

Productive Transforming of the Urban Traffic Space

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ABSTRACT

The development of productive transforming of urban transport land has got more and more attention. And We divide it into three categories, the first one is three-dimensional and efficient use of transport land to conserve land resources; The second is the fuse of traffic space and its other neighbouring urban functions to achieve efficiency multi-functional mixed land use; And finally, it is the integration of traffic space with urban productive space directly that not only can achieve efficient use of mixed land, but also provide a more direct way for the sustainable city. Currently, the research and practice for the first two phases have been fruitful, but the research of the last one is still in its initial stage or under exploration.

The paper attempts to analyze the technologies of transport production. If divided from transport space's type, these technologies can be divided into three types. The spaces on two sides of the road and especially the large-area road buffered region or idle land can carry out more types of energy production technologies, including renewable energy utilization and agricultural cultivation. Finally, we analyzed New York landscape architects Starr Whitehouse's three concepts of the Brooklyn-Queens Expressway to show three categories of transport production.

Keywords: *traffic space, productive, energy, agriculture*

1. INTRODUCTION

Transport is an important link that connects the multiple functions of land use. However, the environment created by urban transport, as the process space that connects the beginning and ending of people's daily life, is often neglected by people in planning and constructions. Everyone will contact and feel the "third space" of a city—the influences of the urban transport environment on citizens are non-neglected. In *The Death and Life of Great American Cities*, there is one paragraph that perfectly expounds on this opinion. A city sidewalk by itself is nothing. It is an abstraction. Streets and their sidewalks, the main public places of a city, are its most vital organs. The massive energy consumption and land waste have a serious effect on the environment of urban traffic. The urbanization of China has consumed as many as 40 percent of cement and over 50 percent of steels in the world. As the basic infrastructure of urbanization, urban traffic has emerged as one of those sectors consuming the most energy in China. The automobile powered by the gas and diesel have contributed about half of the emission of carbon monoxide and nitrogen dioxide in the atmosphere. The development of electric vehicles in recent years can relieve the pollution caused by urban traffic to a certain extent. However, it should be noted that the electricity is still used as the source of secondary energy in China. China is heavily reliant on the burning of coal, which will result in more pollution. Hence, the key to easing the pollution in the urban environment should lie in the development of renewable energy. Due to the mind-set that building more roads can help to deal with traffic congestion, the area of the land used for urban traffic has been on the increase. It turns out that traffic congestion has become an increasingly more serious issue. Many experts on urban transport in the USA and Europe believe that most of the space for urban road in China has not been fully utilized. If some appropriate actions can be taken, the traffic capacity will be increased by 30 to 50 percent.

In a word, the environment of urban traffic is faced with many problems, including the urban structure lacking the connectivity, the constraint on urban vitality, the huge energy consumption and the low efficiency of land use. With the purpose of solving those problems, further efforts can be made to combine urban traffic with production city. It can fully realize the urban potential for production, which will also provide a new solution to the urban sustainable development.

2. ANALYSIS OF PRODUCTIVE

The developmental process of the human society has undergone the separation from traditional production functions from the city. To change the problems by the current city's emphasis consumption and enable the city to achieve more sustainable development, the concept of productive is being emphasized once again and returns to city. Such a production is not limited to agricultural production, yet it includes richer connotations.

By absorbing experience from foreign theories and combining the author's conclusions and thoughts, Professor Zhang Yukun of Tianjin University of China attempts to set up a theoretical system of "production city" that has richer connotations. "Production city" is a multiple-layer urban-town system that takes green production as the main characteristic and integration; by using the basic means of reservation, replacement, superposition, integration and reconstruction, attempts to establish a perfect industrial structure within the most appropriate region, which provides new thinking for a city's sustainable development. Such urban planning concept emphasizes the active "production" functions of a city, and incorporates the "saving" function that is traditionally considered as passive into the "production city" theoretical system. It is thought that "saving" is also a type of "production" from a certain perspective.

