UNIQUE COMPETITIVE CHARACTERISTICS OF STU PRODUCT

STU is free from the basic shortcomings of railway or motor transport. At the same time it has the advantages of aviation and elevated roads that are provided by its transport module moving above the ground along the openwork track structure.

STU with the length of spans between the supports ranging from 30 m to 2 km is capable to overpass marshlands, sands, water barriers, mountains, taiga, tundra and permafrost in any country of the world, in all natural-climatic zones of the Earth (from -60°C to +60°C) moving at the travel speeds ranging from 50 km/hour to 500 km/hour.

STU is resistant to the atmospheric phenomena, earthquakes, floods and mudslides. String transport system will become the cheapest, the most durable, economically efficient and safe transport system of the “second level” to handle passengers and freights.

STU routes are all-weather operational, in winter period at the negative temperatures there is no need to remove snow or ice from the track if the height of the supports exceeds the height of the snow cover.

Operation costs are reduced to the periodical protection of metal structures against corrosion (once every 10-20 years). With a string-rail body made of stainless steel or high-strength aluminum alloys and supports made of reinforced concrete the operation costs will be associated only with a seasonal examination of structures (to reveal construction defects).

ENVIRONMENTAL QUALITIES OF STU

The use of STU will make it possible:

- to reduce consumption of non-renewable energy carriers (oil and petrol products, coal and gas), nonmetalliferous, ferrous and nonferrous metals thanks to the lower metal-intensity of STU track structure and supports as compared with other modes of transportation; elimination of resource-consuming facilities such as embankments, depressions, overpasses, viaducts, bridges, water pipes, etc. in the course of STU routes construction;
- to reduce environment pollution as a result of the low specific energy consumption (by 5-10 times less as compared with an automobile); cautious attitude to the development of vulnerable eco-systems (tundra, permafrost zone, jungles, marshlands); a possibility to use alternative ecologically clean types of energy (wind, solar, etc.) in the course of STU operation;
- to reduce the amount of fertile lands allocated from agricultural use thanks to the reduced land allocation requirements for string routes (less than 0.1 ha/km);
- to reduce noxious emissions. For example, in electrified STU they will be less than 0.01 g/pass.x km, i.e. less than in the high-speed railways which is attributed to the absence of dust-generating embankments, rubble cushions and lower deterioration level of a rail, wheels and disk brakes;
- to reduce the level of noise and vibration. STU is a considerably weaker source of noise and soil vibration than, for example, a high-speed train. A string-rail track structure is provided with a system of internal dampers that are also used to install the supports to suppress the low- and high-frequency vibrations of the track. Furthermore, the total mass of any model of a rail car will be considerably

less than that of a railway train. A track will be smoother thanks to the elimination of temperature deformation joints on the whole length;

- to preserve natural landscapes and biocenosis – STU does not require construction of embankments, depressions, tunnels, large-scale elevated roads, overpasses and viaducts which produce a negative impact on natural landscapes and biocenosis and are not stable to natural disasters (earthquakes, floods, mudslides); there is no need in cutting forests, removal of peat and vegetable soil cover.

Safety of STU traffic

Accident rates in Russia are 3-4 times higher than in the developed countries and the number of road and traffic accidents is further growing.

During the last five years, from 2004 to 2009, the number of traffic accidents registered in Russia amounted to more than 1 million accidents (not including railway transport) in which more than 150,000 people were killed and more than 1 million people were injured. Among all existing modes of transportation motor transport is the most dangerous. According to the data of the World Health Organization annually on the motorways 1.5 million people are killed (including those who died as a result of after-accident traumas) and more than 10 million are injured to become cripples or invalids[1].

According to the WHO forecasts the traffic accident rates will be further growing (for example, during the last 5 years the global death rates as a result of traffic accidents increased by 300,000 cases per year) and by the year 2020 it will take the third place among other causes of death against the 11th place in 2003.

In the light of the above said an idea to introduce STU as the safest mode of transportation capable to remove a car from the market seems to be very timely. STU safety first of all is attributed to the installation of its track high above the ground which eliminates collision with other vehicles, pedestrians, animals, etc. as well as to the stability of movement of each wheel provided by the availability of two rims and anti-derailment system in contrast to the friction force of an automobile wheel. It also makes STU resistant to the impact of hurricane wind, shower rain, icing, fog, sand and dust storms, floods, earthquakes, tsunami, mudslides and other natural disasters that could be the cause of passengers’ deaths using the existing modes of transportation.

