INVESTMENT MEMORANDUM

Development and commercial use of Unitsky String Transport

Developed on the order of:

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Contents

1. Introduction

Those inventions that shorten the distance have made the greatest impact on the development of civilization.

As the world statistics shows investments in SREDW[*] at the stage of finalization of scientific programmes could give the return with the ratio of 1:100 and even 1:1,000

The present Investment Memorandum was prepared for institutional and private investors interested in the efficient investment of their capital.

The given document is a well-grounded proposal aimed to invite a potential strategic partner (hereinafter referred to as "Investor") to take part in the programme (hereinafter referred to as "Programme") with the aim to promote commercial application of a principally new type of a transportation system — Unitsky String Transport (hereinafter referred to as "UST").

It should be noted that we do not mean construction of a concrete route but rather finalization of UST as a finished commodity product ready for commercial use all over the world. It opens up much wider opportunities for Investor who will get his share of rights to all non-material assets received in the course of the Programme implementation.

The present Investment Memorandum formulates the essence of the proposal and prospects for gaining profit on the invested capital. Cumbersome calculations, cost estimates, technical details and many other issues were left beyond the limits of this document. Some of them are given in the Appendix. The authors are ready to provide a potential investor with additional data on the Programme (except confidential information) upon his request.

As far as UST is at the stage of finalization of experimental and industrial development some indices contained in this document are estimated data or data received as a result of preliminary tests and could considerably differ from the actual data.

The main focus of this Investment Memorandum is on the application of UST in Russia that has the greatest in the world undeveloped territory and offers the greatest potential market for the implementation of the UST Programme in the 21st century. However, there is an equal possibility for UST to be successfully implemented in any other country or to be applied for the provision of transportation communication between countries.

The authors of this document do not impose any limitations on the use of information contained in this Investment Memorandum and reserve the right for readers to use it on their discretion with relevant references and within the framework of the efficient legislation.

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[*] SREDW – scientific research and experimental design works

2. Resume

Herewith you are invited to take part in the Programme aimed at the commercial use of a principally new mode of transportation system — Unitsky String Transport (UST).

UST is designed as a special automobile on steel wheels (rail automobile) put on two string-rails that are installed on the supports. The given mode of transportation is intended both for passenger and freight traffic. Fig. 1—3 show various alternatives of UST application.

It is assumed that due to its unique qualities this mode of transportation will be able to take the leading position on the world market of transportation services.

In comparison with other widespread existing modes of transportation the given transportation has the following basic advantages:

- low material consumption for construction of UST routes and, as a consequence, low net construction costs;
- low operation costs;
- high consumer qualities (high travel speed, comfort, safety, etc.);
- high carrying capacity;
- high ecological characteristics;
- lower land allocation requirements for road construction;
- possibility to build UST route in difficult to access regions.

Works for this Programme were started in 1977 and were the most active beginning from the year 1998 when the first UN grant was received. The total input in the Programme amounts to about USD 6 million (in current prices (20% per year) including risk compensation it gives the sum of about USD 60 million). A great number of research, experiments and testing activities were carried out including construction of a pilot UST section in the town of Ozyory of Moscow Region which is the first in the world materialized full-scale fragment of a real string transportation system. Project and design documentation was prepared for more than 10 types of string transportation structure, intermediate and anchor supports, different types of transportation modules.

At the present time the Programme has reached the degree of development that does not cause any doubt of developers or experts about its feasibility in terms of practical implementation and high efficiency.

Positive assessments were received from 14 expertises including Siberian branch of the Russian Academy of Transportation, RF Gosstroy, Ministry of Economy and Transportation, Russian Engineering Academy, Scientific Council of Petersburg State University of Ways of Communication, UN experts.

The Programme has received a wide national (Administration of Moscow Region, Krasnoyarski Krai, cities of Sochi and Togliatti) and international (United Nations Human Settlements Programme — UN-HABITAT) support.

UST has an important advantage as compared with other developments in the sphere of new modes of transportation which is referred to its relatively simple technical implementation.

Fig. 1. Double-track UST route in the centre of a city street
(speed up to 100 km/hour)

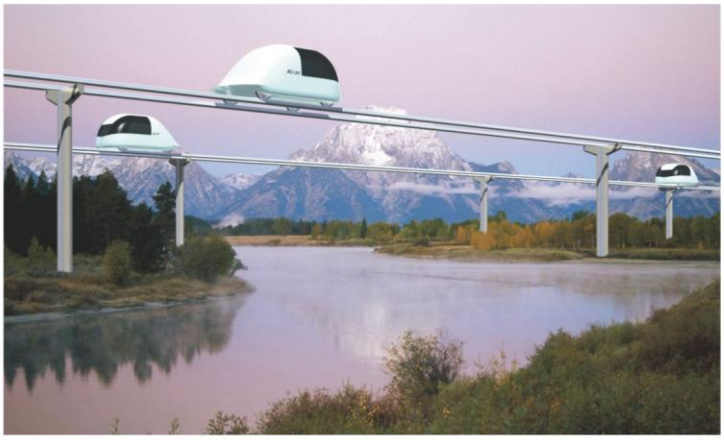

Fig. 2. Double-track UST route in a rugged terrain site
(speed up to 350 km/hour)

Fig. 3. Freight UST train on the base of a serial truck
(mass up to 500 t, speed up to 100 km/hour)

A string system is actually associated with pure mechanics and its many constructive elements have been already approved and widely used in the engineering sphere, for example: a steel wheel, gear, string, rail, pre-stressed track structure, supports.

It makes the UST programme much more attractive than other knowledge-intensive SREDW transportation programmes such as mono-rail roads and train on a magnet suspension.

In the course of UST development the best qualities of all existing modes of transportation were taken into account including: metal wheel and rail of railway transportation after relevant transformations and improvements enabled to achieve low rolling resistance; aerodynamic qualities of modern aircraft and hydrodynamics of submarines helped to design high-speed rail automobiles with the lowest among other known transportation modes aerodynamic resistance; installation of routes at the “second level” (above the ground) and use of high-strength cables was taken from the design of cableways and pre-stressed reinforced structures, hanging and guy rope bridges.

All necessary completing parts and equipment for UST construction could be provided by the Russian industry as well as by industry of any other industrially developed country. An exception could be some completing parts for a rail automobile that at the initial stage it would be reasonable to buy abroad.

Initiator of the Programme aimed at the development, application and operation of String transport is Anatoly E. Unitsky — author and general designer of UST (hereinafter referred to as “Initiator”). He is the author of more than 100 inventions including a principal UST scheme, Doctor of philosophy in transportation, Academician of the Russian Academy of Natural Sciences and member of other Russian and international academies.

According to the assessment of independent experts (appraisers) the intellectual property of the UST author Anatoly Unitsky developed from the year 1977 is estimated at USD 970 million. The outcomes of scientific and technical UST developments are protected by 41 patents.

The volume of external investments necessary to certify UST amount to about USD 30 million and could vary depending on the geographic and climatic conditions and the country of the Programme implementation. The key direction for the use of monetary resources of Investor for practical realization of UST will be construction of a testing ground for the full-scale experimental and industrial testing of the transportation system and its certification as a market product.

It is also possible to establish cooperation for the implementation of separate parts of the Programme (the size of investments from USD 1 million). Final terms and conditions for the participation in the Programme shall be determined by the way of negotiations with a potential Investor.

Investor is invited to provide financing of the Programme in the form of the direct investments: share in the capital of a Parent UST Company (hereinafter referred to as “Company”) especially established to implement the given Programme.

The following structure of Company’s capital is suggested: 50% — Investor who forms his share in the Company’s capital by monetary resources and 50% — Initiator of the Programme who forms his share in the Company’s capital by non-material assets — “know-how”.

Investor shall become a co-owner of all "know-how" created within the framework of the Programme from the moment when financing of the Programme activities was started. The Programme is characterized by high return rates on the invested capital.

The estimates show that the net profit value of the Programme (NPV) for the 18-year estimation horizon is USD 9 billion (pessimistic alternative).

NVP for Investor will be USD 4.5 billion. In this case profit index will be 14 900% and payback period — 6 years from the starting date of financing (pessimistic alternative).

It is proposed that Investor will participate in the Programme implementation not only through its financing but also through the active involvement in the economic and juristic aspects of the programme activities, management and solution of arising problems and attraction of administrative resources.

In other words, to implement the UST Programme Initiator needs a strategic partner who will be fully aware of the UST prospects and ready for the long-term cooperation on a mutually beneficial basis.

3. History of the Programme development and property

Works for the development of string transportation were started by the author, Anatoly Unitsky, in 1977. The most significant results were achieved during the period from 1988. To a great extent the works were supported from the personal author's resources. During this period the total input in the Programme amounted to USD 6 million out of which the volume of attracted funds amounted to about USD 3.9 million. Detailed structure of financing and data on the rights to the assets created as a result of the Programme performance are given in Appendix 3.

Sufficient contribution to the UST Programme financing was made by UN-HABITAT (1998—2002), Russian businessman Dmitry Teryokhin (2000—2001), Ukrainian entrepreneur Alexandr Kapitonov (1994—1996 and 2002), Governor of Krasnoyarski Krai Alexandr Lebed (2001) and Russian entrepreneur Mrs. Nadya Kosareva (2003—2005). Furthermore, more than 100 investors became Programme shareholders who made their investments ranging from USD 10 to USD 10,000. It made it possible to solve a number of scientific research tasks, to implement a great volume of estimation and design works, to test a number of technological processes necessary for the UST development.

In response to the application of the UST author Anatoly Unitsky to Habitat Executive Bureau in 1998 a special international project was initiated within the framework of the programme of cooperation between UN-HABITAT and the Russian Federation aimed at the application of UST in the cities of Russia and other countries. UN-HABITAT Executive Bureau facilitated financial support to the UST project activities. In 1999—2000 the project FS-RUS-98-S01: "Sustainable Development of Human Settlements and Improvement of their Communication Infrastructure through the Use of a String Transportation System" was implemented on the order of UN-HABITAT under the leadership of Anatoly Unitsky. In July 2002 the work was started for the second UN-HABITAT project No. FS-RUS-02-S03 "Provision of Sustainable Human Settlements Development and Urban Environment Protection through the Use of a String Transportation System" with Anatoly Unitsky as the Project Manager. In June 2004 the second stage of activities aimed at the application of UST under various urban conditions was finalized within the framework of this project. Executive of both these projects is the Regional Public Fund to Assist in the Development of a Linear Transportation System (Moscow) headed by Anatoly Unitsky. Within the framework of these projects the international expertise of UST was carried out which showed their positive outcomes and possible applicability under urban conditions including inter-urban transportation purposes.

The key outcomes of the scientific research and experimental-design works for the UST development could be summarized as follows:

- project and design documentation was prepared for several dozens of types of a string track structure, intermediate and anchor supports to be used under various weather-climatic and geographic conditions, various span length, types of the rolling stock (heavy freight trains, low-, high- and super-high-speed rail automobiles);

- project-design documentation was prepared for the rail automobiles of various types including a high-speed passenger concept — U-361 module being a basis for more than 20 modifications of passenger, freight, and freight/passenger rail automobiles;

- models of the high-speed rail UST automobiles (scale 1:5) of various types (single-, double- and triple-unit with various contours for the speeds of 200, 350 and 500 km/hour) were investigated in a wind tunnel at the Central Scientific Research Institute named after Academician Krylov (St. Petersburg, 1995—2002). Research made it possible to design a rail automobile with aerodynamic resistance coefficient ranging from 0.07 to 0.1 against 0.25—0.35 in a modern automobile;

- mathematical static and dynamic UST models were built with the involvement of a group of mathematicians from Belorussian State University, Petersburg State University of Transportation, Voronezh Polytechnic Academy, Academies of Sciences of Belarus and Ukraine;

- technical/economic analysis of string transportation systems was made for passenger and freight transportation. Organisation of rail automobile traffic was optimized to reduce the net cost of transportation;

- projects were prepared and preliminary agreements were made for the construction of concrete UST routes including: ring road around Moscow, Krasnoyarsk — Norilsk, St. Petersburg — Moscow, Moscow — Minsk, Moscow — Kaliningrad, Sochi — Adler — Canyon, Abu-Dhabi — Sharja, etc.;

- technology of UST construction was developed and special technological equipment and assembly instrumentation for pre-stressed track structure including anchoring and stretching of strings, etc.;

- the first in the world pilot section of UST was built in the town of Ozyory of Moscow Region in 2001 (fig. 4) which is the first in the world realized full-scale fragment of a real string transportation system. It has the length of 150 m, height of supports up to 15 m, maximal span — 48 m, string tension — 450 ts (at +20ºC), relative rigidity of a maximal span under the load — 1/1500, metal consumption of a track structure — 120 kg/m, slope — 100‰. A modified ZIL-131 truck (mass — 12 tons) was used as a simulator of a rail automobile installed on steel wheels with 700 mm diameter. Successful approbation was carried out at the testing ground to investigate building technology of a track structure and supports and to test the basic UST nodes and components exposed to static and dynamic load, natural and climatic factors and anti-vandal sustainability (during three years the testing ground had no safeguarding). The above tests and investigations proved the estimated UST characteristics.

Fig. 4. Presentation of the pilot UST section to Governor of Moscow Region Mr. Boris Gromov, town of Ozyory, Moscow Region, October 2001

UST was presented to wide public at various exhibitions, forums and seminars where it generated great interest among professionals who appreciated its high potential, for example:

- in July 2004 a contract was concluded for "Unitran" Fund to assist in the development of string transportation to attend the World EXPO-2005 Exhibition (Nagoya, Japan, 25.03—25.09.2005) and to demonstrate the operational UST model (scale 1;10) within the Russian section — "Noosphere Technologies";

- in December 2001 at the International Exhibition "Industry and Transportation: Cooperation and Collaboration — 2001" the UST technology and projects of passenger and freight rail automobiles were awarded with three Golden quality marks "Russian Mark" (award of the National Programme for the promotion of best Russian goods, services and technologies "Russian Mark");

- outcomes of the UN-HABITAT project were submitted to the exhibition timed to the Global Ministerial Environmental Forum in Malmo, Sweden held from 29 to 31 May, 2000. Ministers from 11 countries, members of the Governing Council of UN Human Settlements Programme noted a great potential of UST in terms of its application for intercity, suburban, citywide, passenger and freight transportation. A special emphasis was made on a possibility to use UST in health resort and tourist centres and national parks;

- September 25—29, 2000 the author of UST took part in the World Urban Environment Forum as a member of the Russian delegation. The Forum was held by UN-HABITAT and UN Environment Programme (UNEP) in Cape Town, South African Republic. In the course of the Forum upon the invitation of Deputy Secretary General of the United Nations Mr. K. Toepfer and Mayor of Cape Town Mr. Bantom the operational UST models were presented to the representatives of "West Cape" (South Africa) province government;

- October 29, 1997 General Designer of UST made a report: "Development of a transportation system "Paris — Moscow" at the International Conference devoted to the development of a communication system "Paris — Berlin — Warsaw — Minsk — Moscow" (Minsk, Republic of Belarus). The Conference that was attended by the ministers of transportation from 7 countries recommended to investigate a possibility of using UST as a high-speed component of Crete transportation corridors.

Scientific papers devoted to UST were published in 5 monographs, 32 reports and articles; 67 inventions were made, the outcomes of scientific-technical developments are protected by 41 patents (a number of patents were issued for the whole group of inventions, therefore, the number of inventions is greater than that of patents).

