Transport Infrastructure Design

Utopias for Guideways and A Review of The Marmaray Project

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Transport infrastructure design has regarded as a task in the field of engineering; architects have mostly involved in the design of terminals and stations, but not in the routes of mobility –the guideways. The spatial value of guideways has not been examined, since they have been taken as paths for vehicles embedded in the landscape in a notion of separating transportation space from built environment. But, this paper aims to spatially conceptualize guideways as city structures and nodes connecting different modes of transportation while housing various architectural facilities. As a case, three utopic guideway designs are proposed for roads, bridges and viaducts in Istanbul, the biggest city of Turkey. And a current guideway construction in Istanbul is introduced and discussed according to the concepts addressed throughout the study. The Marmaray Project is a tunnel design, which can be appreciated as a real-time utopia connecting two sides of Bosphorus under water.

Transport infrastructure; guideways; architectural-urban design; Istanbul; utopias; the Marmaray Project

I. INTRODUCTION

Since the dawn of civilization moving people, transporting goods, transferring information and communicating have been the structures of societies. This is also what has been shaping the built environment. From a contemporary perspective, 'transportation' is the backbone of our lives and cities. A wide range of disciplines from engineering to politics converge on this subject in an attempt to make transport more functional and thereby our cities more livable. Three aspects of transportation that concern people most are: travel time, speed and ease of access to desired destinations combined with affordable prices [1]. The movement is also expected to be safe and efficient, with minimum negative impact on the environment.

The medium of movement creates a classification for transport; whether ground, water or air. Each mode has its own distinct system in terms of design and operation. A well-known taxonomy lists the physical components of transportation systems as; infrastructure, vehicles, equipment, power systems, and fuel in addition to control, communications and location systems [2]. Infrastructure has three categories; guideways, terminals and stations. Guideways are highways for any rubber-tired vehicle can travel on, and railroads for vehicles designed to travel on rail tracks. There are also guideways we cannot physically see such as air corridors or waterways. Terminals and stations are also cited as infrastructure, serving a variety of functions such as regulating schedules, carrying and storing freight and of course where passengers begin and end their journey.

The infrastructure of transportation is conventionally assigned as the subjects of engineering and to some extent architecture. Terminals and stations are designed by architects, while guideways are kept totally out of the spatial arena. However, this paper aims to present guideways as a spatial installation by addressing the potential of that rather ignored part of the relationship between architectural design and transport infrastructure.

Figure 1 helps to explain at which point this study stands in the literature of transport architecture. Spatial design is an important feature in vehicles and infrastructure. Vehicles are not only mobile machines, but also cabins for a short or long period of time. Design of a vehicle interior is related with ergonomics and the comfort of its passengers (or occupants). Some types of vehicles are occupied for days, months or even years. Caravans, for instance, are road vehicles intended for human habitation. Their interiors include all the practical furniture a house could have. The spaces of vehicles are designed in response to the mode of transport and to the usage span as well. The other way in which architecture and transportation collaborate is infrastructure. It encompasses terminals and stations including other maintenance/supporting structures such as hangars, docks, fuel stations and parking facilities. Even a lighthouse could be labeled as a type of transport architecture. This research adds 'guideways' infrastructure to this list via a proposal integrating architectural space and transportation.

The century we live in is an era of 'travelling'. New technologies have required new types of spaces and intermodality has changed the design patterns dramatically. Architects have skilfully adapted spatial innovation to transport buildings. Airports, train stations, bus terminals and underground systems are spatially organized in accordance with the mobility of people in this new millennium. A similar visionary thought will inevitably penetrate the guideways, which saturate almost every piece of land in the city and are ever increasing. They will not remain as only two dimensional paths, non-spatial parts of the city or bare tools of transportation. The significance of this study lies in the point of

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view that future cities will demand new utopic ideas from architecture; which make the guideways a spatially integrated part of the city and city life. This article highlights a new innovative way of thinking and prompts architects to be active participants, not passive spectators behind the technological processes in transportation.

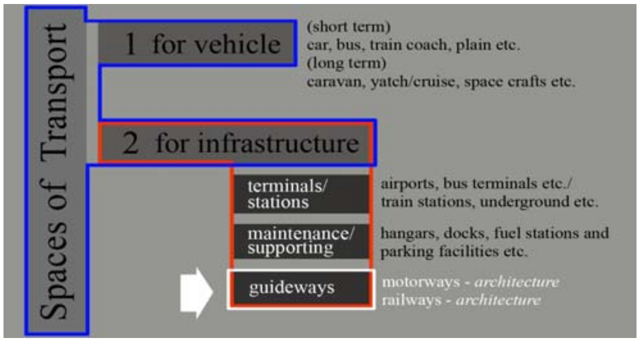

Figure.1 Spaces of Transport. Guideways are proposed along with terminals, stations, and other types of transport buildings.

Only the guideways of land transportation is the subject of this research, while keeping other sorts of systems such as air and water out of scope. The aspects of transportation infrastructure with architecture and city are discussed in the next chapter as the theoretical part of the study, where literature review is methodologically used. The subsequent chapter includes recent design thoughts and a selection of projects in order to show previous studies on this theme, then an original case study is conducted by giving unique proposals for three main guideway structures; roads, bridges and viaducts in Istanbul. Finally, a utopic transport infrastructure work in progress: the Marmaray Project, a subsea tunnel crossing the Bosphorus, is introduced and discussed within the scope of the paper. Located alongside the Bosphorus, Istanbul is one of the most important cities in Turkey in economic and cultural terms. Transportation in the city is an arduous and problematic task due to two main phenomena: (a) population growth and urban sprawl –need for effective transportation modes and networks, (b) dynamic topography –need for uninterrupted transportation which effectively embraces the urban geography. That Istanbul is a city founded on a major seismic belt has also made transportation a more challenging issue.

II. TRANSPORTATION AND ARCHITECTURE

This chapter is comprised of two sections. The first one focuses on the architectural design of transport infrastructure especially of terminals and stations. And the second one addresses the infrastructure within the context of city and social life, also showing the transportation of urban utopias devised in the last century.

A. The Issue of Design

The main buildings of transport infrastructure; terminals and stations are important typologies in architecture. These buildings have complex architectural programs that should be well-organized spatially in order to allow people, freight and vehicle to move easily. In a word, functionality is a crucial design parameter for architects. Moreover, serious feasibility studies should be carried out since transportation projects are large scale constructions and big investments in financial terms. So a proposal needs to be flexible and adaptable enough to fulfil all, even unpredictable, conditions that may occur during the building's operational life.

Transportation today requires terminals and stations to adapt to and integrate them effectively. For instance, an airport has runways that aircrafts land or take off on, has transfer systems such as railways and highways, and also accommodates extra space for transportation such as parking areas. An airport also houses stores, food courts etc. distinct from the activities directly related with transportation. Even a hotel may be built in the vicinity for short term stays. The functions attached to the terminals or stations increase in amount and vary especially when architects conceive these transport nodes as 'public spaces'. We may to encounter an exhibition or an art installation in a tube station. From a provocative viewpoint, these infrastructure buildings are like extensions of streets, squares or parks. They are fundamental public areas where sometimes hundreds of people flow through in seconds.

