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GAZİANTEP'S TRANSFER HUB DESIGN PROJECT INSPIRED BY THE INTRACELLULAR PROTEIN TRANSPORT SYSTEM

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ABSTRACT

This article explores how to design a Transportation Transfer Hub inspired by Nature. The Transfer Hub in the study was designed to solve the transportation problems of Gaziantep, one of Turkey's major cities located on the historical silk road. The research was conducted to prepare the Gaziantep Spatial Strategy Plan. The literature review, document analysis, case study, in-depth interviews, focus group interviews and systematic observation methods were used. The research had shown that the biggest problem of Gaziantep is the unsustainable and non-integrated urban transportation system. Therefore, a transportation transfer hub to Gaziantep city centre was proposed in the strategic plan as the best move to solve the problem. The perspective of biomimicry theory was used in the study. In adopting the biomimicry perspective, the research work commenced with the following research questions: (i) What would Nature do if it encountered such a problem? (ii) How would Nature solve this problem? The intracellular protein transport system has inspired the Gaziantep Transportation Transfer Hub and contributed significantly to the urban design project. First, with Nature as an inspiration, an original design, unlike any other transportation transfer hub in the world, has emerged. Second, an organic urban design in harmony with Nature has also emerged. Third, ratio and proportion, size and standards are on the agenda of design. Thus, in the third dimension, an aesthetic physical environment with balanced occupancy and the void ratio has emerged. Fourth, technological solutions have entered the design agenda. Fifth, Gaziantep's transportation problem has found a solution with an intriguing, interesting, innovative, and beneficial, sustainable method. The study has shown that many urban/rural problems can be solved using the biomimicry perspective. Mankind still has a lot to learn from Nature.

Keywords: *Turkey, Transportation Transfer Hub, Biomimicry, Intracellular Protein Transport System, Nature-inspired Urbanism*
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INTRODUCTION

This article explores in detail how a Transportation Transfer Hub is designed with inspiration from Nature. Transportation Transfer Hub is proposed to Gaziantep, one of Turkey's major cities located on the historical silk road. The aim and scope of the study, the concept of "biomimicry", and the city of Gaziantep are briefly introduced. In the methodology section, the research methods used in the study and the method of taking inspiration from Nature are explained. In the third section, the transportation problems of Gaziantep and the Spatial Strategy Plan that is proposed to resolve these problems are explained. In the fourth section, details of the urban design project inspired by the intracellular protein transport system for Gaziantep Transportation Transfer Hub are demonstrated. In conclusion, the contributions inspired by Nature through the intracellular protein transport system in urban design project are summarised.

Biomimicry

The learning method of the early people in human civilisation was to be inspired by Nature. Early humans learned from the cycles of Nature, including animal lives. According to the Qur'an Surah al-Maidah ayat 31, Qabil (Cain) learned from the crow that he had to bury his brother, whom he killed, in the ground. As described in the story, Qabil did not know what to do after he killed his brother Habil (Abel). Then Allah sent two crows.

One of the two crows attacking each other killed the other and buried it in the ground. Seeing this, Qabil said: "It is a pity to me that I could not even bury my brother's body as much as that crow" (Harman, 2020).

"…So (Qābīl's) mind encouraged him to murder his brother, so he murdered him and became of the losers. Then Allāh sent a crow which scratched the ground to show him how to hide the dead body of his brother. He (the murderer) said: "Woe to me! Am I not even able to be as this crow and to hide the dead body of my brother?" Then he became one of those who regretted…" (Al-Ma'idah 5/30-31)

Throughout history, all civilisations have been inspired by Nature while solving the problems they encountered. The best examples of being inspired by Nature in Architecture and Urbanism are seen in Andalusian Civilisation. Andalusians reflected the proportions that exist everywhere in Nature at the micro and macro scales such as the 'Golden Ratio' on the architectures they produce. The width and height of the buildings they built were determined by the square roots of 1, 2 and 3, just like in Nature (Figure 1). Again, the columns used as the carrier system in the Alhambra Palace in Andalusia, Granada, were built by taking inspiration from the body dimensions (radius and height) of the palm trees commonly grown in that region (Vilchez, 2015).