More than 60 essays and correspondences were published in press, more than 10 TV shows were arranged by central Russian TV canals (NTV, RTR, ORT, etc.). UST Programme was presented in foreign press, radio and TV (Germany, China, South Korea, South Africa, UAE, Sweden, Libya). UST was presented at more than 50 exhibitions, fairs, symposiums, forums including the international ones, awarded with more than 30 diplomas, medals, etc.

According to the independent experts' assessment the current cost of intellectual property developed by the author from the year 1982 (non-material assets — patents, "know-how", engineering, design developments, construction, project, technological and other documentation) is estimated at USD 970 million (see Appendix 10).

4. Description of Unitsky String Transport

4.1. General description

UST is a principally new, multi-purpose communication system (fig. 5) designed as a pre-stressed stretched cable/beam structure installed on the supports with the height of 1—10 m and more. The basic component is a track structure intended for the movement of freight and passenger wheeled transportation modules (rail automobiles) that as their gear use electric motor, internal combustion engine or any other known type of engine. The basic component of UST track structure includes string-rails designed without any joints along the whole length. Strings in the rail are pre-stressed (stretched) to the stress of 100—500 tons (depending on the span length and mass of a rail automobile) and rigidly fixed on anchor supports installed every 1—5 km from each other. In the intervals between anchor supports the track structure is supported by the light supporting masts. Optimal distance between these supports is 20—50 m and maximal distance — 2,500—3,000 m.

4.2. Characteristics of the basic components

String

String is made as a bundle of steel high-strength wire (non-twisted cable) or several reinforced twisted seven-wire K-7 cable with 3—6 mm diameter of home or foreign production. Depending on assembly and operation conditions traditional cables of 15.2 mm diameter (breaking stress — 24—26 tons, permissible normative strength in the track structure — 14 tons), cables with a protective cover or polyethylene envelope including protective lubrication (breaking stress — 26—28 tons, permissible strength — 20 tons) could be used. The cost of cable is USD 1000—5,000 per 1 ton.

String-rail

String-rail is an ordinary continuous (along the whole length) steel, reinforced concrete or steel-reinforced concrete beam equipped with a rail head and additionally reinforced with pre-stressed (stretched) strings (Fig. 6).

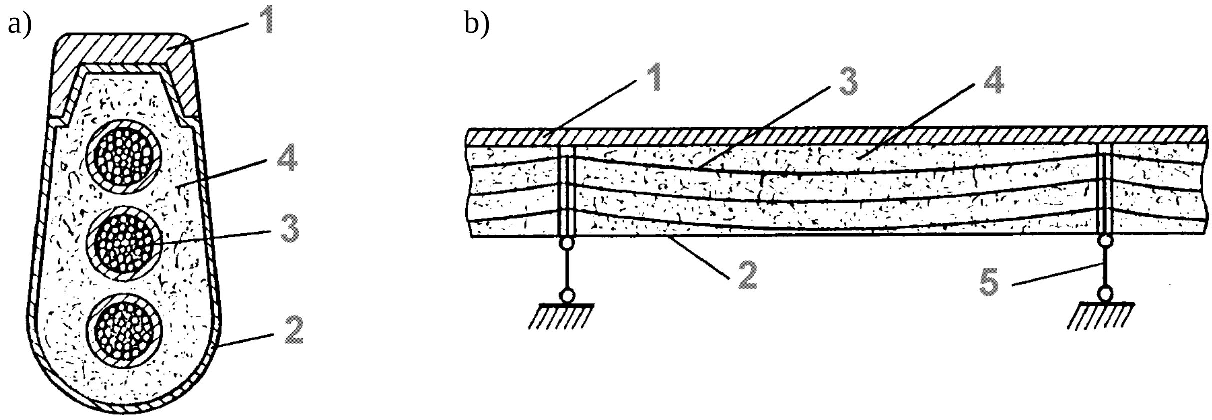

Fig. 6. One of the string-rail design alternatives:
a) cross section; b) longitudinal profile;
1 — head; 2 — body; 3 — string; 4 — filling aggregate; 5 — supporting mast

Maximal string stress per one rail (depending on a span length and mass of the rolling stock) is 100—500 tons (at +20°C temperature).

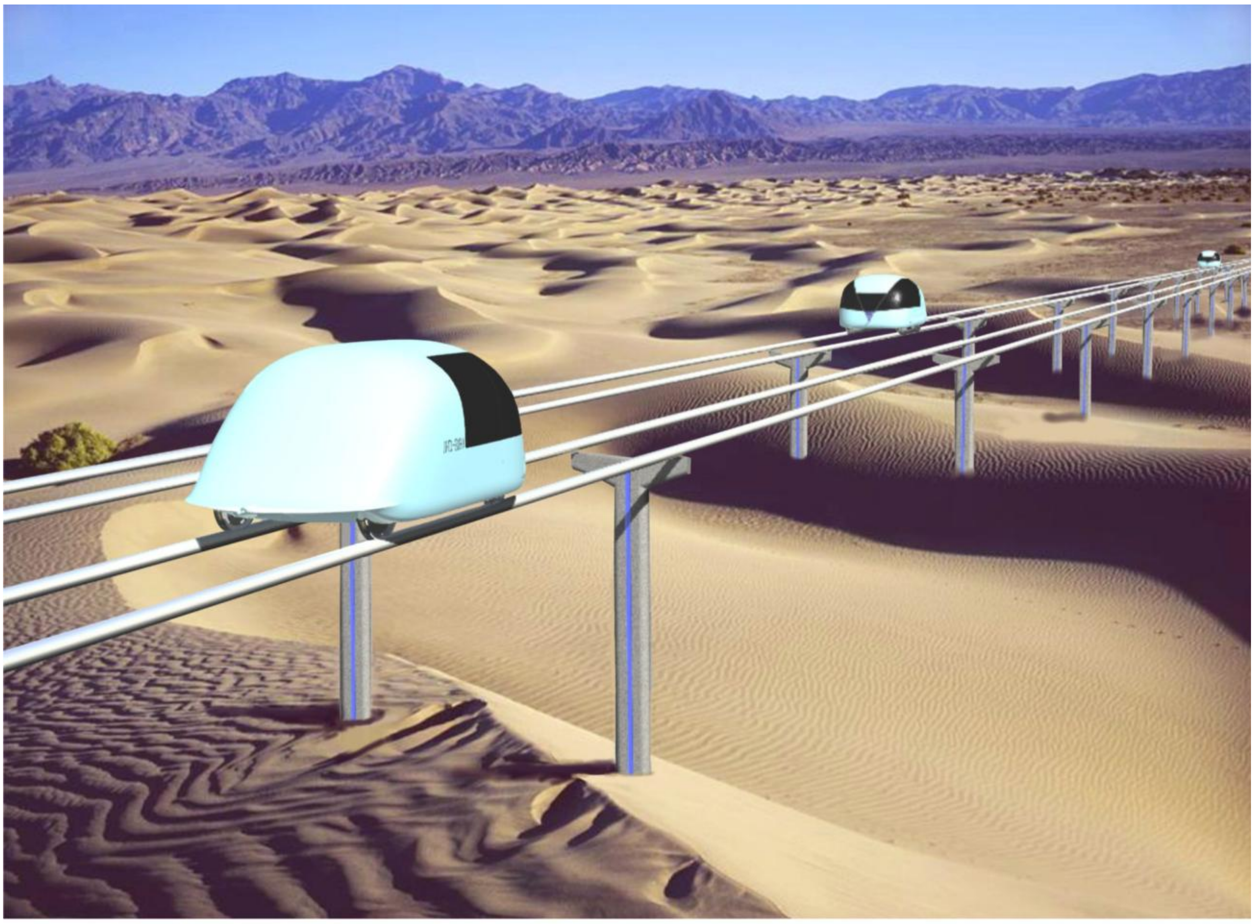

Fig. 5. High-speed rail automobile on the string-rails
(speed up to 350 km/hour, carrying capacity - 25 passengers)

It combines the qualities of a flexible thread (at a large span between the supports) and a rigid beam (at a small span under the wheel of a transportation module and above the support), therefore when it is exposed to the concentrated load of a wheel the deflection (curvature) radius of a string-rail will be equal to 300—500 m and more. Therefore, it enables a wheel to roll smoothly, without shocks both in the middle of a span and above the support. String-rail is designed to maintain the relative rigidity under the impact of the designed load: 1/600—1/100 for the low- and medium-speed routes, 1/1500—1/2000 for the high-speed routes, 1/2000—1/3000 for super high-speed routes (for comparison: relative rigidity of bridges and overpasses at the modern high-speed railways amounts to 1/600—1/1000, therefore the UST track structure will be characterized by the higher dynamic smoothness as compared with a rail track structure of high-speed railways).

String-rail is characterized by a high degree of strength, rigidity, smoothness, technological production and mounting, low material consumption (steel: 25—50 kg/m, concrete: 0.005—0.015 cub.m/m), a wide range of working temperatures (from +70 to –70°C). It provides an ideally smooth road for the rolling wheels as it has no technological or temperature joints along its whole length (rail head is welded as a single weaving).

The cost of the assembled string-rail ranges from USD 50,000 per 1 km which is less than the cost of assembled railway rail on a sleeper grid.

Track structure

Track structure is designed as two string-rails to make a gauge of 2,000 mm width. It is equipped with switch-over devices similar to those used for trams. It is possible to install it on the supports, on the ground (with a special sleeper frame, spacing between sleepers — 5—10 m), or on a sand, gravel or concrete longitudinal (0.2—0.5 m wide) cushion. It could be designed as dismountable structure. A UST gauge is almost 1.4 times wider than that of a railway and centre of mass of the rolling stock is located 1.5—2 times lower to ensure higher (by 2—3 times) steadiness of movement along such track. The left and right string-rail will be connected with each other every 10—50 m with special cross plates to fix the gauge like sleepers used in the railways. Taking into account the fact that UST is not critical to the terrain relief it is possible to lay the UST tracks along the shortest path, i.e. along the straight line. However, if necessary, track structure could have a curvature both in vertical and horizontal plane with a minimal radius of curves amounting to 20 m.

Supports

Supports are subdivided into anchor supports and supporting masts.

Anchor supports take up horizontal load of strings and braking and acceleration horizontal strains of the rolling stock. They are installed every 1—5 km depending on the length of steel wire and steel cables produced by the industry.

Supporting masts take up vertical load of strings, track structure and rolling stock as well as horizontal wind load resulting from the impact of side wind on the transportation line and the rolling stock. They are installed every 10—50 m and more.

For UST routes it is possible to use either earlier designed standard supports with their height ranging from 0.5 to 20 m, made of reinforced concrete or steel welded structures and additionally designed supports to meet special customer’s requirements.

Depending on soil peculiarities either pile (driving, screw, filling, injected) or slab (monolithic or assembled) foundations are possible.

Supports could be installed in any ground — from marshlands and permafrost. Supports and unsplit string-rail in UST form a rigid frame structure therefore bearing capacity of supports is increased, for example, compared with a mono-rail by 8 times (the cost of supports is accordingly reduced). The cost of intermediate and anchor support ranges from USD 500 and USD 50,000, respectively.

Design alternatives of supports of small height (3—6 m) are given in fig. 7—8.

Wheel

Wheel is made of high-strength steel or other strong and rigid material, for example, titanium or aluminium alloy (fig. 9). It has an independent "automobile" suspension and two sloping rims each 40 mm high (against a wheel pair and one steep rim 30 mm high in each railway wheel). Between its rim and nave the wheel is provided with damping and sound-absorbing polymeric gasket. Rolling resistance coefficient is 0.0005—0.001 (1.5—2 times lower than that of a railway wheel having a conic rest surface); the wheel mileage (operating life) is up to 1 million km.

Though a wheel of a UST rail automobile has no articulated flange (rim) it is more stable on the rail than that of a railway train because its supporting surface is designed as an internal surface of a tore the side walls of which are smoothly sank below the rail head. This factor in combination with the lack of a wheel pair eliminates the impact of the rolling stock in motion which is especially important at high-speed movement, because the movement of each wheel is self-adjusting and self-extinguishing in case the equilibrium is disturbed. It will contribute not only to higher safety of movement as compared with railway transportation (reducing a possibility of derailment) but also to the reduced noise level and deterioration of the rail head and wheels.

Rail automobile

Rail automobile is a kind of a conventional automobile put on steel wheels. Like a traditional automobile it could use a diesel, gasoline or turbine engine or a combined engine (for example, "diesel — generator — energy accumulator — electric engine"). If necessary, it could use ecologically clean energy sources such as natural gas, hydrogen, spirit, compressed air, etc. Furthermore, UST could be electrified using external power sources (like a trolleybus, tram or metro) or autonomous energy sources — on-board accumulators, condensation energy or fuel batteries, etc.

High-speed rail automobile has a unique shape characterized by the lowest aerodynamic resistance coefficient among all known transportation vehicles[*]. As an example, fig. 10 gives the external view of one of the designed high-speed passenger rail automobiles.

The body of a rail automobile is load-bearing, made of composite materials. In its tail part, in the aggregate compartment the engine, transmission nodes and other devices are located. All wheels are equipped with an independent suspension.

Brief characteristics of this rail automobile are given in Table 1.

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[*] Aerodynamic resistance coefficient of a high-speed rail car is equal to 0.07—0.1 which is 2—3 times lower than that of a modern sports automobile (the data were obtained experimentally in the course of numerous wind-tunnel tests).

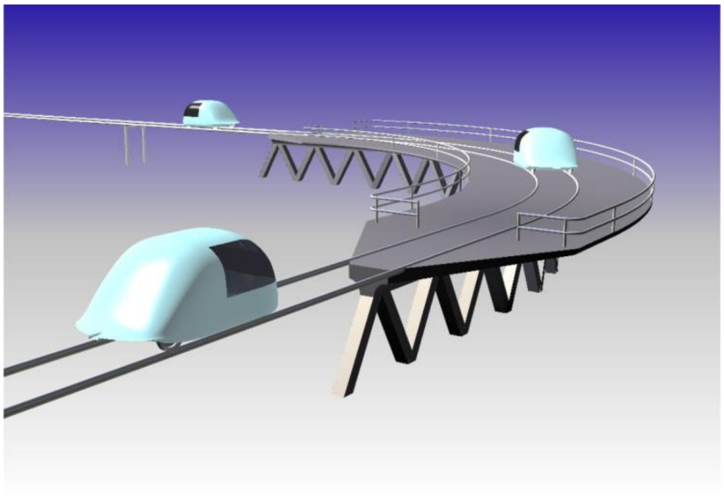


Fig. 7. Anchor UST support
combined with a track turn and a stop platform

Fig. 8. Intermediate support
of small height in a single-track UST route

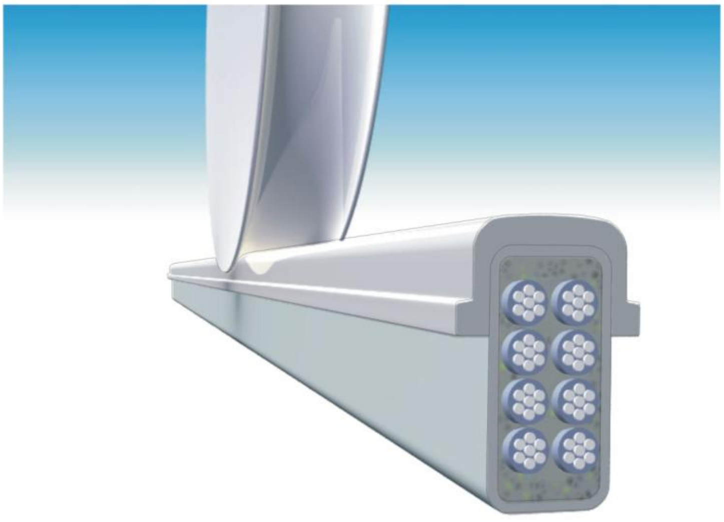


Fig. 9. Wheel on a string-rail

a)
b)
c)