The intensive utilization of land and space can be referred to as a production function of the space. To a certain extent, the integration of urban transport and architecture can realize the spatial production of urban traffic system. But in most cases, the compensation has been confined to the urban traffic or the area surrounding the transportation junction featured by the frequent change of means of traffic. The majority of the linear urban road can not directly combine with architecture space, but there is still some potential for production function. If the urban roads which have been neglected can be fully utilized for the production of space, it will create huge benefits for the sustainable development of the city.

3. CLASSIFICATION OF PRODUCTION OF TRANSPORT SPACE

The productive urban transport can be divided into three types: From the perspective that saving is a type of production, the efficient land use of transport is productive; secondly, the complex land use of urban transport space improves the efficiency of land use; the third type is directly integrating the space of productive functions and transport spaces, which has become a completely new means of reforming the transport space.

3.1 Efficient land use of transport itself

As early as the Renaissance, Leonardo da Vinci proposed the thinking of "the system of pedestrian and roadway 3-dimensional dividing". German planner, Ludwig Hilberseimer, proposed the 3-dimensional transport plan that different planes divide the human traffic and vehicle traffic. In the current day that emphasizes green traveling, people are trying to use the complex transport space to improve the utilizing efficiency. Comprehensively utilizing the urban road space and especially the urban road underground space is one of the important means of efficiently utilizing urban road space.

The TransGlide 2000™ Bicycle Transit System is a new strategy in bicycle transport. This technology increases the efficiency of the bicycle by providing an environment within which bicyclist can ride comfortable, making the bicycle a faster, safer, less expensive, and more convenient mode of transport in urban areas. STS's Transglide 2000™ bicycle transit system has many advantages. (Figure 1)

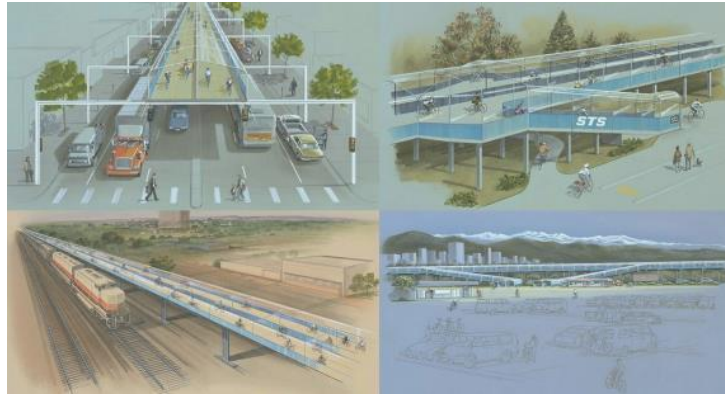


Figure 1: The TransGlide 2000™ bicycle transit system (<http://www.bikeplans.com/gallery.html>)

3.2 The mixed-function land use of transport

One of the urban transport's roles lie in connecting various functional spaces within the city, so that people can come and go more conveniently and effectively. The current cities attach unprecedented attention to transport, yet the wide and dense roads bring more trouble to the crowds that go through the city. This is because these traffic facilities cut the city's continuity, forcing various functional relations in the city to be more distant instead of being denser. An increasing number of architects, planners and landscape designers have already noticed the problems existing in the urban transport and thought about the new urban transport space. They attempt to establish closer relations between the urban transport and the architectures & landscape with various urban functions. They even integrate these two into one. The urban transport space can be carried out smoothly and safely. It can also be abundant, interesting, comfortable and enjoyable. In the 3-dimensional urban spatial coordinates, the transport space can be inserted with the architectural space through various dimensions and stacked up.

The student of British Bartlett School of Architecture, Alex Sutton, proposed a new concept in his graduation work— In the future, airports do not need to be constructed in the suburbs and airplanes can take off over the street. The future airport should be one part of the city. (Figure 2) Such a designing that transport fundamental facilities will be dissolved into cities attracts full attention and affirmation from people. It can be seen that the integration of urban transport and a city's other functions is very necessary.



Figure 2: Concept of future airport (Alex Sutton, 2016)

3.3 The combination of transport and production

If the concept of productive space is introduced into the transport space, it will achieve the sustainable development of urban transport to a larger extent and bring unexpected social, economic and ecological benefits.

