


Systems Thinking as a Methodological Approach to Study Infrastructure Space in Architectural Design Education

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Abstract: In architectural education, urban-scale studies provide an opportunity for architectural students to study the challenges that cities confront and their physical and conceptual frameworks with a multidisciplinary approach. The design process necessitates the critical evaluation of the inputs that define, structure, and govern the cities and the acknowledgement of social, economic, ecological, geographical, and experiential conditions. The critical reading of the city also demands an understanding of its prevailing, speculative, and emergent conditions, which can be appraised through a cohesive structure of relations shaped by directives from various agents. Advocating for a novel methodological practice in architectural education, this approach fosters the engagement of architecture students with the networks, constellations, and associations of contemporary urban conditions.

With this conceptual framework, the paper speculates on the potential of introducing systems thinking as a methodology for architectural education, which encourages the study of interrelations between different parties, in diverse scales, to design contemporary urban conditions. It subjects students' works in the fourth-year architectural design studio, where systems thinking is acknowledged as a methodology to study the notion of infrastructure space. In these studies, infrastructure space is considered as the site of multiplicities, coexistences, and overlaps beyond its typical association with "physical networks for transportation, communication or utilities" (Easterling, 2014). Studying the infrastructure space through a systems thinking approach is believed to enable the integration of inchoate states and territories of local, trans-local, and global occurrences. To sum up, the paper will discuss the outputs of integrating systems thinking in architectural education, and the reconceptualization of 'infrastructure space' as an instrumental approach in dealing with the complex structure of cities.

Keywords: Architectural education, Infrastructure space, Systems thinking, Design studio.

Introduction

Contemporary cities have started to be defined as the sum of interconnected and dynamic systems, where the invisible infrastructural networks play a crucial role in shaping the

urban experience. Prioritizing connectivity, interaction, and flow over static conditions, contemporary cities today can be argued to operate as complex networks of connections, which require continuous adaptation and

adjustment. Therefore, addressing these complexities necessitates an interdisciplinary approach that incorporates insights from various fields, including ecology, technology, and social sciences. This broad perspective can be argued to assist the development of resilient and innovative solutions for urban challenges and allow for more responsive and adaptable urban environments. However, updated definitions of contemporary cities necessitate new methodologies and strategies for their understanding and design. Strategies developed to understand the multi-layered structures of cities can be essential inputs for enabling different readings of cities and their structuring, such as the infrastructure spaces and networks that make them exist.

In understanding the dynamics of urban conditions, infrastructure space can be considered as an underlying framework, especially to read the challenges of contemporary definitions of urban life, where the built environment, with all its intangible and tangible forces and networks, is regarded as a continuous field. This approach was initially introduced by James Corner & Stan Allen, but further developed by Keller Easterling in *Extrastatecraft*. She states, "Far from hidden, infrastructure is now the overt point of contact and access between us all, rules governing the space of everyday life" (Easterling, 2014). According to Easterling, understanding the dynamics of cities through "infrastructure spaces" highlights the active operational systems and networks that shape urban and global spaces and challenges conventional understandings of architecture and urbanism (Easterling, 2014). It is possible to emphasize the interconnectedness and networked nature of urban infrastructure by foregrounding the importance of these underlying systems and their broader implications. Easterling's definition highlights the underlying systems that govern urban spaces, such as telecommunications, logistics, and governance protocols. This approach welcomes a "site of multiple, overlapping or nested forms of sovereignty, where domestic and transitional jurisdictions collide" and proposes it as a medium to define these crossroads" (Easterling,

2014). Understanding these forces makes it possible to explore the interactions between technology, society, and urban environments from various disciplinary perspectives. Besides their sociopolitical implications, Easterling points out that interlinked networks that operate across different scales and dimensions shape the physical layout of cities and influence social interactions and economic activities. Affecting urban life by directing capital, goods, and information flows, infrastructure spaces can be understood through a more holistic, forward-thinking approach.

About recent climatic crises that affect society, economy, ecology, geography, and human experience, architecture as a field is tasked with providing resilient solutions to address rapid urbanization, climate degradation, and the swift pace of technological advancements while also challenging established norms and expectations through an interdisciplinary approach (URL-3, 2023). Therefore, incorporating the concept of infrastructure space into architectural design encourages considering broader systems, which define more integrated, resilient, and responsive environments. In this framework, architectural research is expected to employ a multifaceted approach to grasp the intricate interactions central to the economic, political, and ecological dynamics of 21st-century cities.

To understand these redefined urban conditions, it is essential to adopt a holistic perspective that examines the broad associations and relationships within urban environments. This requires reassessing assumptions, strategies, and tactics in urban design, architecture, engineering, and politics. Given that architectural research is intertwined with the current state of cities and the issues of resilience, addressing the complex, unpredictable, and dynamic nature of contemporary urban conditions demands a series of detailed and broad analyses. To deal with the complexity of urban conditions as a learning objective of architectural education, in the 4th year studio in the Architectural Department of TED University, infrastructure space was set as a subject of study. The idea lying behind the introduction of infrastructure

space is directly linked to understanding the city's broader dynamics and complex networks of relations. To read, study, interpret, and design infrastructure space, which is shaped by emerging conditions defined by various agents, including human, non-human, international, intergovernmental, and non-governmental entities, "systems thinking" was utilized as a research and design methodology.