STU is characterized by the high degree of anti-terrorist resistance. A STU track installed high above the ground is highly visible. Even if one or several supports were exploded by terrorists the whole line will remain operational. Falling of a support (each support is fixed to a track structure with a special unfastening mechanism) could only double a span, therefore, increase a track deformation. It will have an impact only on a wheel suspension but not on passengers. Therefore, explosion of one or several supports will not disturb the system operation.

[1] For comparison: the average number of people killed in military conflicts including world wars on the planet amounts to approximately 500,000 per year.

STU accident rates will be lower than those of aviation or railways (for example, the total number of people killed in the world as a result of air crashes in 2008 amounted to less than 1,000). STU will be the safest mode of transportation among other known transport systems thanks to a considerably reduced number of accident causes and cases and a possibility to evacuate passengers from emergency unibuses to the ground with the help of special rescue devices (fire escapes and other equipment) installed in the rolling stock which, for example, is not possible in the emergency aircrafts or helicopters when they are in the air.

If in the 21st century at least 50% of motor transport were replaced by a safer string transport it will be possible to save 50-60 million lives and to prevent 1.5-2.0 billion cases of injures and disability. If untimely human deaths and disability were evaluated in terms of the world average insurance norms as USD 1 million and USD 100,000, respectively, the summary economic effect of the reduced traffic traumatism at the scale of the global civilization could be estimated at more than USD 200 trillions.

INVESTMENT ADVANTAGES OF STU

All the above discussed advantages of STU that are attributed to the main qualities of its structural and technological novelty, low investment cost (defined by the reduced material-consumption of a string-rail track structure and the rolling stock and smaller area of STU stations) and low operation costs could be used as a basis to evaluate the investment advantages of STU. In its turn, these advantages are regarded as a priority by a customer in the course of choosing an advanced transport technology to address the main transport problems. The average cost recovery period of concrete STU routes on the average ranges from 2 to 7 years and directly depends on the intensity of passenger and freight flows on each route. In this case the cost of passenger tickets or the tariffs for freight traffic does not only exceed the standard rates of railway or automobile travel but in some cases will be much lower.

Consumer qualities

High accessibility of the transportation services (no barriers for laying the STU routes), all-weather operation and high resistance to the extreme nature conditions, minimal waiting time (unibuses are coming at call rather than according to schedule), high level of comfort in the course of traveling along the super-smooth string-rail track with higher speeds eliminating unnecessary stops and, finally, low net cost of travel are the qualities that help STU conquer a large share in the market of transportation services. This market of transportation services “of the second level” could supplement the existing market of the first level similar, for example, to mobile communications that managed rather to create an additional market than to replace the existing market of wire telephone connections.

Investment cost

Highly reduced material consumption of a string-rail track structure and unibuses, their simplified design and reduced floor area of STU stations with the preserved carrying capacity of the transportation system considerably reduce the investment costs entailed in the STU routes construction as compared with the traditional transportation systems.

Operational costs

The low level of energy consumption by unibuses, considerably lower maintenance costs of a track structure, especially in winter time, and reduced requirements in the service staff to operate a fully automatic transportation system having the longer service life make it possible to considerably reduce the net cost of STU transportation services as compared with the traditional modes of transportation. It, in its turn, considerably reduces the period of cost recovery of the transportation projects based on the use of STU technologies.

Environmental impact

Elimination of the need to occupy the wide strips of land for the distribution of a track structure and to carry out the large-scale earth works, a possibility to eliminate the demolition of structures to lay the STU routes within the urban built-up environment, rugged terrain and forests; low energy consumption, minimal noise and other environmental impacts create the necessary conditions enabling considerable reduction in the ecological costs and the integration of STU systems into any transportation project based on the use of STU technologies.

COMPARATIVE CHARACTERISTICS OF STU

Under the equal usage conditions (the volume of passenger and freight traffic, travel speed of the rolling stock, the height at which a track structure is installed, etc.) capital-intensity of STU will be lower as compared with other modes of transportation, namely:

- conventional highway or railway located on the ground level and elevated– by 2-3 times and by 15-20 times, respectively;
- mono-rail road and light metro – by 20-3o times;
- train on a magnet suspension and high-speed railway – by 25-35 times;
- underground metro – by 30-40 times.

This figures include not only the cost of a track structure as it is usually accepted but also the cost of all other constituting components of the transport system including: the rolling stock, infrastructure and land allocated from various land-users.

Thanks to the lower contact tension in the “wheel-rail” pair (10-20 kgs/mm2 against 100-200 kgs/mm2 in railways) the wear of a string-rail head will be by an order less intensive as that of a traditional railway rail. The rail head size is estimated for the whole service life of STU (50-100 years). For example, to provide the summary volume of traffic in the amount of 500 million tons it is enough to have a rail head with the width of 20-25 mm.