A design is naturally more than a mere functionality. Transport buildings provide the required ease of movement, but they also "celebrate the sense of arrival and departure" [3], and give more expressions which somehow suit with movement. That is the semantics of design are what architects occasionally try to imply by buildings. A century ago, main railroad terminals in big European cities were designed as splendid iron and glass buildings to symbolize industrialization. Today, the spectacular engineering and architectural design of terminals still symbolize innovation and technology. People may use the iconic pattern of physical resemblance or analogy as a way of perceiving transport buildings. For example; the TWA Terminal building at John F. Kennedy Airport in New York, designed by Eero Saarinen in the 1950s, gives a notion of flight by the metaphoric and literal image of an eagle in mid-air with its wings spread ready for landing (Figure 2). For Saarinen the challenge was to design a building in which the architecture itself would express "excitement of travel… not as a static enclosed place, but as a place of movement and transition" [4]. On the other hand, other concepts or connotations are associated with movement and transportation such as *dynamism*, *energy* and *flow* also inspire architectural design. Fluid and kinetic spaces are used not only in transport buildings but also in other types of buildings.

Figure.2 TWA Terminal Building. Anonymous.

B. The Urban Scale

A city has a set of people who have diverse needs and wishes, and a set of activities which are spatially separated.

Numerous combinations are drawn from these two sets via a continuous transportation network in the city. The spatial syntax of transport infrastructure is what remains when the buildings are omitted. This system varies from city to city and co-exists with the built environment and landscape.

From a geographical perspective there are three fundamental concepts of urban transportation; accessibility, mobility and equity [5]. Accessibility refers to the number of opportunities –activity sites, available within a certain distance or travel time, and mobility refers to the ability to move between different activity sites. As the distances between activity sites have become longer, accessibility has come to depend more on vehicle mobility instead of pedestrian mobility. Hence, the need for mobility (by vehicle) can be seen as the consequence of the spatial separation, while mobility itself prompts increased separation of land uses in the urban area. Equity of a transportation system or a transportation policy is about how the costs and benefits are shared among different groups of people.

Based on the concepts mentioned above, the attractiveness of a particular location in the city is related with its relative accessibility –that depends on the quality and quantity of transport infrastructure [6]. The land uses and values either in the short or long term are determined by urban transportation infrastructure. So, the spatial and economic development of cities and regions are linked to transportation. Planners and policy makers should be fully aware of this relationship and regard transport investments as the major instruments in shaping cities. The level of development does not only depend on a well-structured transport system, but also how the problems transportation cause are handled and solved. It is certain that transportation is the source of many seemingly intractable urban problems such as congestion, pollution, climate change and in-equality. Importantly, economic and social development, and environmental preservation constitute three fundamental piers of "sustainable transportation" [7] for cities in planning and provision.

Besides those theoretical issues quickly illustrated above, the practical side is varied by the visionary designs of architects and urban planners. From a historical perspective, transportation has always been an important part of utopic projects and radical manifestos (Figure 3). Futuristic approaches at the age followed by industrial revolution encompass diverse suggestions for transportation. For example, in Antonio Sant'Elia's "Citta Nuova" (1912-1914) building groups and monolithic skyscrapers were linked to one another with terraces, bridges and overpasses. Distinctly another proposal; "Flying City" by Georgy Krutikov (1928), left the earth completely green and the city was settled with such systems hung to flying craft, and airborne transportation was provided via flying modules. In the second half of the twentieth century, mobility and modularity were influential by the projects of Metabolism, Archigram and GIAP. With cities still expanding and becoming crowded over the past decades, ecological and natural design approaches, and suitable transportation have been an important focus for a problem-free city life and a better protected environment.

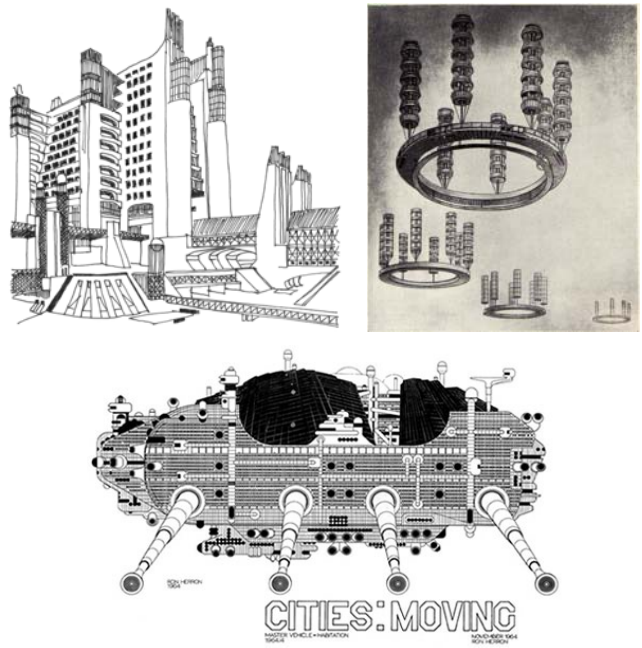

Figure.3 (above left, right and below) Citta Nuova, Flying City and The Walking City by Ron Herron, Archigram. Anonymous.

III. New Approaches

Especially in recent decades, physical integration of transport infrastructure guideways within the urban structure they cross has emerged as an important concept for architects and urban planners. The road with its architectural meaning is comprehensively discussed in the first International Architectural Biennale in Rotterdam held in 2003, presenting the theme of "mobility" in a broader geographical and theoretical context. Francine Houben and Luisa Maris Calabrese, the editors of the press of the event, first highlight that the construction of mobility routes is seen as a technical matter, which traffic planners, engineers and politicians deal with, in which designers play no part. However, mobility itself is not just about traffic jams, asphalt, delays and tollgates; it gives a sensory experience of the city and countryside for people travelling in a train or car which is regarded as "a room with a view" [8]. So, the infrastructure and vehicles are not only for getting from A to B, they are public spaces people spend time in. Authors remark that cities search for ways to re-absorb the infrastructure spaces; knowing that transport systems occupy increasing amounts of space, and constantly re-create the city and the landscape; shaping the daily lives of people concurrently. So, the social and cultural aspect of mobility networks has dramatically changed the conventional treatment of infrastructure in design and policy.