The paper argues that this comprehensive approach may define a ground for working with change and dynamism as well as resilience in an urban context through complex design and research processes. With this drive, it discusses how diverse urban conditions are confronted in the design studio, in reference to the notion of infrastructure space as studied in three consecutive years.

Embracing Infrastructure Space in Design Studio through the Methodology of 'Systems Thinking'

A conscious approach that requires working with multiple perspectives and acknowledging the conditions defined in line with various diverse agencies is hard to achieve, especially in undergraduate education in architecture departments. Embracing infrastructure space in the design studio as a design objective required different methodologies of research and design, as discussed above. Consequently, architects need new tools to develop this kind of research on cities and embrace sources, which may not always be directly from the field of architecture. With this aim, the studio initiated a methodology defined as 'systems thinking', as a novel approach that may be instrumental in considering the overall system together with and other related systems and its discrete parts.

The concept of 'systems thinking' belongs to the field of management, which is discussed in detail by Peter Senge as the fifth discipline. He defines systems thinking as a framework for creating a learning organization where parts interact with each other and build complex systems. According to Peter Senge, systems thinking is "a framework for seeing interrelationships rather than things, for seeing patterns rather than static snapshots. It is a set

of general principles spanning fields as diverse as physical and social sciences, engineering, and management" (Senge, 2006). For Senge, 'systems thinking' as a discipline is instrumental for seeing wholes, focusing on inter-relationships rather than things, and patterns rather than static 'snapshots' (Senge, 2006). It defines a cohesive system where different parts, in different scales and with different properties are interrelated with each other to define a complex whole.

This approach offers a deep understanding of complex conditions by recognizing dynamic "behavior that arises from the interaction of a system's agents over time" (Sweeney & Sterman, 2000). It highlights the importance of focusing on relationships instead of outputs and acknowledges nonlinearity and irregularity. With these potentials, systems thinking can be acknowledged as a research and even design methodology for studying structures and understanding system dynamics from different perspectives.

Welcoming collaboration and input, systems thinking as a methodological approach aims to increase the delivery of complexity and hence focuses on defining a complex whole. The idea of 'wholeness' acknowledges that a system consists of various sub-systems, all of which contribute to defining the entire system. For example, according to Ackoff, a system is not the sum of the behaviors of its parts; it is a product of their interactions (Ackoff, 2015). This definition of wholeness as a system facilitates the understanding of complex organizations that function in a dynamic and interconnected manner dynamically and interconnectedly. The concept of wholeness in the systems thinking approach aims to zoom in and out to observe various relationships and interactions, prioritizing the system's dynamics over its outputs. Therefore, acknowledging the systems thinking approach allows focusing on the whole system with a holistic view holistically and requires us to consider each action in the context of the broader systems in which it is embedded (Cavaleri and Sterman, 1997).

Another specific concern of systems thinking is the dynamism of the organization, which demands a specific emphasis on feedback loops rather than the linearity of the process and cause-and-effect relationships. Considering the effects of action not only on the discrete condition isolated from its broader context but also and its influences and effects on other systems alters how the system is envisaged (Senge, 2006). The conceptualization of the system as a 'whole' composed of various complex systems in different scales and compositions allows the redefinition of each sub-system concerning a change defined in another system. This continuous feedback loop within the system also embraces the concept of emergence, where the behavior of the system cannot be predicted only by individual components. This methodology is argued to be entirely in line with the concept of infrastructure space, which was established as a significant component of the design studio. What is argued under the infrastructure space in its relation to systems thinking was highlighted as its potential to orchestrate activities that can remain unstated but are nevertheless consequential (Easterling, 2014).

Adopting systems thinking in the reading, designing, and structuring of contemporary urban conditions was argued to assist the embracing of the urban as an infrastructure space, which may initiate the definition of new opportunities for dealing with the pluralities, contradictions, degradations, complexities, and challenges of 21st-century cities. Therefore, by adopting this methodology, architectural research can consider the broader and long-term implications, focus on interrelationships rather than cause-and-effect relationships, and provide a multi-focal rendering of relations, which define a holistic approach to the design problem and the understanding of infrastructure space in urban scale. Within studio practices, the definition of infrastructure space relates to the concept similar to an operating system, where a series of networks work in association. Going down the path that Stan Allen paved, as deterritorialization of disciplinary striations of the environmental disciplines, like architecture, the design studio practices in these years tried

to move away from the design of discrete artifacts to a choreography of multitudinous relations defined under infrastructure space (Allen, 2008).

To gather, interpret, and utilize data from a constantly changing and evolving city and to regard its territory as a field of information, the studio welcomed speculative research tools, which can integrate both qualitative and quantitative data made accessible by technological advancements. Therefore, data visualizations, in particular, were often used to display diverse information and data simultaneously, aligning with systems thinking methodology. As a new challenge for the infrastructure space approach, these multi-layered and multidimensional representations of complex data were utilized to map the ever-changing relationships and expand data of the city in all its aspects, reshaping our understanding, definition, and visualization of urban environments.

Diverse Articulations on the Notion of Infrastructure Space

This method of conducting an in-depth analysis of the city from various scales and perspectives, where multiple systems interact to form a complex whole, offers advantages for embracing complexity in architectural research. Using this framework, this paper presents a selection of student works which were studied in undergraduate architectural design studios at TED University's Department of Architecture in Ankara, Turkey. The semester projects aimed to discuss how the 'systems thinking' approach has been adapted to architectural research in studying the urban complexities of contemporary cities, where diverse articulations of infrastructure spaces were introduced as an architectural response to the experienced changes.

