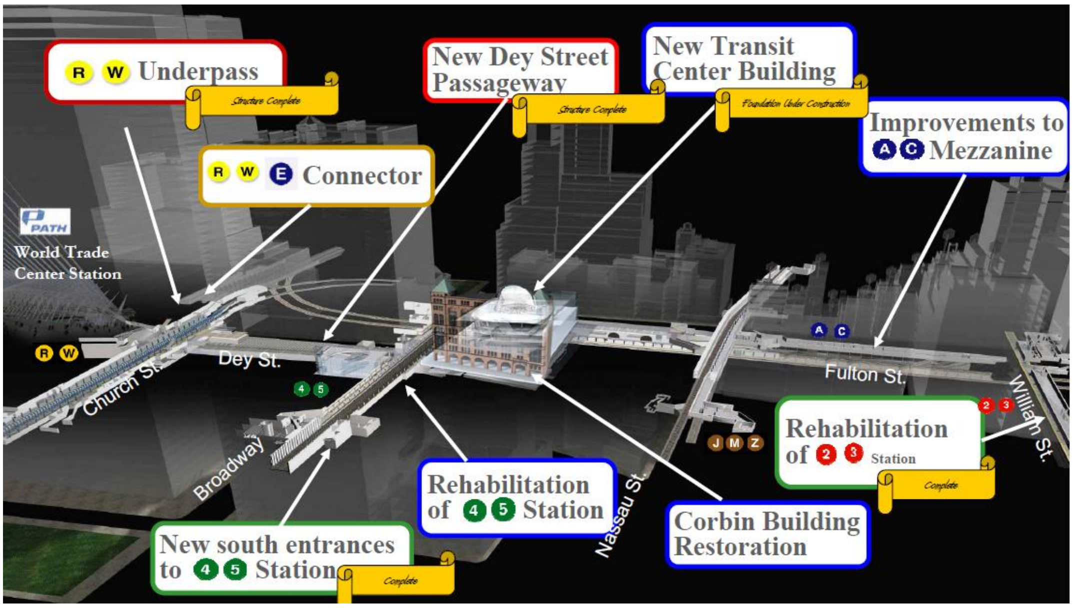


**Figure 4.29** The proposed sub-surface expansions in the Fulton Street Station
(image: www.mta.info. Last accessed on 09.03.2010)

**4.1.5 Contextual Factor 5**: Underground Transportation Hubs of New Urban Centers

Brian Richards uses the term 'sub-center' in his book 'Future Transport in Cities',[133] referring to areas outside the city that contain office facilities for a population of professional people and businesses that do not need to be located in the city center. He mentions the importance of public transportation for these sub-centers, which means maintaining good connections both with the city center and other sub-centers. Since these urban areas are not hindered by the restrictions related with historical city centers, there is potential for creative planning and design solutions, says Richards. He adds that these sub-centers have recently started to attract shops, restaurants, hotels and residential facilities.[134]

Richards puts forward La Defense in Paris as an example of such a sub-center, which is one of nine such sub-centers planned around central Paris since 1950 that were intended to decrease the pressure on the historical core.[135] H. V. Savitch lists these nine suburban growth areas as Versailles, Velizy, Thais-Rungis, Creteil, Rosny, Bobigny, Roissy de Bourget, St. Denis and La Defense. Besides these suburban cores, various new towns, urban corridors, and suburban poles were also planned in France in that period, and Savitch claims that there were four objectives behind these developments: To replace vacated sections of industrial Paris with post-industrial activity, reinforcing the importance of the center as a focal point of commerce; transportation and culture; reshaping the balances between the eastern and western sides of the urban core; and renovating the historic urban heritage for a new class of inhabitants.[136]

Among those developments, La Defense is located at the west of the city center, on the axis of Champs Elysees. The area contains a large hypermarket, and numerous shops and cafes that serve the 20,000 people living in the 9,000 apartments in the area. Some 140,000

[133] Brian Richards. Future Transport in Cities. London: Spon Press, 2001. p 77-79
[134] Ibid
[135] Ibid
[136] H. V. Savitch. Post-Industrial Cities-Politics and Planning in New York, Paris, and London. New Jersey: Princeton University Press, 1988. P 130

people work in the office buildings surrounding a 100 m wide and 1,200 m long underground transportation hub that Richards refers to as the 'deck'. The boundary of the 170 hectare development has been determined by a one-way peripheral motorized traffic road, which provides access to 12 multi-storey car parks containing space for 30 000 cars. There is no parking at street level in La Defense.[137] (Figure 4.30)

The RER (Réseau Express Régional – Regional Express Train Network) is served from the lowest level of the underground transportation hub in La Defense, providing access to the historical city center of Paris in around 15 minutes, and extending east to the site of the new university in Nanterre. Above the RER platform level, the A14 motorway runs through the deck. Originally planned as a motorway, the A14 was reduced to a one-way road in order to allow the construction of a metro line. There are now two metro stations serving the deck in La Defense. The western end of the deck is designed as a bus station providing bus links to the neighboring suburbs. At this end of the deck there is also the office building called the Grand Arche,[138] a landmark building designed by architect Johann Otto von Spreckelsen and constructed between 1982 and 1990.[139] Beneath that building is an RER station, a metro station and parking facilities.[140] Nearly 75 percent of the workers and visitors to La Defense use one of the four modes of public transport serving the area.[141]

The Euralille, the Zuidas Master Plan and the Sagrera HST Station Area Master Plan may also be suggested as examples of transportation hubs that have been developed in multi-functional urban master plans with over and underground forms.

OMA's basic idea for the arrangement of the transportation lines led to the formation of an underground multi-layered transportation hub. The highway was rerouted underground to run parallel to the TGV line, and a huge multi-level parking garage was located between the TGV line and highway 'as a short circuit of the two major infrastructural flows'.[142] OMA designed a multi-layered underground transportation hub using a subtraction method: '*At the point of greatest infrastructural density, an absence of building reveals the highway,*

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[137] Brian Richards. Future Transport in Cities. London: Spon Press, 2001. p 77-79
[138] Ibid
[139] http://www.greatbuildings.com/buildings/La_Grande_Arche.html > 09.03.2010
[140] http://www.grandearche.com/international/english.html > 09.03.2010
[141] Brian Richards. Future Transport in Cities. London: Spon Press, 2001. p 77-79
[142] Ibid.

*railway, three levels of parking and the metro, which dives underneath the complex, in one overtly metropolitan moment – Espace Piranesien.'*[143] (Figures 4.31, 4.32)

Different from the Stuttgart Main Station Renovation Project, in which some of the former terminating rail lines are planned to be extended through the old terminal building, Gare Lille Europe could be said to play a supporting role in providing a continuation of the transportation lines of the Gare Lille Flandres.

After the completion of the Sagrera master plan, the city of Barcelona will boast two high-speed stations: Sants Station to the south, and Sagrera Station to the north, which are linked by a 5.6 km tunnel. Sagrera Station will be Barcelona's largest building, housing a multi-modal transportation hub for high-speed trains, local trains, the underground train system, buses, coaches, taxis and private vehicles. The station will be connected directly to the city's motorways and ring roads via two one-way subterranean roads, while the underground transportation hub will be surrounded by six buildings housing business facilities.[144] The Sagrera underground mega structure itself is planned to be constructed in the form of concrete orthogonal box, with the below ground area exclusively set aside for transportation systems and immobile facilities planned for location in the outwards and upwards developments earmarked for the area.

The final case to be analyzed under this heading is the Zuidas Project. In the Zuidas Master Plan of 1998 the city council proposed an integrated development concept for the district, and future developments, including urban planning concepts and phased plans, were prepared according to this new decision. Currently a business district, Zuidas has been earmarked for development incorporating a variety of new land uses, with residential, cultural and leisure facilities integrated into the plan, alongside the existing commercial elements of the area, to provide a balance.[145]

The underground infrastructure in the Zuidas Project was given the name the 'Dok Model' in the design of the Henning-Larsen Architects. The decision to take the infrastructure

[143] Ibid.
[144] Ibid 8-13.
[145] The 2004 Vision of the Zuidas, City of Amsterdam. p 2-3.

underground was born out of the central government's proposed infrastructure policies to increase the potential of its urban facilities. As such, the Dok Model was planned to meet the heavy traffic load and to increase the use of public transportation modes. The underground transportation hub of Dok in Zuidas could also be put forward as an example of a concrete orthogonal box typology, which is commonly used in underground formations.

The Dok is of vital importance in the Zuidas Project, as all of the infrastructure in Zuidas will be brought below ground level, including six train lines, four subway lines and a maximum of 10-12 highway routes, planned to be projected through a 1,200 meter underground urban section.[146] The Dok model will create a network of streets and cycle paths in a north-south direction, and will be connected to an infrastructural urban network and many underground parking garages. The Dok provides a direct underground connection between the urban districts of Zuid and Buitenveldert, while  transition between the Dok and the existing Beatrix Park, under which a car park is to be constructed, will also be provided. Some 50 percent of Zuidas visitors are expected to use public transport once the underground infrastructure enters into use.[147]

In terms of the construction process, the subterranean Dok will be the first element to be built in the project, after which additional programs will be introduced. In the Zuidas Master Plan upwards, downwards and outwards development has been foreseen. The underground transportation hub could be stated as downwards development, whereas the high-rise programs around the hub will be in gradual outwards and upwards directions. The urban development above the Dok has been given the name 'Composer', which will include offices, residential units and parks. Since moving the infrastructure below ground will reduce noise and pollution, the surrounding environment of the Dok will become appropriate for the addition of housing settlements and leisure areas.[148]

All three examples introduced in this section share the same formal scheme. In each case, a multi-modal and multi-layered transportation hub will be surrounded by dense high-rise

[146] http://www.skyscrapercity.com/showthread.php?t=608136 > 09.03.2010
[147] The 2004 Vision of the Zuidas, City of Amsterdam. p 10,26,44,54
[148] Ibid p 5.

formations, with the underground infrastructural elements providing connections to the formations above them. The high rise formations in the Zuidas project will be mixed use, while in Sagrera the plan is to create a devoted business district. In Euralille, the high-rise hotel and office formations at the perimeter of the project area will constitute the upwards of the project, while and the underground transportation hub will be the downward development. These three cases offer examples of upwards, outwards and downwards development. It is interesting to note that the underground transportation centers in such urban centers are described using dock/deck terminology. While there is no explicit formal similarity between underground transportation hubs and docks/decks, the reason these metaphors have been adopted is to illustrate that underground transportation hubs are places where vehicles meet and disperse.