A brand new book titled "Infrastructure as architecture; designing composite networks" (2010), edited by Katrina Stoll and Scott Lloyd, is also a noteworthy collection of many essays and projects engaging infrastructure and architecture in various ways. The theoretical proposal of the editors reflect on the idea that transportation and communication systems at the end of the twentieth century, when globalization and neo-liberalism have become pervasive, play a crucial role in urban form and growth. The spatial structure of the new urbanization is “fluid;” where information, people, finance and more flow and are connected via adaptive infrastructure networks and exchanges. In this context, architects tend to design multiperformative infrastructures by organizing multiple functions in composite networks providing local, social, aesthetic and ecological conditions. The design of “The Island Proposition 2100” project, which “was developed in response to a call for submissions of future urban visions for the Australian Pavilion at the 2010 Venice Biennale” [9], is an infrastructural spine between urban centres and their supportive territories. The IP2100 will service high-speed and inter-connected transportation of people and goods, with efficiency in transformation of waste and transitioning energy. New housing, industry and retail space will be located along the network (Figure.4), and new zones for interaction and public space will emerge as the spine moves across different cities and landscapes. This hybrid spatial infrastructure is expected to aid urban existence at both global and local levels.

Figure.4 IP2100

The idea of combining infrastructure and architecture has been the theme of many visionary projects. Here, those related with guideways; roads, bridges and viaducts will be introduced.

ROADS… Anthony Hoete mentions the scenario of “highrise highways” due to the increased need to verticalise street and road networks; “The surface of the road is no longer ground bound” [10]. For example, the design by UR Architects [11] lifts the road from its landscape and positions residential space below the highway. The environment around the infrastructure housing becomes a place for the collective assembly of its inhabitants –the road no longer severs the landscape (Figure 5). In actual fact, roads cut up and shape the parcels of land in a city. The road and the street are called syntactically as “continuous open space” [12] which are not buildings-“cells”. But the road is built for vehicles and cuts off pedestrian flow, different from streets which facilitate public interaction. Nevertheless a road should be taken together with paved public thoroughfares on each side and the possibility of unrestricted movement of people should be designed together with the roads.

An attempt from the teams WORKac and ZhuBO [13] redesign a one kilometre section of Hua Qiang Bei Road in China from the idea of a “3D Street.” They create bridge buildings and underground areas to provide connections across the streets, which also contain public programs such as a museum and library. The buildings are high enough to maintain views along the road (Figure 6).

Figure.5 Lelystad NL, Europan 6 competition 2001, 1st prize

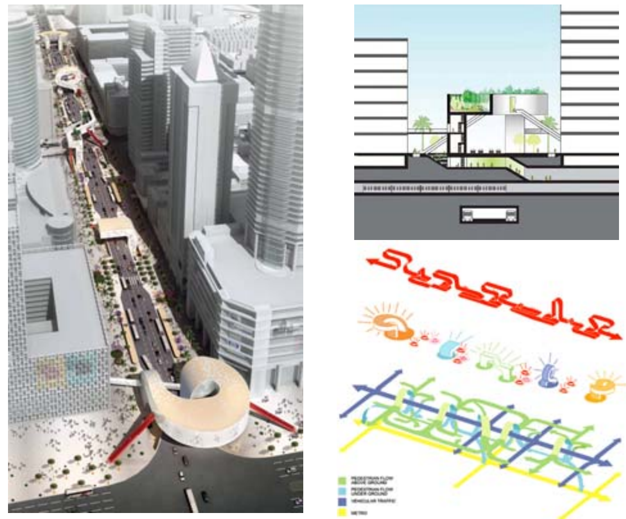

Figure.6 Hua Qiang Bei Road

In addition, proposals for the design competition WPA 2.0 try to place infrastructure at the heart of rebuilding cities during this next era of metropolitan recovery. As an example Figure 7 belongs to a submission by Chesley, Kryzmowski and Venezia (2009) for a highway infrastructure to support the healthy development of town centres [14].

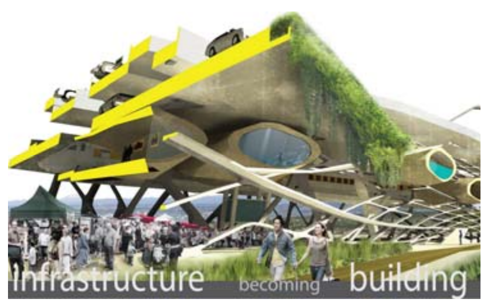

Figure.7 A WPA 2.0 entry

BRIDGES… The “Paik Nam June Media Bridge” proposal (2010) by Planning Korea is a mega-structure over the Han River that aims to expand the city fabric on to the water [15]. With a length of nearly one kilometre, the bridge connects the north and south of Seoul for cars, pedestrians and cyclists. It provides accommodation in addition to a number of public facilities such as a museum, library and an IT complex mall (Figure 8).

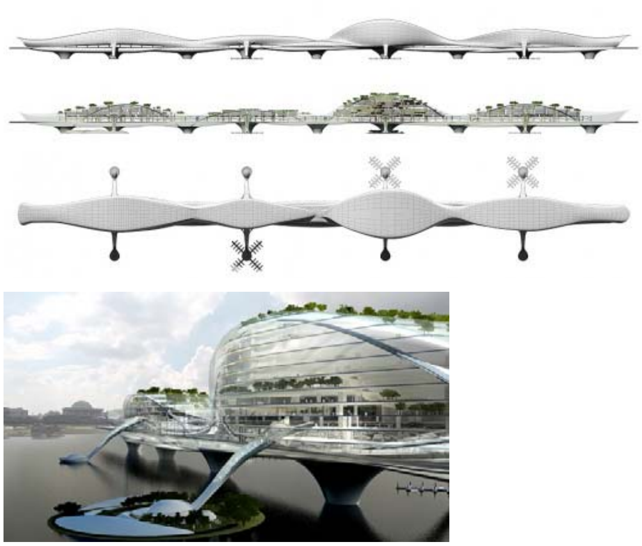

Figure.8 Paik Nam June Media Bridge

For the international Zaragoza expo which was held in the north of Spain in 2008, Zaha Hadid, the Pritzker Awarded Architect, designed a bridge pavilion spanning the Ebro River and linking the city to the expo site [16]. That multi-level bridge apart from its function as a gateway housed three exhibitions related to the water and sustainability theme of the expo (Figure 9). It also figures a symbolic building with its gently flowing form inspired by water.

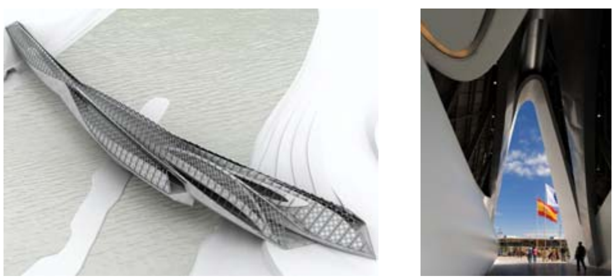

Figure.9 Zaragoza Bridge Pavilion

In 2009, to mark the 800th anniversary of the opening of the first London Bridge in 1209AD, RIBA organized an architectural ideas competition asking today's designers to imagine a new version of the 'inhabited bridge,' based on the present structure [17]. The entrants were expected to provide public transport in an alternative way to wheeled traffic. Upper levels of the bridge were allowed to have either residential or non-residential uses. All proposals, some are presented in Figure 10, were imaginative and visionary projects in terms of attributing spatial features to infrastructure.