As illustrated in the detailed examination of the examples, the systems thinking approach, usually implemented in the first semester of the 4th year, requires students to develop a series of analyses and interpretations of the entire city rather than focusing solely on a specific site. Consequently, the assigned areas for each

semester demand unique inquiries that necessitate solutions and design approaches at an urban scale, enabling the conceptualization of the city as an infrastructure space rather than an architectural one. Each example analyzed here was selected from a different semester. Therefore, each example focuses on a different city and includes different infrastructural networks that make up comprise the urban tissue.

Selected cities share the typical quality of being port cities within their regions. Three port cities in different geographies were studied for three consecutive years, one being Beirut in Lebanon, and the other two are from the southern and northern regions of Türkiye, Mersin, and Samsun, both of which are significant port cities of the country. It was aimed to discover the spatial, material, and experiential dispositions along the encounters of water with land/city and develop adaptive, solitary, and resilient strategies for the particular urban context. The utilization of infrastructure and urban space was emphasized in the studio works' research and design processes emphasized the utilization of infrastructure and urban space. All the student groups focus on a different aspect in structuring the basis of their research. However, the main aspect common in all examples lies in their attempt to develop distinct tactics for studying complex urban conditions through infrastructure space and utilize systems thinking to cope with the discovered pluralities and networks of relations. Incorporating systems thinking as an architectural research and design methodology and experimenting with this methodological approach through infrastructure space provided valuable inputs to the studio processes. Through this approach, students studied complex problems that cities face today, generated ideas about rapidly changing cities, and ensured resilient futures for the cities.

Beirut Port as an Infrastructure Space

The cities selected for studio research, Beirut, Mersin, and Samsun, provided comprehensive

data to study the urban collapse that the cities faced in the last decades from multiple perspectives and on various scales. In Beirut, issues related to the economy, urban management, transportation, limited access to public and green spaces, and climate risks are just a few problems requiring larger-scale interventions and comprehensive urban strategies. The Beirut Port explosion on August 4th can be seen as a natural outcome of this decline in many respects. The blast created a ground-zero condition at the port area, significantly impacting the land and urban landscape of the waterfront edge (URL-1, 2020). Understanding the specific characteristics of Beirut's urban land, both before and after the explosion, demands a deeper analysis of various aspects of the city on a broader scale. The city's multicultural makeup, historical significance, and regional position are crucial in comprehending and revitalizing Beirut's urban qualities and waterfront urban edge.

Beirut Port is Lebanon's vital economic, strategic, and cultural asset, with significant contributions significantly contributing to trade, employment, and regional connectivity. Facilitating a significant portion of the region's trade, the port is a primary source that supports various industries by providing essential import and export facilities. Being an ancient trading hub, the port has cultural and historical significance in the region, affected by economic, political, and social developments. Because of its connections with multiple modern terminals and its potential as an urban space, the port also acts as an infrastructure space for the city and the Mediterranean region on a larger scale (URL-2). It is related to the networks of the city, where underlying systems of multiple and nested forms operate at various scales and complexities. In this respect, the port is regarded as an infrastructure of the city, and the following student project approaches the networks of relations entrenched by the port (Figure 1).

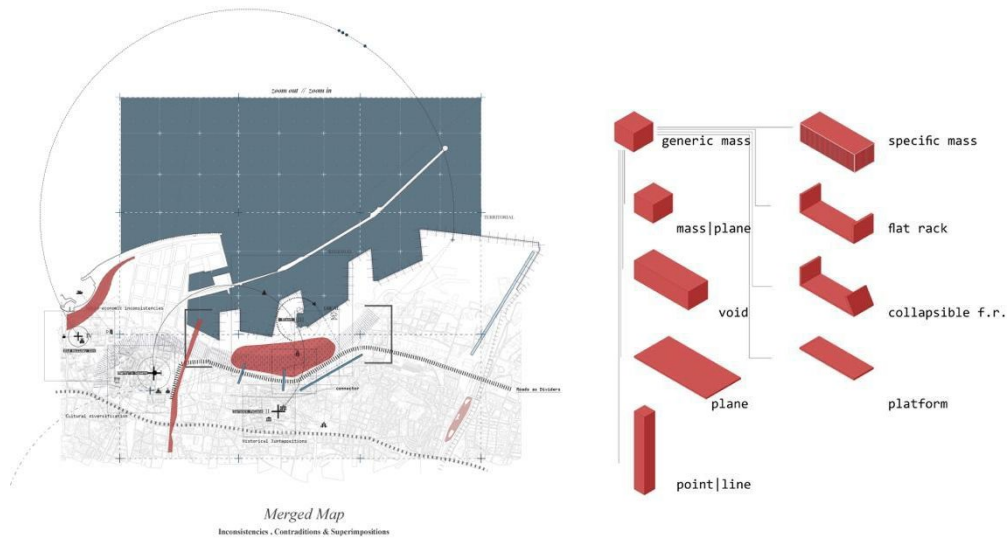


Figure 1: Research on visible and invisible networks of relations in the port area, Beirut (Authors: Bilgesu Sever, Gökçe Yıldız, Deniz Yeni, Umay Çınar, Ruaa Albasha, TED University, Fall 21-22)

The harbor area, which controls the geography of the city's northern border along its entire length, is, in fact, a significant factor in determining the city's possible relations with the water. Mapping the inconsistencies, contradictions, and superimpositions, the project tried to discover new territories by overlapping different networks and infrastructures in relation to the port area of Beirut (Figure 1, 2). The research focused on

the superimposition of various clusters formed by the intersection of different zones rather than the linear character of the harbor as the result of its operative necessities and questioned how this should be considered a novel input to the design process. In its attempts to unravel how it generates its own infrastructure networks, the research tried to overcome the limitations of conventional maps and plans, as a base.

