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## PROCEEDINGS

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# GREEN FUTURE TRANSPORT

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## ABSTRACT
This paper sets out a range of requirements for future transport systems and analyzes how these requirements are met by the solutions that are already used in the transport industry or will be employed in the foreseeable future.
**Keywords:** TRANSPORT, ENVIRONMENT, ECOLOGY, FUTURE TRANSPORT, STRING TECHNOLOGY

## INTRODUCTION
The impact that the fast-growing transportation industry is having on the environment and society is hard to overestimate. The rapid development of the transport industry is driven by a growing global population, progressing urbanization and the processes associated with it, as well as the increasing globalization of industrial links between countries and continents. It may turn out that errors in assessing the prospects of transport development may also be one of the main reasons for its demise, in particular through the de-industrialization of the world economy, including in the transport and infrastructure industry.
We should keep the analysis within the next 25-30 years. It is during this period of time that drastic measures must be taken to improve the mobility of populations on all continents of the planet while ensuring the sustainability of civilizational development of mankind.

## 1.MODELING AND ANALYSIS
The emergence of transport, i.e. the ability of people and goods to move by means of technical solutions, has been the historical foundation of the birth and development of our industrial civilization. However, the increasing number of transportation means, their intensification and the expansion of infrastructure facilities in the future will cause a catastrophic impact on all biosphere resources of the planet (air, soil and water), as well as on economic development, living standards and social aspects of life of all mankind.
First and foremost, carbon dioxide emissions into the planet's atmosphere cause justifiable concern, which has already, in some estimates, led to climate change and, accordingly, to a negative impact on the flora and fauna of practically the entire Earth.
The second factor, which practically kills the environment and affects possible climate change, is the need to build new roads and road structures. As a result, billions of new square meters of soil are massively excluded from natural circulation and "rolled up" under asphalt, concrete, sleepers and rails. At the same time conventional construction of roads in the earth embankment creates artificial barriers and dividing lines for animal migration and destroys natural watercourses (surface and ground). This often causes swamping of large territories on one side and desertification on the other side of the road embankment. In the transport corridors, trees are cut down, fertile soils are destroyed, and natural ecosystems of small animal, insect, and microorganism communities that have developed over thousands of years are ruined.
The growth of the world's population, the number of vehicles and the scale of transport and logistics challenges undoubtedly lead to an increase in the number and size of the transport infrastructure elements. It is impossible to change the vector of development of our "transport and infrastructure civilization", which began with the construction of pyramids, aqueducts, Roman roads and ancient cities. But we need to dramatically reduce the material intensity of transport and infrastructure structures as well as their impact on the landscape and soil, vegetation and wildlife.

The new green transport must address not only environmental and climate change problems, but, more importantly, the socio-economic problems associated with the need to ensure the mobility of people and goods of our fast-growing civilization. The new "clean" transport must reduce the number of accidents that kill millions of people and billions of animals every year. This requires, in the first place, excluding the human factor from safety systems – the control systems of transport complexes must be fully automated, and all vehicles must become unmanned. In the second place, it is necessary to take the trajectories of the rolling stock beyond the Earth's surface, where practically all life and industrial activity actually exists. It is necessary to exclude other vehicles, people or natural and technogenic obstacles on its route. In the third place, the very possibility of collisions and derailment of a rolling stock from a traveling structure must be eliminated by equipping all vehicles with 100% reliable antiderailment system. Thus, the need to relocate the traffic to a space above or below the ground is apparent.

The well-known systems of above-ground and underground transport are very expensive, and only a few countries can afford the large-scale construction of above-ground road or railway overpasses. The developing countries of Asia, Africa, and America, which, by the way, are home to the majority of our planet's population, simply do not have the means to fundamentally address transportation challenges and create "clean", sustainable and "smart" passenger as well as cargo transport and infrastructure complexes.
Therefore, when deciding on the transport and infrastructure technologies of the future, one must consider their affordability, the extent of their development and, most importantly, the availability on the market.
Based on all of the above, such a logistics complex must differ from existing systems in terms of high energy efficiency and productivity, low material intensity, and the possibility to be operated safely under unmanned control. It must also be located on the "second level" – above the ground. At the same time, the capital expenditures for construction and operating costs must be low.
Today, transport complexes that fully meet the above-mentioned requirements for "clean" transport already exist and operate successfully. For example, there are 7 pilot passenger, freight and cargo-passenger complexes of Unitsky String Transport (uST), which are operated in the Innovation Technology Center in Sharjah (United Arab Emirates) and in EcoTechnoPark in Maryina Gorka (Belarus). In addition, the first commercial uST project, a tourist trail in Belarus, is scheduled to begin operation this June.
Unitsky String Transport is based on the use of a "second-level" string rail overpass and can be used for passenger and cargo transportation. The speed of vehicles can reach 150 kilometers per hour in the city and 500 km/h in the intercity traffic. The string rail track structure is based on the use of pre-stressed steel cords and does not require the construction of a massive reinforced concrete overpass. Besides, it is durable, reliable, equipped with an antiderailment system. It has no parasitic screen effect and is several times cheaper than any other transport solution due to its low material capacity and minimum land allotment. At the same time, the urban string transport complex can carry up to 50 thousand passengers per hour.