### 4.2 An Analysis of Underground Transportation Forms Due to their Contents

In this section, the second research question asked at the beginning of the study will be answered: 'What were the architectural and urban space properties of the underground transportation sections that have been built after the second half of the 20$^{th}$ century?' All of the case studies that have been analyzed in this thesis study indicate the presence of a fundamental paradigm shift in urban planning and architecture. These evolutionary changes in cities affected by underground urban formations can be assessed through four basic concepts: Movement, process, form, and density.

#### 4.2.1 Movement

The main factor driving the creation of underground metropolitan forms can be claimed to be transportation. In other words, the primary objective of creating subterranean systems is generally to take transportation modes below ground level; while other below-ground programs and facilities can be considered as an afterthought. Vehicular roads and metro lines, which work as dividing lines on the urban fabric, reversely become connecting elements when they are placed underground. By taking transportation underground, the surface becomes available for the creation of urban parks, squares or other metropolis facilities. Besides the benefits to the urban fabric of the surface, a subterranean construction strategy may also have positive effects on journey quality. It can be claimed that transitions between different transportation types become easier when the transportation problem is solved underground, as a multi-modal system operating below ground is not affected by factors such as traffic or weather. In other words, by taking transportation underground, sustainability can be increased.

Multi-modal transportation has become extremely popular in recent years due to the three advantages it offers: savings of time; the opportunity to carrying higher capacities of passengers; and flexibility. Allowing the distribution of passengers to different transportation modes prevents accumulation in specific modes, and enables the transportation of higher numbers of people. Flexibility can be defined as the opportunity to make choices in the use of different combinations of transportation modes, and since every transportation system in the city has its own network, accessing a particular point in the urban fabric is quite frequently possible using different combinations of transportation modes, allowing passengers to reduce their traveling times. In summary, multi-modal transportation has become an indispensable part of the metropolis in satisfying the demand for speed associated with modern life.

The combination of different modes of transportation has rendered urban transportation more fluent and flexible, and that is not only valid for metropolises, but also for transportation between neighboring countries as multi-modal transportation nodes begin to integrate with international networks. Some of the multimodal transportation nodes are being designed as stations of international networks. To exemplify, the crossing of the North-South Metro Line and the IJ Central Station provides an international connection to this transportation corridor. Another case that has already been covered in this study, the Euralille, also provides international continuity as a transportation hub, but unlike the Amsterdam case, in which the movement corridor gains an international identity by being connected to a main terminal building, in Lille it is the international lines themselves that provide the point of juxtaposition.

Another way underground transportation formations can gain an international identity is through connections to airport express lines. Kowloon Station can be given as an example of such a strategy, as the station offers check-in facilities in town for flights departing from Hong Kong International Airport. Kowloon Station will incorporate three rail lines and airport check-in facilities, as well as access for buses and other motorized traffic, allowing an interchange of passengers between modes. A central concourse has been designed in the station that will ease interconnections between the different modes, while vertical movement has been concentrated in a single area where there is an abundance of escalators. To allow natural light into the underground levels, glass has been used extensively in the design of the central hall. Functions are organized by floor in the station: the train platforms are located at basement level two. Above that, the Airport Express Line (AEL), roadways, train platforms, bus stations and baggage handling are organized around a public hall; the entire ground level is allocated for motorized traffic, along with car parking, a bus station and roadways. The upper two mezzanine levels are assigned as public halls rather than transportation levels, offering direct access to the Kowloon Station Square.[149]

An aspect of the AMFORA Project that is open to criticism is in the selection of transportation modes. Roads for motor vehicles and parking areas have been designed as the only transportation layers in this underground urban network; however such a project, if claiming to be truly innovative, should have also given place to other transportation modes. For example there is no evidence of a railway in the architectural drawings of AMFORA, and such an exaggerated emphasis on motorized transport may bring with it extra congestion in urban traffic.

Although each station on the North-South Metro Line is claimed to provide multi-modal transportation for its passengers, provisions for car and bicycle parking have been made only in some of the stations, such as at Vijzelgracht and Rokin.[150] It would have been a much more beneficial approach to include such parking facilities at all of the stations, as this would have helped to decrease congestion at Amsterdam's ground level.

#### 4.2.1.1 Immobile means below the surface

[149] Ibid

[150] Ibid.

Besides various modes of transportation, many other functions are also beginning to locate in subterranean urban complexes, as revealed in this chapter; and land use in these underground complexes can now be listed under two headings: transportation facilities and immobile facilities. The benefit of locating immobile facilities in underground complexes is related to visitor potential, and commercial activities in particular are increasing in density in underground transportation hubs for that very reason. Taking transport facilities below street level can be defined as a more appropriate approach when compared with the subterranean placement of immobile facilities. Surface noise and air pollution caused by traffic decreases when the transportation layers are taken below ground; and accessibility to the dense urban fabric may also increase with the help of underground transportation.

The McGill Station could be exemplified among these attempts. There are several shops and a cafe within the passageways of McGill Station, and besides being a key component of the Underground City of Montreal, McGill Station is also used as an exhibition space, with visitors to the station able to view a number of works or art while passing through.[151] In the AMFORA project in Amsterdam, the area beneath the canals has been allocated for recreational activities, including bowling alleys, music studios, museums, sports facilities, clubs, dance studios, squash centers, tennis courts, climbing walls, fitness centers, supermarkets, media centers and storage units, all of which are planned for location in the underground network.[152] AMFORA is expected to contribute to the quality of urban life of the city in terms of social life, economy and environmental aspects.

However, the location of certain facilities below ground may be more defendable, particularly those for which sunlight is an undesirable factor, such as museums and cinemas. Since subterranean areas provide a naturally isolated medium for the design of these spaces, their location below ground may be deemed suitable. Another advantage of placing some immobile facilities below the ground would be to free up urban space at street level for land uses that most need daylight, such as educational and medical establishments and residential areas.

[151] http://www.metrodemontreal.com/green/mcgill/index.html > 09.03.2010
[152] The Presentation Booklet of AMFORA Project, p 14

There are also the placements of immobile programs in Les Halles and Souterrain cases. In the case of Les Halles, different functions are spread throughout the underground urban section, instead of matching particular layers with particular functions. Commercial activities are located in the top three levels. Besides the transportation networks and commercial activities, there are also cultural and sports facilities in Les Halles, with a swimming pool in the third underground level and a museum in the first sub level. The Souterrain Tram Tunnel is also home to a poster museum, for which the lack of light below ground has been turned to an advantage for the lighting of exhibitions. (Figure 4.33)

### 4.2.2 Process

The construction of multi-layered underground urban complexes around the world indicates a change in the design process of urban planning and architecture. As it could be seen in all of the cases covered in this study, cities have started to be designed in three-dimensional section planes rather than two-dimensional plan planes. In other words, we will no longer be able to understand the design of cities implicitly by looking at maps. Decisions related to the programming and location of transportation facilities were made as projections on the ground in the classical town planning, however matching facilities to fields on a planimetric plane is no longer a preferred design method, as the boundaries of spaces have begun to be determined according to their sectional features.

Both as part of the urban infrastructure and as public spaces, underground multi-layered urban forms may be claimed to be developing at the intersection of urban planning and architecture. The relationship of these two disciplines was based on a consecutive process: After the locations of different projects were set on the urban fabric by planners, architects designed buildings according to the proposed boundaries of the sites. Underground mega structures, however, can be said to have broken that sequential relationship into a more interactive state. Since these large-scale complexes are superposition points of various city networks, their design is in the domain of urban planners; while also being the field of the architect, as public spaces include different combinations of projects. The cases introduced in the ”Underground Transportation Hubs of New Urban Centers” section of this thesis may be raised as examples of multi-layered urban forms developing at the intersection of urban planning and architecture, being: Zuidas-Dok, Sagrera Station, Euralille and La Defense. These cases include underground mega structures which that have emerged through the superposition of various urban transportation networks. Besides, varying facilities take place in wide urban areas. Architects and urban planners have worked together in the design process of all of these cases.

### 4.2.3 Form

Rather than the only option being singular objects representing their own programmatic and formal existences in the cityscape, large-scale mega structures below ground level are also now feasible. These subterranean complexes can be considered as co-joined buildings with no space left between them. In other words, numerous small-scale buildings which would on the surface be located at comfortable distances from one another are created underground as huge singular urban complexes. This can be interpreted as the cramming of more things into less space, resulting in a loss of quality in the architectural and urban form.

Whether for transportation or for other programmatic functions, it is obvious that underground architecture faces many restrictions. Besides the limited daylight and problems of orientation, there are many constrains related to architectural space and form. For example, the 'facade' is a concept that loses its area of usage in underground buildings since the external boundaries of the construction faces only soil, and so expression is only possible through the interior space of the building.

Current technologies in underground construction allow the creation of huge orthogonal 'box' forms; and most of the cases analyzed in this research have very similar sections. As pointed out in this study, the main factors that have led to the creation of these designs have been to decrease congestion above ground, or to integrate new transportation layers into an existing station. Interestingly, the resulting products look like one another, despite being created for different purposes. A prototype-like section is being used in a number of locations around the world, which has led to a loss of subjectivity in urban planning and architecture. The design of the urban tissue or a building takes shape according to the properties of the construction area, which alongside various social, cultural and economic factors may also include physical land conditions and the climate. However, the implementation of the prototype-like subterranean section in diverse locations around the world goes against the basic subjectivity principle of design practice. Regardless, an underground hub typology, which offers a generic model of organization, has started to be applied in metropolises around the world.

Among the cases that have been introduced in this thesis, some have succeeded in eliminating the formal constraints of existing construction techniques and the disadvantages of the subsurface medium. There are three strategies that have been followed to overcome these negative aspects: The first is benefitting from the tectonic values of the structural elements. The inverted conical shaped columns of the Stuttgart Main Station may be exemplified to that approach. These columns provide daylight, besides being aesthetic structural elements extending towards the urban park above. These innovative columns allow the Stuttgart Main Station construction to fit into a broken concrete box typology in underground formations.