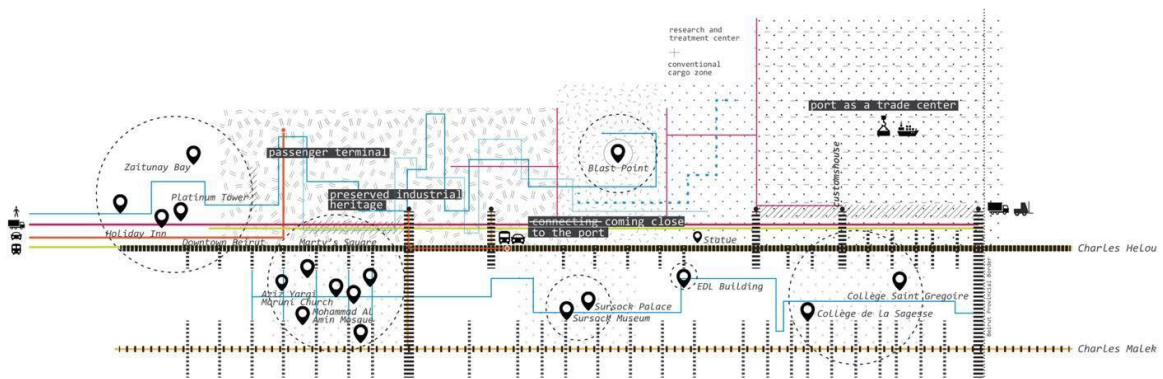


Figure 2: Mapping the diverse infrastructure space of the port area, Beirut (Authors: Bilgesu Sever, Gökçe Yıldız, Deniz Yeni, Umay Çınar, Ruaa Albasha, TED University, Fall 21-22)

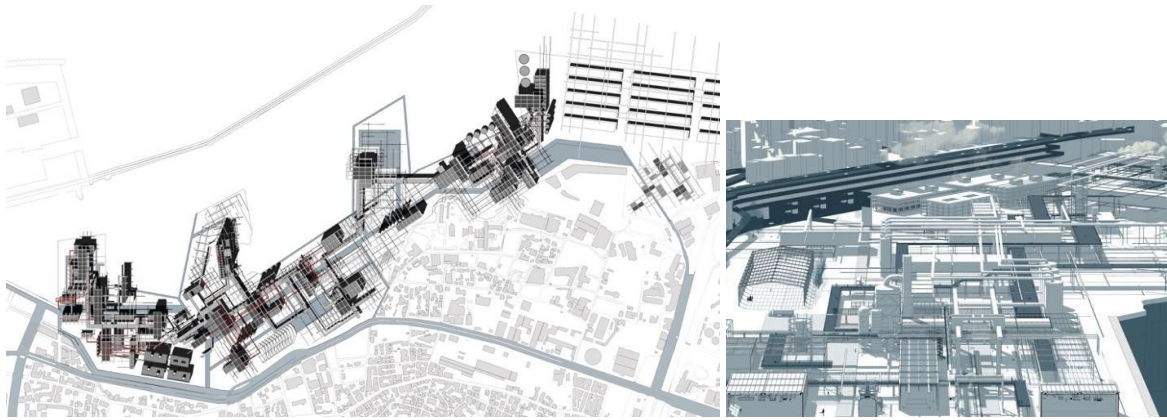


Figure 3: The design proposal displays the port area as an infrastructure space composed of networks of relations (Authors: Bilgesu Sever, Gökçe Yıldız, Deniz Yeni, Umay Çınar, Ruaa Albasha, TED University, Fall 21-22)

The design approach of the research benefited from the idea of understanding the operative structure of the port area and initiating a similar design strategy for the whole area. This strategy can adapt to changes easily and interact with others constantly. While proposing a more layered network of relationships, it puts forward the idea that these systems should be considered holistically, functioning and interacting with one another rather than analyzing the infrastructure and superstructures of the port separately (Figures 3, 4). In this scenario, each element constitutes a sub-part of a more extensive operating system, temporarily and permanently decoupled from each other. It can

be argued that the correspondence of the research method with the design methodology has led to a more holistic approach to the design process, thus effectively relating the solutions of problems across scales and in the operationalization of systems thinking (Figure 4).

Defining the Infrastructure of Transportation in Mersin

Mersin, a significant port city of Turkey located on the southern coast of the country, is a city that has been developed along the rail line that runs along the east-west axis, connecting the city with other ports and trade centers on the