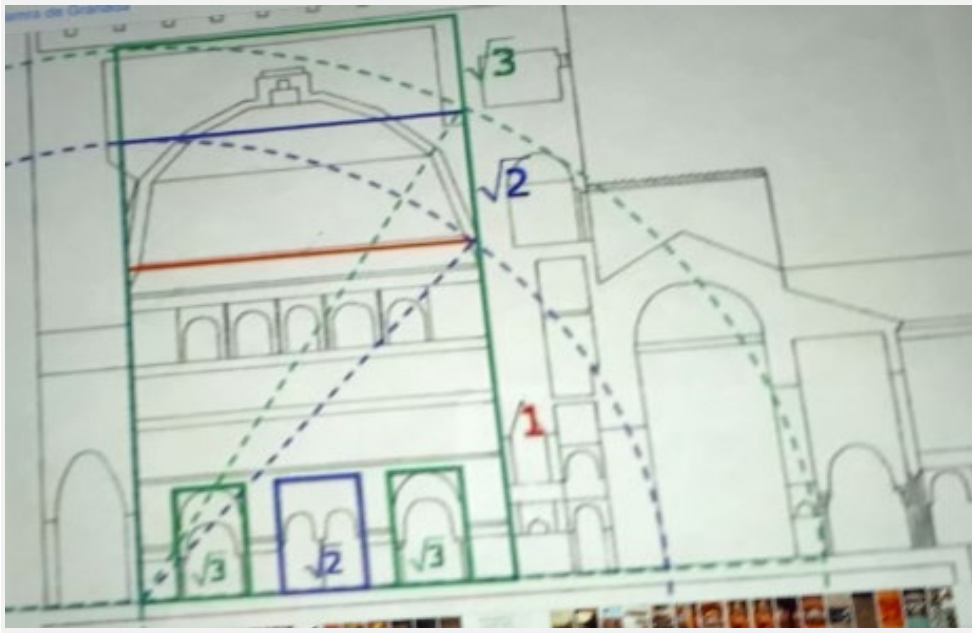

Figure 1: Golden ratio in nature used in the Al-Hambra Palace belonging to the Andalusian Civilization
(Source: from authors' archive)

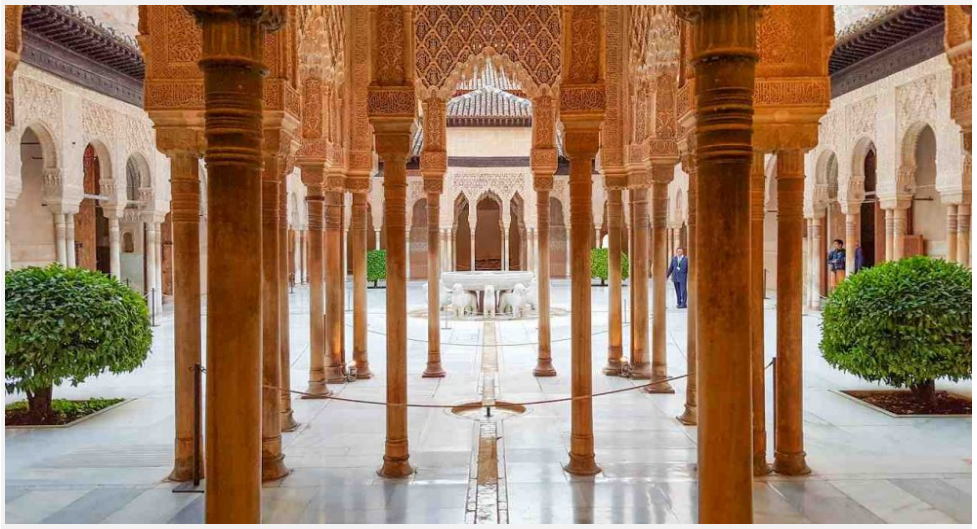

Figure 2: Pillar forest inspired by palm trees in Al-Hambra Palace
(Source: from authors' archive)

Although the act of taking inspiration from Nature is not a new phenomenon, the concept of Biomimicry was introduced to the literature with the book *"Biomimicry: Innovation Inspired by Nature"* written by Janine M. Benyus in 1997. The concept of Biomimicry, born of the word's "life" and "simulation", was an element that breaks the monotony of designs produced in the digital age and attracted the attention of many people around the world. This concept is based on the idea that Nature is full of unique and perfect organisations to inspire. Nature not only analyses design but also presents its designs to people aesthetically (Benyus, 2003).

The philosophy of biomimicry understood Nature, as a phenomenon through its existence millions of years ago has encountered many problems similar to those faced by Man and had resolved them remarkably. Man has to look to Nature and find out how Nature solves the problems. However, Nature does not offer a straightforward solution as "do this to solve this problem". In a way, Nature offers a perspective that helps people to distinguish between right and wrong (Schauberger, 1999).

"See nature as a teacher rather than a warehouse."

Janine M. Benyus,

Biomimicry is the technology of biology. A person who needs a guide must look to Nature. There is a difference between being inspired by Nature and copying nature. It is an approach that seeks innovative and beneficial sustainable solutions for human survival problems and develops models and strategies inspired by Nature (Seymenoğlu, 2019).

Urban design can also be viewed from a biomimicry perspective. In the 1900s and 2000s, when the importance of urban design was understood and popularised monotony and similarity in cities increased. This occurrence was due to reliance on mechanisation, industrialisation and digitalisation. Efforts to produce uniform solutions in urban design projects aimed at the problems of globalising cities prevent the emergence of different ideas and perspectives. Similar design ideas in projects are disconnected from Nature and do not offer permanent solutions. Man must leave themselves neither to the natural environment nor to the artificial environment to lead. It is not impossible to produce artificial environments that are compatible with the natural environment, and this is perhaps the best thing one can do for humanity. Mankind can produce comfortable living and working spaces without fighting Nature. This ideal can be realised when the resources offered by Nature are presented at minimum scale in urban spaces. The use of the exciting and intriguing process of Nature as a tool in the solution of urban problems brings different alternatives in project development (Beatley, 2011).

This article explains how to design a Transportation Transfer Hub inspired by Nature. The Transportation Transfer Hub has been designed to solve the transportation problems of Gaziantep's inner city.

Gaziantep

Gaziantep city is located in the TRC1 planning region in Turkey. It is adjacent to the cities of Hatay, Osmaniye, Kahramanmaraş, Adıyaman, Şanlıurfa and Kilis and borders with the Syrian state. The surface area of 6,222 km², the city's population is 2,028,563 people, and the city is Turkey's ninth most populous province. There are nine districts in total, three centres (Şehitkamil, Şahinbey, Oğuzeli) and six surrounding districts within the city of Gaziantep (Figure 3).