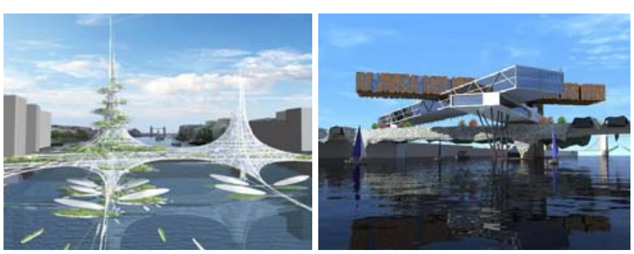

Figure.10 London Bridge 800: Design an Inhabited Bridge

As a distinct example of *bridge building*, a proposal takes infrastructure as a solution to social and political conflict, the SOM Winner project of Viktor Ramos in 2009, creates a liveable giant bridge (transforms into a tunnel if necessary) encourages Israeli and Palestinians to coexist peacefully [18]. A continuous infrastructural network connects the fragmented territorial landscapes through a series of under- and overpasses; also housing people and allowing transportation (Figure 11).

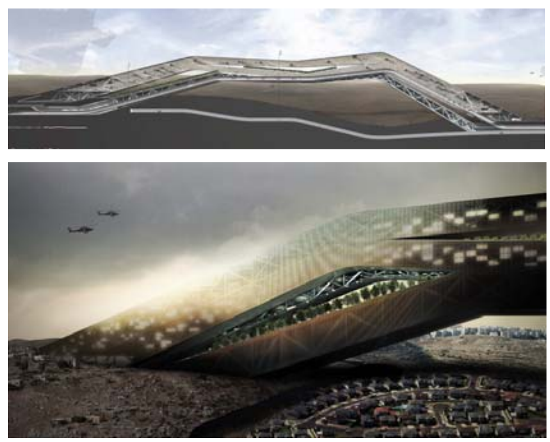

Figure.11 The Continuous Enclave: Strategies in Bypass Urbanism

VIADUCTS… In 2010, the Solar Park South international competition was organised to collect revolutionary proposals for the stretch of highway from Salerno to Reggio Calabria in Southern Italy which began in the 1960s [19]. That includes an old route of reinforced concrete viaducts with views of terraced rural landscape, the sea and the coast. Ideas or projects were expected to be developed on the basis of "the production of renewable energy; experimenting with new eco-friendly technologies; favouring connections between villages and access to the valuable crops on mountain crests; and, finally, developing new forms of environmental and land art capable of stimulating responsible tourism." (Figure 12) The winner developed a concept that used the existing massive pylons of the bridge as the basis of a sort of high-rise vacation complex. With very little impact on the landscape the concept consists of volumizing the bridge. The vertical privacy of the inhabited piles supports the horizontal sociability of the public equipped decks that are thickened to support three levels of public spaces, landscape and technical flows. Second place was given to a design that incorporated wind and solar power for a continuous production of energy. Twenty six wind-powered turbines were installed into the structure of the viaduct which would also have a solar-paneled roadway. That hybrid system was foreseen to produce around 40 million kWh per annum – enough energy to provide power for approximately 15,000 families. And the third has proposed to transform the viaducts into sustainable energy education and research centres. Those centres make possible investigation on renewable energy technologies, as visitors' experience it directly and interact throughout the "Leaf Shelters" located along the highway in certain viaducts.

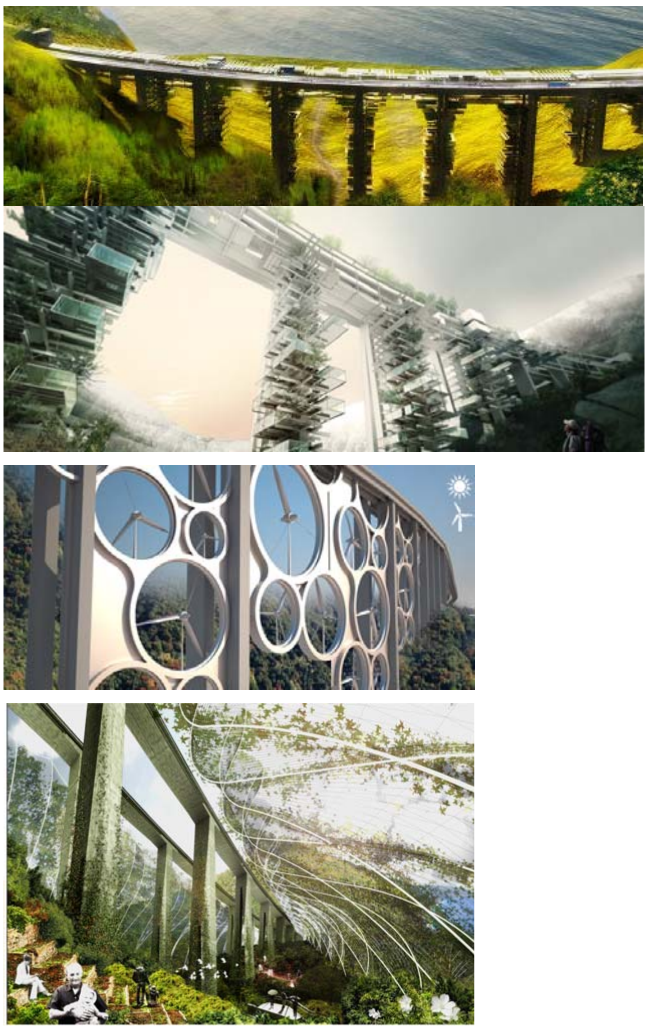

Figure.12 Solar Park South Projects. First, second and third prizes respectively.

IV. Utopic Proposals for Guideways in Istanbul

Istanbul is the biggest city in Turkey in terms of socio-political structure and economic growth. It is the cultural capital of Europe and a world city as an important node for global capital. Due to the increase in population, the city is sprawling rapidly with a hybrid spatial formation; in a way an appropriate transit network has to fit to that complex and chaotic urbanization. Public transportation is mainly based on wheeled vehicles on guideways (motorways) which are roads, also bridges and viaducts as the dynamic topography of the city requires. New infrastructure projects including extension of ways, road improvements, junctions and connections are being implemented for safer, faster and more comfortable mobility of the city inhabitants. But the attempt here is to go beyond this by proposing three utopic visionary projects for motorways in Istanbul, which will be appropriate for the new millennium in terms of architectural and urban design.

A. Roads

This section presents a new infrastructure-architecture project for Istanbul, which can be applied in both dense urban districts and suburban areas. Road-space relation has been practiced in three ways so far; (a) overpass and (b) underpass construction for public crossing, and (c) buildings along the road –such as a gas station or motel. As the fourth and a new type of relation; an embedded structure combining road and space is proposed to allow built environment, infrastructure and landscape to co-exist (Figure 13). This project is conceptually an overlap of systems which aims to reduce urban sprawl and to save green spaces. Also it will support an envisaged interlinked mobility accordant to everyday life in the city for the coming centuries. The most important aspect of this multi-layered system is to destroy the two dimensional traditional pattern of the city; comprised of transport paths and built on land which are territorially independent. In other words, the flattened layers of functional fragments in the city are vertically re-structured.