Analysis of the available data showed that STU is a very economically efficient transport system. For example, as compared with aircrafts an inter-city high-speed electrified STU will be by 3-4 times more efficient (non-electrified STU with a diesel drive will be even more energy-efficient: by (3—4)×90,5%/33,5% = (8,1—10,8) times if energy is converted into primary energy, for example, coal used at power plants; 33.5% - efficiency of a heat power plant); by 2.5-3.5 times – as compared with a high-speed railway; by 6-9 times – as compared with a "Transrapid" train on a magnet suspension which in terms of its energy efficiency is inferior to aircrafts.

Because of the lower travel speeds a city suspended STU will be more efficient as compared with an international high-speed STU – on the average by 3-4 times whereas primary energy consumption by an overhead STU will be by 2.5-3.5 times less or as compared, for example, with a passenger car – by 25-35 times less. Accordingly, in terms of its environmental impact STU will be much safer.

Efficiency of STU

Efficiency of STU as compared with the main existing ground transport systems (all routes are double-track, all indices are relative under equal conditions of system construction and operation) is given in Table 2.

Table 2.

COMPARATIVE ANALYSIS OF STU OTHER TRANSPORT SYSTEMS

Indices	Relative size of indices	Justification of STU advantages
1. Average cost of the transportation system (route*, infrastructure** and the rolling stock***): • STU • motor transport • railway • mono-rail road • train on a magnet suspension	 100% 300—500% 150—200% 1,000—1,500% 1,500—2,000%	Reduced cost of STU is the result of the following factors: low material consumption of a string track structure, supports, rail cars and basic infrastructure components; use of traditional, low-cost and non-deficient materials and initial raw materials, machine-building nodes and aggregates; high production and building technologies of the route, infrastructure and rail cars; low cost and highly efficient operation (without traffic jams, and high-speed all-weather circulation without road accidents, etc.); rail cars (requiring reduced number of vehicles per 1 unit of transportation work); small land occupancy and small volume of earth works.
2. Average net cost of passenger and freight transportation: • STU • motor transport (passenger only) • railway • river transport • mono-rail road • train on a magnet suspension (passenger only)	 100% 300—400% 150—200% 1,000—1,500% 300—500% 1,500—2,100% 3,000—3,500%	STU has the lowest net cost of passenger and freight transportation among other known ground transportation systems which results from the low value of its constituting components: 1) low construction costs (low material consumption for the track structure, supports, infrastructure, rail cars and the use of the low-cost materials, nodes and aggregates; high construction and production technologies of all components; low volume of earth works and small land allocations; 2) low amortization costs (long service life of the track structure, supports, infrastructure, rail cars and their low cost; 3) low operation costs (small fuel consumption; high durability of the track structure, not requiring repair and restoration works; all-

* the cost of routes includes the cost of land withdrawn from land-users for the distribution of the transportation system

** the infrastructure includes: stations, terminals, cargo terminals, depots, repair shops, garages, passages, bridges, overpasses, traffic exchanges, filling stations, power transmission lines, power sub-stations, etc. as well as the land they occupy

*** it includes the average cost of passenger and freight rolling stock per 1 km of roads (for highways — motorcycles, passenger cars, mini-buses, buses, trolley-buses, freight vehicles, etc.)