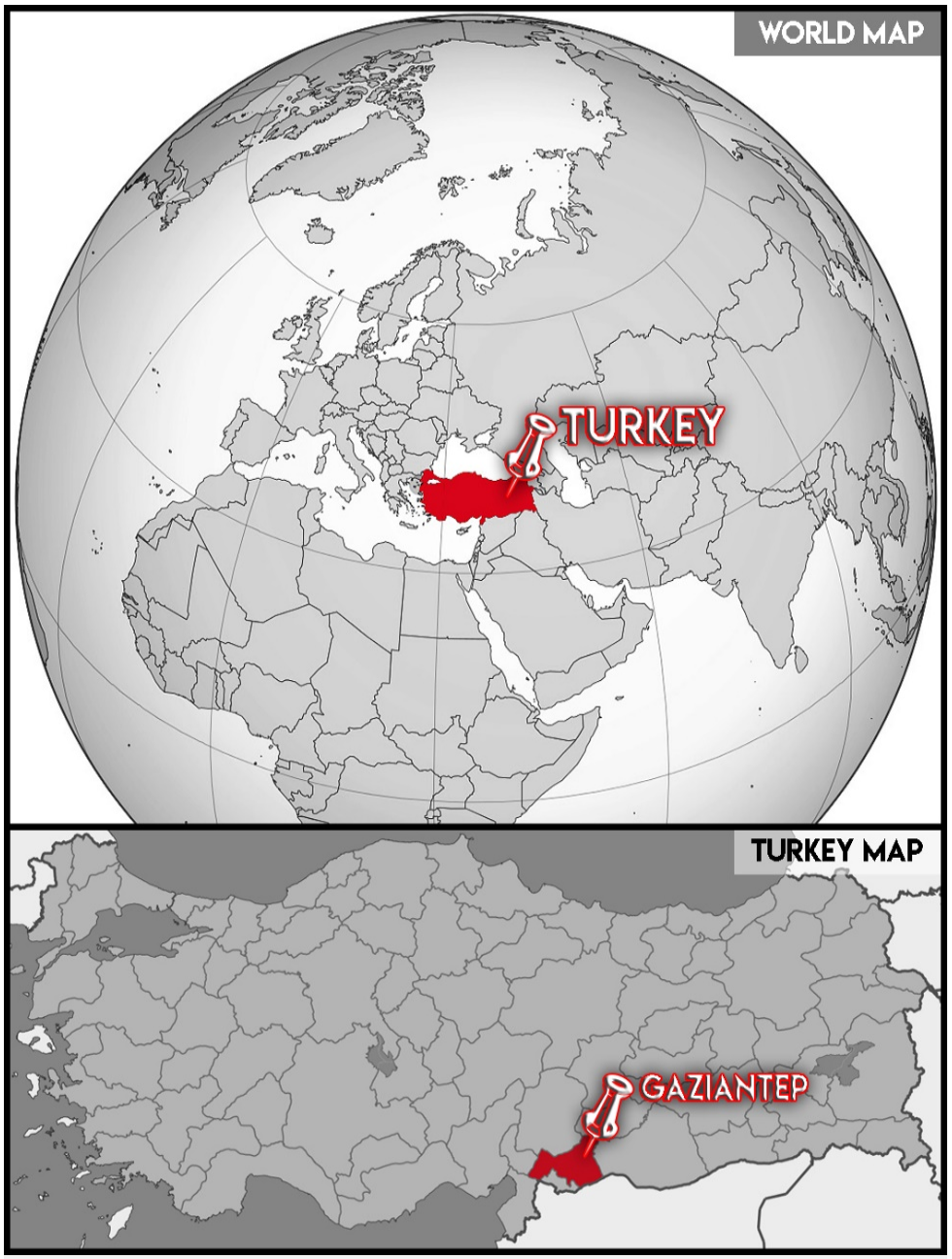

Figure 3: Gaziantep's position in the world and Turkey
(Source: Authors)

Starting in 1950, Gaziantep is part of the rapid urbanisation in Turkey. Rural to urban migration has increased, and the population growth rate has also increased from 6.8% to 35%. With the Syrian crisis in 2012, more than 200,000 Syrian refugees migrated to Gaziantep. Population growth and immigration in the city brought transportation problems to Gaziantep. Automobile-oriented transportation projects to solve the problem have gradually increased environmental pollution and traffic congestion.

RESEARCH METHODOLOGIES

In this study, Gaziantep's most important urban problem was determined. Up-to-date academic articles written for Gaziantep were obtained from the literature review. The current sectoral reports prepared for Gaziantep were also examined using the document analysis method. Then, a case study was carried out in Gaziantep between 21-28 October 2019. Within the scope of the field research, in-depth interviews were held with the officials of Gaziantep Metropolitan Municipality, Silk Road Development Agency, Gaziantep Governorship and Gaziantep Regional Directorate of Highways. Focus group meetings were then held with the citizens on the streets in Gaziantep city centre to determine, "What is the most important problem of the city?". The question was directed to residents of the city. Pedestrian and vehicle mobility and urban life in the city were also monitored for seven days using the systematic observation method.

The literature review, document analysis, case study, in-depth interviews, focus group interviews and systematic observation were conducted as a basis for the Gaziantep Spatial Strategy Plan proposal. The findings showed that the biggest problem of the city is the unsustainable and non-integrated urban transportation system. The best move to solve this problem is to make a transportation transfer hub in the city centre. With these findings, using the biomimicry perspective, we started to work with the following question: "What would Nature do if it encountered such a problem? How would Nature solve this problem?"