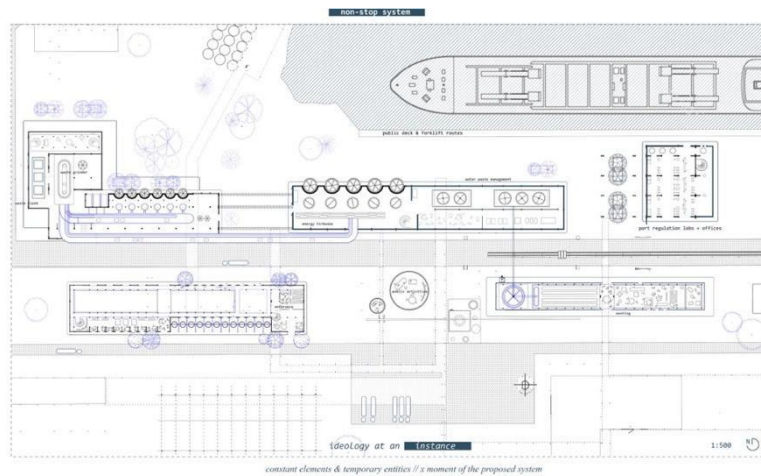


Figure 4: The design proposal strategies for adapting to change (Authors: Bilgesu Sever, Gökçe Yıldız, Deniz Yeni, Umay Çınar, Ruaa Albasha, TED University, Fall 21-22)

south coast. In recent years, Mersin has been one of the cities experiencing dramatic transformations, especially in its coastal areas. With its increasing urban problems, it has become the subject of the studio. Despite the port being a critical edge of the city and its development over the years since the 18th century, the growth experienced after the 1960s and the subsequent urban transformation have changed Mersin's urban areas demographically, culturally, politically, and economically. As a result of migration (internal or external), social tensions, infrastructure problems, and urban corruption have become the city's main issues.

One of the unique features of the city of Mersin is the train line between Adana and Mersin, as well as the industrial and educational diversity that has developed due to its use. The train line, considered part of the city's infrastructure, along with a series of associated spaces (port, train station, industrial zone, etc.), forms a complex network of relationships and offers an opportunity to investigate the city's problems and potential. In this context, the project

displayed in Figures 5 and 6 aims to overlay data such as the density of the train line, passenger transport rates and schedules, freight transport information, and diversity to question the city's current position and development. Through analyses and visualizations explicitly used to understand the relationship between industry and urban spaces, the train line and its surroundings were considered as infrastructure space and examined through their interaction with the other networks of the city.

The rail line defined and controlled the city's development, industrial and educational spaces, and the most critical transportation axis between the two major cities of southern Turkey: Mersin and Adana. The station and the rail line were discovered to act as the major infrastructural space of the city, together with the port and the industrial facilities that are attached and related to this linear urban structure (Figure 5).

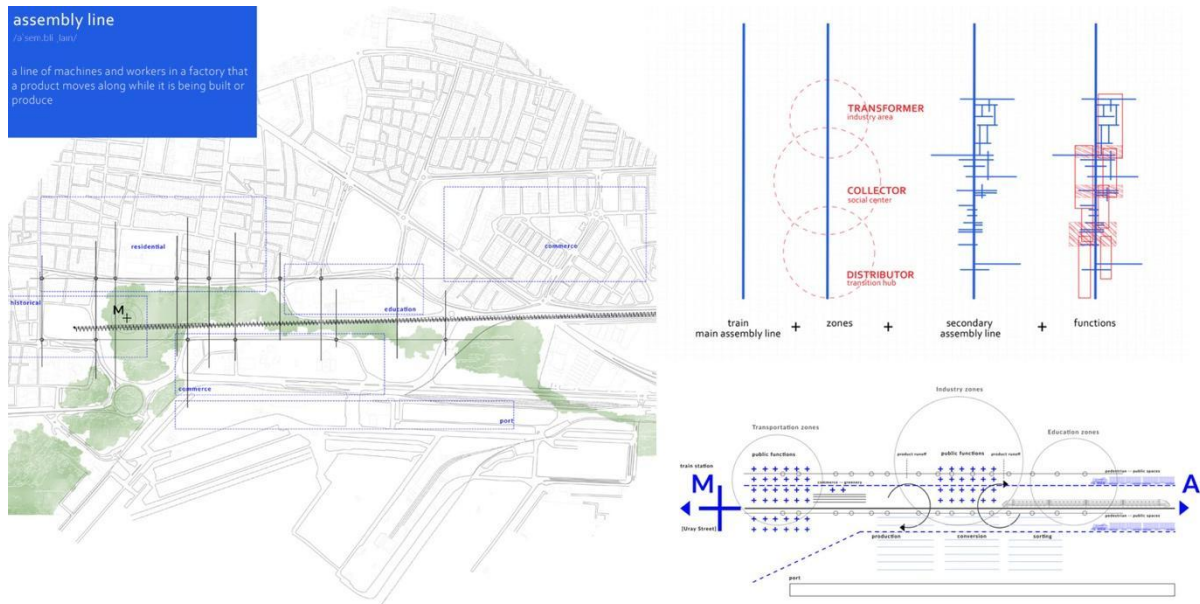


Figure 5: Rail line as an Assembly line in Mersin (Authors: Rabia Öykü Emiroğlu, Şeyma Dilara Aldemir, Bensu Acarakçay, TED University, Fall 22-23)