As an example, a mega structure is proposed to be framed on a highway with a length of 300 metres. Pedestrian access is possible from ground levels and also subway or car parks. Vehicles passing through the system may use ramps to reach different levels. Drivers' experiences are like travelling in a tunnel –Istanbul has even longer ones, but it is a tunnel with many divergences or stops for lots of facilities and parking lots. Levels below the ground are allocated for car parking and technical units, whereas the upper levels are designed to house various facilities such as retail and housing. Architectural design fundamentally depends on a flexible system, where usages can change or take on different spatial features. So a modular system is constructed for the higher levels above the ground. The vertical circulation connects all levels from the subway to the highest point. The whole structure also keeps a wide area of green space at different levels; also open recreational activities can be occupied. Moreover, that linear system laying for metres supports cross connections to provide uninterrupted public space and ecological green areas as well. Pedestrian access is managed by streets joining the structure at different levels. Energy supply by solar panels located at the top platforms, waste recycling, and carbon filters support the whole system; both transportation and other facilities.

B. Bridges

Spanning over the water is an important issue for Istanbul which has a natural canal and firth –Bosphorus and Golden Horn, in terms of building a continuous transport network.

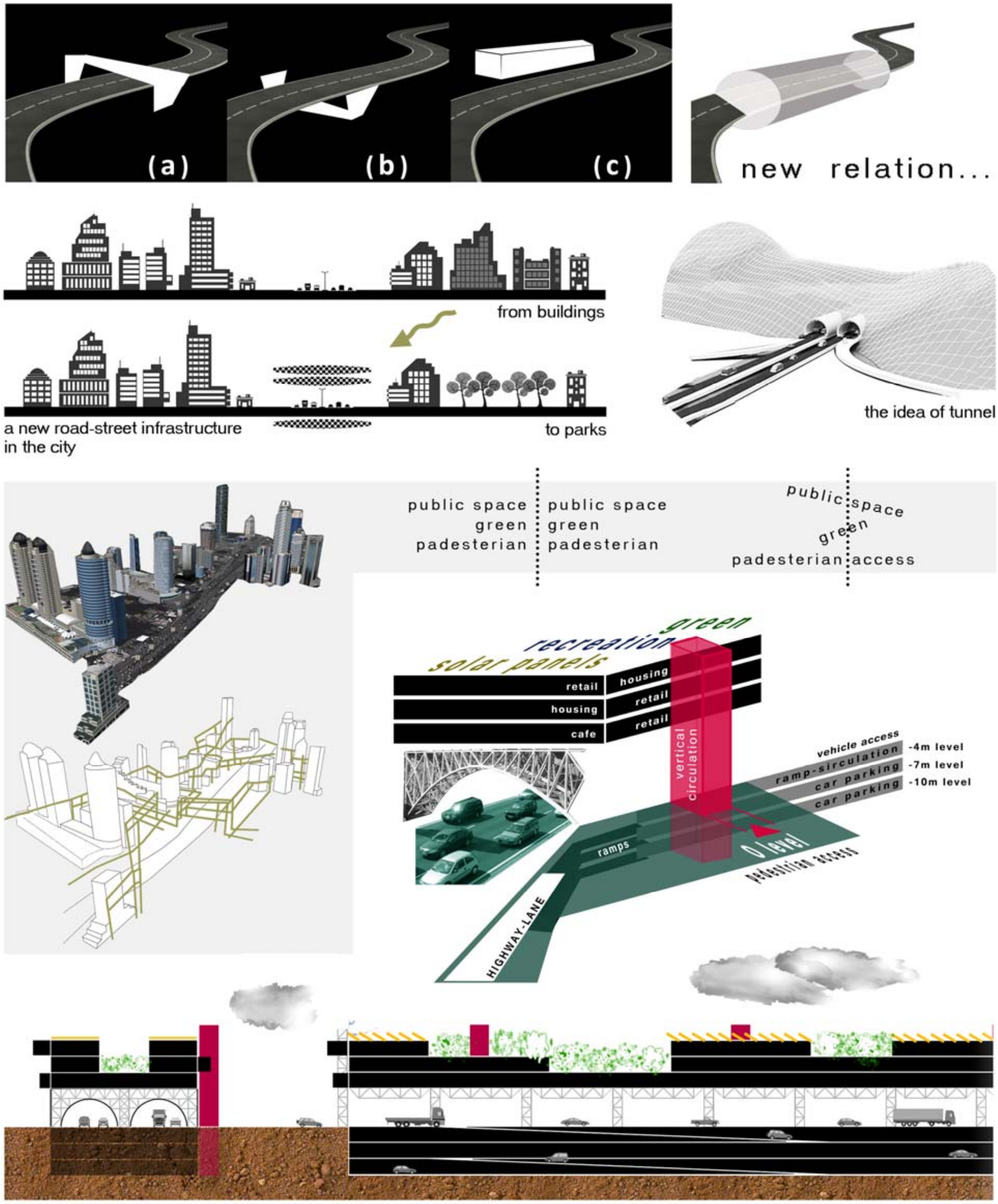

Figure 13 Ideas for Roads

Historically, the bridges over the Golden Horn connecting the administrative part and the rest of the city were social-cultural axes too; with many stores or individual sellers on the deck, even ferry stations at their water level platforms. The idea of building a bridge with additional facilities is not a recent one; bridges are mostly designed not as mere infrastructures of flow, but a spatially integrated part of that flow of traffic; living nodes of the city.

The proposal under this part shares an idea that a bridge is not only a guideway, and brings a utopian approach to the new prospective Bosphorus Bridge in Istanbul. There are two suspension bridges over the Bosphorus built in the 1970s and 1980s respectfully. Their architectural and structural designs are similar and both allow only wheeled vehicle traffic. The two bridges are fundamental parts of the city motorway network by connecting main highways on both sides of the city. However, they are already used beyond their capacity, always being congested. That is what makes a new third bridge idea a current debate for the solution to high dense urban transportation problem. The new bridge proposed by the government is located on the north of the two existing bridges over the Bosphorus. The architectural and structural design of the new bridge is very similar to the existing ones, but will include railroad and appropriate passenger transit options. Here, an alternative to that bridge is designed with a new harmony of transport infrastructure with the city.

The most exciting part of the proposed project is the column-structures of the bridge, which are conceived as buildings with a potential to extend towards the deck side or land side (Figure 14a). Transportation nodes as social spaces are designed by placing boat stations (and public amenities) at the bottom of the columns, different from the abandoned spaces under the other two bridges. A vertical structure (circulation tower) rising along with the bridge's column behaves as the spine of the system. It connects all modes of transportation; underground, water, rail and road, also aerial cableway transportation between two columns. A cable car service across the Bosphorus provides a spectacular view of Istanbul. And, a heliport will be situated at the top of the building. The circulation tower also links all facilities the bridge building has, including both temporary ones such as exhibitions and permanent one such as housing. Accommodation is provided by modular architectural design that allows great flexibility.