Inspiration by Intracellular Protein Transportation System

Some proteins in the human body are secreted directly from the cell. Other proteins are transported from the Golgi apparatus to the plasma membrane, using endosomes as an intermediate step. Figure 4 describes how the protein is transported between the Endoplasmic Reticulum, Golgi Apparatus, Endosome and Cell Membrane.

Endoplasmic Reticulum (ER): It is an organelle in the cell consisting of vesicles, tubes, and cisterns. This organelle allows the transportation of proteins inside and outside the cell. This organelle is responsible for the cycle, folding and transport functions of membrane proteins or proteins to be secreted through a membrane (outside the cell or into a membrane-surrounded organelle). Endoplasmic reticulum with ribosome on it is called endoplasmic reticulum with granules, non-ribosomes are called endoplasmic reticulum without granules (Palade, 1956).

Golgi Apparatus: An organelle found in most eukaryotic cells. The basic tasks of the shadowy are related to secretion. It is the production and storage centre of secretions such as sweat and saliva. Substances such as glycoproteins and lipoproteins produced in the endoplasmic reticulum come into shadow thanks to their receptive surface. Here it is arranged and modified and reaches the cell membrane with the vesicles formed on the sending surface. These molecules give the cell its specificity by joining the structure of the cell membrane (Farquar and Palade, 1981).

Endosome: A cell is an organelle. Many endocytosis transporters derived from the cell membrane are transported to and combined with the endosome. Some substances that undergo endocytosis enter the endosome without going to the lysosome. Endosomes are responsible for storing substances that undergo endocytosis before they go to the lysosome. The process allows some substances to return to the cell membrane.

Cell Membrane: It is the selective permeable layer located on the outside of the cell, which takes molecules into or expels them according to their properties. The cell membrane has a dynamic and flexible structure.
Each compartment seen in Figure 4 communicates with each other and with the outside of the cell via transport vesicles. Proteins are transported from the ER to the cell membrane through biosynthetic secretion (red arrows) or to lysosomes via late endosomes. In the endocytic pathway (shown as green arrows), molecules are taken up in vesicles derived from the cell membrane and delivered to early endosomes and then to lysosomes via late endosomes. Many molecules ingested by endocytosis are retrieved from early endosomes and brought back to the cell surface for reuse. Likewise, some molecules are taken back from the late endosomes and returned to the Golgi apparatus. Some molecules are taken back from the Golgi apparatus and returned to the ER. All these ways of retrieval and retrieval are indicated by blue arrows (Rothman, 1994).

Figure 5 describes protein transport with vesicles from ER to Golgi. Proteins and lipids are transferred from ER to Golgi with transport vesicles that bud through the transitional ER membrane and combine to form ER-Golgi intermediate compartment (ERGIC) vesicles and tubules. ER proteins in the lumen are enclosed in vesicles and released in the Golgi lumen. Membrane proteins remain in the membrane in Golgi (Kobayashi, 2008).
The intracellular protein transport system inspired the Gaziantep Transportation Transfer Hub design, as follows: In the Endoplasmic Reticulum (ER), we always encounter the 1/3 ratio in nanoscale measurements. This ratio was used in the building height, span, and width length of the houses to be included in the urban design. ER transports proteins within the cell at a rate of 40 nanoseconds. In this context, the maximum speed of vehicles in the urban design area was determined as 40 km/hour.

The Golgi apparatus performs the task of storing and secreting in the cell. Inspired by the Golgi apparatus, parking areas were created based on the “park and continue” system in urban design. The endosome is the organelle that connects the ER and the Golgi apparatus. In urban design, autonomous vehicles that move between different units in the centre take the role of endosomes. There is no driver in these autonomous vehicles. Vehicles can move in two directions. Therefore, these vehicles do not require large manoeuvring space for turning. How the inspiration was adopted for the design of Gaziantep Transportation Transfer Hub in the intracellular protein transport system is explained simply in Figure 6.