Solar Serpent is a case involving the land use of transport for energy production. Developed by the Mans Tham who is a Swedish architect and urban planner, it is a device which can provide energy for the expressway by making use of solar power. In 2010, the design was unveiled at the Summit Conference of Major Cities of the World held in the University of California, Berkeley. Because the traditional solar power generation occupies a large area of land, the limitation of land resource has become a major constraint on the utilization of solar power. If the upper space of the expressway stretching for about 800 kilometers can be utilized for solar power generation on a large scale, it will save the land greatly. Moreover, Solar Serpent also has many advantages. Firstly, the most

direct advantage of utilizing renewable energy is to reduce the emissions of harmful gases. Besides, when the transport system carries out energy production, using the spaces over and onee both sides of the road may have some indirect advantages of this transport system's energy conservation. For example, setting up the solar PV panel up the road can effectively block the radiation of sunshine on the road, lengthen the life of the road and lower the costs of maintaining the road. It also plays a certain role of promoting the transport tool's energy conservation on the road. The solar panels on the road can block solar radiation for driving automobiles and prevent the AC's energy consumption caused by rising temperature within the vehicle in summer.

If a city can carry out agricultural production, it can not only solve the pressure on agricultural production brought by the rural population's migration, but also make the urban life more comfortable and ecological, which alleviates the urban problems brought by urban expansion and prevent reverse-urbanization phenomenon to some extent. The urban transport land use is a type of land that accounts for a high proportion in urban land. It needs to take the transport greening and buffered land as affiliated land. If we can fully utilize the scattered land for agricultural production in these cities, it not only can solve the grain problem to some extent, but also plays a certain ecological role in the urban transport. It also brings more attractive landscape outcomes for urban residents' traveling.

4. TECHNOLOGIES OF TRANSPORT PRODUCTION

Energy harvesting technologies from road infrastructure is a new research territory that encompasses technologies that capture the wasted energy occurred at pavements, accumulate and store it for later use. Eventually, the paths of gathering energy still depends on various scientific technology, such as nano-science, electrical science, machinery and environmental engineering. These technologies can be applied into transport panning and transport infrastructure facility construction. New technology will bring new thoughts for transport planning. It is also necessary for urban planning designers to get to know and master these technologies.

We can find out that these technologies can be divided into asphalt solar collectors combined with pipes; photovoltaic applications (PV); piezoelectrical and thermoelectrical generators; induction heating and; phase change materials and nano-materials. If divided from transport space's type, these technologies can be divided into three types: on two sides of the road, on the road's surface and over the road. If fact, the spaces on two sides of the road and especially the large-area road buffered region or idle land can carry out more types of energy production technologies. (Table 1) These technologies are not restricted by the transport space and only utilizes transport land efficiently. Therefore, they are not enlisted in the statement, including renewable energy (solar energy utilization, wind energy utilization, biological energy and other renewable energy) and agricultural cultivation.

Traffic Space	Energy Harvesting Technologies
Side Space	PV-Noise Barriers Piezoelectric Sesnsors PV-V2G
Surface Space	Induction Charging Nanomaterials Phase Change Materials TNO PV Canopies
Upper Space	Asphalt Solar Collector/Hydronic PV Bridge Roofs

Table 1: Comparing the energy harvesting technologies applied to different traffic space

5. CASE ANALYSIS

Brooklyn-Queens Expressway(BQE) was completed in the 1950s. A lower groove was used to change the twisting lines at the upper layer, which could ease the traffic congestion at that time. The BQE which was built had divided the physical surrounding into two parts. It also formed an unnatural boundary between them by splitting and even damaging the surrounding environment. The existing roads which connected sidewalk and pedestrian overpass were not wide enough to satisfy the needs. In addition, the overly high speed of those vehicles on the road would

pose a hazard to human safety. With the automobile exhaust and noise pollution of BQE spreading to those communities around, it had affected the life of local residents.