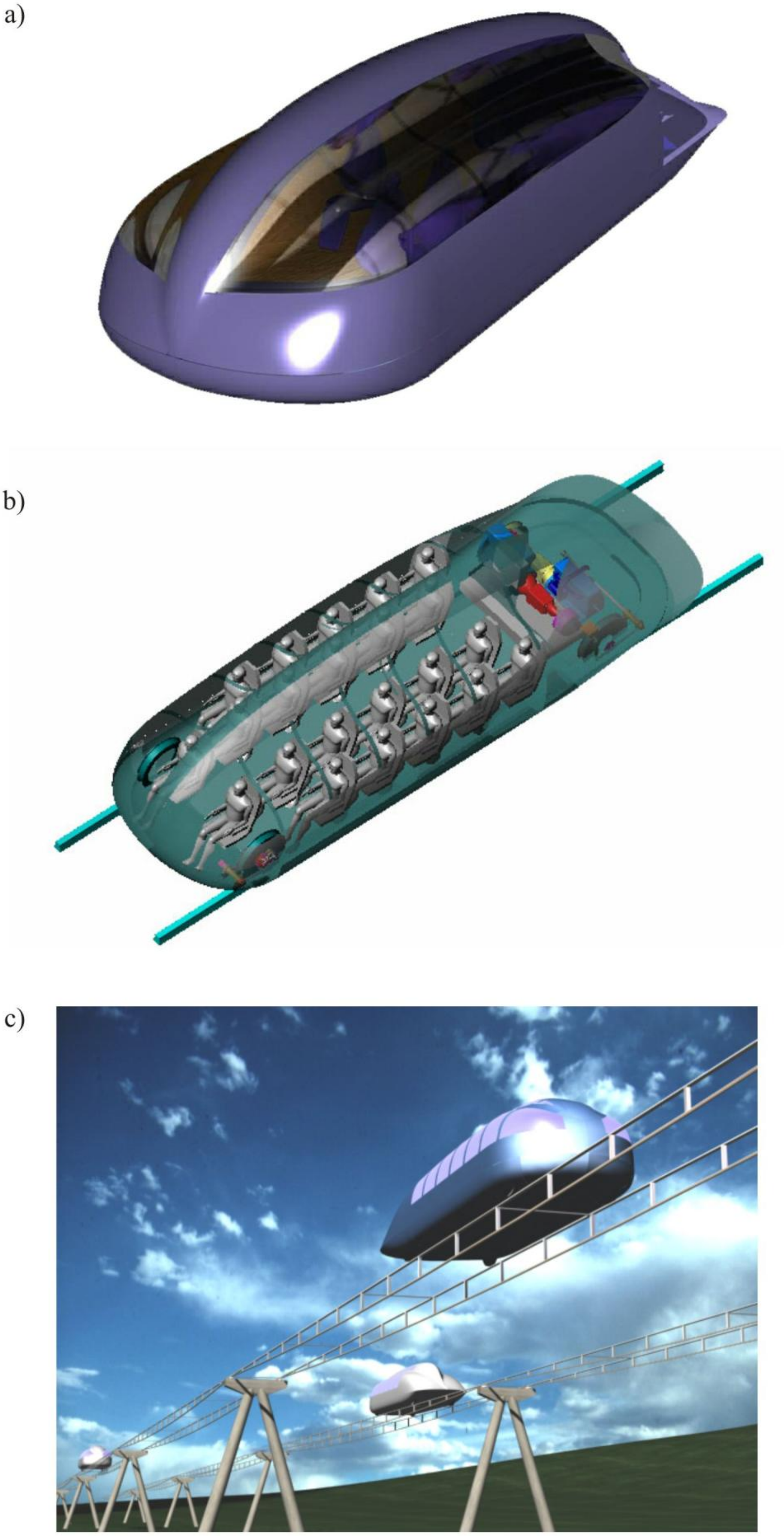


Fig. 10. High-speed rail automobile
a) general view; b) design alternative with passengers placed in the saloon;
c) rail automobile on a string track structure

Table 1

Technical characteristics of the high-speed rail automobile

Parameter	Value
Number of passenger seats	25
Mass, kg:	
- loaded	3 800
- total	6 000
Overall dimensions, mm:	
- length	10 250
- width	2 850
- height (body)	2 200
Base (distance between the axes of front and rare wheels), mm	6 700
Aerodynamic resistance coefficient	0.08
Engine power (diesel), kWt	up to 450
Maximal speed, km/hour	up to 500

Rail automobile is the most economically efficient transportation vehicle among all known vehicles.

Its efficiency is especially visible at low speeds, for example, 100 km/hour traditional for motor transportation. Fuel consumption per 100 km of travel to maintain the given speed will amount to 2 liters (or 0.08 liters / 100 pass.×km or 0.8 liters / 1,000 pass.×km)[*] as the required engine capacity is 9 kWt including: 6.6 kWt — aerodynamic resistance, 1.5 kWt — rolling resistance of a steel wheel and 0.9 kWt — transmission losses.

The cost of one rail automobile of serial production will be about USD 10,000 (for small, 3—4-passenger modules with travel speed up to 200 km/hour).

Passenger rail automobiles could be designed as individual vehicles (for private use), many-seat vehicles for 10—60 passengers or as specialized vehicles for a few seats of various comfort level ranging from urban public transportation to a sleeping car of a railway or a cabin in a yacht. If necessary, depending on customer's demand it is possible to install on the UST track structure practically any known passenger or freight vehicle, mini-bus or bus with relevant transformations made in their design.

It is envisaged that first UST rail automobiles will use a diesel and a gear box produced in Germany adjusted to them and to the mass overall dimensions of a rail automobile.

It is assumed that first rail automobiles will be operated by drivers and in future they will be operated automatically on a centralized basis.

The whole family of rail UST automobiles was designed to be used for various purposes including: freight automobiles for transportation of liquid, friable and piece freights; passenger automobiles — for intra-city, suburban and high-speed intercity transportation.

The following terms are proposed for their designation:

[*] For comparison: fuel consumption by the best passenger cars is 20—30 times more (1—1.5 liters / 100 pass.×km) at the lower level of comfort and safety.

- Unilet — high-speed and super high-speed passenger rail automobile;
- Unibus — low- and medium-speed rail automobile;
- Unitruck — low- and medium-speed rail freight automobile;
- Unitrain — train set of passenger and freight rail automobiles linked with each other mechanically or with “electronic coupling”.

Fig. 11 shows a designed low-speed rail automobile (Unibus U-361*) of medium carrying capacity with various passenger occupation alternatives which could be used both for city and intercity transportation.

Infrastructure

Infrastructure includes stations (fig. 12—13), terminals, loading and unloading terminals, garages, depots, filling stations, switching devices.

Elevation of a track structure to the second level opens up new possibilities for the construction of stations and terminals. Thanks to more favourable operation regimes of a rail automobile the need in garages and filling stations is reduced as compared with traditional motor transportation. Compact rail automobile design makes it possible to reduce the size, and consequently, the cost of terminals, stations and platform length by 5—10 times compared with railway transport.

4.3. Technical and economic characteristics

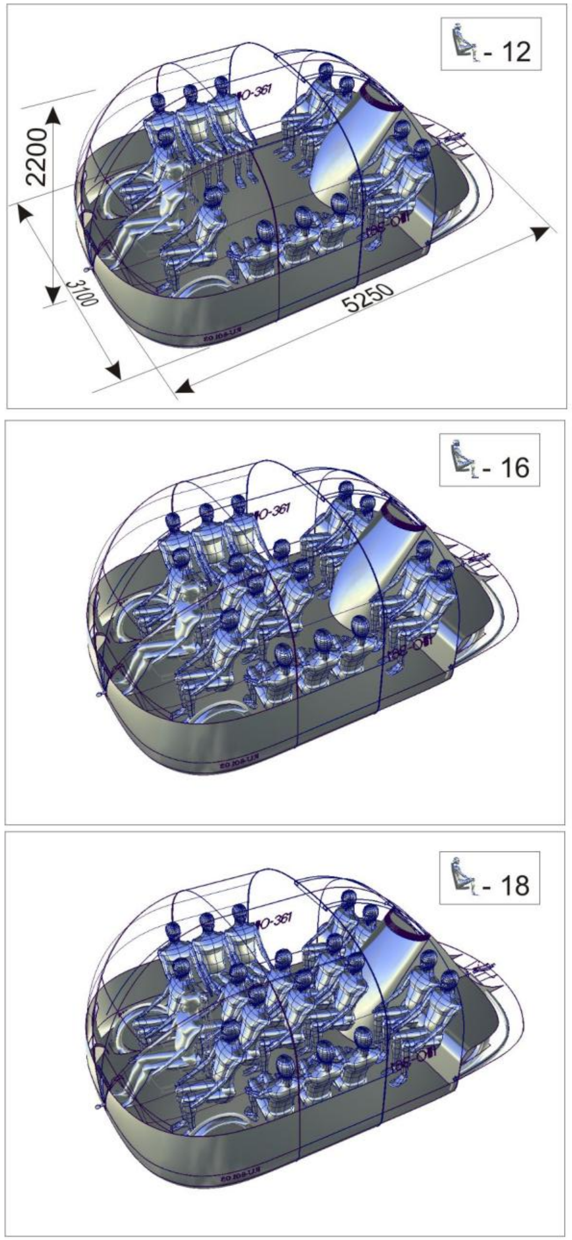
The key average technical and economic indices of UST routes of serial production are given in table 2.

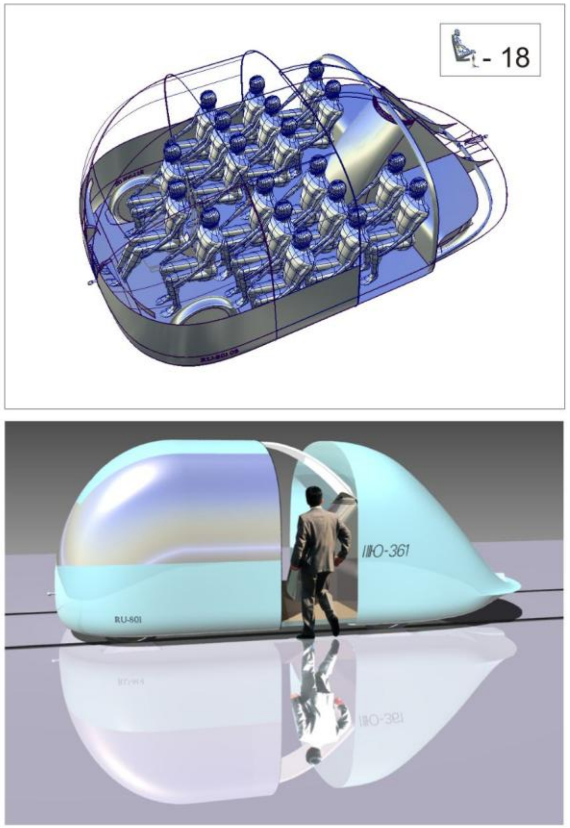
Table 2

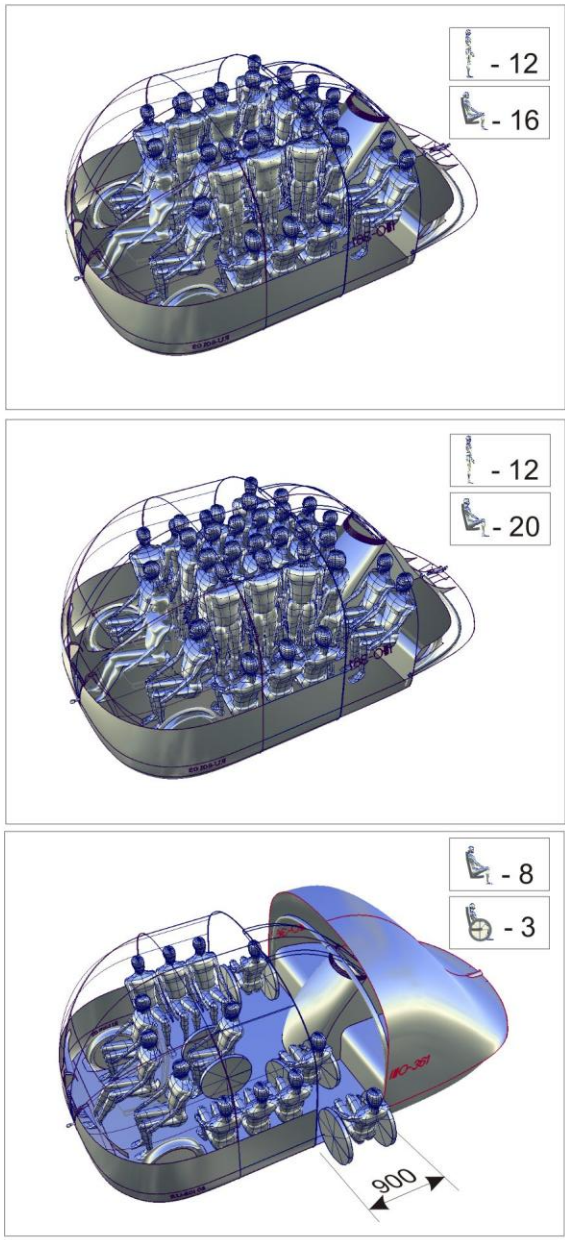
Key characteristics of serial UST routes

Parameter	Unit of measurement	Value
1. Carrying capacity:		
— single-track route:		
• passenger	mln. pass./year	up to 5
• freight	mln. t/year	up to 2
— double-track route:		
• passenger	mln. pass./year	up to 50
• freight	mln. t/year	up to 20
2. Travel speed:		
— low-speed routes	km/hour	up to 100
— speed routes	km/hour	up to 180
— high-speed routes	km/hour	up to 350
— super high-speed routes	km/hour	up to 500
3. Minimal curvature radius	m	20
4. Fuel consumption (with slopes at prolonged gradients up to 20 ‰ and speed 100 km/hour):		
— passenger transportation	liters/100 pass.×km	0,1—0,2
— freight transportation	liters/100 t×km	0,2—0,3

* Figure 36 in a Unibus mark means ordinal number of the designed rail car model, figure 1 designates the length of a cylindrical insertion (in meters) in a module body between its nose and tail part (this length could range from 0 to 12 m)







- 12 Quantity of seats
- 20 Quantity of standing seats
- 3 Seat's quantity for disabled people

Fig. 11. Unibus U-361 with various passenger occupation alternatives

Fig. 12. Two-level station at the intersection of single-track UST routes

Fig. 13. Two-level station at the intersection of double-track UST routes

Ending of table 2

Parameter	Unit of measurement	Value
5. Net cost at speed route*:		
— passenger transportation	USD/100 pass.×km	0.9
— freight transportation	USD/100 tons×km	1.1
6. Net construction cost of average double-track route (without infrastructure and rolling stock) of serial production (under conditions of Russia):		
— on a plain	thous. USD/km	550—650
— on slightly rugged terrain	thous. USD/km	650—800
— on heavily rugged terrain	thous. USD/km	800—1000
— in mountains	thous. USD/km	1000—1500
7. Rates of flow-like route construction	meters/24 hours	up to 500

4.4. Environmental qualities

The use of UST will make it possible:

- to reduce consumption of non-renewable energy carriers (oil, petrol products, gas, coal), and non-ore materials, ferrous and non-ferrous metals) due to the lower material consumption of UST track structure and supports as compared with other modes of transportation; no need in the construction of embankments, depressions, viaducts, bridges, drainage pipes and other facilities associated with high resource consumption;

- to reduce environmental pollution due to: low specific energy consumption (for example, 5—10 times and more lower than by a passenger car); minimal human intrusion into vulnerable natural eco-systems (such as tundra, permafrost zone, jungles, marshlands), a possibility of using alternative environmentally sound energy sources (wind, solar, etc.) in the course of UST operation;

- to reduce land allocations including fertile agricultural lands for string routes construction (less than 0.1 ha/km);

- to reduce noxious emissions. For example, in electrified UST they will be less than 0.01 g/pass×km, i.e. less than emissions at high-speed railway roads, which could be attributed to the absence of dusty embankments and crushed stone cushion; furthermore deterioration of rail, wheels and disk brakes will be considerably lower;

- to reduce noise and vibration. UST is a lower source of noise and soil vibration as compared, for example, with a high-speed railway train. A string track structure is provided with a system of internal dampers and is leaned against the supports also through the system of dampers that will damp and intercept low- and high-frequency track vibrations. Furthermore, the mass of a rail automobile of any model will be considerably less than that of a train. The track will be more smooth as along the whole length there are no temperature deformation joints;

* According to the data of final report on the project of UN Human Settlements Programme (UN-HABITAT) No. FS-RUS-98-S01.