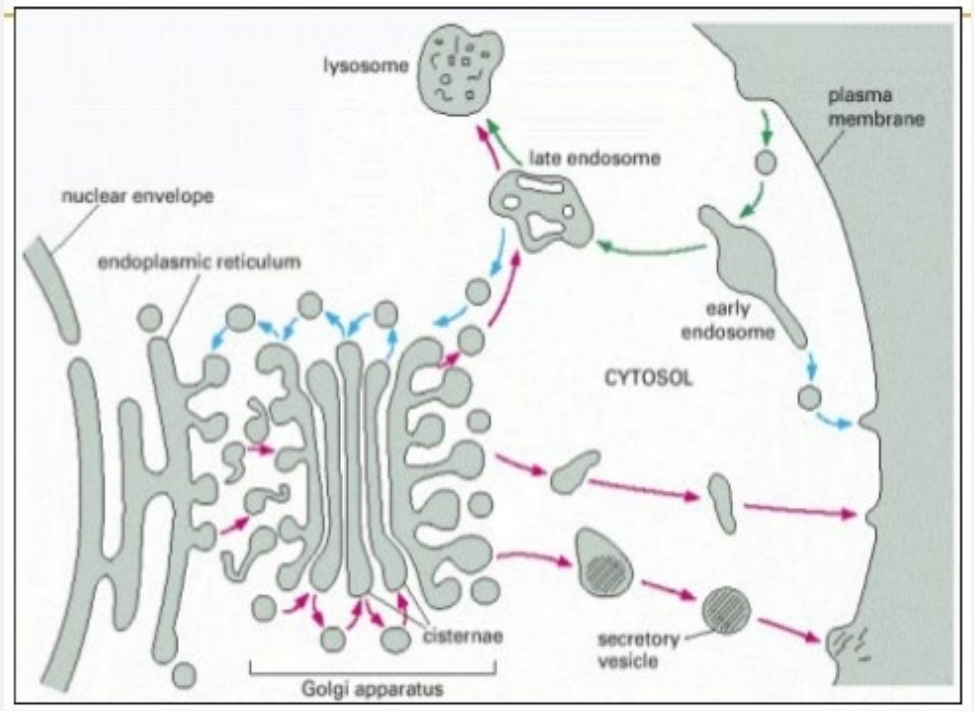

Figure 4: Intracellular protein transport system
(Source: Rothman, 1994)

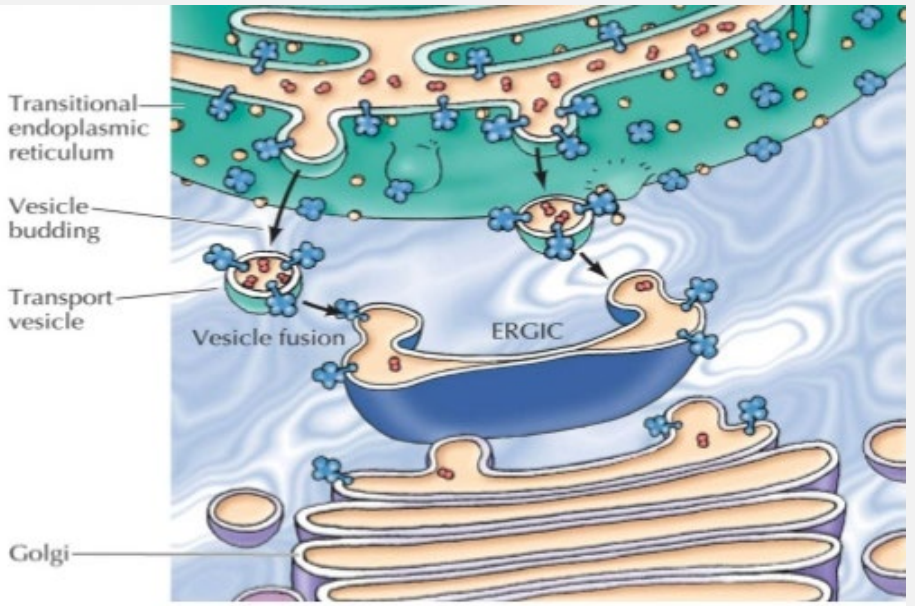

Figure 5: Protein transport by vesicles from ER to Golgi
(Source: Kobayashi, 2008)