The vertical based structure is expected to stretch towards the deck and the land sides to embrace the urban pattern better. The deck, on the other hand, is an important part of the design. It is not regarded only as a platform of the guideway, but a technical and supportive infrastructure for linear extensions; the above and below of the deck is re-skinned with spatial components. Also, below of the structure is thought as a vertical dock with sliding cranes inbuilt to the deck.

C. Viaducts

In design, viaducts are similar structures to bridges, but they are composed of several small spans with more bearing columns and they generally cross over valleys not water. The dynamic topography of Istanbul with hills and valleys requires viaducts within a similar approach to bridges for an uninterrupted transportation network. Some viaducts in Istanbul go through the landscape, and some are located in dense urban areas, where residential settlements are below. Viaducts close to neighbourhoods cause negative effects such as constant noise and an unpleasant view or the even more dangerous threat of collapsing. Viaduct infrastructures are also very disconnected with the social and public environment it goes through.

Either a viaduct goes through a rural or an urban area, the idea set forth under this part looks at redefining the viaduct structure by attaching spatial function to that infrastructure. The aim is to design a viaduct, and also a city fabric concurrently. The structure has a path for transportation, but below it transforms into a 'permeable and porous wall' to which various spatial facilities, energy supply units and vertical green features could be hung (Figure 14b). Holes in the wall allow visual continuity, while public space and green can flow on each side easily. The proposed wall structure accommodates housing containers placed and re-placed by cranes, and some fixed supportive units. So, many informal housing or unhealthy settlements under the viaducts would possibly move into these housing spaces, leaving the valley clear –for organic farming or such types of usages to self-support the life on the wall. The wall also has vertical green features and gardens for inhabitants. The structure is also designed to have wind turbines for energy generation together with the solar panels that lay partly on the guideway of the viaduct. The bearing columns of the viaduct also create the cores for vertical circulation between the guideway, residential areas, parking flats and ground level of the valley.

V. The Marmaray Project

Under this title, a transportation project which is under construction in Istanbul is introduced, and related arguments on the relationship between city and infrastructure are presented. The Marmaray Project is the upgrading of approximately seventy six kilometres of commuter rail in the city, including the Bosphorus crossing by connecting two sides of the Istanbul strait from under the sea [20]. A sub-sea tunnel is not a new idea for the Bosphorus, the first proposals being put forth a century ago [21]. During the Ottoman Empire, in 1891, a design was put forward by the French S. Préault Railways Company for the route between Sarayburnu and Uskudar. The project aimed at rail transport via a tunnel carried by piles fixed to the ground covering a distance of approximately 800m under the Bosphorus strait (Figure 15 a). The construction of another tunnel between the Anatolian (Uskudar-Salacak) side and the Rumelian side (Yenikapı-Sarayburnu) came to the forefront soon after in 1902. That project belonged to three American engineers -Frederic E. Strom, Frank T. Lindman and John A. Hilliker. It was also aimed at rail transport via a tunnel which would be built on sixteen large piles fixed to the sea bed (Figure 15 b). It was anticipated that it could operate three-wagon trains -two wagons for passengers and one wagon for goods- and would connect to Haydarpasa, the central station of the city. These early projects although never realized can be regarded as utopias in the context of the era they were devised. But the idea of building a 'road' under water is still highly