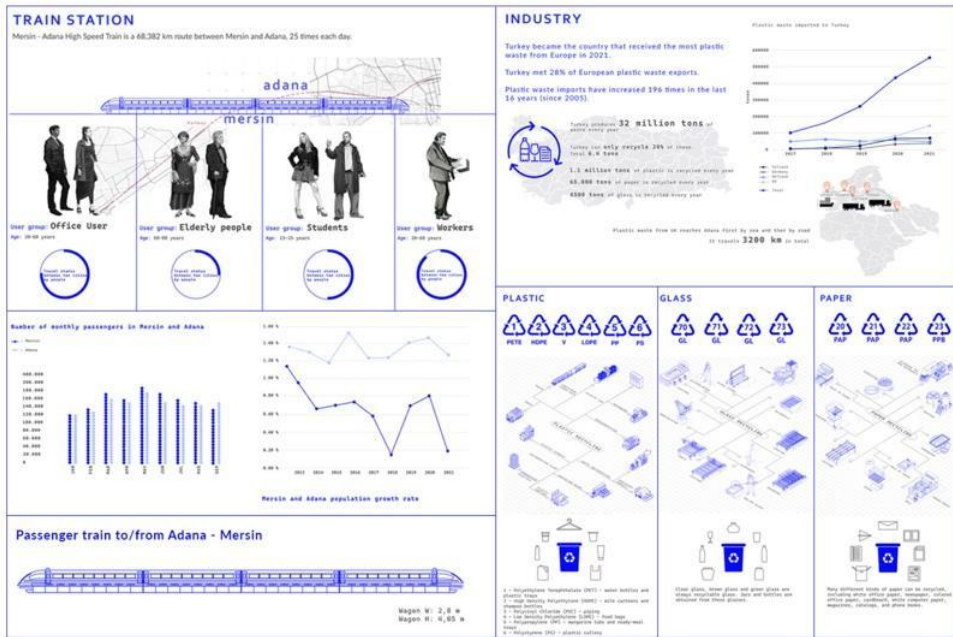


Figure 6: Analysis of Mersin-Adana rail line (Authors: Rabia Öykü Emiroğlu, Şeyma Dilara Aldemir, Bensu Acarakçay, TED University, Fall 22-23)

The project provided research, which emphasizes emphasizing the continuous transportation loop /flow of people/goods, etc., between two cities and considers it as a challenge for the city's future urban development. Focusing on the potential of this investigated linear axis not only as a transport axis but also on its potential to host many different activities on and around it; the project adopted the approach that this urban infrastructure space could be regarded also as an urban assembly line. The research process revealed the potential of this infrastructural line as a space where multiple conditions can overlap and even emerge as a new hinterland that can host new urban interactions (Figure 5).

By studying the line quality and accompanying urban spaces, the project proposes that the line can be acknowledged as an infrastructural link between industrial facilities supporting the industrial potential of two cities. The environmental conditions, for example, the central role of Adana in collecting and transferring global garbage/waste, were regarded as an industrial input, which can assist the exploitation of the rail line as an infrastructural urban interface (Figure 6). In line

with the research findings, the project developed a scenario that connects the garbage /waste transfer from different parts of the world through Adana and how the linear infrastructure can turn into an operative line for recycling and upcycling the accumulated waste and managing its transfer to other countries through the Mersin port (Figure 7).

The project approached the definition of the infrastructure space in the city of of Mersin by integrating the recycling, rail station, rail line, and industrial zone. This integration is argued to enable the creation of an industrial network that supports the city's urban development. Conversely, the recycling industry, in conjunction with the port, rail station, rail line, and industrial zone, which are defined as the infrastructural space of the city, amplified urban networks, proposed new urban scenarios, and extended the lands of coexistence. Consequently, the project embraced a systems thinking approach and defined the infrastructural space to study local, trans-local, and global occurrences in a contemporary industrialized city, Mersin.



Figure 7: The industrial network proposing unilinear assembly for cycling waste (Authors: Rabia Öykü Emiroğlu, Şeyma Dilara Aldemir, Bensu Acarakçay, TED University, Fall 22-23)

Wetland as the Infrastructure Space of Samsun

Samsun, another industrial port city on Turkey's northern coast with infrastructure characteristics similar to Mersin, has been dealing with the consequences of urban challenges that have emerged over the past decades, altering its social, geopolitical, environmental, and architectural conditions. Recognized as a transportation and industrial hub in the northern region, Samsun is connected to the Black Sea region of Anatolia through various routes. For years, the city has managed national and international trade routes and has been promoted as an industrial and agricultural center that strengthens its geopolitical and geomorphological position in the region. However, in recent decades, environmental degradation, urban decay, and industrial policies have significantly changed the city's urban conditions and definition.

The project aims to analyze the city on a large scale, considering its geological and climatic

characteristics. It has defined a water formation library for the city, as presented in Figure 8. Within this scope, the project can be seen as a reading that defines the relationship between the city of Samsun and water by analyzing the water patterns of different cities and mapping the potential formation of water movements. The project addresses the Mert Stream, which has lost its wetland characteristics due to uncontrolled uses, and its surroundings as an infrastructure space, aiming to conceive the stream as part of a large-scale infrastructure network. To propose a new network, creating a comprehensive library that maps and compares existing water patterns from various cities allows for developing various water management tactics and guidance in the design. The information obtained and collectively mapped, rather than individually, opens up the possibility of new data relationships that may not be perceived when analyzed independently (Figure 8).