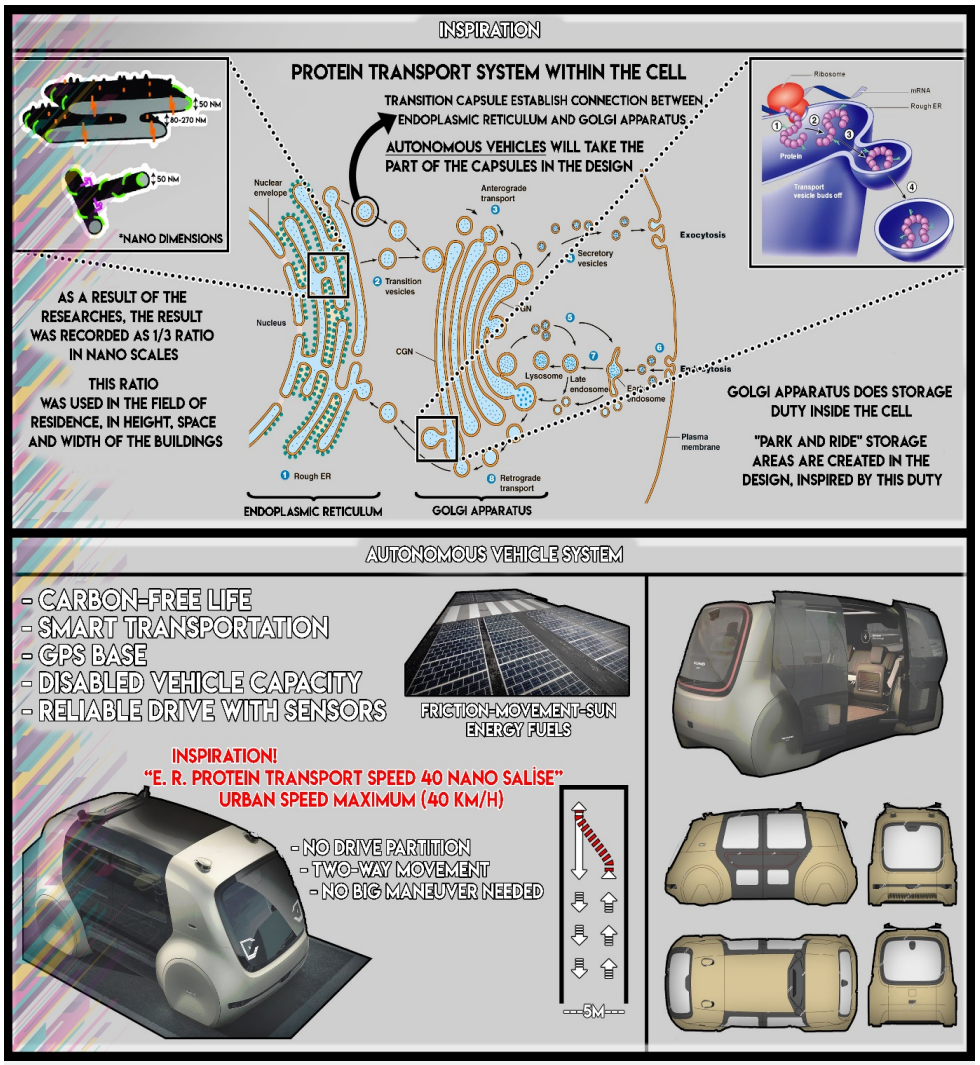

Figure 6: Inspiration for Gaziantep Transportation Transfer Hub design: Intracellular protein transport system
(Produced by the authors, 2020)

UPPER SCALE APPROACH: GAZİANTEP SPATIAL STRATEGY PLAN

Before explaining the Gaziantep Transportation Transfer Hub design project, this section was approached from the upper scale. In this context, 1 / 25.000 scaled Spatial Strategy Plan proposed for Gaziantep is explained in this section.

The major problem in Gaziantep stems from the fact that the zoning plans are prepared not by giving priority to public transportation but focusing on private transportation instead. For this reason, some neighbourhoods in Gaziantep city fringes cannot benefit from public transportation services sufficiently. Increasing individual vehicle ownership and giving priority to the use of wheeled vehicles led to an increase in the traffic volume in the city (Figure 7). This situation has brought problems such as environmental pollution, noise, traffic congestion and decreased pedestrian safety. The ineffectiveness of the rail system throughout the city or the lack of priority has paved the way for urban traffic problem to arise today.

The fact that the rail system is not integrated with other public transportation and the use of individual vehicles prevents the rail system from being used effectively and efficiently. If the rail system serving Gaziantep city centre can spread throughout the city, urban transportation will become faster, safer, punctual and more comfortable.

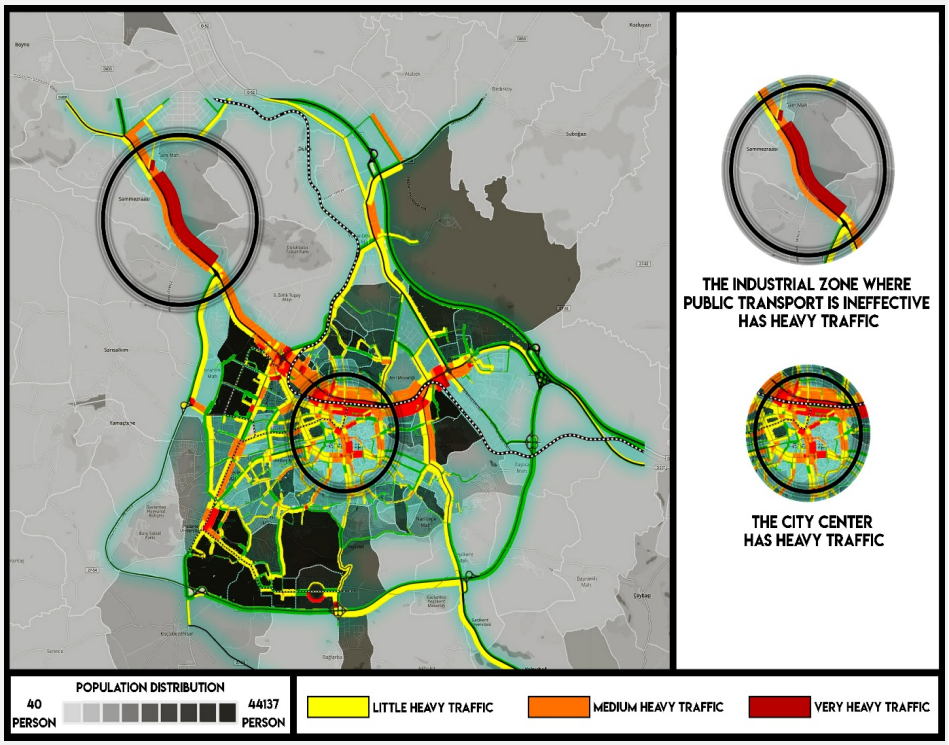

Figure 7: The distribution of the population and the routes with traffic jam in Gaziantep
(Produced by the authors, 2020)

A new rail system network with low carbon emissions was proposed in the Spatial Strategy Plan for the solution of traffic problems in Gaziantep. The rail system network, which is newly proposed in the Spatial Strategy Plan, can reach all essential focal points in the city and respond to travel demands from all directions within the city. Integration of the rail system with all transportation modes in the city is considered. Accordingly, in the Gaziantep Spatial Strategy Plan, a Transportation Transfer Hub was proposed at the intersection of the bicycle, minibus, bus, and private vehicle lines.
Gaziantep Transportation Transfer Hub is proposed in the area where the existing train station is in the city centre. Two lines are served at the train station. While the first line provides access between Gaziantep and other cities, the second line connects the city centre with the important industrial areas of the city. The metro line, which is proposed to surround the city like a network, was integrated with the transportation transfer hub. A divided bus route was also proposed so that the transfer hub can be integrated with public transport with rubber wheels. Pedestrian access to the transfer hub is provided by green axes extending from all over the city to the city centre. A "park and continue" system was also proposed for private vehicle users within the Transfer Hub. Gaziantep Spatial Strategy Plan aims to free the city centre from private vehicles and to make sustainable integrated public transportation attractive in the city (Figure 8 and Figure 9).