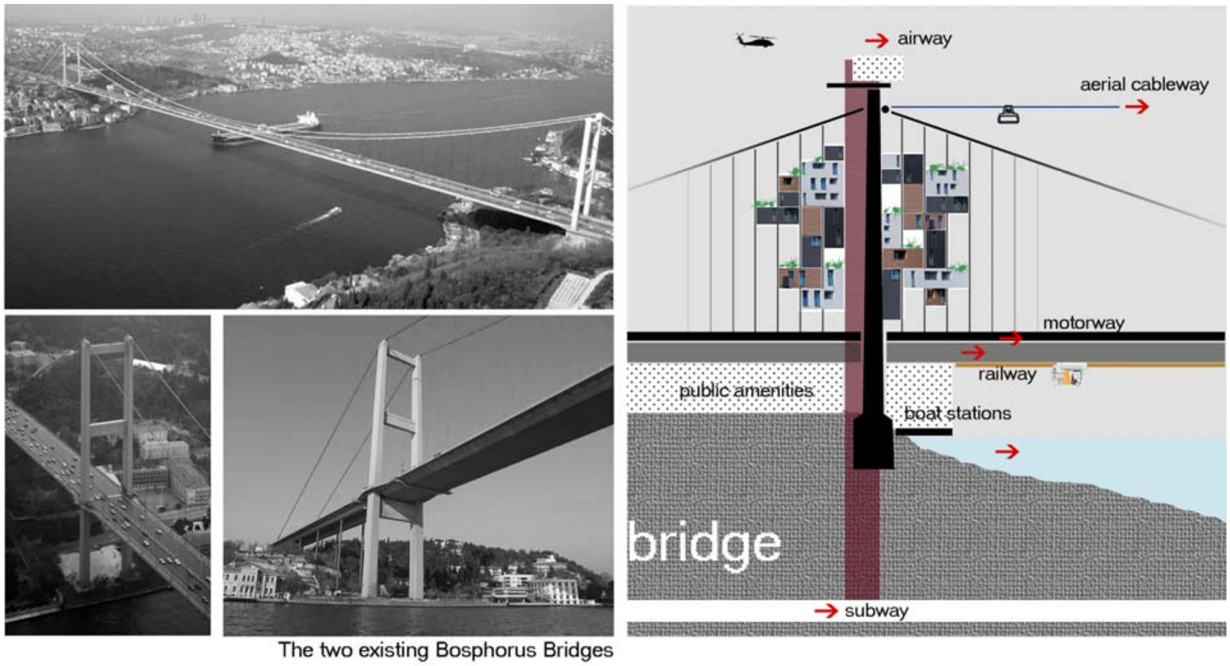

Figure 14 a Bridge Proposal

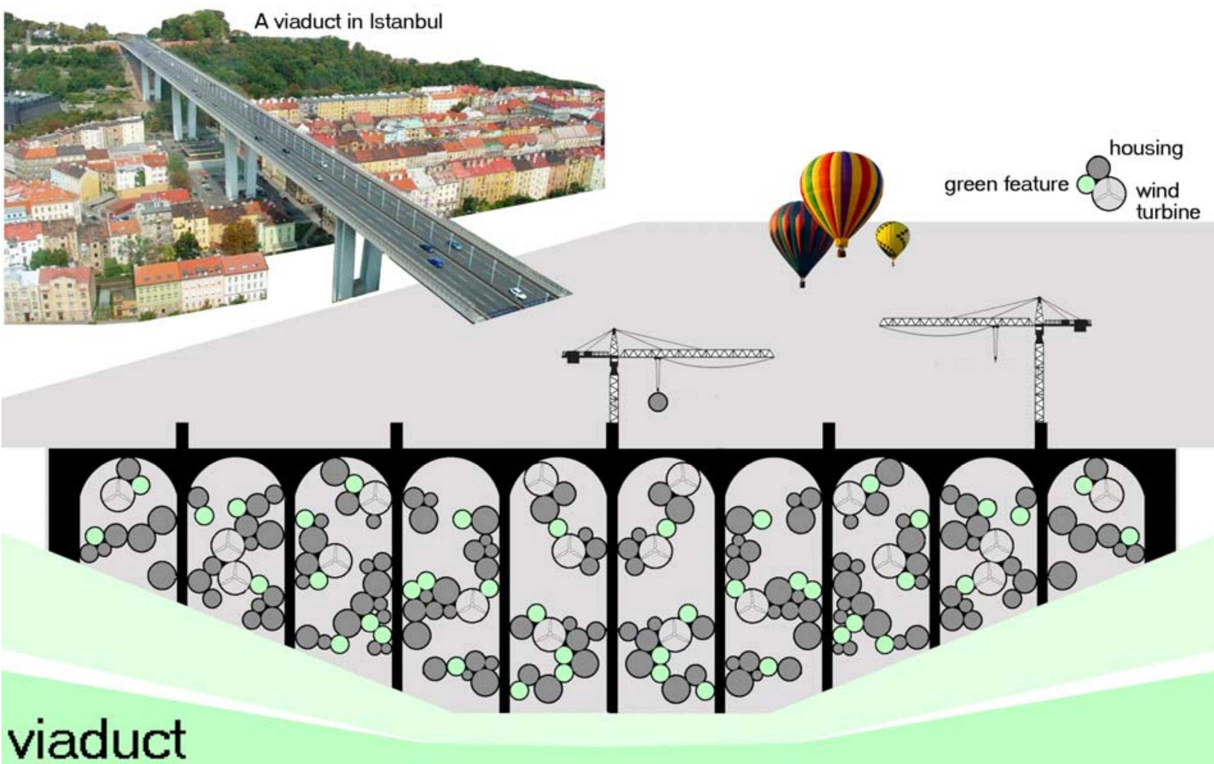

Figure 14 b Viaduct Proposal

impressive. And this prolonged wish is about to come to fruition by way of the Marmaray Project, the construction having started in 2004 (Figure 16 a). It is a rail tube crossing between Sarayburnu and Uskudar matching the routes of previous tunnel proposals.

It is certain that this novel design suggests a system where the foundation, hydraulic and seismic engineering principles are cleverly combined with advanced technology. The immersed tube tunnel of the Marmaray is 1.4km in length. Two integrated tubes which will allow for the one-way passage of each train are completely buried under the bottom of the sea. The upper part of the tunnel is covered with backfill in order to ensure stability and protection of [22]. This project experiences the challenges of being situated in the Bosphorus in terms of construction that needs to take into account the current, heavy vessel traffic between the Black Sea and the Sea of Marmara; non-homogenous pattern of the ground in the Strait; and the fault line very close to the tunnel.

A few issues regarding the Marmaray are highlighted here as the prominent features of the project:

1. Cultural Aspect. The idea of such an infrastructure recognises the legacy of the proposals designed a century ago. Such futuristic and visionary access could only arise from the distinct geographical and topological attributes of Istanbul, which makes this infrastructure a unique and an important part of the city's identity. On the other hand, the construction of the Marmaray unexpectedly and unintentionally has contributed to the history of Istanbul. Some ruins from the fourth century were discovered during the excavation work in stations at Uskudar, Yenikapi and Sirkeci. Archaeological surveys were conducted, which made the construction not only an endeavour of engineering but also a kind of cultural and social exploration.

2. Transportation Aspect. Marmaray, which will be integrated into the current and future rail systems in Istanbul, is a significant phase towards the notion of creating an uninterrupted rail system network. This infrastructure investment is expected to provide a long-term solution to the current transportation problems of the city; as being more promising than a third bridge proposal over the Bosphorus or other waterborne transportation. The objective of the project is to maximize capacity, reliability, accessibility, punctuality and safety on the rail services whilst reducing travel time and increasing comfort for a large number of commuter passengers. It is also appreciated that this system will discourage car usage in the city centre and consequently will help improve the air quality.

3. Architectural-Urban Aspect. This infrastructure has the potential to influence not only the daily traffic pattern of Istanbul, but also the development of the city. Land uses and values will change at both sides of the strait towards the periphery. Also, the regions where the sub-sea tunnel starts and ends are old city centres which are very traditional settlements in an established texture. The project will dramatically regenerate these city fabrics by creating a new interface between water and land. So this infrastructure should be treated as not only a fulfilment of a transport function but an urban planning and architectural design project, especially by stressing its 'waterfront' characteristic. Additionally, in terms of mobility, people will experience a new route and environment which is unique in the sense of crossing the Bosphorus under water.

The Marmaray Project is expected to be completed by October 2013, and so the first train between the continents of Asia and Europe is going to run very soon. The rest of this chapter evaluates the project according to the main concept of the paper; integrating infrastructure with the built environment.

The stations of the tube tunnel on both sides of the Strait will be important transit hubs where hundreds of people will flow through each day. So, they cannot be perceived as ordinary subway stops; but terminals efficiently combining different modes of transport. The model images belonging to the stations of Marmaray in Figure 16 b do not reflect the idea of creating transport and urban nodes; as having been placed in the built environment arbitrarily not considering the full role and impact they will have. However, these structures connecting the underground infrastructure and the outside environment in the uniquely established city patterns should be approached as new architectural and urban design projects. A huge waterfront regeneration which merges infrastructure and a rich architectural programme can be applied to those urban edges, where city meets the sea. For instance, a cultural and arts centre can be proposed encompassing a transport museum (especially displaying the roots of this infrastructure) and many temporary exhibitions. Also various open-air activities and recreational facilities can be arranged to make these places lively and popular public spaces.

Another design parameter for such an infrastructure can be to emphasize its symbolic value. While the big infrastructure projects such as the Bosphorus bridges stand as iconic images on the cityscape, this immersed tube tunnel of Marmaray built under the sea is totally out of sight. In other words, one of the most breathtaking engineering works of the world is completely invisible. Of course, a tunnel cannot be supposed to be visible; nevertheless some implementations can alter the unobtrusive presence of this stunning infrastructure. For example, the waterfront structure designed as the station can be somehow symbolic; or have a prominent feature such as a tower, a balloon, or a pier; an extension on the water matching with the route of the tunnel below. To illuminate the path of the tunnel on the water by an appropriate technique such as a laser can also show the project as an important part of the night-time city. In addition, some vista points can be proposed in the city, from which people can observe both sides of the tunnel; Sarayburnu and Uskudar. So a virtual-imaginative connection can be created by visitors who want to sense the infrastructure on a different scale.