- to preserve natural landscapes and biocenoses — UST does not require construction of embankments, depressions, tunnels, large-scale elevated roads unstable to the impact of natural disasters (such as earthquakes, floods, landslides); there is no need in felling forests, peat cutting of marshlands, removing of the vegetation cover of soils.

Appendix 5 includes the key environmental characteristics of various modes of transportation. For comparison the table also gives the estimated environmental characteristics of electrified UST routes.

4.5. Safety of transportation

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

In 2003 in Russia there were more than 200,000 traffic accidents (except railway) in which about 36,000 people were killed and about 240,000 persons were injured.

Automobile is the most dangerous mode of transportation. According to the data of the World Health Organisation the number of people killed every year as a result of road accidents amounts to 1.2 million (including those died as a result of the received injures) and up to 50 million people are injured and become cripples or invalids.[*]

According to the forecasts of the World Health Organisation the accident rate will be further growing (for example, during the last 5 years the death rates in transportation increased to 300,000 cases per year) and in the year 2020 it will take the third place (against the 11th in 2003) among other causes of human death.

Russia joined the European convention which recognizes the need to reduce by half the number of people killed in road accidents during 8—10 years. This target was included in the transportation strategy.

In the light of the above said the idea of UST application as the most safe mode of transportation capable to push a car from the market seems very acute. Safety of UST is ensured, first of all, by the installation of its track high above the ground surface which eliminates possible collisions with other transportation vehicles, pedestrians, animals, etc. as well as by the availability of two flanges in each wheel (rather than frictional force in an automobile wheel) which is responsible for their stable motion. It also contributes to the higher UST resistance to the impact of hurricane wind, pouring rain, snow, hail, freezing, fog, sand and dust storms, floods, earthquakes, cyclones, landslides and other natural disasters which could become the cause of passengers' death while using the existing modes of transportation.

UST is characterized by the high anti-terrorist sustainability. The track that is elevated high above the ground is easily visible. Even if one or several supporting masts were blown up it will not lead to the accident in the line. Falling of a support (each support is fixed to the track structure with a special unfastening mechanism) will result just in the doubling of the span length and, consequently, growing deformation of the track which will be damped by the wheel suspension without any impact for passengers. Therefore, even if a number of supports were blown up or damaged at a time it will not take the route out of operation.

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[*] For comparison, the average number of people killed on the planet in military conflicts including the world wars is about 500,000 per year.

It is assumed that the accident rate in UST will be lower than that in aviation or railway transportation (for example, the number of people killed in air crashes all over the world during 2003 was less than 1,000). UST will be the most safe mode of transportation among the known transportation systems which could be attributed both to the considerably reduced causes and rates of accidents and to a possibility to evacuate passengers from the emergency modules to the ground with the help of special emergency and rescue devices available in the rolling stock (rescue hoses, ladder escapes and other equipment).

UST routes are characterized by the higher vandal sustainability — pilot UST section in the town of Ozyory built in 2001 has no safeguarding, however, it is in operational condition.

If in the 21st century it were possible to replace at least 50% of automobile transportation by a safer string transportation it could be possible to save 50—60 million of human lives in this century and to prevent 1.5—2 million cases of injuries and disabilities. If we assess the cost of premature human death and disability by the world average insurance norms as USD 500,000 and USD 50,000, respectively the summary economic effect from the reduced transportation traumatic injury rates within the scale of the global civilization will amount to about USD 100 trillion.

4.6. Distinctive consumer qualities

Within the framework of this Programme the ultimate users will be offered services for the transportation of passengers and freights which will be facilitated as a result of the implementation of specific UST projects in various regions of the world carried out on the received orders after certification of UST as a market product at the pilot section. Consequently, the users of UST services will be passengers, freight senders and receivers.

From the point of view of passengers services provided by UST will have the following distinctive qualities:

- comfort of travel due to the low noise level, vibration and relatively small number of passengers in one rail automobile; aesthetic view from the window (the highest spot in flatland sections of UST route is a string-rail along which a vehicle is moving therefore at the level of passenger’s eyes there will be no structural components);
- high travel speed (both due to the high speed characteristics of a rail automobile and a possibility to build UST routes in difficult to access sites where by-pass roads are built for the existing modes of ground transportation), the lack of traffic jams;
- higher safety of UST (especially as compared with automobile transportation);
- resistance to natural disasters (earthquakes, floods, tsunami, cyclones), anti-terrorist sustainability;
- reasonable fare due to the relatively low capital investments in route construction and low operation costs.

From the point of view of freight senders and receivers UST will have the following distinctive qualities:

- high speed of freight delivery;
- small probability of freight loss or damage in the course of transportation;
- possibility of freight delivery in small lots which is economically inefficient for conventional modes of transportation;
- attractive tariffs for freight transportation.

These distinctive qualities in the aggregate make UST attractive for users and enable it to occupy a considerable share in the world transportation market.

4.7. Sphere of application

UST is a universal transportation system having a wide spectrum of application. It could be used for carrying passengers and freights within the city, between cities, countries and continents as well as for the transportation of friable, liquid, piece and container freights.

It is also possible to use UST, for example, for construction of low-cost* freight routes for the following purposes:

- transportation of building materials;
- ore delivery to concentration plants;
- transportation of coal;
- transportation of oil to oil refinery plants;
- garbage removal beyond the boundaries of metropolitan areas;
- transportation of sea containers from ports to warehouses;
- delivery of the high quality natural drinking water to densely populated areas.

UST technology could be used as a basis for the construction of the low-cost** rapidly built string pedestrian crossings, automobile and railway bridges, overpasses, elevated roads, ferries, elevated roads for mono-rail roads and trains on a magnet suspension as the cheaper alternatives of a string load-bearing structure as compared with the traditional beam, truss and guy span structures.

5. Initiator of the Programme

Initiator of the Programme aimed at the development, application and operation of String transport is Anatoly E. Unitsky.

Anatoly Unitsky was born in 1949 in Kryuki village of Bragin district, Gomel Region (Republic of Belarus). In 1966 he graduated from the secondary school in the city of Dzhezkazgan (Kazakhstan) and in 1967 became a student of Tyumen Industrial Institute.

In 1973 graduated from Belorussian Polytechnic Institute, specialization — engineer of ways of communication (highway roads). In 1984 — higher education (second higher education) in patent and invention activity.

Occupations: building trust (leading expert), design institute, design bureau, scientific research institute. In 1988 retired from civil service as Chief of Patent and License Division at the Institute of Metal-polymeric System Mechanics under Belorussian Academy of Sciences (Gomel)

Anatoly Unitsky:

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* The cost of freight routes depending on the designed travel speed and the volume of traffic will be 1.5—2 times lower than that of passenger routes.

** The cost of string span structures will be 2—3 times lower than that of the similar beam span structures.

- general designer of UST, author of a group of inventions “Unitsky String Transport” (in total 67 inventions);
- president of “Unitran” Fund to assist in the development of string transportation (Moscow);
- general director — general designer of Unitsky String Transport Co Ltd;
- author of more than 100 inventions (75 inventions with author’s certificates of the USSR and 67 inventions with 41 patents) including the principal UST scheme. 26 inventions are applied in construction, machine-building, transportation, electronic and chemical industry, scientific research in the Russian Federation, Republic of Belarus, Ukraine and other CIS countries;
- Doctor of philosophy in transportation;
- member (Academician) of the Russian Academy of Natural Sciences;
- member of the USSR Federation of Cosmonautics;
- author of more than 100 publications in scientific and popular scientific journals. Author of 5 scientific monographs;
- awards: Honourary award of “Knight of Science and Arts” of the Russian Academy of Natural Sciences, two golden medals “Laureate of All-Russia Exhibition Centre”, “Russian Mark” (“Russian Brand”) medals for string transportation technology, design of freight and passenger rail automobiles.

Anatoly Unitsky is the owner of intellectual property related to the UST programme which is estimated at USD 970 million (according to the assessment of independent appraisers). Extract from the experts’ assessment of the intellectual property of Anatoly Unitsky related to UST programme is given in Appendix 10.

6. Operator of the Programme

To enable efficient operation of the Programme it is proposed together with the Investor to set up Parent UST Company (hereinafter referred to as “Company”) which management staff shall include representatives of Investor and Programme Initiator on the following terms: 50% of shares to Investor and 50% shares to Initiator.

Initiator (general designer of UST) shall form his share of the authorized fund by investing his patents, engineering, design and technological developments, “know-how” and form the basic design, project and technological potential of the Company from already trained professionals of the relevant spheres. Investor shall form his share of the authorized capital by monetary resources.

On the agreed terms with Investor it is possible to set up a Company based on any existing organizational and legal form of ownership and in any civilized country of the world.

Company’s tasks shall include strategic decision-making to specify the ways for Programme development, operational management of certification activity and further commercial use of UST, administration and accounting, representative functions.

Project-design and production-construction block of the Company shall be formed predominantly by the Programme Initiator. Company will be provided with qualified personnel having the relevant knowledge and experience necessary for practical implementation of the Programme. Over 27 years of work for the UST development (from 1977) the Programme Initiator has created his own UST school of professionals living in Russia, Belorussia, Ukraine, USA and Germany. These experts will be engaged at the stage of project and design works and certification on a sub-contract basis or within temporary working teams (TWT).

Investor is envisaged to form financial/economic and operation block.
The structure of Parent "UST" Company is given in fig. 14.

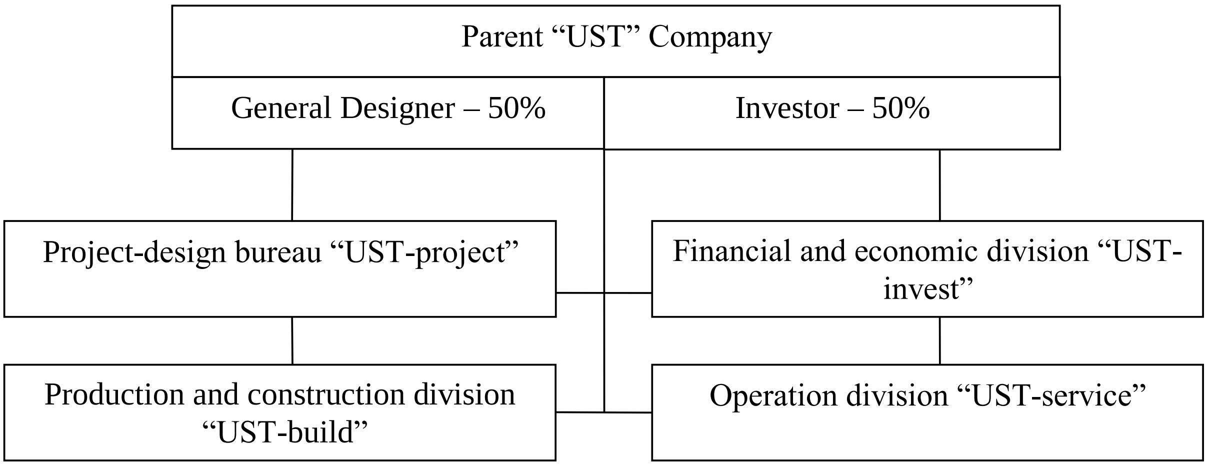


Fig. 14. Structure of Parent Company

Personnel requirements for the first stage of activities — certification of high-speed UST (speed up to 150—180 km/hour) — will amount to 40—50 persons. Mainly they will include designers, technical experts and managers. The major portion of work at this stage will be carried out by sub-contractors and TWT.

At the second stage of activities — certification of high-speed UST (speed up to 300—400 km/hour), 2—3 years after the establishment of the Company the total number of its personnel will increase to 300—400 persons to include the best experts from sub-contractors and TWT.

At the third stage of activities — certification of super high-speed UST (speed up to 450—500 km/hour), after 4—5 years of Company's existence its staff will increase to 600—800 persons.

In future the total number of personnel will be further growing and in 8—10 years the Company will become a trans-national corporation with the total personnel of more than 40,000 persons.

7. Description of the branch, market and competition

7.1. Global transportation industry and ways of its development

Today the total length of the global ways of communication amounts to about 25 million km including: 21 million km of motor roads, about 1.5 million km — railways, 1 million km — main pipelines.

Transportation is an enormous industry which in the 21st century is in the face of great anticipated changes associated with the following basic factors:

- the situation with energy resources on the planet is changing. Modern transportation almost fully depends on the availability of oil resources that are rapidly depleting to result in the situation when they become inaccessible for the use in transportation. Various means to raise the efficiency of oil use could just postpone but not prevent the time of the occurrence of this situation;

- existing road network is consuming a great amount of materials both at the stage of construction and operation whereas in future many resources will be subject to depletion and in this case their cost will be increased;
- the global transportation system the main standards of which such as, for example a railway gage, were specified as early as in the 19th century, became obsolete. Some elements of the world transportation system became obsolete long ago as all changes that were made were very small and insufficient and did not affect the basis of the system;

- the global problems of ecology and safety in the 21st century will become even more acute because transportation due to the great scale of its application became the most dangerous invention of the mankind. As a result of traffic and road accidents in all parts of the planet every year about 1.5 million of people are killed (out of which about 1.2 million at automobile roads which is inadmissible from the point of view of humanization and provision of sustainable development of civilization);

- the number of users will increase to about 8 billion people and according to the UN data already in 2030 communicative capacity of people will increase by 6 times and the total population of the world cities will increase by 3 billion people. Therefore, the need in the high-speed safe and environmentally friendly mode of transportation will be proportionally growing;

- the share of transportation costs in the total cost of the world product is constantly growing;

- in the 21st century the cost of land as a very limited resource on our planet will grow considerably to make up the major part of the total costs for newly-built roads. At the same time track structures of the major transportation communications built in the 19th—20th centuries are located immediately on the ground surface. About 60 million ha of lands have been already allocated for their construction which exceeds the summary area of Greece, Belgium, Austria, Hungary, Portugal, Denmark and Switzerland. These lands are not capable to breathe and to produce oxygen because all plants with their vegetation cover including humus generated by living nature during millions of years have been destroyed. The flow of ground and surface waters in these sites is disturbed to result in soil erosion, turning of these sites into swamps or deserts and, consequently, there are growing land allocation requirements for road construction. In regions adjacent to the roads movement of large and small domestic and wild animals is disturbed (more than 1 billion of animals are killed on the roads every year). Much greater areas with their soils and all living and growing there are contaminated by cancerogenous and noxious substances (more than 100) being the products of fuel combustion, deterioration of tyres and road surface, anti-freezing salts, etc.