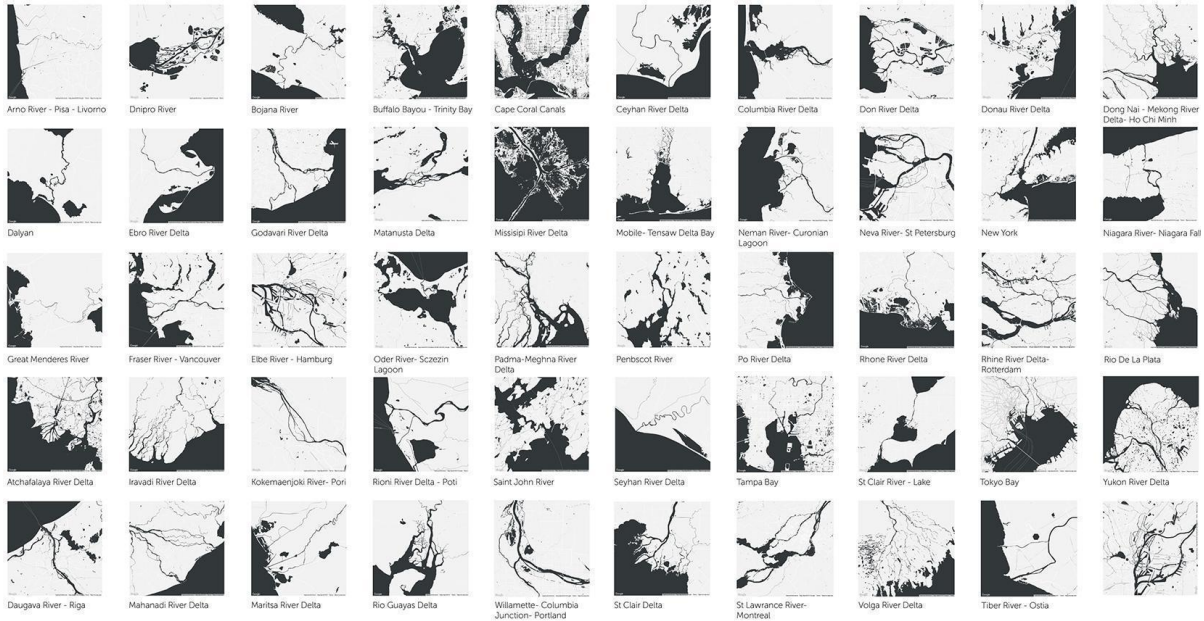


Figure 8: A library of water-land relations. (Authors: Bartu Aydınli, İlayda Ülgen, Zeynep Süner, TED University, Fall 23-24)

The Mert River, flowing through the city center, has been re-envisioned as a fundamental infrastructural element that not only delineates but actively shapes the urban and industrial conditions of the city. Historically, the river has been pushed to the periphery as urban development prioritized separating the industrial zone from residential areas. This shift has relegated the river to a mere boundary rather than an integral component of the cityscape. The project seeks to rectify this oversight by treating the river as a pivotal zone with extensive physical, ecological, and biodiversity value capable of addressing various emerging crises within the city. The project adopts a comprehensive approach by analyzing the river and the broader regional water resources, including flood patterns and environmental changes. This analysis reveals that the river's current state results from uncontrolled developments and neglect, which has led to its diminished role in the urban environment. By mapping these conditions, the project highlights the need to reconceptualize the river as a waterscape and a vital infrastructure space that can enhance the city's resilience.

To address these issues, the project proposes the establishment of a water treatment zone along the river. This zone will manage and process waste from residential and industrial zones, thus mitigating pollution and improving water quality (Figure 9). Additionally, the project envisions the development of alternative waterways to manage flood risks more effectively. By expanding the riverbeds to their original dimensions and introducing new channels, the project aims to adapt to varying water levels and mitigate the impact of floods in different seasons (Figure 10). The plan also includes the creation of a lagoon and several islands that will serve multiple urban functions. These new spaces will integrate residential, recreational, educational, and industrial activities with this newly formed wetland. This integration will redefine the relationship between the urban fabric and the river, creating dynamic spaces and a network of relations that respond to the river's changing states.