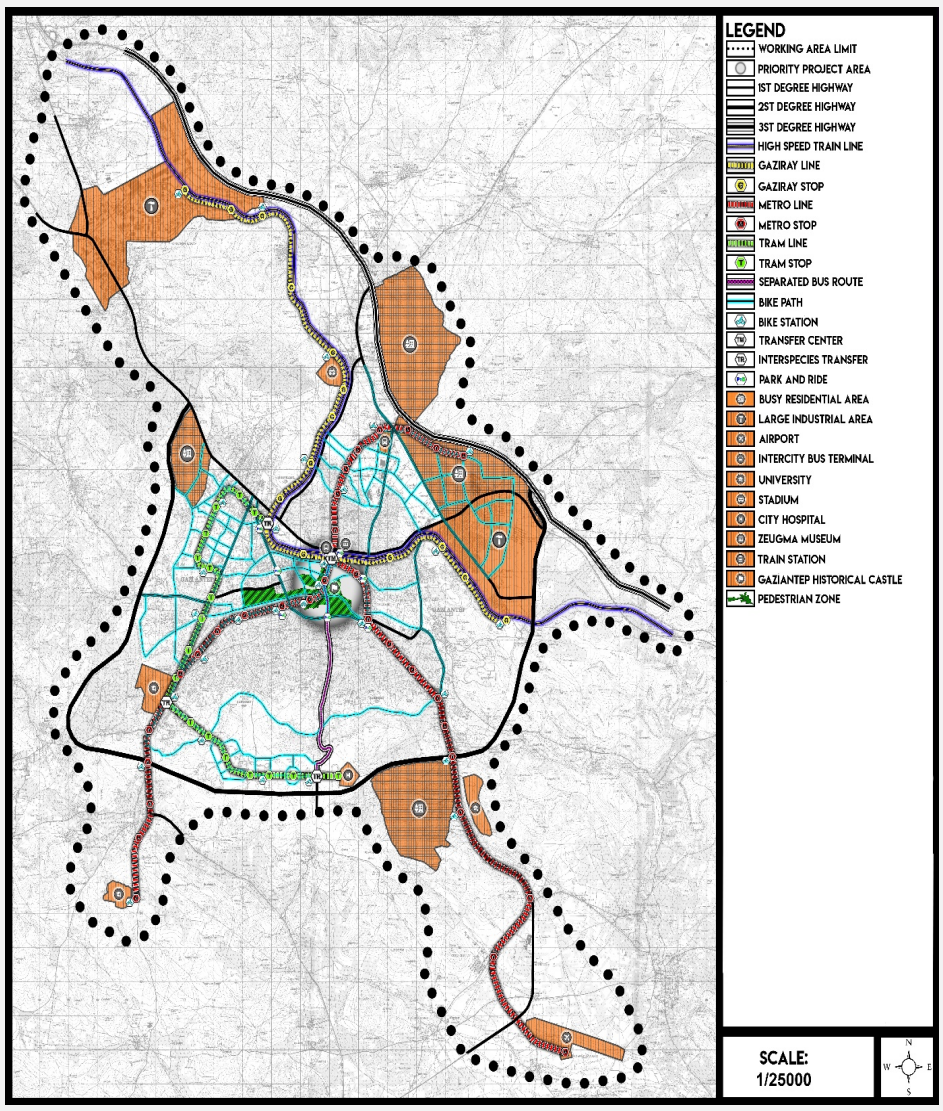

Figure 8: Gaziantep Spatial Strategy Plan
(Produced by the authors, 2020)

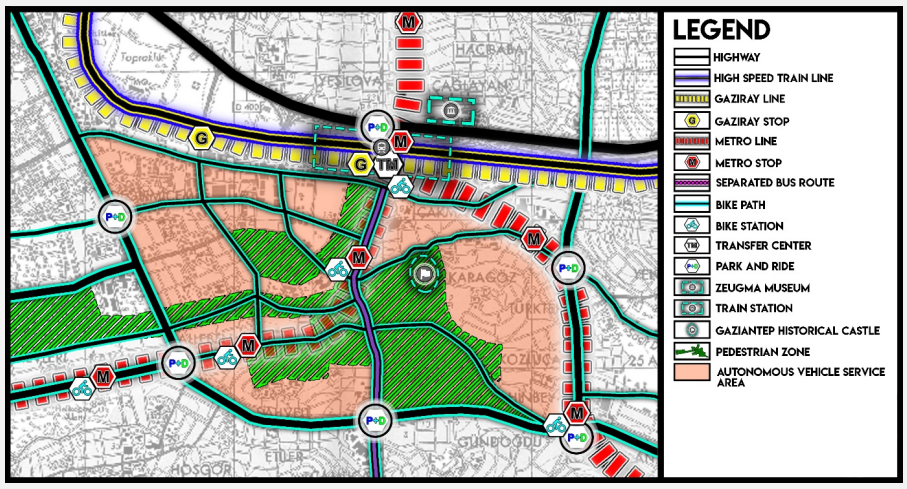

Figure 9: Gaziantep Transportation Transfer Hub designed in a sustainable and integrated manner
(Produced by the authors, 2020)