The Haussmann-St Lazare Station can be given as an example of another underground transportation hub that has gained a spatial quality by benefitting the plastic values of its structural elements. This hall has a very attractive spatial quality with its huge bracing beams and joists. The huge underground spaces of Haussmann-St. Lazare Station were very difficult to engineer owing to the magnitude of the area that had to be excavated. The large halls of the station were built using the *cut and cover* technique. After the installation of the wall supports, barrel vault roofs were constructed for the large spaces, as well as catenary vault roofs for the smaller passages. Martha Thorne states that the civil engineering element accounts for 90% of the project budget in underground transportation lines such as EOLE. She points out that the architects of the station have attempted to have the spaces defined by the structures as expressive as possible, and that the material selection of the station has also been an outcome of that strategy. Concrete poured in situ is one of the characteristic materials of the station; timber and metal are used for the walkways; and the facades of mechanical rooms are covered with copper. Thorne mentions that the lighting scheme of the station increases the affect of the spatial quality formed by the structural elements, with huge hanging colored lamps providing illumination in the station. The impression of enclosure is diminished with such design aspects according to Thorne, who claims that underground station spaces are often poor and make orientation difficult when compared to surface level stations, citing the Haussmann-St. Lazare Station as a case in which the creation of a qualified underground environment has been achieved. [153] Another element of the Haussmann-St Lazare Station that distinguishes it from other cases is related to its spatial setup. Rather than being based on a singular volume, the station is divided into segmented halls, making the architectural space more dynamic. (Figure 4.34)

Different from typical subway stations, which are located on pedestrian sidewalks, the entrances and exits to the Haussmann-St. Lazare Station are located at the ground levels of existing buildings, which was a prerequisite of the city authorities.[154] The entrances to the Westminster and McGill Stations have been incorporated into the ground levels of surrounding buildings, which is an interesting approach, in that it eliminates completely the need for underground forms in the urban space.

Creating a void between the transportation layers is the second strategy that has been applied to address the formal constraints of being underground. That strategy results in a common space of interaction, allowing the use of daylight in underground hubs. The creation of voids can help in reducing problems of orientation in underground forms, as can be found in the central galleries of Les Halles, Euralille, and Shibuya Station. As mentioned previously, the architects of the underground transportation hub of Euralille, Rem Koolhaas and OMA, referred to the cut out space in the complex as '*Espace Piranesi'.*[155] (Figure 4.35) The term *Espace Piranesien* comes from the design's similarity to environments created in the engravings of famous artist Piranesi, who in his sketches frequently dealt with multi-layered dark environments. The architects of Westminster Station also have aimed at incorporating a 'Piranesian' effect into the interior space of the building, claiming that this effect has been heightened through the use of rough concrete on the box walls, framed by massive beams and buttresses.[156](Figure 4.36) If a relationship is constructed between the use of exposed concrete and the 'Piranesian effect', the Canary Wharf-Jubilee Line and the Haussmann-St. Lazare stations should also be evaluated due to this metaphoric analogy.

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[153]Martha Thorne. Ed. *Modern trains and Splendid Stations*. Chicago: Merrell-The Art Institute of Chicago, 2001. pg 74-77
[154] Ibid
[155] Koolhaas, Rem, Bruce Mau, Hans Werlemann. S,M,L,XL. New York: The Monacelli Press, 1997. p 1166.
[156] http://www.hopkins.co.uk/projects/_8,109/ > 09.03.2010

The gloomy interior spaces of these cases have been designed with exposed rough concrete surfaces. However the Piranesian effect is also a natural outcome of a subsurface medium that lacks daylight and it is interesting to note that this metaphoric analogy is in common use and is much sought after by designers of underground transportation hubs around the world.

Designed by Japanese architect Tadao Ando, Shibuya Subway Station stands as an architectural attraction of the district. Tadao Ando has created an innovative structure that symbolizes the entrance to the revived region of Shibuya. Ando incorporated an egg-shaped *chichusen* into the structure, which means an underground spaceship, through which passengers must pass to reach the subway platforms, giving visitors the feeling that they are in a spaceship hovering over the subway tracks. That 'spaceship' is represented by a structure that stretches over the three main floors, and contains a central atrium. The central cut-out space is in the shape of an elliptical funnel with the void wider at the top floor than in the middle, which is a design decision to increase visual connections in the station, and thus ease orientation. Visitors can observe the trains moving at the lower level due to the openness provided by the cut-out space. (Figure 4.37)The 15 meter-high atrium visually connects the three levels of the station: The top floor, which corresponds to the street level; the middle concourse, which contains the ticket barrier; and the lowest level, where the platforms are located, 30 meters below the surface.[157]

A cut-out space has also been used in the subterranean formation of the Fulton Street Station, but what is striking about this example is its method of illumination. A 33 meter high asymmetrical tapered dome that rises above the underground transit hub is designed by Grimshaw Architects in collaboration with artist James Carpenter. The structure is clad with translucent glass and supports a metal inner skin, and has been designed in response to an existing problem faced by passengers: The 30 existing entrances of the Fulton Street/Broadway-Nassau Station complex were difficult to recognize in the crowded urban tissue, and as such the highly extroverted and transparent dome has been designed to make the complex easily recognizable among the surrounding buildings.[158] (Figure 4.38) Although it is an example of contemporary modern architecture, the Fulton Street Center's

[157] http://www.designbuild-network.com/projects/shibuya-station/ > 09.03.2010
[158] http://www.designbuild-network.com/projects/Fulton/ > 09.03.2010

dome has been inspired by a classical piece of architecture, the Pantheon in Rome. The gap in the Pantheon's dome is called an oculus, which provides light to the interior, but Grimshaw and Carpenter have aimed to go a step further, designing a dome that allows daylight to pass to the two subsurface levels of the station, and Carpenter used a 3D model of the dome to understand the interaction of the architecture and the path of the sun when carrying out the design. Besides these efforts to provide daylight, increased artificial illumination will also be used to improve the quality of space in the transit center.[159]

The third typology-breaking strategy can be described as the non-orthogonal use of transportation layers in subsurface formations. Such an approach has been applied in the Souterrain Tram Tunnel, a design by OMA. In the Souterrain case, the architectural space is broken up with the help of pedestrian circulation paths crossing through the transportation layers. In Souterrain, various visual connections and the transparent materials used between the different layers of the tunnel also have eliminated the lighting disadvantages associated with being underground. The transparent partition walls between car parking ramp and the tram station platforms contribute to the spatial unity of the building. (Figure 4.39)

The formal similarity between the underground urban formations caused by the constructional constraints is also valid for the different program elements inside them. Distinct programs are solved as similar orthogonal partitions with varying scales in these 'boxes'. In other words different facilities are represented as rooms which have been derived from the same analogy. Les Halles could be exemplified to that aspect. Although a part of it has been differentiated with the help of a space subtraction, the rest of the Les Halles complex has the form of orthogonal box. There is no spatial differentiation between the distinct functional spaces in Les Halles. Both the transportation layers and the immobile areas are formed as different separations of varying heights. However the market place called 'des Halles' has been differentiated from the general order of the hub with the help of a space subtraction. A shaft to provide illumination to the complex has been created in the underground shopping area, providing the only evidence to the existence of the complex above ground.

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159 http://www.designbuild-network.com/projects/Fulton/ > 09.03.2010

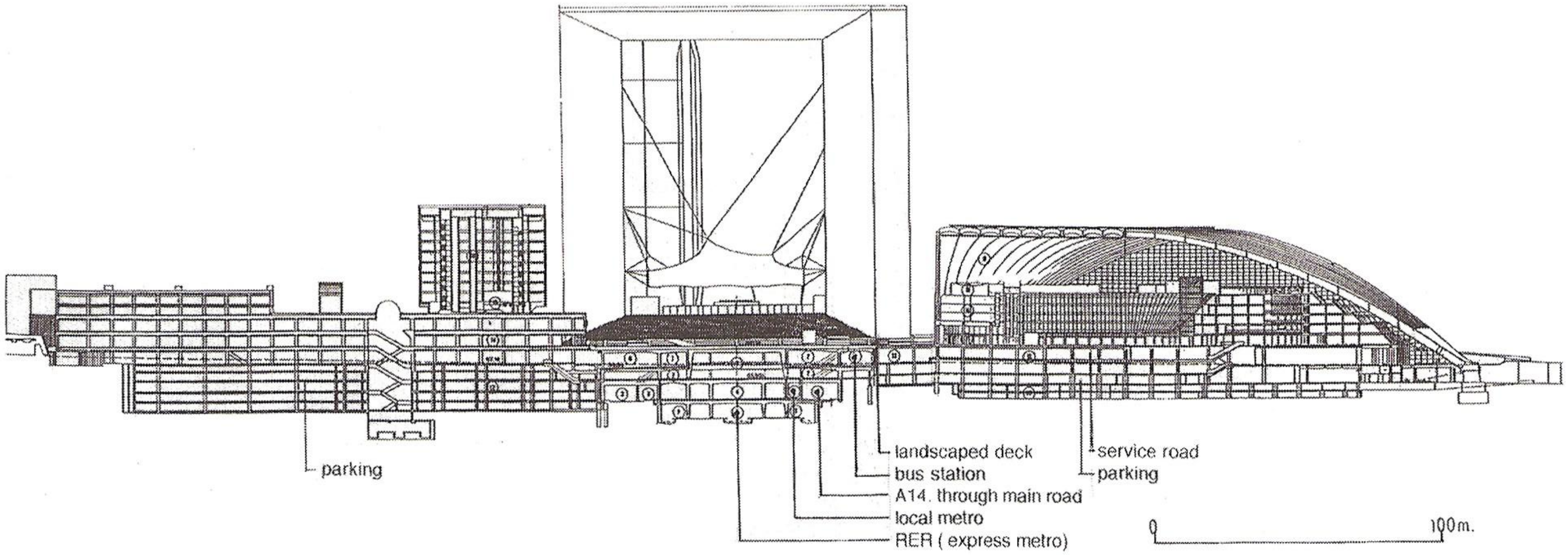


**Figure 4.30** The section drawing of the La Defense in Paris (Source: Brian Richards. Future Transport in Cities. London: Spon