Currently, intensive pilot operation of several lines of string transport in the UAE and Belarus is underway. Although there is no experience in full commercial operation of this technology yet, in 2021 the uST complexes, including uPods (unmanned rail electric cars on steel wheels), a string rail overpass and "second-level" infrastructure, were certified in the United Arab Emirates in compliance with international regulations.

Fig. 1 illustrates a typical uST transport system [1]

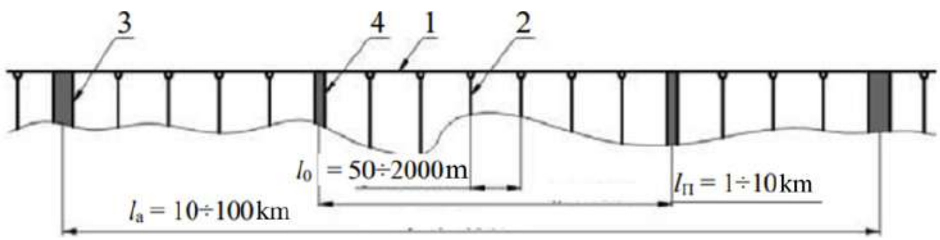


Fig.1. Structural diagram of a typical UST transport system

l0, lП, la correspond to the span size between the supporting towers, driveway anchoring and end anchoring structures, respectively.

This system is a structure containing a pre-stressed string rail track structure 1 placed on supports divided into three distinctive types: supporting tower 2, end anchoring structure 3 and passing anchoring structure 4. The latter differs from the end anchoring structure 3 as it is in a balanced state when the overpass is put into operation. However, during construction and tensioning of string elements, it is the outermost and terminates the forces from pre-stressed elements in the already assembled sections. The distance between supports depends on construction technology, terrain relief, materials used for load-bearing structural components, operating conditions, weight and design speed of vehicles, tensioning forces and other factors.

The economic efficiency of uST Transport & Infrastructure Complexes can be assessed by analyzing the design specifications and estimates of the complexes, which can be operated both in dense urban development and in the suburban area. Typical solutions in these projects are single-track circular and diametral routes. The main design characteristics on the example of a real developed facility for the Eastern region are given in Table 1. This project assumed the possibility of using a circular or pendulum route with a semi-rigid or flexible track structure.

Table 1. The main feasibility characteristics of string transport complexes on the example of a real developed object for the Eastern region [1].

| Parameter | Route type | | | |
|---|---|---|---|---|
| | circular | | pendulum | |
| Type of track structure | semi-rigid | flexible | semi-rigid | flexible |
| Route length, m | 5 268 | | 2187 | |
| Number of passenger stations, pcs. | 10 | | 4 | |
| Number of supporting towers, pcs. | 10 | | 4 | |
| Time to run one cycle, s | 836 | | 712 | |
| Maximum speed, km/h | 85 | | 85 | |
| Standard embarkation/disembarkation time, s | 25 | | 25 | |
| Capacity of uCar | 16 passengers (6 seats) | | | |
| Interval with a max. number of uCars, s | 42 | | 712 | |
| Interval with a min. number of uCars, s | 167 | | 712 | |
| Passenger flow at a max. number of uCars (20 % turnover – 3.2 passengers on average), ppl/h | 2 280 | | 2 092 | |
| Passenger flow at a min. number of uCars (20 % turnover – 3.2 passengers on average), ppl/h | 585 | | 674 | |
| Passenger flow at a max. number of uCars (50 % turnover – 8 passengers on average), ppl/h | 6 080 | | 3 072 | |
| Passenger flow at a min. number of uCars (50 % turnover – 8 passengers on average), ppl/h | 1 560 | | 1 024 | |
| Route extension option | yes | yes | yes | yes |
| Integration into neighborhood buildings | yes | yes | yes | yes |
| Requirement to relocate utilities | no | no | no | no |

## 2. CONCLUSIONS

The only technology that best meets all the requirements for the future transport is string transport technology, which could form the basis for a new transport and infrastructure industry capable of solving the mobility problems on the "second level", the logistical problems of the rapidly growing world economy and, at the same time, address most of the environmental, climatic and socio-economic challenges.

Creation of the "second-level" transport system integrated into human life, in particular, into the urban environment, seems to be a practical task using modern achievements in the fields of calculation models, materials science, safety methods and tools, and information technology. This concept has been implemented in uST String Transport Complexes, which are being tested in EcoTechnoPark of Unitsky String Technologies Inc. (Maryina Gorka, Belarus) and in uSky Test & Certification Centre in the Emirate of Sharjah (Sharjah, UAE)[1].

The introduction of new innovative technologies, and not only in transportation, is a challenge. It is a challenge that people, countries, and all of humankind must take on, because not only specific issues related to climate change, but also the survival of all humankind and the preservation of our civilization, our common home – the biosphere of planet Earth – depend on the courage and speed of our decisions.

## REFERENCES

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