Therefore, there is an urgent need in the development of a new transportation system based on innovative technologies and standards capable to bring about radical changes in the means of transportation.

Future transportation system for carrying passengers, small- and large-tonnage freights should meet a variety of contradicting requirements including:

- high carrying capacity at small land coverage and low maintenance and repair costs for transportation facilities;

- minimal negative environmental impact at high daily mileage rates;

- high average circulation speed at lower fuel consumption and the reduced number of traffic and road accidents;
- transport should be appropriate for public and individual use to ensure operational, safe and comfortable communications irrespective of the distances and be accessible for non-professional user;

- transportation system should be "omnivorous", i.e. at the beginning to operate on relatively cheap oil fuel, then to be electrified or converted into alternative environmentally sound types of fuel or other renewable energy sources without any additional costs.

The total capacity of the world market for UST in the 21st century is estimated by experts at USD 10 trillion.

7.2. Transportation branch in Russia

In Russia the share of the transportation sector in the gross domestic product of Russia amounts to almost 7% and it has 12% of the basic assets and 15% of investments. The total employment is 3.1 million people or 7% of economically active population; annually 12 billion tons of freights and 45 billion of passengers are carried by the sector and its share in the tax revenues to the consolidated budget amounts to 15%.

Growth in the volumes of production, commerce and external trade turnover predetermined the growing demand for transportation services. During the 2000—2003 period the total volume of freight transportation and population mobility increased by 23% and 12%, respectively. The volume of investments, not including road economy, almost doubled. And it is predicted that the current trends will be retained. At the total 3% growth in population mobility the greatest growth (10%) in traffic volumes is observed in civil aviation. The total freight turnover by car and industrial railway transportation increased by more than 3% and 10%, respectively.

At the present time the transportation branch of Russia is in the face of a number of challenges including:

- growing deterioration of basic assets;
- lower population mobility — almost by 2.5 times lower than in the developed foreign countries;
- competitiveness of Russian carriers on the world market and growth in the quality of transportation services at the country level are hindered by backwardness in the quality of transportation engineering, technologies, organization of production. Alongside with the impact of the objective factors it leads to the situation when the share of transportation costs in the net cost of product amounts to 20—25% against 10—15% in countries with the developed market economy;
- export of certain cargo types is experiencing the deficiency of carrying and transportation capacities;
- national transit potential is not fully realized.

Additional 1.5 million of cars entered the roads of Russia in 2003. Today there are 47 cars per 1 km of roads of public use in Russia against, for example, 19 in Canada, 33 — in USA, 34 — in France. At the present time there are 150 private cars per 1,000 population and by the year 2010 this figure will be doubled.

As seen from the aforementioned data the transportation branch has a lot of problems to address in the nearest years.

Given below graphs and diagrams (fig. 15—17) clearly illustrate the state and development directions of the Russian transportation branch and its dynamics during the 1998—2003 period.

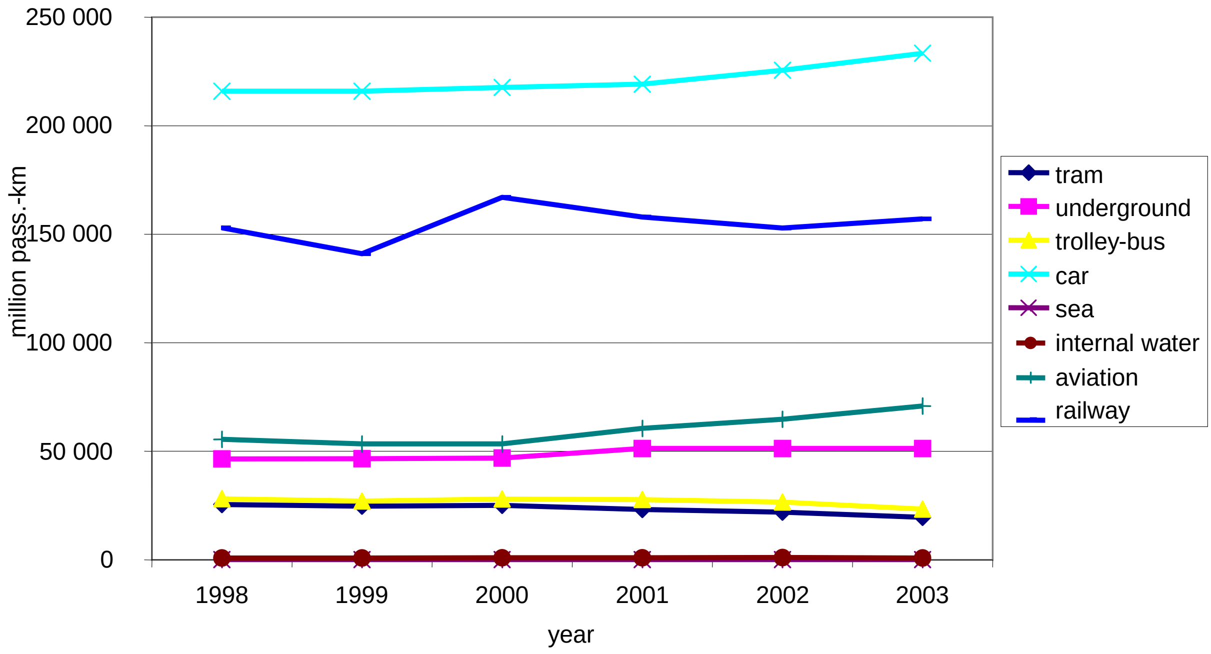


Fig. 15. Passenger turnover in Russia by modes of transportation

As seen from fig. 15 passenger turnover in car and aviation transportation has a trend of stable growth.

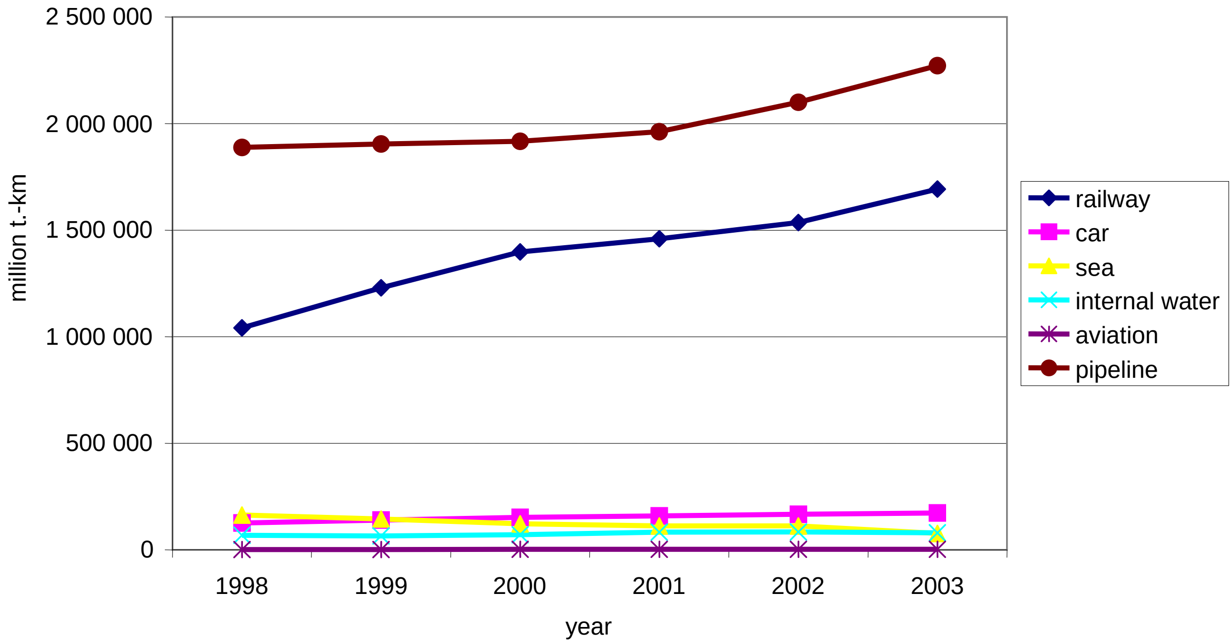


Fig. 16. Freight turnover in Russia by modes of transportation

Referring to freight turnover (fig. 16) in the recent years there was a stable growth in the volume of freights carried by railway and pipeline transportation.

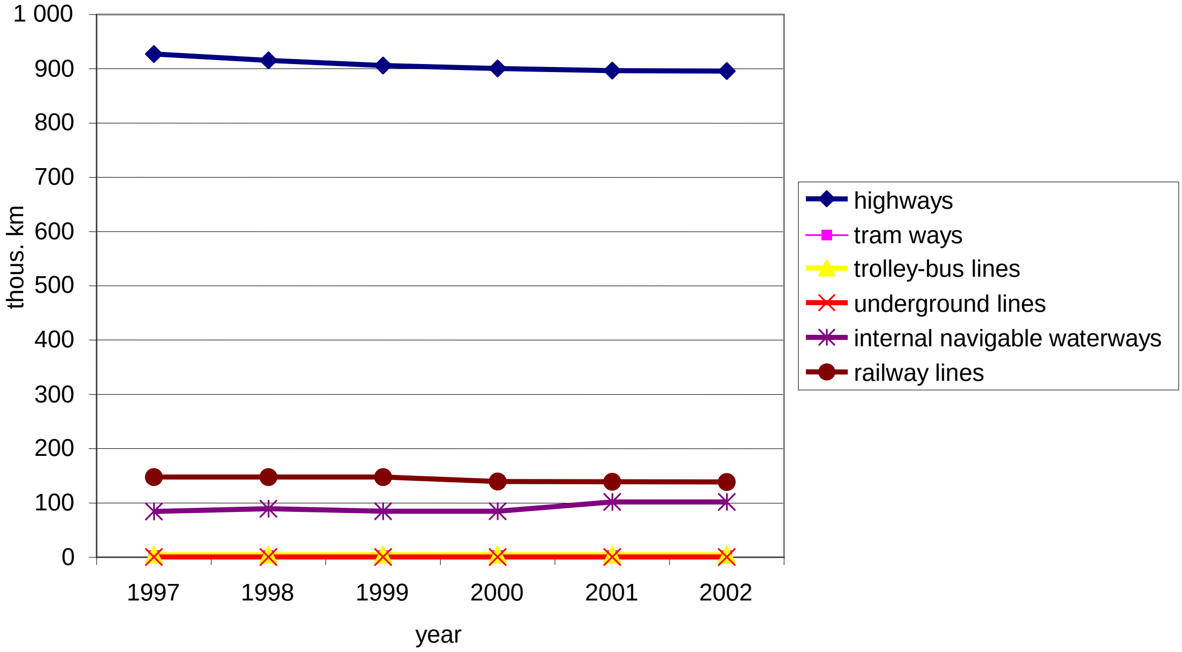


Fig. 17. Length of ways of communications in Russia

As it is clearly seen from fig. 17 there was not only any growth in the total length of transportation lines in Russia but it was reduced because some of them got out of order. Taking into account the stable growth in freight and passenger turnover as well as the total number of transportation vehicles it is possible to assume that in the near future existing transportation ways will not be able to cope with the growing volume of traffic. First of all it refers to highway roads.

7.3. Competitive environment, characteristics of the key modes of transportation

Today there are more than 300 known different modes of transportation and transportation system alternatives.

At the present time the greatest volumes of transportation in the world are carried by railways, cars and aviation. However, their analysis showed the availability of serious drawbacks.

Given below were the major modes of transportation, each of them having a number of alternatives. For example, a screen-jet is an alternative to an air plane, electric car is that of a motor car. These and other modes of transportation, in total more than 300, are the object of research in many countries of the world. Among them there are some modes that, in the author' opinion, could be referred to very exotic ones, for example, routes for aircrafts with shortened wings to fly in the underground tunnel of 50 m diameter (Japan) or "a flying saucer" which creates vacuum in front of a nasal part of an aircraft (Russia).

Analysis shows that the existing traditional and future modes of transportation are associated with high costs and environmental hazard, their construction requires alienation of large areas of valuable lands.

None of them is capable to cope with noise requirements whereas noise protection measures would entail increased maintenance costs of the high-speed roads.

Therefore, at the present time there is an urgent need in the development of a new transportation system based on innovative technologies and standards that will be able to bring about radical changes in the means of transportation of people and freights.

Railway transportation

In its modern meaning it appeared at the beginning of the 19th century though first track roads were in existence already in Ancient Rome. The total length of railways built all over the world is about 1.5 million km.

Under the present average world conditions the cost of 1 km of a double-track road including infrastructure is USD 1—2 million and more, the cost of one passenger coach is about USD 1 million, electric locomotive — about USD 10 million. Road construction is associated with great resource consumption including: metal (steel, copper), reinforced concrete, gravel. The volume of excavation works on the average amounts to about 50,000 cub.m/km. Land withdrawn from different users amounts to about 5 ha/km or 10 ha/km including infrastructure.

Difficult geographic conditions require construction of unique structures such as bridges, viaducts, elevated roads, tunnels which considerably increase the total cost of the system and have greater negative environmental impact. The average weighted travel speed is 60—80 km/hour.

Wildlife habitat and residents of the adjacent human settlements are exposed to noise impact, vibration, heat and electromagnetic radiation generated by the moving trains. The total annual amount of garbage generated by passenger trains per 1 km of road and its right of way amounts to 12 tons including 250 kg of feces.

Railway transportation is characterized by enormous water consumption and heavy pollution of water basins. Every year about 1,000 people and millions of animals are killed in Russia under the train wheels.

Among the advantages of railway transportation it is necessary to note its low operation costs. First of all the rolling resistance of a steel wheel on a steel rail is 20—50 times less than that of a rubber wheel on a road surface. This advantage is easily realized in railways thanks to the availability of a gage. Thus, a railway train could be as long as necessary while the length of a car train is limited by one trailer due to instability of movement along the road especially during braking. Secondly, the service life of rails is 20—40 years while the service life of asphalt-concrete surface is 5—10 years. Railway transportation is characterized by the high safety of circulation due to a flange (rim) available on each wheel which eliminates a possibility of derailment.

Automobile transportation

It emerged at the end of the 19th century. Over the past period more than 20 million km of roads were built and about 1 billion of cars were produced.

The cost of a modern highway is USD 1—10 million and more, land requirements are estimated at more than 5 ha/km or 15 ha/km including infrastructure. The volume of excavation works reaches 50,000 cub.m/km and more. The cost of an average statistic car is about USD 15,000, the average weighted travel speed is 60—80 km/hour.

Among the advantages of car transportation it is necessary to note low cost of the rolling stock and roads and high mobility and compactness of cars which make its infrastructure simpler and less expensive including access roads, loading and unloading terminals, repair shops, etc.

The major disadvantages of car transportation are associated with its high accident rates and environmental hazard which is attributed to the fact that the car wheel is held on the road surface only by frictional force. Furthermore, automobile became a major source of noise and air pollution in the cities. Noxious components contained in motor transportation exhausts and petroleum evaporation products become the source of air pollution as well as soil and surface water contamination.

Highways and their infrastructure withdrew from the noosphere approximately 60 million ha of lands (for example, the summary territory of FRG and UK) and destroyed unique and invaluable soil layer generated by the wildnature during millions of years.

Aviation

Aviation has a bit more than 100-year history. Advantages of air transportation include high travel speeds. However, at medium distances (up to 1,000—1,500 km) the speed of passenger “door-to-door” transportation is not high (150—200 km/hour) due to time losses to get to and from the airport, loading and unloading, etc.