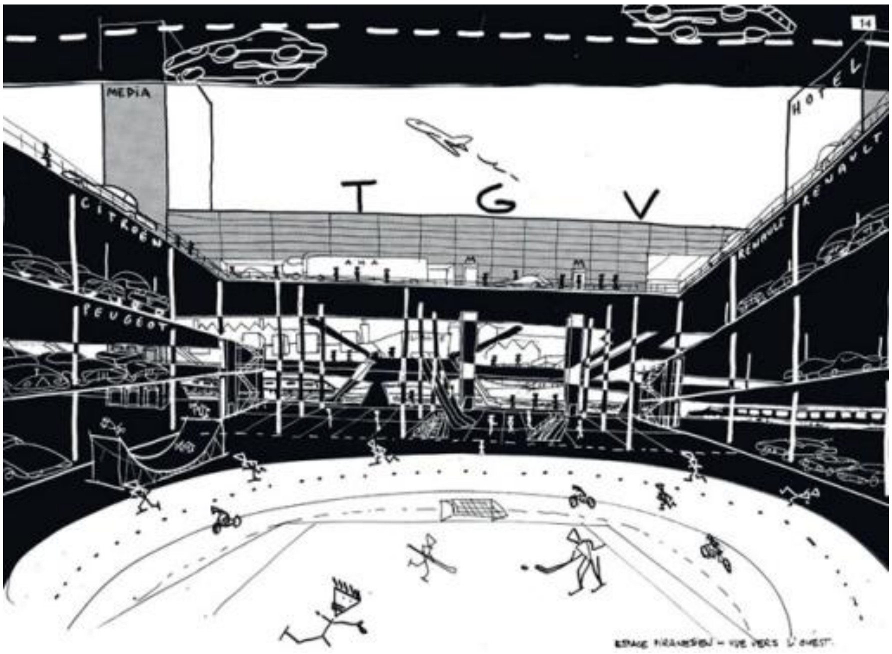


**Figure 4.31** The sketch drawn for Espace Piranesien by OMA
(Source: www.en.nai.nl. Last accessed on 09.03.2010)

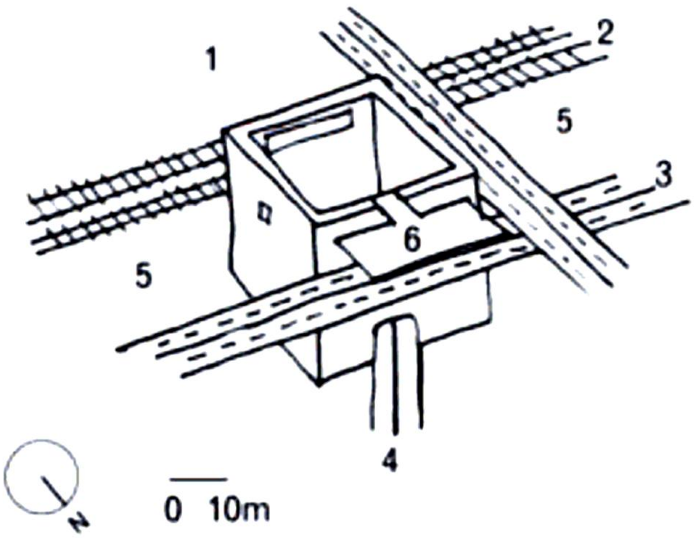


**Figure 4.32** Image showing the placement of the transportation layers and their relation to the central void space in the Espace Piranesien. (1:Central city, 2: TGV, 3: Motorway, 4: Metro, 5: Parking, 6: Square)
(Source: Rob Aben, Saskia de Wit. The Enclosed Garden: History and Development of the Hortus Conclusus and Its Reintroduction into the Present-day Urban Landscape. Rotterdam: 010 Publishers, 1999. p 206)

**Figure 4.33** The poster museum in the Souterrain Tram Tunnel (Source: www.lab-da.nl. Last accessed on 09.03.2010)

**Figure 4.34** The attribution of structural elements to the spatial quality in the Haussmann-St Lazare Station (Martha Thorne. Ed. *Modern trains and Splendid Stations*. Chicago: Merrell-The Art Institute of Chicago, 2001)

**Figure 4.35** The Espace Piranesien in Euralille (Source: www.flickr.com. Last accessed on 09.03.2010)

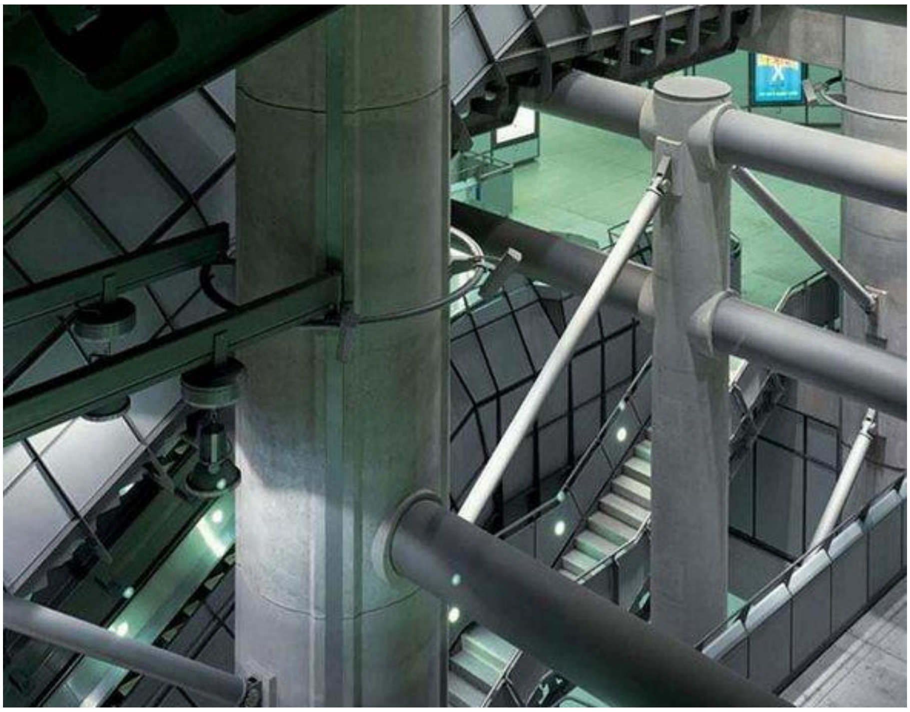

**Figure 4.36** The attribution of structural elements to the spatial quality in Websminster Station (Source: Michael Hopkins and Partners Official Website http://www.hopkins.co.uk/projects/_8,109/ Last accessed on 09.03.2010)

**Figure 4.37** The central cut-out space in the Shibuya Station
(Source: www.designbuild.com. Last accessed on 09.03.2010)

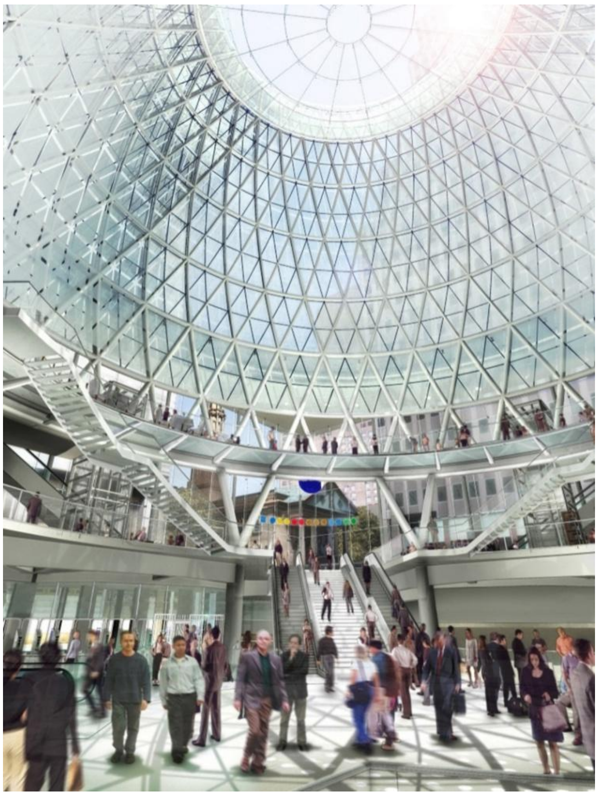

**Figure 4.38** The glass dome in the Fulton Street Station
(Source: www.desginbuild.com. Last accessed on 09.03.2010)

**Figure 4.39** The cross pedestrian bridges in Souterrain (Source: www.lab-da.nl. Last accessed on 09.03.2010)

An alternative to the current design and construction methods should be found in order to prevent replication in design. The use of more innovative technologies in the future would eliminate the disadvantages related to the creation of underground systems, both architecturally and related to the urban form.

Moche Zwarts points out that underground space is lacking in two qualities found above ground: orientation and light. In AMFORA, the problem of orientation is claimed to have been eliminated with the help of existing bridges, which form points of reference. Another facilitative factor in terms of orientation is the underground network, which has been designed as a projection of the existing canals at street level. Using variations in lighting and the projection of over ground images, the other potential disadvantages of being underground are intended to be eliminated.[160] Although a very challenging project, the AMFORA boasts a very conventional design in terms of architectural form, being not unlike a conventional concrete underground hub. The relations of space and the formal properties

[160] The Presentation Booklet of AMFORA Project p 15

of the project remain as generic and traditional; however this may be evaluated as a conscious effort to prove the applicability of such a challenging idea.

#### 4.2.4 Density

While once extending only upwards and outwards, metropolises in the 21st century are now also capable of extending downwards, and underground mega structures have brought about some basic changes in the density distributions of cities. These concentrated underground urban forms could be claimed to have accelerated accumulation in city centers around the world, as although these infrastructural spaces are built to decrease congestion in their environment, they also cause a rise in demand in the areas in which they are built. According to the website of The World Association of Metropolises, 38% of the world's population was living in metropolises in 2005,[161] and density difference between the metropolises and other settlements in the world will grow if infrastructural investments continue to be focused on existing centers. This will result in additional congestion in the city centers, since visitors to these specific locations will increase in direct proportion to the increases in infrastructural facilities.

Accumulation-dispersion points have started to be created in cities, where urban movement becomes concentrated at multi-layered multi-modal transportation hubs, and diffuses into the city from these points. These accumulation-dispersion points are interconnected with the transportation networks of the city, and with the help of these networks and hubs, movement in the metropolises has become less 'visible' since most of the transportation lines are now being constructed underground.