Indices	Relative size of indices	Justification of STU advantages
		weather operation eliminating the need in the removal of ice and snow from the track in winter time; high operation efficiency of rail cars as a result of the high-speed movement, the lack of congestion and all-weather operation).
3. Area of land occupied by the transportation system (route and infrastructure): • STU • motor transport • railway • mono-rail road • train on a magnet suspension	 100% 5,000—8,000% 3,000—5,000% 200—500% 400—600%	Reduced area of land occupied by the STU is the result of the following factors: elimination of embankments, depressions, multi-level exchanges, bridges and overpasses that in highways or railways require the land-consuming high and long dams to access them; elimination of a wide continuous carriageway resting on a cushion and, consequently, on the earth embankment and ground surface; reduced (by 2—3 times) cross section of supports as compared, for example, with a mono-rail.
4. Volume of soil removed in the course of the route and infrastructure construction: • STU • motor transport • railway • mono-rail road • train on a magnet suspension	 100% 3,000—5,000% 4,000—6,000% 200—500% 400—600%	Reduced volume of soil removed in the course of STU construction is the result of the following factors: elimination of depressions, embankments*; reduced size and depth of the foundations of supports thanks to the reduced loads on the supports as compared with a mono-rail road; elimination of a continuous carriage-way (or a rail-sleeper grid in railways) resting on a cushion and thickened soil; reduced (by 2—3 times) cross section of supports, for example as compared with a mono-rail.
5. Fuel consumption (electric energy) per 1 unit of the transportation work (by the rolling stock at the travel speed of 100 km/hour): • STU • motor transport • railway • river transport • mono-rail road • train on a magnet suspension	 100% 2,000—3,000% 200—400% 300—600% 500—1,000% 800—1,200%	Reduced fuel (electric energy) consumption by STU for passenger and freight transportation is the result of the following factors: lower (by 20—30 times) rolling resistance of a steel wheel moving along the steel rail as compared with a rubber wheel; cylindrical shape of its bearing surface (in railways it has the form of a cone); two rims or derailment side rollers on each wheel (in railways there is one flange on a wheel) and lack of the wheel pairs (each wheel is provided with an independent suspension); improved aerodynamic qualities of the rolling stock eliminating screening effect (the lack of a continuous carriage-way); higher efficiency of a steel wheel as compared with an electro-magnetic suspension; reduced mass of the rolling stock per 1 unit of freight; improved evenness of the carriageway (due to the elimination of temperature deformation joints and preliminary tension of strings and the rail head).
6. Material consumption (except soil) for the route and infrastructure construction and manufacturing of the rolling stock: • STU • motor transport • railway	 100% 2,000—3,000% 1,000—1,500%	Reduced material consumption for STU construction (reduced resource-intensity of a system) is the result of the following factors: elimination of a continuous material-consuming carriageway resting on a cushion and embankment (which is replaced by compact, low material-consuming and low-cost string-rails); reduced material consumption for a track structure due to the use of pre-stressed strings (so that a track structure operates rather as a rigid thread than as a bridge beam for deflection) without

* the volume of earth works in the course of modern highway and railway construction reaches 100,000 cub. m/km which results in their increased cost and great damage to the natural environment.

Indices	Relative size of indices	Justification of STU advantages
• mono-rail road • train on a magnet suspension	1,000—1,500% 1,500—2,000%	worsening the strength and rigidity of a track structure; reduced loads on the supports and their foundations (only 1% of supports is exposed to the increased load, i.e. anchor supports); reduced material consumption of a rail car (on conversion to 1 unit of freight) as compared with the traditional rolling stock.
7. Summary environmental pollution in the course of the transportation system construction and operation: • STU • motor transport • railway • river transport • mono-rail road • train on a magnet suspension	 100% 1,000—1,500% 300—400% 250—350% 200—300% 200—300%	Reduced summary environmental pollution (by STU as compared with other transportation systems) is the result of the following factors: significant reduction in fuel (energy) consumption for the transportation of passengers and freights within the whole range of travel speeds (under equal external conditions); no deterioration of rubber tires and asphalt and the lack of their smell in hot weather; elimination of dusty, easily destroyed earth embankments and depressions, gravel and other cushions; elimination of the use of anti-icing salts and snow-removing machines in winter; elimination of high electric voltages, currents and strong alternating electromagnetic fields; low resource-intensity of a system contributing to the increased environmental safety at the stage of construction (increased technological ecological purity results from the reduced environmental load on natural environment at the stage of raw materials extraction and processing and implementation of construction and assembly works in the construction site).
8. Summary operation costs (including consumption of fuel, electric energy, repair and maintenance costs of a track, the rolling stock and infrastructure, salary for the staff, etc.): • STU • motor transport • railway • river transport • mono-rail road • train on a magnet suspension	 100% 200—300% 150—200% 150—200% 400—600% 200—300%	Low operation costs of STU are the result of the following factors: low fuel consumption per 1 unit of transportation work; increased service life of a string-rail, supports and rail cars (due to the lack of temperature joints and high evenness of the rail head STU is practically free from the dynamic shock loads of the moving wheels); all-weather operation of the rolling stock (including shower, hail, strong fog, hurricane wind, icing, heavy snow, flooding, etc.); no need to remove ice and snow from the track structure in winter time; under the extreme weather conditions (hurricane wind, shower, flooding, earthquake, tsunami, etc.) no need in the restoration of a track that is not damaged; reduced volume of repair and restoration works due to the increased durability of a system and its reduced material consumption.
9. Traffic accident rates (including injures and death of people, domestic and wild animals): • STU • motor transport • railway • river transport • mono-rail road • train on a magnet suspension	 100% > 10,000% 300—500% 100—150% 100% 110%	High stability of rail cars on the string-rails (thanks to the provision of each unibus wheel with a derailment system and independent suspension and a more stable gage as compared with railways) and "the second level" of circulation eliminating collisions with ground vehicles, people, domestic and wild animals which makes STU the safest transportation system (accident rates including injures and deaths of people will be lower than in railways and aviation today, i.e. approximately by 100 times lower than in highways). Elimination of embankments and depressions does not hinder the flow of ground and surface waters, migration of people and animals, dislocation of agricultural and other technical devices which contributes to the reduced accident rates and increased safety of the system. Elimination of embankments unstable to the