Lastly, further design concepts may be derived from the idea behind the Marmaray Project, different from the last two approaches which are related with building a complex and symbolic representation. This infrastructure supports visionary thoughts and utopic proposals such as life underwater and a floating city. It encourages designers to roam on the fringe of futuristic architecture and urban design based on different scenarios and perspectives. For the sake of having a widespread effect, an international competition or a call for

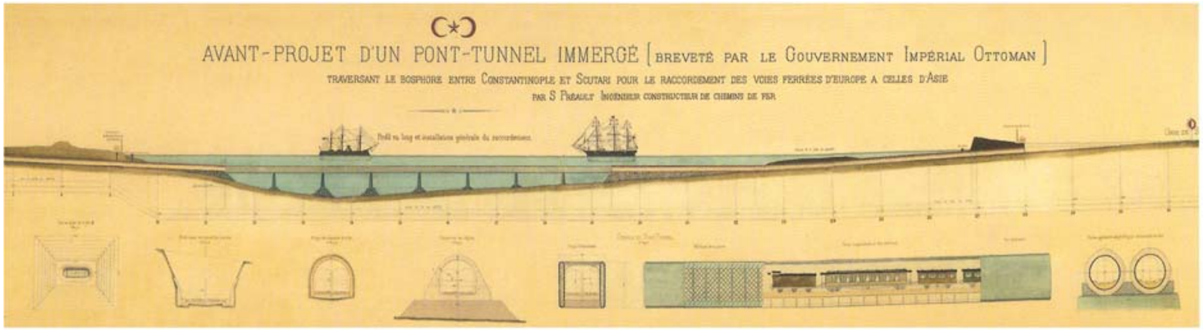

Figure 15 a
Design by French S. Préault Railways Company [21]

Figure 15 b
Design by Frederic E. Strom, Frank T. Lindman and John A. Hilliker [21]

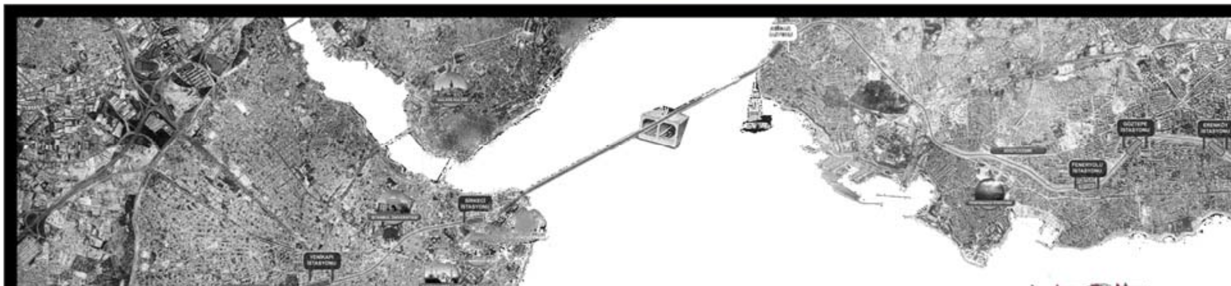

Figure 16 a
The Marmaray Project
[20], [22]

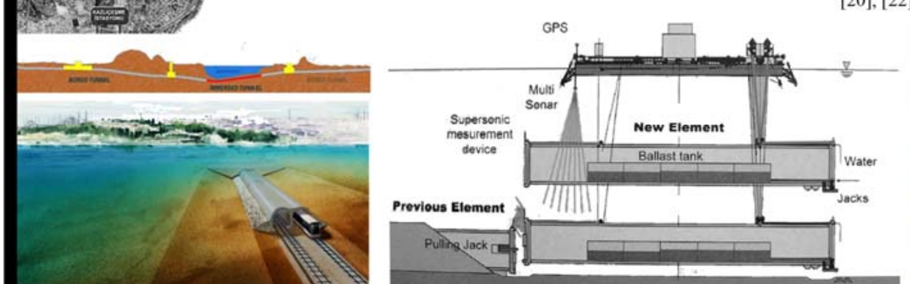

Figure 16 b The Marmaray Project-Stations [22]

academic publications can be attached to the Marmaray process, which will prompt designers from all over the world to think about Istanbul and its future relation with water. Currently, there are many projects taking water as a theme on the harmony of existing between technological advances, sustainability and innovative design; like the submissions to Evolo, one of the pioneering journals that promotes and discusses the future of design (with references to the projects of "Water-Scraper: Underwater Architecture" by Sarly Adre Bin Sarkum and "Underwater Skyscraper" by Higinio Llames and Ifigeneia Arvaniti). Although the infrastructure project Marmaray does not have an architectural unit under water that incorporates a habitation, it is worth seeking ways to allow people to experience a travelling underwater. To some extent, passengers could perceive they are going beyond the surface and travelling in the sea by means of using proper materials and techniques in the structural design. Or, even using some audio or visual installations during the journey underwater can influence the sense of mobility dramatically.

VI. CONCLUSION

The literature covering the future of transportation mostly depends on the new technologies for vehicles, appropriate infrastructure systems and travel planning computation. Additionally there is lots of research addressing a better mobility in social and economic terms, also constantly advocating and encouraging 'green' vehicles, fuels and modes of transportation. On the other hand everyday life changes by the innovations in transportation towards the new meanings of mobility and new perceptions of movement. So, the cities spatially transform in order to adapt to the new century of travelling. Infrastructure buildings such as terminals and stations are designed as the places of interchange and intersection. However, the future of cities requires more than nodal connectivity of terminals or stations; that is what interlaces transport infrastructure with space. On that point this study proposes a visionary idea for the future of both transportation and cities. That is a type of infrastructure architecture for guideways. The aim of the design approach is to re-conceptualize the non-spatial guideways as spatial structures which are highly integrated with its social and physical environment. On the other hand, spatial interpretation of guideways as transport infrastructures is not a new born approach. In fact, many utopic projects have been addressed throughout this paper. Also, there is a rampant interest in the new topics –architecture and the aesthetic of mobility.

The case study of the paper presents new proposals for guideways; roads, bridges and viaducts in Istanbul. This metropolis is one of the most appropriate examples due to its perpetual necessity for a well-integrated transportation network. One of the shared points of all proposals for roads, bridges and viaducts is to think of infrastructure, city and landscape together, not as separate and impermeable parts of the design process. Each proposal has a multi-levelled structure, connecting both different functions and different modes of transportation. Architectural design is based on flexible principles and modularity. Also every project is concerned about green protection and energy efficiency in terms of both generating power and re-cycling. Additionally, a real-time utopia; an infrastructure design proposing a guideway under water is discussed. It is clear that the Marmaray Project is a great design in terms of engineering, but still has a conventional figure in the relation between guideway and city. From the viewpoint of the paper, the spatial interpretation of the project is rather poor when the cultural, transport and architectural-urban aspects of this infrastructure are taken into consideration. In response, three design approaches are manifested to reveal the potential of the project; which are about the building structures of the guideway, the representation of the guideway as a city image, and the other utopic concepts that might be inspired by the guideway.

As a conclusion, this paper draws attention to a rather new type of relationship between transport infrastructure and architecture. One of the aims is to also highlight the role of architect and planner in transport infrastructure for spatial construction of cities and for the lives of the people in them.

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