### 4.3 Urban Underground Transportation Systems in Turkey: Ankara and Istanbul

#### 4.3.1 The Ankaray-Metro Transfer Station - Ankara

The Ankaray Light Rail Line and the Ankara Metro Line converge at the Metro-Ankaray Transfer Station in Kızılay, Ankara. The Ankaray line extends in a west–east direction, while the Ankara Metro Line runs in a northwest–southeast direction. (Figure 4.40) Ankara

[161] Website of The World Association of Metropolises http://www.metropolis-server.com/metropolis/en/node/1570 > 09.03.2010

Metropolitan Municipality decided to build the Ankaray in 1990, and construction of the 11-stationed, 8.7-km line began in 1992 and was completed in 1996. Ankaray is part of the Ankara Urban Transportation Main Plan for 2015, which envisages a light rail link between the interurban bus terminal (AŞTİ) and the city center. [162] In 2009, the Ankaray Light Rail System carried more than 37 million passengers. [163]

The Ankara Metro Line is a 14.6 km, 12-stationed heavy rail system.[164] Built between 1991 and 1997,[165] the line connects the city center with the district of Batıkent. In 2009 more than 58 million passengers used the Metro System.[166]

The Metro-Ankaray Transfer Station is at the center of a subterranean pedestrian network under the Kızılay Square in Ankara. The underground pedestrian network has a large number of non-mobile elements, including a large shopping complex, a prayer room (*masjid*), a police office, a medical room, a natural gas sales unit, two banks and a referendum center. (Figure 4.41) The station also incorporates an exhibition space; however the lack of lighting or architectural elements to differentiate it from the rest of the underground network makes the area unsuitable for any serious exhibition. (Figure 4.42)

Since the Kızılay Square junction is subjected to heavy vehicular traffic, the underground passages provide a good alternative route for pedestrians to traverse the square. The subway system may often be used by pedestrians as an escape from the Ankara climate, whether it be the high temperatures of the summer or the intense precipitation experienced in the winter.

Every Friday afternoon the underground passageways in the Kızılay Transfer Station becomes an extension of the prayer room, being laid out with prayer mats to accommodate the practicing Muslims wishing to offer their Friday noon prayers, and causing much

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[162] The Official Website of the Ankaray Light Rail Line http://www.ankaray.com.tr/tarihce.htm
[163] The Official Website of the EGO General Management http://web.ego.gov.tr/inc/newsread.asp?id=252 > 09.03.2010
[164] The Official Website of the Ankara Metro Line http://www.ankarametrosu.com.tr/geneltnt.html
[165] Kızılay'da Yayalar ve Yaya Ulaşımı: Sorunlar, Sebepler ve Süreçler. Prepared by the Ankara Branches of TMMOB Architects Union and The TMMOB Urban Planners Union. Ankara: 2004. p 99-100
[166] http://web.ego.gov.tr/inc/newsread.asp?id=254 > 09.03.2010

congestion in the underground pedestrian network. (Figure 4.43) The logic behind the locating of a religious space in a station building needs to be discussed, as this use of space is unique in all of the case studies analyzed in this thesis. There is little doubt that such an architectural program placement originated from an ideological purpose, in which prayer becomes an ideological display rather than a private ritual. Considering that the Friday prayers, which are performed collectively, are a demonstration of power for those practicing the Muslim faith, the existing prayer room may be assumed to have been planned intentionally small to encourage such an ideological display.

This case is just one reflection of the conservative policies that have been implemented in Turkey, especially after the 1990s, when religion has been manipulated to represent a political symbol rather than a personal belief. A further example can be seen in the decision of the current conservative municipality administration to change the symbol of the city of Ankara from the Hittite Sun into a representation of a mosque. Unfortunately, this religious symbol continues to be used to represent the capital city of the secular and modern Turkish Republic.

When analyzed in terms of vehicle-pedestrian priorities, the case of the Metro-Ankaray Transfer Station can be seen to have been a result of a solely vehicle-oriented planning approach. As discussed in this study, citing various cases from around the world, the motivations for taking traffic underground include decreasing vehicle congestion at ground level, or reclaiming the street level for urban parks. However in the Ankara case the reason for building the underground transportation complex in Kızılay has been to facilitate the movement of the dense motorized traffic at street level. The subterranean station and facilities in Kızılay Square could be deemed worthwhile if, for example, the surface had been arranged as an urban recreation park for pedestrians, with the traffic re-routed to a ring road around the square.

In October 2003, the Ankara Metropolitan Municipality, in a new arrangement for Kızılay Square, closed the pedestrian crossings with glass barriers and removed the traffic lights, forcing pedestrians to use the underground route. After a number of the glass barriers were broken by pedestrians they were supplemented with secondary concrete barriers. Strong objections to these applications were raised by professional chambers, non-governmental organizations and the general public, and as a result the municipality launched a referendum among the general public of Ankara to decide upon the situation, which was eventually won by the municipality.[167] Later, the barriers were removed and traffic lights were replaced on 19th November, 2003 after a member of the public won a judicial case against the applications of the municipality.[168]

The current metropolitan municipality of Ankara has been in administration since 1994, and has implemented the unhealthy urban policy described above since that date. Another application of the municipality that could be open to criticism is its policy of building grade-separated junctions on all the major routes in the city. Starting with the construction of the Akay Junction in 2001, the Ankara Metropolitan Municipality decided to build 22 further grade-separated junctions in 22nd November, 2002.[169] As a result, underground projections of existing roads have been constructed at many points of the city, with major vehicular crossroads at street level. It has been claimed that the underlying reason behind the construction of so many grade-separated junctions at various points of the city has been to conceal the lack of underground rail transportation investments. The existing Metro[170] and Ankaray[171] rail lines were constructed using foreign credits arranged by the former municipality prior to 1994; while the existing administration, on the other hand, is yet to open any rail systems to the public since coming to power. It is claimed that the reason for this is that the municipality has been unable to arrange any financial credits as its reliability has been called into question over misuses of authority.[172]

All of the urban transportation policies applied in Ankara has targeted the easier movement of motorized vehicles, which has resulted in serious parking problems in the city. Public transport use should be encouraged by the municipality to decrease private car usage. Rather than forcing pedestrians underground and building more grade-separated junctions, Ankara would be better served by a transport policy that includes the construction of a

[167] *Kızılay'da Yayalar ve Yaya Ulaşımı: Sorunlar, Sebepler ve Süreçler.* Prepared by the Ankara Branches of TMMOB Architects Union and The TMMOB Urban Planners Union. Ankara: 2004. p 41-43
[168] Ibid
[169] Ibid 101
[170] http://web.ego.gov.tr/inc/newsread.asp?id=194 > 09.03.2010
[171] http://www.ankaray.com.tr/tarihce.htm > 09.03.2010
[172] Kışlalı, Murat. '*Gökçek Ankara'yı Bitirdi*'. 03.01.2008 dated Cumhuriyet Newspaper.

comprehensive rail network under the city. The Ankaray and Metro Lines should be extended, and new lines should be constructed, as in its current state, the local rail network fails to meet demand by a long way.

A three-level underground urban complex was planned to be constructed in Kızılay in 1988 that was to include a car park and a shopping center. The project was earmarked for construction underneath Güvenpark, an afforested urban park neighboring Kızılay Square that is a busy public recreation and meeting area. Built in the 1930s, the park holds symbolic importance for Turkish society as the site of the Güven Anıtı monument,[173] which commemorates those who fought in the Turkish War of Independence and thus brought about the creation of the modern Turkish Republic. Proposals to build an underground complex beneath the park were met with much opposition, and a court case was opened by three members of the public resulted in the cancellation of the project.[174]

The addition of an underground car park to the existing rail transfer station in Kızılay Square could be proposed as a better solution to the problem, rather than the construction of a complex under Güvenpark. Most of the cases that have been analyzed in this study have taken a similar approach, which could also be applied in Kızılay case: All possible transportation modes should be integrated into the underground complex, and the street level should be left as a pedestrian area. Such a solution would decrease congestion in this metropolitan center.

The second chapter of this study cites Paul Virilio's perception of the relationship between politics and developments in transportation. He mentions that in Germany, the Nazi government supported the Volkswagen automobile company as a means of preventing revolutionary street rebellions.[175] Kızılay Square could also be claimed to have been retained as a motorized area for ideological reasons. Since such a central metropolitan area is a likely venue for political gatherings and protests, it can be said to have been in the interest of the government to purposefully retain it as a busy traffic junction. Ankara

[173] Güven Anıtı is designed by Celement Holzmeister in 1931 and constructed by sculptors Anton Hanak and Josef Thorak in 1936.
[174] *Kızılay'da Yayalar ve Yaya Ulaşımı: Sorunlar, Sebepler ve Süreçler.* Prepared by the Ankara Branches of TMMOB Architects Union and The TMMOB Urban Planners Union. Ankara: 2004. p 99
[175] Paul Virilio. *Speed and Politics. pg* 25-31

contains no large central gathering place for the general public. Other existing urban squares are either too small, or also serve motorized traffic, just as the Kızılay case. The central squares in Ulus, Sıhhiye and Tandoğan, are mainly used by vehicles. The Şili Square in Çankaya district and the İtfaiye Square in Ulus are too small. Among these examples, Tandoğan Square has a different role. The area may be opened to the public for community meetings with political agendas; however this is only possible if the traffic is diverted. In other words, the general public of Ankara is forced to make a choice between their right to assembly and their transportation rights. The fact that there are no urban squares in the capital city of Turkey that could accommodate a large-scale demonstration can be assumed to have been a conscious a-politicization policy that has been applied in Turkey, starting with the Military Coup of 12th September, 1980.

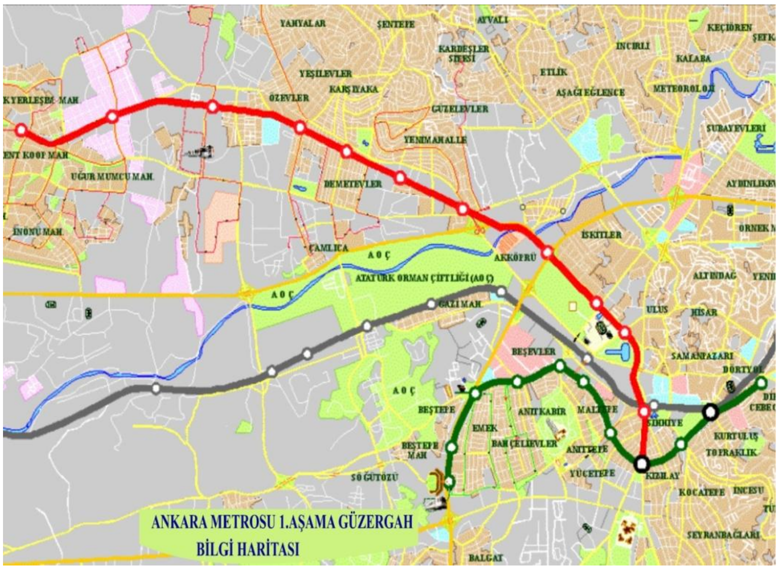
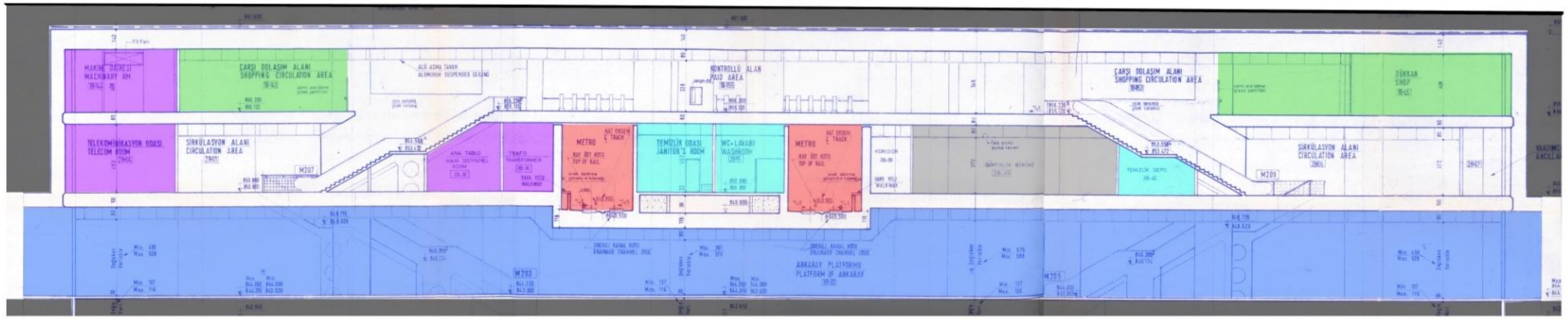