Aviation is the most environmentally hazardous and energy-consuming mode of transportation. The summary amount of noxious atmospheric emissions from modern aircraft reaches 30—40 kg/100 passenger×km. The bulk of aircraft emissions is concentrated within the area of airports, i.e. in the vicinity of large cities where the major portion of population is living, in the course of flight at small heights and engine reheating.

During many-hour flight every passenger is exposed to additional irradiation as a result of cosmic natural gamma-radiation equal to several thousands of micro-roentgen (exposure doze in the aircraft saloon reaches 300—400 micro-roentgen/hour against a standard of 20 micro-roentgen/hour).

Another important factor entailed in airport construction is related to land allocation requirements that could be comparable with those for railway and highway construction however, in this case these are lands located in the immediate vicinity of cities, thus, having considerably higher value.

Aviation produces a heavy noise impact, especially within the area of airports, and considerable electromagnetic pollution generated by radars.

Air transportation is the most expensive mode of transportation. The cost of modern airliners is as high as USD 100 million, while construction costs for a large-scale international airport exceed USD10 billion. Aviation is associated with high fuel consumption amounting to 6—8 liters per 100 pass.×km for higher-quality aircraft.

High-speed railways

Construction of high-speed railways (HSR) was started in the last quarter of the last century. Maximum travel speed is 400 km/hour, average operating speed — 180—200 km/hour.

HSR is an ordinary railway road provided with improved and reinforced track structure (rails, sleepers) and cushion (special reinforced embankment and ballast foundation) and special high-speed rolling stock.

The cost of 1 km of road is USD 10—20 million and more, the cost of 1 coach — USD 2—5 million. Their environmental impact is heavier than that of conventional railways. For example, according to the ecologists' assessment environmental impact of the construction of a high-speed "St.-Petersburg — Moscow" railway will be equal to that of Chernobyl accident. In this case the net cost of travel will be USD 123 per 1 passenger (with the total length of the route — 660 km).

HSR requires noise screening facilities and special enclosures to prevent penetration of cattle and wild animals to the railway tracks which could result in train derailment. HSR embankment creates an insurmountable obstacle for wild and domestic animals, surface and ground waters.

During 40 years (from 1964 when the first high-speed road was put into operation in Japan) the total length of the high-speed roads built in Europe and in the world amounted to as little as 3,000 km and less than 5,000 km, respectively.

Trains on a magnet suspension

"Transrapid" (Germany)

Train with an electric magnet suspension using traditional conductors. For a car length of 25 m the clearance between the rolling stock and the road structure should not exceed 10 mm, otherwise the suspension would not work. Such roads place very high and difficult requirements for their construction and operation. At low travel speeds (up to 50 km/hour) it is based on special wheels available in each car.

The cost of a road is USD 25—50 million/km, the cost of 1 car is USD 6—10 million and more. For example, business-plan of the German "Transrapid International" Company submitted to the Government of Moscow specified the cost of a "Transrapid" route — "Airport Sheremetyevo — Centre of Moscow" with the total length of 29 km as USD 1.5 billion (not including the cost of land and demolition costs of buildings and structures). "Transrapid" route built in 2002 in China ("Shanghai — airport", length — 30 km, cost — about USD 1.5 billion, fare — USD 8) has approximately the same technical and economic indices.

Construction of track structure, supports and infrastructure is associated with high building material consumption including reinforced concrete and steel for the massive span beams (beam height is about 2 m for a 24 m span) and heavy supports (to eliminate even smallest displacement under the load).

Travel speed is up to 500 km/hour. It is characterized by heavy noise at high travel speeds which is attributed to the fact that the car shell fully encloses the load-bearing beam (on top, bottom and on both sides) and air is sucked in the clearance with high speed. The energetic efficiency is very low: substation efficiency is 34% (alternating current frequency modulated by a substation is used to form a magnetic field running along the track), efficiency of a linear electric motor is 40%. Multiplication gives the total efficiency of 13.6% which is somewhat higher than that of a locomotive.

"Maglev" (Japan)

It is a super-conductive magneto-levitating railway road. Cars are equipped with super-conductive coils and the power of their magnetic field is so high (no similar magnetic field has ever been found in nature either in our Planet or in the solar system and the Galaxy, therefore, imagine how hazard it could be for all live things) is capable to provide suspension at the height of 10—20 cm. Travel speed is up to 500 km/hour. Coils located in a passenger coach are cooled by three cryogenic circuits of liquefied and gaseous helium and liquefied nitrogen. Jump-type losses in super-conductivity could result in coil explosion equivalent to that of several kilograms of trotyl. The cost of 1 km of road is USD 20—30, the cost of 1 car is more than USD 10 million.

Monorail

Monorail has been widely spread in the USA, Canada, France and other countries**.** In Moscow first monorail road was built in 2003 but its structural drawbacks hinder its putting into operation.

A wheel cabin is moving along a beam (ALVEG) or under a beam (SAFEGE) which should have a large cross section in order to ensure the cabin steadiness. A system is characterized by high material consumption for span structures and supports. Suspension system is responsible for unfavorable vibration dynamics of a cabin and its poor aero-dynamic qualities therefore monorail roads have low travel speeds failing to reach 200 km/hour. The cost of 1 km of monorail road is USD 8—20 million and more.

Trolleybus

Trolleybus is used as urban mode of transportation. It requires construction of roads with hard surface and special infrastructure with a contact feeder network. Therefore, modern trolleybus routes are more expensive than conventional highways. The average cost of a modern trolleybus is about USD 500,000.

Trolleybus is one of the most clean transportation modes from the point of view of a city resident because power plants responsible for natural environment pollution are located far away from them. It requires greater amounts of primary energy (such as fuel at power plants) as only one half of energy generated by power plants reaches the electric engine of a trolleybus.

High-speed tram

In the recent years is was widely used in the USA, Canada, Europe, South-East Asia. Travel speed is up to 100 km/hour. The cost of routes is USD 6—12 million per 1 km. The cost of 1 tram is about USD 1 million.

Rail bus

Rail bus is a variety of a tram which uses a diesel instead of an electric motor. Its production was started in Germany in 1995. The cost of 1 rail bus is about USD 2 million.

Cable roads

Aerial transportation system designed by a Swiss engineer G. Muller has been already put into service in Canada, USA and Germany. It consists of passenger coaches that are moving along the cables hanged on the light metal supports. It is a relatively low-cost structure (USD 1—2 million/km), however, it fails to reach travel speeds more than 50 km/hour.

7.4. Key competitive advantages

Comparison of UST with other transportation systems is correct only if we consider other high-speed systems such as high-speed railway and train on a magnet suspension. Furthermore, these modes of transportation should be elevated above the ground level.

For example, it is not correct to compare ground roads — railway or highway — with a road of the second-level (it is more correct to compare UST with highways or railways in the elevated alternative).

It is either incorrect to compare UST with the low-speed systems such as cable or monorail roads.

The known roads of the second level, i.e. elevated above the ground, are extremely expensive (train on a magnet suspension, railway or highway elevated roads — USD 25—50 million/km), or expensive and low-speed (monorail — USD 8—20 million/km, speed — up to 80 km/hour), or relatively low-cost but very low-speed (cable road — USD 1—2 million, speed — up to 50 km/hour).

An important competitive advantage of UST as compared with other "know-how" in the transportation sphere is associated with the fact that UST track structure and supports are designed as the elevated road in compliance with the requirements of the Russian SNiP (Construction norms and rules) 2.05.03-84 "Bridges and Pipes" as well as with due regard to the basic provisions of the bridge norms of the USA and EU, therefore, no certification is required. Each designed UST route as well as any other transportation facility is only subject to expertise by the relevant state authorities and testing in the course of their putting into operation.

The following competitive advantages distinguish UST from other transportation systems with similar efficiency:

1) Lower requirements for capital investments in the course of construction including UST routes and rolling stock which could be attributed to the following factors:

   - low material consumption for UST routes;
   - low construction costs for UST routes;
   - low cost per 1 seat in a rail automobile;
   - reduced land allocations for road construction.

2) Lower net cost of transportation attributed to the following factors:

   - low maintenance costs in the course of route operation;
   - economic efficiency of rail automobiles.

3) Favorable environmental qualities of UST;

4) All-weather operation

5) Safety

6) Multi-purpose application

7) High consumer qualities (high travel speed, comfort, safety, etc.)

Given below is a detailed description of each of the competitive advantages and factors responsible for these competitive advantages of UST.

Low specific material consumption for UST route construction

Material consumption for a double-track UST route is as follows: metal structures — 150—250 kg/m, reinforced concrete — 0.1—0.3 cub.m/m.

For comparison:

- railway construction requires: metal structures — 400—800 kg/m, reinforced concrete — 0.5—0.8 cub.m/m, gravel — 2—3 cub.m/m, volume of earth works — 10—50 cub.m/m and more;
- monorail construction requires: metal structures — 1,500—3,000 kg/m, reinforced concrete — 0.5—1.5 cub.m/m.

Low construction cost of UST route

Construction cost of UST route including infrastructure is 2—3 times lower than that of railway or highway under similar conditions (20—50 times lower than for train on a magnet suspension; 10—20 times lower than for high-speed railway; 8—20 times lower than for monorail road); the time of construction is reduced by 2—3 times.

Planned average cost of the UST routes of serial production is up to USD 1 million/km. For comparison: the cost of a high-speed railway is USD 10—20 million/km, monorail road — USD 8—20 million/km, train on a magnet suspension — USD 25—50 million/km, underground — USD 50—100 million/km, conventional railway — USD 1—2 million/km, modern multi-lane highway (autobahn) — USD 5—10 million/km and more, cable road — USD 1—2 million/km.

The use of UST for the development of the worldwide road network with the total length of 10,000,000 km will make it possible to save: more than USD 10 trillion as compared with highways with asphalt surface; more than USD 30 trillion — against highways with reinforced concrete carriageway; about USD 20 trillion — as compared with railways; more than USD 80 trillion — as compared with elevated motor roads; more than USD 30 trillion — as compared with elevated roads of a monorail type; about USD 80 trillion — as compared with elevated roads for trains on a magnet suspension (see Appendix 1).

The cost of 1 km of the average double-track UST route without infrastructure at serial production will be as follows: USD 0.9—1.1 million — for flatland sites; USD 1.5—2 million — in city and in mountains; USD 2—3 million — in the marine sections above water (as compared with the net construction cost of UST routes their cost includes profit of building organizations in the amount of 30—50% of the net cost).

Low cost of a rail automobile

The net cost of UST rail automobile of serial production will be at the level of the cost of a conventional passenger automobile (USD 3,000—5,000 per 1 seat).

For comparison: the cost of 1 passenger seat in some other modes of transportation is as follows: airbus — USD 200,000—300,000; train on a magnet suspension — USD 100,000—200,000; high-speed railway — USD 20,000—30,000.

Low maintenance costs in the course of UST route operation

Thanks to the lower contact voltage in the "wheel — rail" pair (50—60 kgs/sq. mm against 100—120 kgs/sq. mm for railways) deterioration of a rail head will be less intensive than in railway transportation (1 mm deterioration of a rail height after the impact of 100 million ton load). The rail head thickness is designed for the whole service life of UST (50—100 years), for example the head thickness of 20—25 mm is sufficient to ensure the volume of transportation amounting to 500 million tons. These advantages could be attributed to the application of new standards to design the UST wheel and rail: supporting surface of a wheel is the internal surface of a tore and the working surface of the rail head has a cylinder form (in railway transportation it is a cone and cylinder in a tram).

Operation costs are mainly associated with periodic protection of metal structures against corrosion (once per 10—20 years). With a string-rail body made of stainless steel and supports — of reinforced concrete the operation costs will include seasonal inspection of structures (to reveal construction defects). Track structure does not require any efforts to remove snow or ice in winter time at negative air temperatures if the height of supports exceeds the height of the snow cover.

Economic efficiency of a rail automobile

Only thanks to the fact that the moving high-speed rail automobile is elevated above the ground surface its fuel consumption is reduced by 1.5—2 times. It is explained by considerably lower air resistance, especially at high travel speeds (more than 250 km/hour) resulting from the elimination of screening effect observed in the traditional continuous road carriageway. Wind tunnel tests carried out at St. Petersburg Institute of Hydrodynamics named after Krylov fully proved these estimates. Improved aero-dynamic qualities of a rail automobile body (this shape of a rail automobile body has not been used in any transportation system) made it possible to additionally reduce fuel consumption by 2—3 times as compared with a passenger car. Furthermore, lower rolling resistance of a steel wheel as compared with a rubber one makes it possible to reach additional 2—3 time reduction in fuel consumption (as compared with automobile transportation) at high-speed travel speeds. According to the estimates energy consumption by UST will be 10—15 times less than by traditional car for the same volume of transportation work.

Fuel consumption by UST, for example, at the travel speed of 200 km/hour amounts to 0.3—0.4 liters per 100 pass.×km* (against 4—6 liters / 100 pass.×km by a passenger car at the same speed).

Energy consumption at high-speed movement (in comparable units) as compared with aviation including screen-jets (screen-planes) will be 20—25 times less. For example, at the travel speed of 400 km/hour UST will be 2—3 times and 3—4 times more economically efficient than high-speed railway and train on a magnet suspension, respectively (see Appendix 5).

Smaller land allocations for UST routes

Land requirements for UST construction are 30—50 times less than for railways or highways of similar capacity (land allocations for UST range from 0.05 to 0.1 ha/km including infrastructure; against, for example, 5—10 ha/km, i.e. 50—100 times more — for the high-speed railways or

* The module engine should have an excessive power necessary to enable its fast acceleration along the route and operation of on-board systems (lighting, heating, conditioning, etc.) which results in the increased fuel consumption as compared with an ideal case.

3—10 ha/km — for conventional railways and highways). Consequently, the volume of earth works for UST construction will be 50—100 times less (that are required only for the foundations of supports; with pile foundations the earth works are not required).

Environmental qualities of UST

Construction of string routes is not associated with irreparable damage to the environment because it does not require construction of special facilities (embankments, depressions, tunnels, powerful elevated roads, overpasses and viaducts) resulting in the deterioration of landscapes and bio-geo-cenosis and non-resistant to the impact of natural disasters (such as earthquakes, floods, landslides, etc.)

In terms of its specific environmental impact an electrified rail automobile will be less hazardous than a trolleybus (noxious emissions — not more than 1 g/100 pass.×km) and in terms of noise — safer than an electric car. The rail automobile that uses internal combustion engine is more environmentally friendly than a traditional car (10—15 times at similar transportation work).

Low net cost of transportation

The net cost of passenger (or 1 ton of freight) transportation will be 1.5—2 times lower as compared with railway transportation (or 5—10 lower as compared with aviation, train on a magnet suspension and monorail road or 3—5 times lower as compared with motor transportation).

UST will ensure the net cost of transportation at the level of modern suburban trains — up to USD 1 per 100 pass.×km with higher quality of transportation service (comfort, speed, safety, environmental qualities).

All-weather operation

UST is stable to the impact of hurricane wind (up to 200—250 km/hour), heavy rains (up to 100 mm/day), snow (with the height of snow cover up to 3—5 m), hail, freezing (up to 50 mm of ice of the rail head), fog, sand and dust storms, earthquakes (with 9—10 magnitude by Richter scale), tornado, floods (with water rise up to 5—10 m), extremely hot (up to +80º C in the sun) or cold (up to –70 ºC frost) weather.

Safety

UST transportation system will provide higher safety level of travel by one order as compared with modern passenger air and railway transportation which safety level is higher than, for example, that of car transportation by three orders (approximately by 1,000 times).