TRANSFER HUB PROJECT INSPIRED BY THE INTRACELLULAR PROTEIN TRANSPORTATION SYSTEM

This design project was aimed at creating an integrated urban area based on the concept of Nature. The urban design project prepared for Gaziantep Transportation Transfer Hub was inspired by the intracellular protein transport system, as shown in Figure 10 and Figure 11. The concept was established with the organelle responsible for transport in the cell is the endoplasmic reticulum. Inspired by the Golgi apparatus working on the endoplasmic reticulum organelle, a “park and go system” was therefore developed in the design area. In order to increase the interaction of pedestrians with public transport in the residential areas located to the north of the Transfer Hub, a 1/3 ratio was used in the built environment to direct pedestrians to public transportation. This ratio is the same ratio used regularly within the endoplasmic reticulum. Autonomous vehicles were required to be used in residential areas to ensure pedestrian safety and access. The fact that the rate of material transport in the endoplasmic reticulum is 40 nanoseconds and there is no problem or congestion in material transport despite this speed has inspired the determination of the maximum speed in the autonomous vehicle system as 40 kilometres/hour. In the design, a divided bus road was arranged, and an uninterrupted public transport network was provided so that the rubber-wheeled public transport vehicles that make a ring around the Transfer Hub can have priority in traffic. A “pay-to-go system” has been developed in case of any adverse situations in public transport vehicles with rubber wheels travelling on a single lane. There are bicycle stations at many points in the design field and a bicycle network that appeals to the entire design area. Arrangements have was made to facilitate the use of bicycles at the stops of the light rail system, high-speed train, subway, and public transport vehicles with rubber wheels serving in the Transfer Hub. In the Transfer Hub design project, apart from being inspired by Nature, compliance to universal design principles and criteria adhered.

Figure 10: Gaziantep Transportation Transfer Hub Design Project
(Produced by the authors, 2020)

CONCLUSION

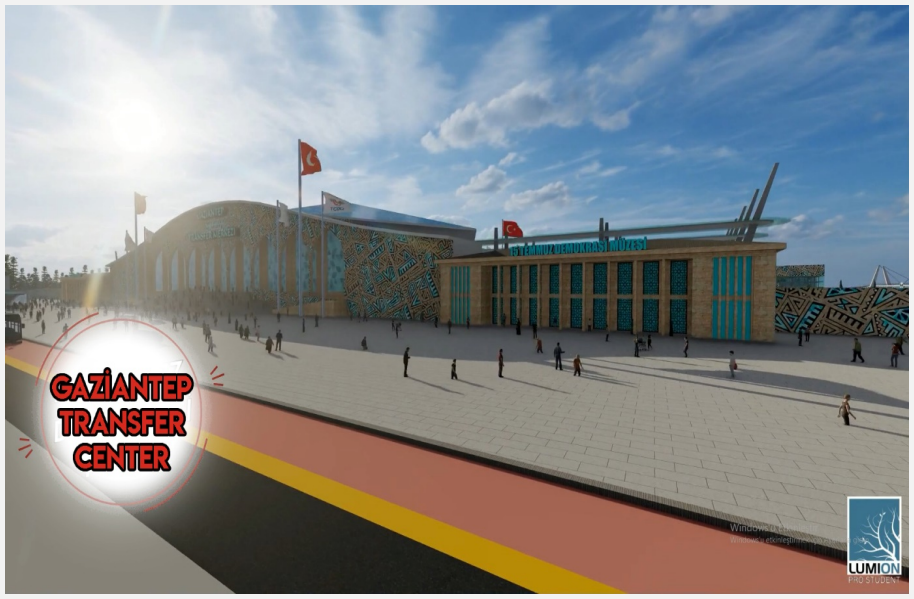

Figure 11: Gaziantep Transportation Transfer Hub
(Source: authors, 2020)

NOTE: You can watch the design project in 3D using this link: https://www.youtube.com/watch?v=AqPeJMSWM-g&list=PLzld-Y4DIbuvOXLgoTS2L9fp86B7hvOHo

In this research, the Transportation Transfer Hub, designed with inspiration from Nature for Gaziantep city, was explained. The research also identifies the primary problem of the city as the unsustainable and non-integrated urban transportation system. The existing system creates other problems such as environmental pollution, noise, traffic congestion and decreased pedestrian safety. To resolve this problem for Gaziantep, a Spatial Strategy Plan was proposed within the scope of the study. The most strategic proposal of the Spatial Strategy Plan is a Transport Transfer Hub to be built in the city centre. Secondly, within the scope of the study, this transfer hub was designed in 2 and 3 dimensions. The intracellular protein transport system inspired the urban design project.

Inspiration from the intracellular protein transport system has contributed significantly to the urban design project as follows:

i. An original design, unlike any other transportation transfer hub in the world has emerged;

ii. An organic urban design in harmony with Nature has emerged;

iii. Ratio and proportion, size and standards are on the agenda of design; thus, in the third dimension, an aesthetic physical environment with balanced occupancy and the void ratio has emerged;

iv. Technological solutions have entered the design agenda; and

v. Gaziantep's transportation problem has found a solution with an intriguing, interesting, innovative, beneficial and through a sustainable method.

Biomimicry brings the method of being inspired by Nature, which was the learning method of the early civilisation, to the present day with modern versions. Today's advanced technology and scientific discoveries have features that will further improve the way and style of Man's inspiration from Nature. This study had shown that many urban/rural problems could be solved using the biomimicry perspective. History prevails that Mankind has still a lot to learn from Nature. Design solutions that will work for human beings are found in Nature. The important thing is to ask the question: "What would the nature do if it faced such a problem? How would nature solve this problem?".

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