**Figure 4.40** The map showing the routes of rail systems in Ankara: The red line represents the Metro Route and the green line represents the Ankaray system.
(Source: The Official Website of the Ankara Metro
http://www.ankarametrosu.com.tr/guzergahmap.html. Last accessed on 09.03.2010)



Metro Lines

Ankaray Train Platform

Shopping Facilities

Service spaces

Technical Spaces

Security Unit

**Figure 4.41** A section showing the relations between different transportation modes and non-mobile program elements in the Ankaray-Metro Transfer Station

(Source of the original drawing: The EGO General Management- Department of Rail Systems Archive (EGO Genel Müdürlüğü-Raylı Sistemler Dairesi Başkanlığı) (The Colored legend has been added by the author)

**Figure 4.42** The exhibition space in the Ankaray-Metro Transfer Station
(Photo by the author)

**Figure 4.43** Friday prayers in the Ankaray-Metro Transfer Station
(Photo by the author)

### 4.3.2 The Yenikapı Transfer Station - Istanbul

The Marmaray Project in İstanbul is a large-scale transportation infrastructure project that will connect the Halkalı District on the Asian side of the city with the Gebze District on the European side. With the opening of the heavy rail line, the traveling time between the two districts will be slashed from 185 minutes to 80 minutes. The project includes the rehabilitation of the existing suburban rail systems in the city, and the construction of a tunnel beneath the Bosporus Strait. Most of the existing stations between Halkalı-Kazlıçeşme and Söğütlüçeşme-Gebze are to be renovated or rebuilt, while new underground stations will be built in Yenikapı, Sirkeci and Üsküdar. The tunnel to connect the two sides of the city will go underground at Kazlıçeşme, and run through the newly built Yenikapı and Sirkeci subterranean stations. After passing under the Bosporus, it will arrive at the new Üsküdar Station on the Asian side and will resurface in Söğütlüçeşme. (Figure 4.44) Upon completion of the project, the renovated and newly built railway system will be 76 km in length.[176]

The efficiency of a metropolitan railway system is determined through a comparison of the usage rate and the total travel numbers. The railway transportation rate of İstanbul in 1997 was 3.6% among other transportation modes, compared to 60% in Tokyo, 31% in New York, 22% in London and 25% in Paris in the same year. These numbers clearly show that the urban rail transportation system in Istanbul is very underdeveloped when compared with the other metropolitan centers of the world. The railway usage rate in İstanbul is expected to increase to 27.7% after the opening of the Marmaray and the other planned rail projects being built as part of the İstanbul Main Urban Transportation Plan. [177]

The idea of constructing a railway tunnel under the Bosporus was first proposed in 1860, and the project has come to the table several times since then, however it was only at the end of the 20th century that advances in technologies made the project truly feasible. The

[176]The Official Website of the Marmaray Project
http://www.marmaray.com.tr/mr/marmaray-anasayfa > 09.03.2010
[177] The Official Website of the Marmaray Project http://www.marmaray.com.tr/mr/menu-genel-bilgiler/talepler > 09.03.2010

*submerging tube tunnel technique* is being used to construct the Bosporus section of the Marmaray.[178]

The will to construct a rail line between the Asian and European sides of İstanbul passing under the Bosporus was increased in 1980s, in part due to the urban congestion in the city. The first comprehensive feasibility studies that also considered the route of the line were carried out and reported in 1987; and as a result the Marmaray Project was determined as being technically and financially feasible. After the determination of the outline of the project in 1987, the feasibility studies were updated between 1995 and 1998. In 1999, an agreement was signed between Turkey and the Japan Bank for International Cooperation (JBIC) for the financing of the sub-marine part of Marmaray. Construction started in 2004 and is still continuing at the time of writing.[179] The tunnel excavation and covering works of the project are foreseen to be completed in 2011.[180]

The Marmaray Project is also expected to improve the environmental conditions of İstanbul. During the first 25 years of operation, the Marmaray Project is expected to remove approximately 29,000 tons of hazardous gases (NHMC, CO, NOx, etc.) annually from the city. The amount of greenhouse gases (foremost $CO^2$) will also be decreased annually by about 115,000 tons. Noise pollution in the city is also foreseen to be decreased with the Marmaray Project.[181]

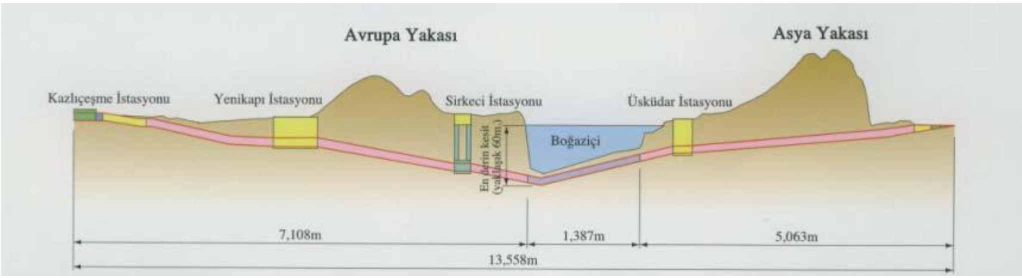



**Figure 4.44** The section showing the underground portions of the Marmaray Project (Source: Ünlütepe, A. Unpublished paper presented at the *Harita ve Kadastro Mühendisleri Odası, Mühendislik Ölçmeleri STB Komisyonu 2. Mühendislik Ölçmeleri Sempozyumu, 2005, İTÜ – İstanbul)*

[178] Ibid
[179] Ibid
[180] The Official Website of the İstanbul Municipality http://www.ibb.gov.tr/en-US/Pages/Haber.aspx?NewsID=299 > 09.03.2010
[181] http://www.marmaray.com.tr/mr/marmaray-anasayfa > 09.03.2010


**Figure 4.45** The rail systems network map of İstanbul
(Source: http://upload.wikimedia.org/wikipedia/commons/thumb/3/30/Istanbul_Rapid_Transit_Map.png/800px-Istanbul_Rapid_Transit_Map.png. Last accessed on 09.03.2010)

There are two metro lines, four tramway lines, two rope railway lines and a funicular line operating in İstanbul today.[182] Five rail lines measuring 51.5 km are currently under construction, while a further 85 km are still going through a design progress.[183] When completed, the Marmaray line will constitute a west–east transportation corridor whereas the Metro Line extends in a north–south direction. These two major transportation lines will meet at the Yenikapı Station, (Figure 4.45) as well as a light rail line extending in a northwest–southeast direction on the European side of İstanbul. Transfer facilities at Yenikapı Station will allow passengers to transfer to the city's bus, ferryboat and tramway systems, making the station the most important transfer center on the Europe side of İstanbul. The Üsküdar station on the Asian side will also be a transfer hub; however Yenikapı Station will be larger in scale and will play a more important role for the city, given its links to a wider range of transportation modes.[184]

The history of civilization in İstanbul dates back 8,000 years, making this opportunity to uncover settlements and remains from ancient times crucial not only for İstanbul, but also for the world. Construction of the Marmaray Project has been preceded by excavation works at the subterranean station sites, revealing the underground heritage of the city. These archeological excavations have continued since 2004 under the supervision of İstanbul Archeology Museum, and construction works can only begin once permission has been granted by the preservation commissions.[185] The archeological works are continuing at the Yenikapı Station site, which is of great importance as the site of the ancient Theodosius Harbor. Finds to date at the site include 51 m of the 1,700-year-old Constantine city walls, 26 sunken boats, a lighthouse, and various other architectural remains from the Roman, Byzantium and Ottoman periods. [186]

The archeological remains found in the Yenikapı area are to be exhibited in a museum that will form part of the station. An architectural design contest will be held for the Yenikapı

[182] The website of the İstanbul Transportation Industry Company
http://www.istanbul-ulasim.com.tr/default.asp?menu_id=3&sayfa_id=0 > 09.03.2010
[183] http://www.ibb.gov.tr/tr-TR/Kurumsal/Birimler/RayliSistemler/Pages/AnaSayfa.aspx > 09.03.2010
[184] http://www.marmaray.com.tr/mr/menu-genel-bilgiler/hrs > 09.03.2010
[185] http://www.marmaray.com.tr/mr/marmaray-anasayfa > 09.03.2010
[186]The website of Arkitera Online Architectural Magazine
http://www.arkitera.com/h30844-yenikapi-arkeolojik-kazi-alanindaydik.html > 09.03.2010

Station-Museum project, and a number of internationally acclaimed architects are to be invited to propose their designs.[187]

The street level of Yenikapı Station is proposed as a planted urban park in the concept design. (Figure 4.46) The entrances to the underground station will be transparent, and central skylights will be used to provide daylight to the subterranean levels. (Figure 4.47)

The Ankara and İstanbul transfer station cases present striking differences from each other. The quality of architectural space is very low in the Ankara example, adhering strongly to the box typology and with no architectural diversity between the different uses of space. Aside from the shops and banks, all of the non-mobile spaces are later additions to the circulation paths in the underground complex that have been created using glass partitions, demonstrating no architectural qualities, and resulting in a loss of station space unity.