Multi-purpose application

UST is not only a transportation system but also a communication system as its string-rail could be used for the distribution of food-pipelines (with 50 mm diameter), power transmission lines (for example, high voltage cable), communication lines both wire and fibro optical ones. UST transportation lines are easily combined with radio-relay lines and cellular communications and its track structure and supports — with solar and wind power plants. Multi-functional application of UST makes it possible to reduce the payback period by 2—3 times.

UST is an optimal transportation system for system analysis of the transportation process as it is (relocation of material objects within the gravitation field and aerial space of the Earth) from the point of view of exact sciences: physics, mechanics, structural mechanics, aerodynamics, etc.

Optimization of the transportation system is given in Appendix 1.

7.5. Forecast of UST position on the world transportation market

Thanks to the aforementioned competitive qualities UST is capable to push aside most of the existing modes of ground transportation and take the leading position on the world transportation market in the 21st century.

Development forecast of the world transportation branch up to the year 2100 with regard to the application of UST is given in the diagram (fig. 18).

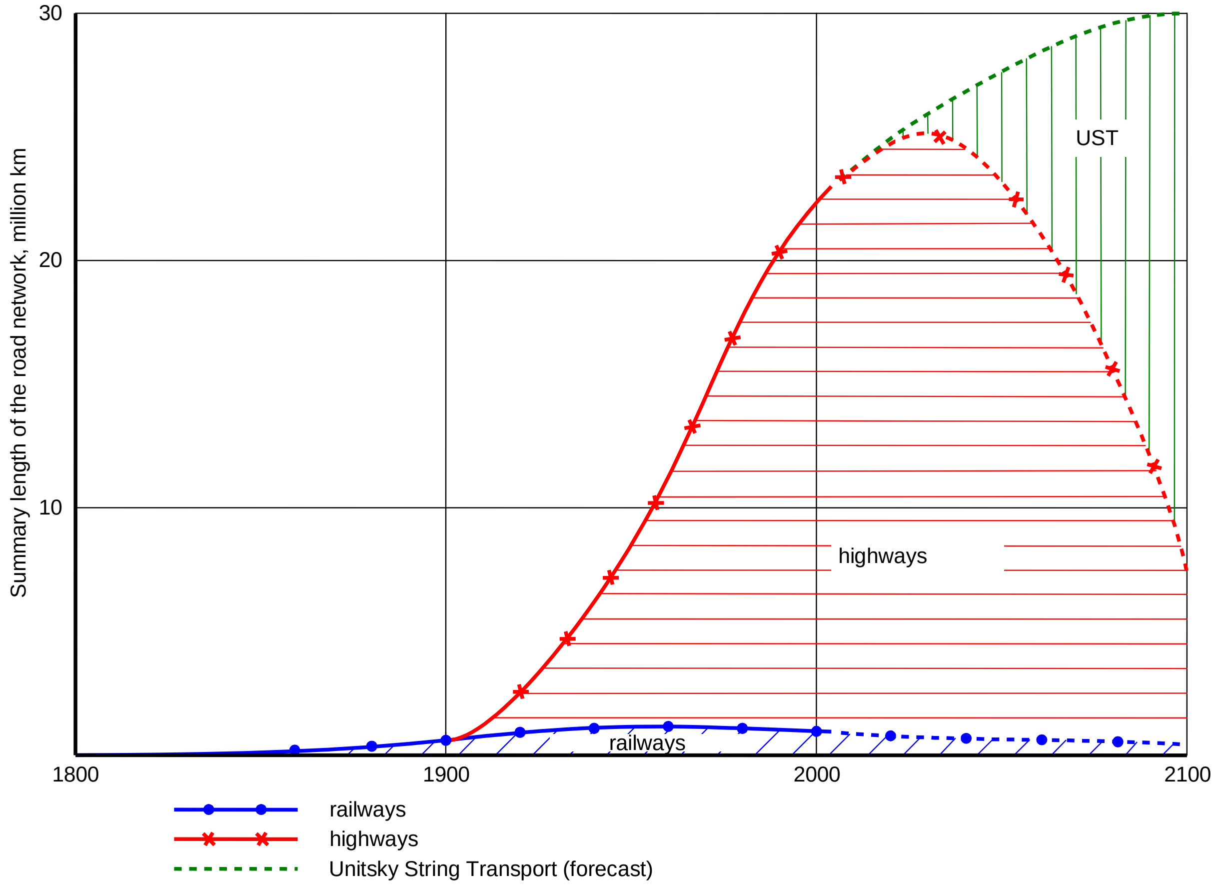


Fig. 18. Development forecast of the world transportation branch in its dynamics up to the year 2100

The diagram shows a pessimistic development alternative of UST road network especially its initial development stages (1st quarter of the 21st century). For example, as it is seen from the graph, automobile transportation was characterized by the most intensive development in the 1st quarter of the 20th century. Therefore, it is possible to conclude that at the present time there are all necessary conditions and greater possibilities for the similar development of a principally new global network of roads of the “second level”, namely: more powerful global economy, higher demand for the low-cost, economically efficient and environmentally friendly and safe high-speed transportation than 100 years ago.

8. Strategic plan

Strategic goal of the given Programme implies development of UST as a ready market product and its wide-scale commercial application: design of UST routes and infrastructure, organisation of construction of UST routes and infrastructure, design and manufacturing of the rolling stock, use of non-material assets (charging of royalty), construction and operation of actual UST routes.

Strategic plan:

1) to certify UST;

2) to create a new transportation niche in the global economy and to hold not less than 25—30% on each of the following markets during the 21st century:

   - design of UST routes and infrastructure;
   - construction of UST routes and infrastructure;
   - design of the rolling stock' manufacturing of the rolling stock;
   - freight and passenger transportation (actual routes).

3) to hold the leading positions in the field of the development of new UST technologies and "know-how" in the 21st century;

4) to facilitate the full-scale use of possibilities of earning profit from royalties charged from users of the "know-how" developed within the framework of the Programme implementation. No unauthorized use of "know-how" is permitted.

9. Operation plan

According to the strategic plan the UST Programme could be conventionally subdivided into 2 stages:

- stage 1 — development of UST as a ready certified product;

- stage 2 — initiation of business to promote commercial application of UST: design of UST routes, organization of construction of UST routes and manufacturing of the rolling stock, use of non-material assets (charging of royalty), operation of UST routes being in full or shared ownership.

In order to implement the first stage it is necessary to pass the procedure of state certification of UST.

Certification of UST implies three phases (see table 3) including construction of pilot testing units (module sections), manufacturing of the rolling stock and basic infrastructure components.

Table 3

Phasing of the Programme implementation

Phase number	Phase name	Duration
1.	Low- and medium-speeds (up to 180 km/hour)	1.5—2.5 years
2.	High speeds (up to 350 km/hour)	2.5—3.5 years
3.	Super high speeds (up to 500 km/hour)	4—5 years

These phases could be implemented either in parallel or one after another by the increment principle starting from more simple and less costly technologies of lower speed levels.

The essence of phase-by-phase certification is as follows: after certification of the low-speed routes Company will be able to initiate their commercial use and re-invest the received profit to certify high- and super high-speed UST routes.

Phase-by-phase certification is justified not only in the economic terms but it is also reasonable from engineering point of view. The outcomes of phase 1 (speed 150—180 km/hour) could not be transferred to phase 2 (speed 300—350 km/hour) because, for example, double increase in travel speed will result in 8 time increase in aero-dynamic resistance of a rail automobile (for example, from 25 kWt to 200 kWt) and 4 time increase in the dynamic loads, etc.

It would be reasonable to implement the above given phases in parallel. It will make it possible for the Company to minimize the costs and implementation time of the first stage of the Programme. Total duration of the whole complex of works could be reduced (as compared with phase-by-phase alternative) by 3.5—4 years (to 4—5 years) and the cost of works will be reduced by USD 17—21 million (to amount to USD 25—30 million instead of USD 42—51 million, see Chapter 14 “Investments and directions of their utilization”).

Works for all phases could be carried out practically simultaneously. Only construction works and manufacturing of the rolling stock will be carried out in sequence: after completion of a pilot section (2—3 km) envisaged under phase 1 the same working team will continue the works for its extension for 6—7 km (to get the total length of 8—10 km as specified by phase 2) with the relevant project and estimation documentation already available. Simultaneously tests and certification under phase 1 will be initiated at the pilot testing unit (tests and certification of individual UST nodes and components will be started earlier, 6—9 months after the start of financing, at the specially manufactured testing units).

In a similar way a pilot section for phase 3 will be finalized to reach the speeds of 450—500 km/hour (detailed phasing of the proposed activities is given in the draft agreement of strategic partnership, Appendix 2).

The total duration of activities starting from the initiation of financing to the finalization of certification of super high-speed UST routes at parallel certification of UST of various travel speeds amounts to about 5 years.

After the experimental and industrial investigation of UST at the testing ground, its standardization and certification Company will get the finished product ready for commercial use all over the world.

Approximate operation plan of the first and second stages of the Programme implementation is given in Table 4.

Table 4

Operation plan of the Programme implementation

Phase	Year from the starting date of financing					
	1	2	3	4	5	6
1st phase						
2nd phase						
3rd phase						

Where:

Preparatory works (Stage 1)
Active works (Stage 1)
Commercial use (Stage 2)

It is envisaged that the detailed operation plan for the implementation of the second stage (commercial use of UST) will be developed together with the Investor.

10. Risk factors and risk reduction strategy

Main risks in the course of the Programme implementation:

Financial:

- increased costs in the course of certify UST.
  Financial requirements were estimated by the authors on the basis of a pessimistic development scenario. Therefore, there is a greater probability that resources will be saved rather than overspend.

- certified UST product received is characterized by considerably lower qualities than it was anticipated which will make its application less attractive.
  The degree of UST development makes it possible to assume that no sufficient deviations from the assigned technical and economic characteristics are expected.

Legal:

- claims for non-material assets within the framework of UST Programme made by the third party.
  At the present time there are no claims from investors involved in the Programme financing in the previous years.

Market:

- analogue product appears on the market.
  At the present moment the authors have no information about scientific research activities with the aim to create similar modes of transportation. Taking into account the knowledge- and cost-intensive nature of the Programme it is hardly possible that an analogue product could be produced in foreseeable future.

Criminal:

- threat to the author’s safety.
  Taking into account the closed-type character of the Programme and the fact that during 27 years of work its author became the only carrier of the total complex of “know-how” and the owner of intellectual property related to UST it would be reasonable to take the relevant steps to ensure his full personal safety.

- unauthorized use of the Programme “know-how”.
  As the economic potential of scientific and technical development becomes obvious for a wider circle of people the information about technical and technological decisions for UST development will require adequate protection against unauthorized use.

11. Social significance of the Programme

The given Programme has a great social significance. The full-scale Programme implementation could result in the following changes in terms of their social implications:

- communicative capacity of population will grow (business and personal contacts, tourist trips, excursions and recreation trips including long-term and short-term weekend rest, etc.);
- it will be possible: to commute to the remote places of employment without changing habitual places of residence; to create sustainable residential (housing) and recreation zones within the walking distances from UST routes;
- use of UST rail automobile as an individual mode of transportation which in terms of its cost is more affordable than passenger car will be promoted;
- accident rates in other modes of transportation will be reduced through the attraction of certain portion of passenger and freight transportation by UST (today only in road accidents in the world about 1,200,000 people are killed and about 50 million become invalids or cripples every year);
- transportation and energy system and communication networks will become better protected against natural disasters (floods, landslides, earthquakes, cyclones, etc.) and terrorist acts;
- transport thanks to the predominance of UST will be all-weather operational (operation of string routes do not depend on the impact of fog, snow, freezing, wind, rain, sand storms and other unfavourable weather conditions) and universal to use both ground and sea sections of the transportation lines.

Implementation of the Programme will make it possible to achieve a number of socio-economic tasks, including:

- reduced distraction of financial resources for the long-term construction projects at the expense of the following factors: low capital consumption of UST (much lower than for any other high-speed transportation system, for example, by ten-folds as compared with a train on a magnet suspension); rapid pay back of capital investments (3—5 years);
- reduced cost of transportation service, its higher accessibility and attractiveness for all population groups at higher quality of service (speed, comfort, safety);
- acceleration and strengthening of integration and cooperation economic links both within the countries and between countries;
- slight dependency of transportation lines on the ground features and characteristics of the site therefore a possibility to develop difficult to access territories such as: deserts, marshlands, permafrost zone, taiga, jungles, ocean shelf, mountains, etc.;
- no need in the construction of separate power transmission and communication lines including fibro optical ones as they could be easily integrated with UST routes;
- possibility to build a global high-speed UST infrastructure within the shorter time limits (10—15 years) which could produce a multiplicative effect in other branches of industry.

12. National significance of UST

Russia has enormous territory which is not densely populated and is not provided with a sufficiently developed road network to result in its high vulnerability. Therefore, Russia needs a programme of communication safety which could lay down the foundation for other types of safety (raw materials, energy, food, territory) and national economy as a whole.

At the present time the total length of the existing road network of Russia is about 1 million km which is twice as less than the estimated minimal level necessary to meet the requirements of the national economy and to solve social problems. For comparison: the USA with its territory 1.8 times less than the territory of Russia has more than 6 million km of roads that provide a basis for the prosperity of this state.

However, construction and maintenance of the deficient millions of km of roads in Russia with its frosts, snow-falls, marshlands, permafrost, taiga, tundra, etc. is a very difficult task requiring colossal material and time costs (it is necessary to note that it took over 1.5 centuries to create the existing 1 million km of roads).

In this respect the application of UST could become the only possible alternative for the solution of the transportation problem in Russia.

It is necessary to note one important feature of UST — UST transportation modules are moving above the ground without stops therefore, like aircrafts, they need only an aerial corridor to cross the boundaries of the states. Passengers and freights are subject to customs control and check only in origin and destination points.

Let us consider the case of Kaliningrad Region. On the way to any region of Russia there are three borders and three custom houses. UST could solve this problem because in this case Belarus, Lithuania and Poland have only to provide an aerial corridor for transit freight or passenger traffic (depending on the route layout alternative).

If it is possible to enable serial production of UST in Russia then Russia serving as a bridge between Europe, Asia and America (across Bering Strait) could take the key positions in the formation of a new global communication policy of the 21st century.

13. Programme support

Thanks to its unique qualities UST has received support at various levels which was *inter alia* expressed in the form of financing of the Programme activities. It should be specially noted that UST is developed under the auspices of UN (registration numbers of the projects in the UN data base are as follows: FS-RUS-98-S01 and FS-RUS-02-S03). Works for the UST application through various programmes within the UN system have been carried out by UN-HABITAT Executive Bureau under Gosstroy of Russia.

13.1. National support of the Programme

In 1997 President of Republic of Belarus requested Prime-Minister of Republic of Belarus “To render assistance to the developer of a string transportation system in the finalization of experimental and design works for its development” (Instruction of 21.02.1997 No. 09/801-42).

In 1997 UST Investment Programme was included in the Federal Target Programme "Socio-economic Development of the Resort City of Sochi up to the Year 2010" (resolution of city administration of Sochi of 10.09.1997 No. 628).

In 2001 an agreement was signed with the Administration of Krasnoyarsky Krai to build a pilot section of UST (as a result a UST testing unit was built in the town of Ozyory, Moscow Region).

Active support to the Programme was given by the RF Ministry of Transportation and Gosstroy of Russia, in particular, in seeking for Investor for the UST Programme (for example, in 2001 Ministry of Transportation made an official proposal to the RF Ministry of Industry and Science to act as Investor with the volume of financing in the amount of USD 42 million; UST Programme is located on the official web site of RF Gosstroy).

In 2002 a Letter of Intention was signed with the City Administration of Anapa for construction of a freight/passenger route.