New York landscape architects Starr Whitehouse came up with three concepts to improve the Brooklyn-Queens Expressway, the first concept called Maximum Green, the second one Connections, and the last one Green Canopy. These three concepts explain the transport space's production from three aspects. (Table 2) In Concept 1, maximum green is one designing of utilizing transport and mixed-function land use, fully utilize the road's buffered space and carry out greening or grow agricultural plants. In Concept 2, connotation is a highly-efficient utilization of the transport space and a transport designing of carrying out 3-dimensions on limited land area. It adds more relations on the original roads to alleviate the division of transport on the city's original fabric. In Concept 3, green canopy is the designing of integrating transport and production, which achieves the integration by combining the PV panel and green integration. As shown in the survey, the transformation elements in the first two concepts have been recognized. The Concept 3 has won the most support from the community. In other words, the community can well accept the combination of urban traffic environment and production city. Instead of broadening the road to improve the environment on the two sides of the road, BQE Enhancement Project has resorted to increasing the area of green land and creating more connections. A variety of methods have been employed to make the urban transport more public and human-centered. It has combined the urban transport with the community more effectively. What is worth mentioning is that Green Canopy has successfully introduced production function into the transformation of urban traffic environment. Hence, it has solved those problems faced by the base quite well.




Concept	Benefits	Drawbacks
<p>Concept1 Maximum Green</p> 	<ul style="list-style-type: none"> ● Slow traffic ● Shortens crossing distances by 11 feet ● Adds 6500 square feet of pedestrian space ● Adds nearly 1 acre of plantings and 412 new trees ● Employs innovative storm water capture and reuse system ● Optional to reduce noise at street level. 	<ul style="list-style-type: none"> ● Limited noise reduction ● Does not increase accessibility ● Parking would be substantially limited and would require heavy enforcement
<p>Concept2 Connections</p> 	<ul style="list-style-type: none"> ● Reconnects severed cross streets ● Increases connectivity for neighborhood ● Slows traffic ● Adds plantings, trees, and storm water management system ● Optional to add up vines ● Potential for solar cells income 	<ul style="list-style-type: none"> ● Limited noise reduction on Hicks Street ● Expense of each bridge
<p>Concept3 Green Canopy</p> 	<ul style="list-style-type: none"> ● Visually screens the highway ● Adds 100000square feet of vines ● Reduces noise by 9 decibels at street level ● Potential for income from photovoltaic panels ● Reconnects severed cross streets ● Slows traffic and manages storm water 	<ul style="list-style-type: none"> ● High cost ● Major construction on Hicks Street

Table 2: Comparative analysis of three concepts

6. CONCLUSION

The research on the transport space's production can determine the transport system's green production from the quantitative perspective, which plays a certain role in promoting the society, economy and environment. Besides, it also has many research values and meanings.

The power generation for urban traffic system is of significant meaning to easing the shortage of power supply. With the drain of conventional fossil energy, new energy should be found to satisfy the growing demand for urban energy. As a type of new energy which is not exhaustible, the renewable energy has the advantages of huge

reserve and clean production. Hence, the renewable energy can be utilized in the traffic system so as to reduce the use of fossil energy and air pollution. The electricity produced can integrate with the urban power grid, thus satisfying those urban residents' need for electricity. The agricultural production of traffic system can infuse new vitality to the dense urban space with the simple function. To a certain extent, it can also ease the over-concentrated function of urban space, tackle the traffic congestion and reduce the urban pollution. The plants can also improve the urban micro-climate and ecological environment by absorbing the carbon dioxide through the photosynthesis. All of those functions must be realized based on the urban traffic system. The greatest advantage is that it can achieve the intensive utilization and production without occupying a large area of urban land. For the urban planning, it is necessary to consider various production measures and functions at the beginning of the planning, carry out overall planning and coordination of various urban spaces, including production, transport, living and entertainment. It is also necessary to analyze the space that sunshine can radiate and the land space with fertile soils, so as to reach the aim of achieving resource, energy and production to the largest extent. The aim and procedures of the transport system's green production have reforming changes and meanings, which make people consider more influence factors and involved aspects in the urban planning.

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