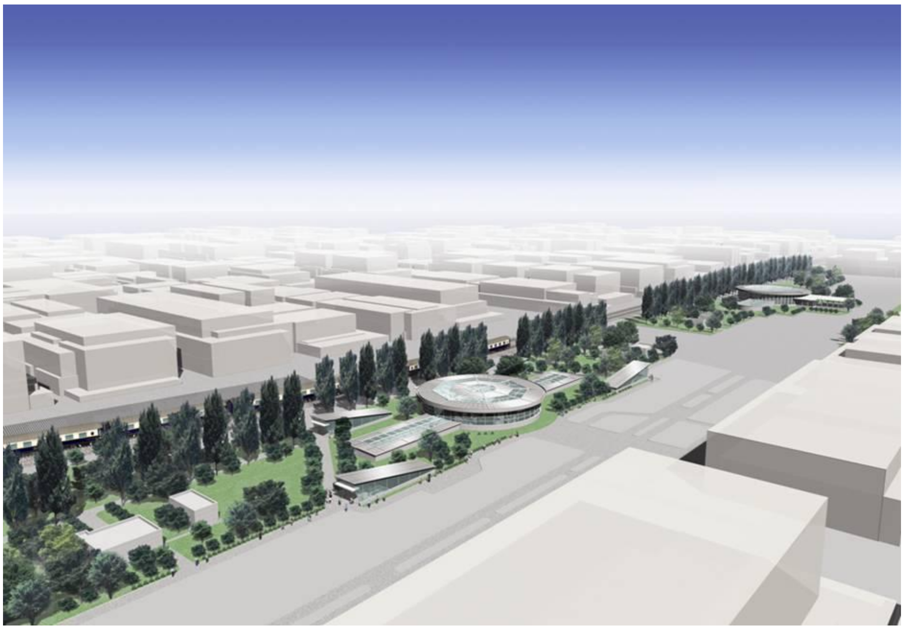


**Figure 4.46** The urban park proposed above the underground Yenikapı Transfer Station
Source: The Ministry of Transportation-Department of Railways, Harbors and Airports Archive (Ulaştırma Bakanlığı -DLH (Demiryolları, Limanlar, Hava Meydanları İnşaatı Genel Müdürlüğü))

[187] The website of Arkitera Online Architectural Magazine
http://www.arkitera.com/h34661-yenikapiya-muze-istasyon-firsati-dogdu-.html > 09.03.2010

**Figure 4.47** The section-perspective drawing of the Yenikapı Station concept project (Source: Marmaray Project Presentation Brochure. Published on behalf of the Ministry of Transportation, by the Marmaray Project Employer Agent Avrasya Common Enterprise. İstanbul: 2003.)

In contrast, the Istanbul case can be said to include some positive aspects in many respects. Firstly, the opening of a competition for the concept project is an extremely positive attempt to incorporate architectural design into the station. The company offering the lowest price in a state tender generally wins the contract for the design of public buildings; and the proofing services given by the municipalities have assisted in the formation of architectural prototypes, which has had a very negative impact on the creativity of architects in Turkey. Therefore, the launch of an architectural competition for the design of the Yenikapı Transfer Station has provided a valuable opportunity to the Turkish architectural medium.

In the İstanbul Yenikapı case, the proposal to designate the ground level above the subterranean station as an urban park for use by the general public can be considered as a highly positive approach. As has been analyzed in this study, such an approach has been a popular aspect of many attempts around the world to decrease urban congestion in metropolitan centers. In this respect, the İstanbul case can be held up as a good example of modern transportation architecture in the world.

Another positive feature of the Yenikapı project is the idea of incorporating a museum into the station to exhibit the archeological findings uncovered from the station site. By combining a transfer station, a museum and urban park facilities, the interest and usage of Yenikapı will be increased, turning it into an urban focal point. If the museum spaces are designed as a part of the station rather than the urban park above, it will be possible to benefit from the insulating properties of the subterranean medium. Since it is necessary to protect archeological finds from direct sunlight and heat, locating the museum facility in the underground Yenikapı station would be ideal for the sustainability of this historical heritage.

# CHAPTER 5

# CONCLUSION

Post-industrialism has considerably changed urban politics according to H. V. Savitch, who describes new politics as '*collecting bits and pieces of the social structure in order to build a vastly more complex city*'. In his opinion, the post-industrial city must be an organic phenomenon that is capable of adaptation, and that to survive, today's cities must adopt some basic post-industrial conditions into their politics, one of which should be increased competition between the cities and nations of the world.[188] Another condition is to construct a complex physical environment: '*Streets, highways, rail terminals, airports, office towers, shopping malls, parks, theaters, museums, houses, hospitals, universities, and research centers need to be constructed with an eye toward the demographics of the twenty-first century. Facilities need to be coordinated, finances need to be secured, and a whole new system of laws needs to be worked out.*'[189] In this competitive medium, what gives a city its world-class status is its ability to take on new technologies and actively create their own environments, according to Savitch. Using their own resources, post-industrial cities must convert old uses to new ones, besides mixing these in permutations, giving priority to some, until they have been virtually re-created.[190] This thesis has dealt with the new conditions of post-industrial cities mentioned by Savitch, and it is essentially the new conditions related with the urban underground transportation politics that have been the point of focus.

[188] H. V. Savitch. Post-Industrial Cities-Politics and Planning in New York, Paris, and London. New Jersey: Princeton University Press, 1988. p 285
[189] Ibid 286
[190] Ibid 304-305

To this end, following the introduction, the concepts of *speed* and *time* and their effects on modern life, the built environment and transportation technologies have been discussed in the second chapter. This begins with an introduction to the industrial periods defined by Daniel Bell, after which the *post-industrial level,* which Bell states as having followed the *pre-industrial* and *industrial* levels, has been analyzed to allow an understanding of the socio-economic circumstances of the period. Speed has been discussed as a phenomenon that began to play a dominant role in industrial era, and still continues to gain importance in the post-industrial world of today. The factors that led to accelerations in economic and social terms, and also in transportation, have been analyzed, while the outcomes of this increased speed have also been discussed. A cross-reading of the concepts of speed and time has been carried out, referencing the ideas of various authors on the subject. However it is the discourses of Paul Virilio and David Harvey that are the subject of most focus.

Chapter three aims to provide an overview of the developments in urban transportation technologies and policies since 1960. For this purpose, the statistical pocketbook published by the Energy and Transport Directorate of European Commission in 2009 has been referenced as the leading data source, according to which the private car has the highest rate of usage among other modes of transport. Strategies developed by governments in order to turn this around and increase the usage of public transportation modes have been examined. High speed train technologies, first introduced in the 1960s, have undergone significant technological advances since the 1980s that have seen there emergence as a significant factor in reducing the popularity of private car. After an assessment of the high speed rail networks in Europe, Asia and America, the interaction between transportation and the urban form is discussed. The properties of today's urban transportation networks have been analyzed, since lines of transportation have a direct influence on the formation of the urban tissue. Finally, multi-modality has been analyzed as a common transportation strategy that is gaining importance in developed countries.

In order to establish the factors that have led certain cities to expand below ground in the second half of the 20$^{th}$ century, case studies of examples from around the world have been provided in the fourth chapter. An analysis of each selected project has been made based on architectural drawings, visual documentation relating to their interior and exterior spaces, and project reports published by the architects and by governmental authorities. Of the various forms of documentation referenced, it is the section drawings that have been most helpful in understand the design of each case. The relations between the underground and over ground spaces, the individual program elements, and the leading factors in the formation of these subterranean urban spaces have all been investigated. As a result of this analysis, it has been ascertained that there are five main factors that motivate decision-makers to create underground urban transportation hubs: ‘Congestion over Surface’, ‘The Arrival of the High Speed Rail Network’, ‘Ecological Aspects’, ‘Integrating New transportation Layers into an Existing Station’ and ‘Underground transportation Hubs of New Urban Centers’. In the first category, underground transportation forms that have resulted from congestion in dense urban centers have been studied. The cases which have emerged after the arrival of the high speed rail network constitute the second heading. The third catalyzing factor has been the desire to reclaim the surface for the creation of urban parks, or to maintain existing environmental conditions. The formation of underground transportation hubs through the introduction of new transportation layers into an existing station is the fourth category; while the fifth heading represents cases that have emerged as part of a multi-functional master plan. Another categorization of the projects has been carried out according to the concepts of *process, form, movemen*t and *density*. The selected cases have been assigned into two groups, whether they are *formed in multiple phases,* or *a single phase.* The form of each project has been analyzed in terms of its success in *breaking the concrete box typology*; while the *outward, downward* and *upward* development decisions of each case have been assessed to clarify their contribution to urban density. Additionally, the search of *Piranesian effect* in the forms of selected cases has been commented upon. The projects are analyzed in terms of the transportation *modes* and *immobile means* they contain below the surface. The outcomes of the two categorizations created in order to understand the selected case projects have been documented by constituting two different matrix tables. (See tables 5.1 and 5.2)

An analysis of these tables will facilitate a further understanding of the data accumulated in this study. Table 5.1 presents a comparison of the respective factors that led to the formation of the selected case projects. This analysis shows that among the 19 projects, 12 were a result of problems related to urban congestion or ecological concerns. Of the seven other cases, four were driven by the arrival of a high speed train network. Whether for climatic reasons or to reclaim green areas at ground level, ecological aspects affected the formation of 13 projects. The integration of new mobility layers into an existing station was a defining factor in four of the cases, all of which were located at historical city centers. The analysis of Table 5.1 reveals an interesting point, that the three of the four cases led by the arrival of a high speed rail have been designed as underground mobility hubs of new urban centers. From this it can be concluded that the high speed train not only catalyzes underground transportation hubs, but also leads the formation of new urban centers in the world.

Table 5.2 allows a comparison of the selected case projects in terms of their process, form, density and movement. The table reveals that 15 of 19 cases were formed in a single phase; and that 14 of the cases are orthogonal in form. The Pranesian effect has been applied in two of the five examples that have succeeded in breaking the box typology. There has been founded over ground formations at the eight of the cases. Rather than point transportation hubs, a mixture of underground-over ground solutions over extended areas have been applied in 11 of the examples. Only 6 of the 19 cases incorporate non-mobile uses of space below the surface; while non-mobile program elements have been designed as parts of over-ground formations in the 6 of the remaining 13 projects. Of the 19 cases, three incorporate international transport connections, and seven provide intercity connections. From table 5.2 it can be concluded that the majority of the underground transportation hub cases presented here have been formed in a single phase, have an orthogonal form, include outward urban formations, and serve for multimodal transportation inside the city.