Indices	Relative size of indices	Justification of STU advantages
		mechanical impacts contributes to the increased system resistance to various natural disasters such as floods, tsunami, earthquakes as well as to the terrorist acts (thanks to the high margin of safety of supports and a track structure and difficult to access string-rail elevated to a considerable height).
10. Summary negative environmental impact (in the course of construction and operation of the route, infrastructure and the rolling stock): • STU • motor transport • railway • river transport • mono-rail road • train on a magnet suspension	 100% 1,500—2,000% 500—800% 400—600% 200—300% 300—500%	Environmental impact of STU will be minimal at all stages of its life cycle which could be attributed to the following factors: suspension systems of the rolling stock relative to the track structure (i.e. a steel wheel) — are characterized by the highest efficiency coefficient among all known and future solutions (99,9%) which could be hardly over-passed in future (for example, electromagnetic suspension of a "Trans-rapid" train, Germany, has the efficiency of 40%), therefore, a rail car in the aggregate with its high aerodynamic qualities is the most economically efficient vehicle among all known vehicles with its minimal environmental impact; jointless rail track with a smooth rolling surface (the working surface of a rail is polished to eliminate micro-unevenness) makes the wheels to move noiseless within the whole range of speeds; improved aerodynamic qualities of rail cars (4—5 times better than of sports cars according to the experimental data) eliminate aerodynamic noises within the whole range of speeds; unlike other ground transportation systems construction of STU routes will not result in the destruction of natural landscapes and bio-cenoses and will contribute to the reduced numbers of people and animals killed in road accidents; small volume of earth works and small area of land allocated for STU construction will result in the minimal withdrawal of fertile soils with its valuable humus generated during millions of years implying land-use and oxygen-generation processes necessary to maintain its constant and continuous rehabilitation in the atmosphere of the planet.

TECHNICAL AND ECONOMIC CHARACTERISTICS OF STU

The key average technical and economic indices of series-produced middle-class STU routes are given in Table 3.

Table 3.

KEY CHARACTERISTICS OF SERIES-PRODUCED MIDDLE-CLASS STU ROUTES

Name of indices	Unit of measure.	Parameters							
		Overhead STU					Suspended STU		
		Up to 100 km/h	Up to 200 km/h	Up to 300 km/h	Up to 400 km/h	Up to 500 km/h	Up to 50 км/ч	Up to 100 km/h	Up to 150 km/h
1. Carrying capacity of a double-track middle-class STU route (passenger module capacity – up to 25 passengers, freight module capacity – up to 5 tons):									
•passenger	mln. pass./year	20	30	40	50	60	15	20	25
• freight	mln.t/ year	3	4	6	8	10	10	15	20
2. Minimal curvature radius:									
• at the station (in depot)	M	10	20	50	100	200	7,5	7,5	7,5
• on the route	M	500	3000	6000	12000	20000	200	500	1500
3. Average fuel consumption (electric energy converted into fuel):									
• passenger traffic	l/100 pass.×km	0,2	0,4	0,6	1,1	1,9	0,05	0,1	0,15
• freight traffic	l/100 t×km	0,3	0,5	0,8	1,5	2,4	0,1	0,2	0,4
4. Net cost of travel on a high-speed route:									
• passenger traffic	USD/100 pass.×km	0,6	0,8	1,0	1,5	2,0	0,3	0,5	0,7
• freight traffic	USD/100 t×km	0,5	1,0	1,5	2,5	3,0	0,3	0,5	0,7
5. Net construction cost of an average double-track STU route (not including infrastructure and the rolling stock) for serial production in the RF:									
• flatland	thous. USD/km	1,0	1,3	1,6	1,9	2,3	0,7	1,1	1,4
• slightly rugged terrain	thous. USD/km	1,1	1,4	1,7	2,0	2,4	0,8	1,2	1,5
• strongly rugged terrain	thous. USD/km	1,5	1,8	2,1	2,4	2,8	0,9	1,3	1,6
• mountains	thous. USD/km	2,0	2,5	3,0	3,5	4,0	1,2	1,6	1,9
6. Flow-type construction rates of a double-track STU route	m/24 hours	1000	800	600	400	300	1000	800	600