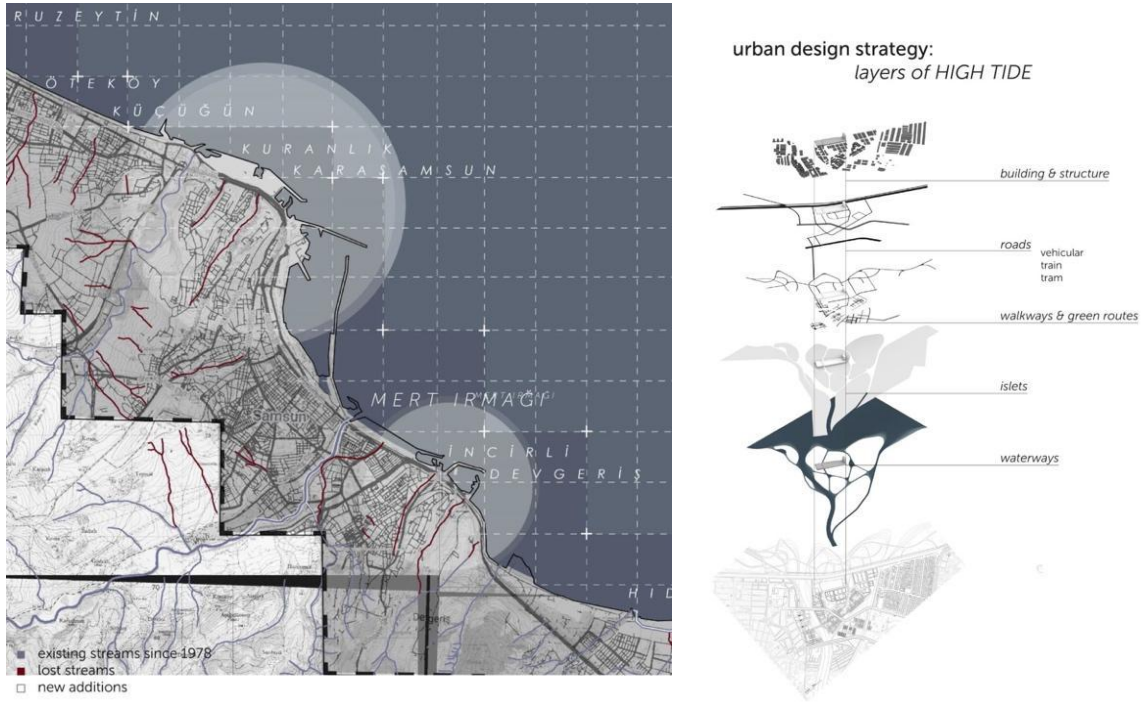


Figure 9: Analysis of water zones and changing patterns within the urban tissue (Authors: Bartu Aydınli, İlayda Ülgen, Zeynep Süner, TED University, Fall 23-24)

All the selected examples emphasize the interrelations in the city and reveal the complex conditions where various layers of data were overlapped and reinterpreted. In the studio process, the data visualizations also create another data set that contributes to the studio's learning environment. Each visualization provides a different perspective on the city's

urban conditions and initiates the reading of visible and invisible states particular to the studied geography. By exposing the diverse networks of the city, these complex visualizations were utilized in the studio process to understand how these networks work and affect one another. Although the paper includes selected examples from studio productions, the visual palette of data sets

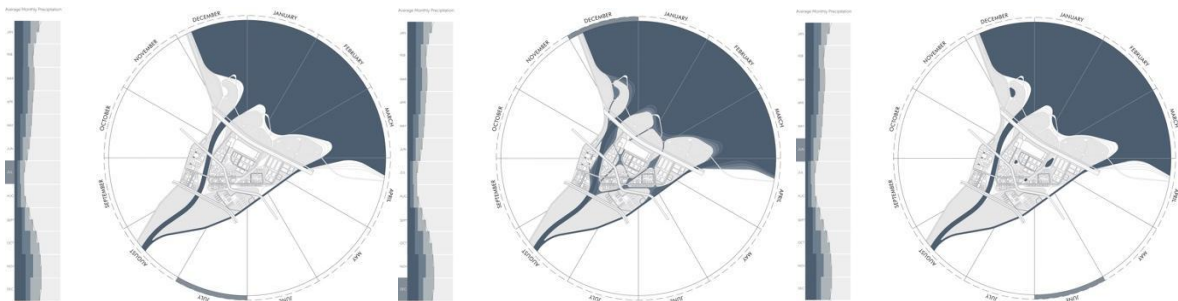


Figure 10: Design proposal adopting to change of water levels and infrastructure of wetland created by Mert Stream in different months of the year (Authors: Bartu Aydınli, İlayda Ülgen, Zeynep Süner, TED University, Fall 23-24)

defines an explorative ground for architectural research and design.

Conclusion

Regardless of their subject of analysis, all the examples discussed here try to unfold the visible or invisible transformations of the cities initiated by social, economic, and often political concerns. It aims to make the unknown urban networks more comprehensible and integrate them into design processes in architectural education to define an alternative methodological approach that can be used to study complex urban design problems. In that respect, the 'systems thinking' approach adapted from a transdisciplinary field provided positive input in the design studio processes, where the students have a chance to can work within non-linear and complex design processes. With this new methodological input, it was possible to overcome the shortage of already experienced and practiced design methodologies for dealing with the difficulties of large-scale urban design problems. The aim has never been to propose a uniform urban analysis or design method, or to recommend the use of using systems thinking in all urban research and design studios regardless of the context. Of course, since all sample projects are the products of undergraduate studios, the research processes and transferring the research output to design cannot be as detailed and comprehensive as the outputs of a master's studio. However, it has nevertheless been a method with many gains in terms of determining the framework of perception and research on the urban scale and understanding the city together with all the systems that make it exist.

As discussed in the article, systems thinking, in that sense, offers new ways to engage with urban complexities and provides more open-ended, flexible research and design processes compared to traditional methods and it also enables the consideration of the urban field as an infrastructure space. Concerning the discussion opened up by Easterling, the infrastructure space is believed to offer means of amplifying urban networks, proposing new urban deals/scenarios, and extending the lands

coexistence. Therefore, it can be embraced local, trans-local, and global occurrences in contemporary industrialized territories (Easterling, 2014). It can be argued that the increasing urban complexity, as demonstrated through various scales and types of infrastructure definitions and spaces, has created a productive discussion platform within the studio. The utilization of systems thinking as a methodology also supported the understanding of the changing conditions of cities and their quantitative/qualitative components, creating a solid ground for responding to the network of relationships that structure the essence of the contemporary city, along with all its climatic, environmental, political, and social issues. As Senge states, "Systems thinking is a conceptual framework, a body of knowledge and tools developed over the last fifty years to help us see patterns more clearly and understand how to change them effectively" (Senge, 2006).

Considering the future roles of architecture and architectural research, ensuring urban resilience is perhaps at the forefront of all discussions. Expanding the field of architectural research and integrating various data and inputs are crucial for developing ecological approaches and creating a more sustainable future. In this context, regarding the city as an infrastructure space supported by the idea of systems thinking forms the basis for discussions on its potential ground-breaking roles in architectural design education and architectural research processes.

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Note: N/A

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