An analysis of the two Turkish cases in this study reveals that there are two main obstacles hindering the development of architecture and quality of urban space in Turkey, and consequently the formation of transportation spaces too. The first obstacle is the effect of the ideologies on the municipalities, who are responsible for the public and individual architectural formations in urban centers. During their term of office, municipalities attempt to impose their political notions onto the built environment; but a more objective approach would be applied to ensure space and service quality as a common point of each different administration. The second factor is the current method of tendering systems. As has been discussed before in this study, rather than being solely based on bid price, competitions should be opened for the design of public and urban spaces in Turkey.

**Table 5.1** The comparison of the selected case projects in terms of their leading formation factors (Study by the author)

| | Contextual Factor 1: Congestion over Surface | Contextual Factor 2: The Arrival of the High Speed Rail Network | Contextual Factor 3: Ecological Aspects | | Contextual Factor 4: Integrating New Transportation Layers into an Existing Station | Contextual Factor 5: Underground Transportation Hubs of New Urban Centers |
|---|---|---|---|---|---|---|
| | | | Climatic factors | Reclaiming the green over surface | | |
| AMFORA / Netherlands | ■ | | ■ | ■ | | |
| North-South Metro Line / Netherlands | ■ | | | ■ | ■ | |
| Souterrain Tram Tunnel / Netherlands | ■ | | | | | |
| Les Halles / France | ■ | | | ■ | | |
| Zuidas Dok / Netherlands | | ■ | | | | ■ |
| Stuttgart Main Station / Germany | | ■ | ■ | ■ | ■ | |
| Sagrera Station / Spain | | ■ | | ■ | | ■ |
| Euralille / France | | ■ | | | | ■ |
| Canary Wharf-Jubilee Line Station / England | ■ | | | ■ | | |
| Canary Wharf -Crossrail Station / England | ■ | | | ■ | | |
| Kowloon Station / China | | | | ■ | | |
| Haussmann-St Lazare Station / France | ■ | | | | | |
| Westminster Station / England | ■ | | | | ■ | |
| Fulton Street Station / USA | ■ | | | | ■ | |
| La Defense / France | | | | ■ | | ■ |
| Shibuya Station / Japan | ■ | | ■ | | | |
| McGill Station / Canada | | | ■ | | | |
| Ankaray-Metro Transfer Station / Turkey | ■ | | ■ | | | |
| Yenikapı Transfer Station / Turkey | ■ | | | ■ | | |

**Table 5.2** The comparison of the selected case projects due to their process, form, density and movement (Study by the author)

| | PROCESS | | FORM | | | DENSITY | | | MOVEMENT | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Formation through multiple phases | Formation in a single phase | Orthogonal box | Breaking the typology | *Piranesian Effect* | Downwards | Upwards | Outwards | Immobile means below the surface | Multimodal movement | monomodal movement | international | intercity | in city |
| AMFORA / Netherlands | | ■ | ■ | | | ■ | | ■ | ■ | | ■ | | | ■ |
| North-South Metro Line / Netherlands | ■ | ■ | ■ | | | ■ | | ■ | | | ■ | ■ | ■ | ■ |
| Souterrain Tram Tunnel / Netherlands | | ■ | | ■ | | ■ | | | ■ | ■ | | | | ■ |
| Les Halles / France | | ■ | ■ | | | ■ | | | ■ | ■ | | | | ■ |
| Zuidas Dok / Netherlands | | ■ | ■ | | | ■ | ■ | ■ | | ■ | | | ■ | ■ |
| Stuttgart Main Station / Germany | ■ | | | ■ | | ■ | | ■ | | ■ | | | ■ | ■ |
| Sagrera Station / Spain | | ■ | ■ | | | ■ | ■ | ■ | | ■ | | | ■ | ■ |
| Euralille / France | | ■ | | ■ | ■ | ■ | ■ | ■ | | ■ | | ■ | ■ | ■ |
| Canary Wharf-Jubilee Line Station / England | | ■ | ■ | | ■ | ■ | | | | | ■ | | | ■ |
| Canary Wharf -Crossrail Station / England | | ■ | ■ | | | ■ | ■ | | | | ■ | | | ■ |
| Kowloon Station / China | | ■ | ■ | | | ■ | ■ | ■ | | ■ | | ■ | ■ | ■ |
| Haussmann-St Lazare Station / France | | ■ | | ■ | ■ | ■ | | | | | ■ | | | ■ |
| Westminster Station / England | ■ | | ■ | | ■ | ■ | ■ | | | | ■ | | | ■ |
| Fulton Street Station / USA | ■ | | ■ | | | ■ | ■ | ■ | | | ■ | | | ■ |
| La Defense / France | | ■ | ■ | | | ■ | ■ | ■ | | ■ | | | ■ | ■ |
| Shibuya Station / Japan | | ■ | | ■ | | ■ | | | | | ■ | | | ■ |
| McGill Station / Canada | | ■ | ■ | | | ■ | | | ■ | | ■ | | | ■ |
| Ankaray-Metro Transfer Station / Turkey | | ■ | ■ | | | ■ | | ■ | ■ | ■ | | | | ■ |
| Yenikapı Transfer Station / Turkey | | ■ | ■ | | | ■ | | ■ | ■ | ■ | | | | ■ |

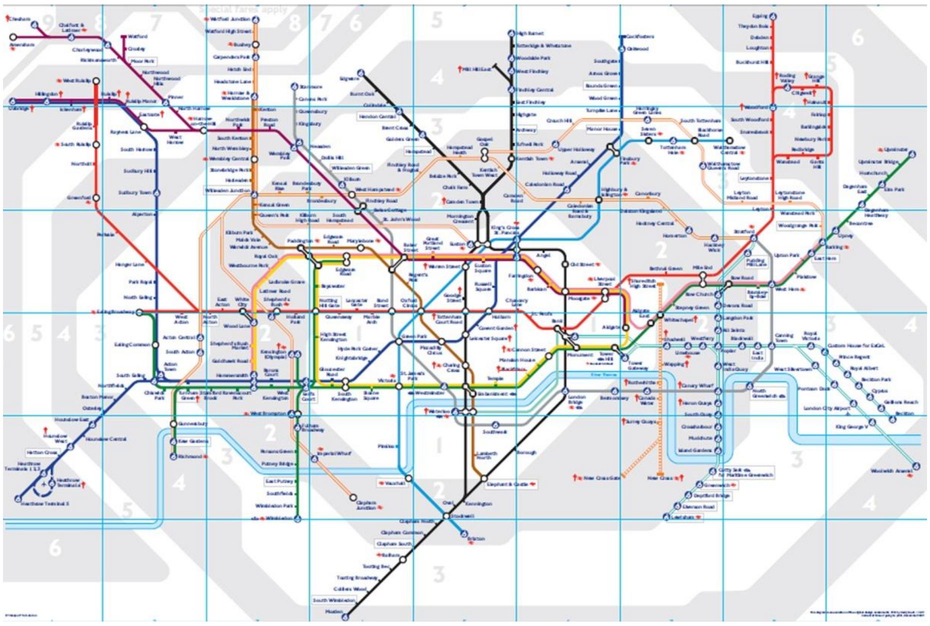


**Figure 5.1** The London Tube Map (Source: The London for Transport Official Website http://www.tfl.gov.uk/assets/downloads/standard-tube-map.pdf. Last accessed on 09.03.2010)

**Figure 5.2** The Paris Metro Map (Source: Paris City Official Website http://www.paris.org/Metro/gifs/metro.pdf. Last accessed on 09.03.2010)

Another point that should be mentioned relating to transportation in Turkey is the inadequacy of public rail systems in the country's metropolitan areas. This deficiency leads to shortfalls in the development level of transportation formations and decreases service quality. As it has been analyzed in this study, there are examples in the world of quite multifaceted underground public rail networks, because of which private car usage has decreased and passengers are able to be transported close to their destination in a safe and fast way. The subterranean public rail systems of London and Paris are good examples of such an approach (Figures 5.1 and 5.2), which when compared with the systems of Istanbul and Ankara reveal how the Turkish systems have developed as individual lines rather than networks serving the entire urban tissue. The underground transportation facilities that have been analyzed in this study are formed through the superposition of dense networks; and as such a style of transfer point may also be built in Turkey in the future if the obstacles in front of the development of transportation systems are removed and rail investments are increased.

Some other general inferences may be made based on the results of the studies introduced in this thesis. It can be claimed that underground has become a principal medium for urban expansion for developed countries in 21$^{st}$ century; which has grown out of the tendency to plan transportation layers below the surface; whether adding layers into an existing station or creating a completely new space. As can be seen in many of the case studies, the creation of underground transportation hubs has become common even in large-scale urban master plans where lack of space is not an issue, which can be attributed to the new urban paradigm discussed within this study.

High speed trains (HST) are arguably the most rapidly emerging mode of public transport today. Statistical data in this study has revealed that investments into this mode of transit are increasing around the world, even in the United States where a high dependency on motorized traffic has developed. The appeal of being able to integrate HST lines into an underground urban special solution has become a clear incentive in a number of the cases covered in this study.

The advantages offered by multi- transportation are a significant motivation for increasing underground transportation spaces in a city. A reduction in the time lost when transferring between different modes of transport is easily achieved in these compact and isolated formations due to the elimination of exterior factors. One of the main objectives of multi-modality is to transport the passenger as closely as possible to their final destination, which is a feature that is inherent in private car use. In this regard, multi-modality is a vital element of increasing the usage rate of public transportation.

Another conclusion of this study is related to the relation between congestion at the surface and underground systems. By taking the traffic and transportation formations below ground in urban centers, the density of the over ground space is aimed to be decreased. However, as has been pointed out in chapter four of the thesis, such a decrease in congestion only occurs at the street level, with underground infrastructural forms witnessing increasing demand on an already densely used space.

It can be said that the leading factor that has led to the growth in popularity of underground systems in the world is related to advances in construction techniques. With the help of developments in this area, the construction of vast subterranean transportation spaces, even in historical city centers, is now possible.

In the light of conclusions that have been drawn in this thesis study, transportation layers of the 21$^{st}$ century can be expected to become much more 'invisible' in metropolises of the future. In assessing the growing popularity of subterranean systems in the world today, it has become apparent that the urban paradigm covered by this thesis will compel architects into a new field of design: subterranean transportation spaces. Designing qualified transportation centers around all the constraints associated with working underground and the formal impositions of the available construction techniques has become a challenge for architects of the 21$^{st}$ century.

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