In February 2002 Governor of Moscow Region signed a resolution aimed at the establishment of inter-departmental working group to coordinate the activity for the development of a transportation ring to link airports of Moscow aviation node with each other and with Moscow through the use of a string transportation system (resolution No. 116-РГ of 15.02.2002).

On April 12, 2002 a joint meeting took place in the town of Ozyory of Moscow Region with the participation of Scientific-Technical Councils of the RF Ministry of Transportation and Ministry of Ways of Communication. Both ministries were represented by the First Deputy Ministers. The meeting was attended by the representatives of more than 50 leading transportation organizations of Russia, scientific research institutes and government structures. According to the meeting conclusions string transportation system was recognized as an established principally new mode of transportation and received the relevant support and approval.

Positive assessments of UST were given by 14 expertises including Siberian branch of the Russian Academy of Transportation, Gosstroy of Russia, Ministry of Economy and Transportation, Russian Engineering Academy, Scientific Councli of Petersburg State University of Ways of Communication, etc.

13.2. International support of the Programme

In 1997 in the decision of the International Conference on the Development of Communication System "Paris — Berlin — Warsaw — Minsk — Moscow" (October 28—31, 1997, Minsk, p. 175 of the proceedings) held with the participation of 7 ministers of transportation from European countries that was approved by the plenary meeting of the Conference it was noted that: "Referring to the development of innovative mode of transportation as a constituent component of trans-European corridors No. 2 and 9: 1. To recommend investigation of a possibility of using the String Transportation System (STS) developed by "Unitran" Research Centre of Republic of Belarus as a high-speed component of Crete transportation corridors".

In 1998—2000 the UN-HABITAT project No. FS-RUS-98-S01 was implemented in the Russian Federation — "Sustainable Development of Human Settlements and Improvement of their Communication Infrastructure through the Use of a String Transportation System". This project made it possible to identify the basic criteria for UST application for urban, suburban and inter-urban transportation with the city of Sochi taken as an example. As a result, business-plan was prepared for UST application in the region of Sochi. Construction of a UST route: "Sochi — Adler — Krasnaya Polyana — Engelmanovy Polyany" was included in the Federal Target

Programme "Socio-economic development of the resort city of Sochi up to the year 2010". Administration of Sochi identified land plots for their allocation for the Programme purposes.

On April 20—21, 1999 the International Seminar took place in Sochi to discuss the implementation of the aforementioned UN-HABITAT project. The seminar participants included 49 Russian professionals from Moscow, Nizhny Novgorod, Sochi and 6 foreign experts.

In 2000 Deputy-Secretary-General of the UN, Executive Director of UN-HABITAT and UNEP applied to General Director of UNEP with a letter in which he proposed to promote the UST project to the following stage of development (planned volume of financing — USD 30 million) considering UST as a real alternative to the existing modes of transportation and first of all in terms of environment protection and rational use of land resources.

In 2001 within the framework of the Programme of Cooperation between Gosstroy of Russia and UN Habitat for the 2002—2003 period a project was signed No. FS-RUS-02-S03 "Provision of Sustainable Human Settlements Development and Urban Environment Protection through the Use of String Transportation System" that was prepared with due regard to the recommendations of the 25^{th} special session of the UN General Assembly "Istanbul +5".

Support of UN structural divisions was given to the Initiator's programme "Clean Water of Russia" aimed to address one of the most acute problems related to the provision of mankind with quality natural drinking water (delivery by UST of Baikal drinking water in the form of food ice to densely-populated regions of the world).

Programme support at the international level is provided by the Executive Bureau of the United Nations Human Settlements Programme (UN-HABITAT) in Moscow.

14. Investments and directions of their utilization

According to the estimates approximate requirements for the external finances necessary to enable the full-scale implementation of the Programme amount to about USD 30 million.

As envisaged under the strategic plan first of all it is necessary to finalize the relevant investigations and tests of UST and then to pass standardization and certification procedures (see Appendix 2). Therefore monetary resources provided by Investor will be used for these purposes.

The main stage in practical implementation of UST implies construction of a multi-purpose testing unit for the full-scale pilot and industrial investigation of UST track structure, supports, rolling stock and infrastructure. Testing unit is designed as a scientific research complex including a laboratory, design bureau, assembly shop, block of autonomous power supply, storage and other premises as well as a pilot UST route (a module section). Investigations and tests of separate nodes, aggregates and components of the transportation line, rail automobile and infrastructure will be carried out with the use of specially designed laboratory units.

Testing ground will be used to solve the following main tasks:

- string track structure is not referred to beam or cable structures, therefore the world experience in the construction and operation of bridges, overpasses, monorail and cable roads and other transportation systems is not fully acceptable for UST. String-rail which makes the basis of UST track structure should be exposed to experimental optimization (rigidity of a rail, string tension, optimal span length, selection and physical and mechanical qualities of the filling agent, etc.) and testing with a rail automobile moving at medium (up to 150—180 km/hour), high (300—350 km/hour) and super high speeds (450—500 km/hour). Furthermore, durability of a string track structure (proposed service life — 100 years) should be experimentally confirmed;

- a scheme of the high-speed string track structure is principally new for the world practice therefore its motion dynamics (theory of UST dynamics for speeds up to 600 km/hour was created by the author — see appendix 9, monograph [6]) which has not been adequately investigated is in need of experimental check. Experimental tests are necessary to specify the frequency and amplitude of fluctuations in a string-rail, wheels, suspension, rail automobile, supports; factors that cause resonance frequencies in track structure components, rail automobile and supports;

- high-speed movement of small in size rail automobiles at the height of 5—10 m and more above the ground surface require a special approach to their aerodynamic qualities, optimization of the body shape and investigation of the impact of various climatic factors such as wind, rain, snow, freezing, high and low temperatures, etc.;

- supports and UST supporting components (anchor, intermediate, braking) differ from the supports of bridges, elevated and cable roads and power transmission lines both in terms of static and dynamic loads to which they are exposed and in terms of specific requirements. All this in addition to tests at the existing testing unit in the town of Ozyory requires experimental checks;

- new solutions in the track structure and rolling stock require non-traditional solutions in the transportation infrastructure which should also be subject to experimental approbation (switching devices, terminal components, stations, freight terminals, depots, filling stations, etc.);

- new transportation concept requires adequate approaches to its standards therefore structural UST standards are in need of experimental optimization (shape and geometrical dimensions of a rail head and supporting part of a two-flange wheel, gage width, distance between two counter transportation lines, dimensions of a rail automobile, etc.), electro-technical standards for electrified UST routes (voltage and type of current — direct or alternating — its frequency), technological, operation and other standards.

Construction of a pilot UST route will be arranged on a stage-by-stage basis (see table 5).

Table 5

Investment requirements

No. phase	Phase name	External financing requirements in the course of Programme implementation	
		In Russia	Abroad
1.	Low speeds (up to 180 km/hour)	USD 4—5 million	USD 5—6 million
2.	High speeds (up to 350 km/hour)	USD 10—12 million	USD 12—15 million
3.	Super high speeds (up to 500 km/hour)	USD 20—25 million	USD 25—30 million

Works for different stages will be carried out either in parallel or in succession. In technological and economic terms it would be reasonable to carry out the works for all three stages in parallel (where possible). It is necessary to note that implementation of successive stages will be possible at the expense of re-investment of the share of profit gained by Investor from the realization of earlier stages (for details see “Operation plan”, chapter 9).

Calendar plan of financing provided by Investor to support scientific research, experimental design and technological works for the Programme (Programme alternative envisaging its implementation abroad) is given in Table 6 (for more detail see appendix 2 — “Agreement of Strategic Partnership”).

Table 6

Calendar timetable of investments provided by Investor

Year from the start of financing	Total, USD mln.	Including by quarters			
		I	II	III	IV
1	3.0	0.3	0.6	0.9	1.2
2	6.5	1.4	1.5	1.7	1.9
3	9.8	2.1	2.4	2.5	2.8
4	9.1	2.8	2.5	2.1	1.7
5	1.6	0.8	0.4	0.3	0.1
Total	30.0	—	—	—	—

Actual Programme requirements for the external finances including Programme development exceed USD 30 million. It is assumed that already in the 3rd year of the Programme performance from the start of financing by Investor it will be possible to enable commercial use of low- and medium-speed passenger and freight UST and to meet its financial requirements through the re-investment of incomes.

In order to further promote the Programme development and to hold the leading positions on the world UST market further Programme financing will be provided by the Company from its incomes.

Approximate utilization structure of investments (USD 30 million) is given in Fig. 19.

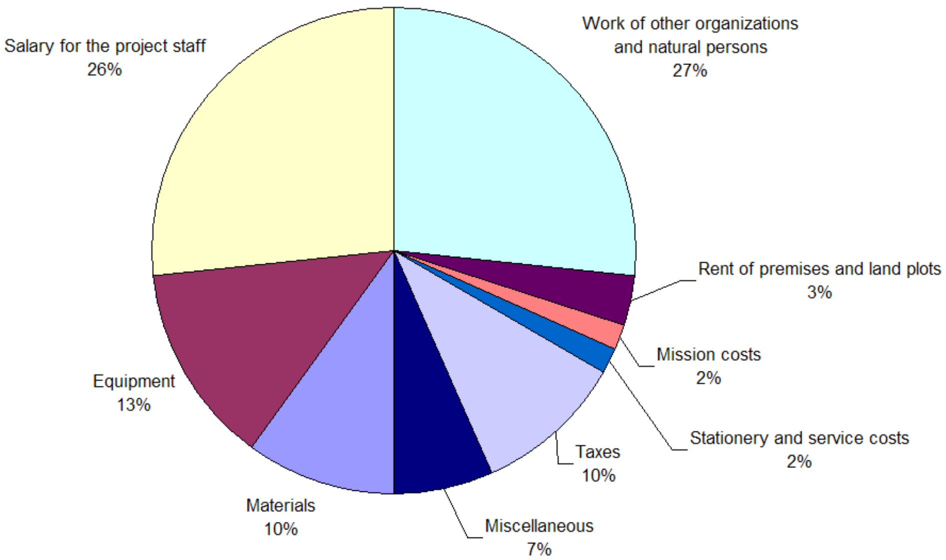


Fig. 19. Utilization structure of investments

Detailed description of utilization directions of investments is given in Appendix 2.

15. Economic efficiency of the Programme

Investor has the following possibilities to gain profit from the invested capital:

- sales of shares (equities, stocks) belonging to Investor at the price exceeding the initial Investor's investments. According to the forecasts capitalization of the Company will grow as the Programme is being implemented;

- sales of a part of Investor's rights to non-material assets previously created (during the 1977—2005 period) by Initiator and received by the Company in the course of implementation of SREDW (their cost will also be growing);

- earnings from the current Company's activity.

15.1. Company's capitalization

Capitalization of the Company will grow as the practical results of SREDW have been obtained at the testing unit. First of all it implies certification of UST routes of different speed diapasons.

Forecasts of Company's capitalization are given in Fig. 20.

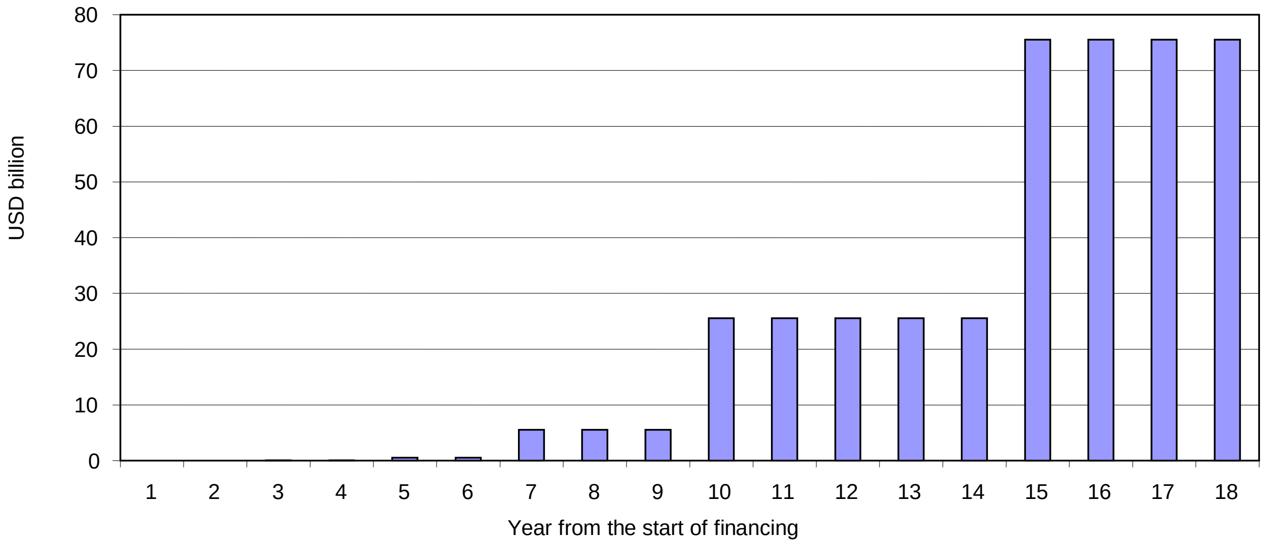


Fig. 20. Company's capitalization, billion USD

15.2. Programme incomes

It is assumed that the Company's income (profit) from the current activity will be made up from the following basic components:

- design of UST routes and infrastructure;
- construction of UST routes and infrastructure;
- design and manufacturing of the rolling stock;
- freight and passenger transportation using its own routes (not considered in the forecasts of the Company's incomes);
- charging of royalty for using "know-how".

Estimations of the size of earnings from each source are given below:

- income from the route design — 5% of the cost of the designed UST route (USD 50,000/km of UST route);
- income from the route construction — 40% of the cost of the built UST route (USD 400/km of UST route);
- income from the rolling stock design and manufacturing — 40% or USD 40,000 of the cost of 1 unit of the rolling stock* (for Unibus U-361, capacity — 20 passengers);
- royalty 1 — 15% of the gross earnings gained from UST routes operation by external companies at the average 5-year recoupment period of all built UST routes according to the following formula:

$$\frac{0{,}15\cdot\sum \text{cost of UST routes}}{5};$$

- royalty 2 — 5% of fuel savings** as compared with an automobile: USD 50,000 per 1 rail automobile/year.

The cost of 1 km of an average double-track UST route (built in slightly rugged terrain; average height of supports — 5 m; average span length — 25 m; estimated travel speed — 250 km/hour) amounts to USD 1 million (in prices as of 01.01.2000). Its structure is given in Table 7.

Table 7

Cost structure (for customer) of an average UST route

No.	Name	Cost including assembly, thous. USD/km
1	Track structure	290
2	Intermediate supports	80
3	Anchor supports (at 2 km intervals)	85
4	Other for transportation line	20
5	Terminal (at 100 km intervals)	20
6	Station (at 10 km intervals)	20
7	Depot (at 200 km intervals)	10
8	Freight terminal (at 100 km intervals)	10
9	Design and survey works	65
10	Income of building/assembly division	400
Total		1 000

Expected earnings dynamics of the Company (pessimistic alternative) is given in Fig. 21 (Appendix 8 includes table of the structure and sources of income from the Programme implementation).

* Average rail automobile: carrying capacity — 20 passengers, speed — 250 km/hour, cost — about USD 100,000. Average demand for rail automobiles: 4 unit/km of a double-track route (2 unit/km in one direction; at even distribution of rail automobiles along the UST route the distance between them will be 500 m — for example, in the USA, similar distance between cars in the highways or coaches in the railways is 60 m and 400 m, respectively).

** Improved aerodynamic qualities of a rail automobile as compared with an automobile for a conditional speed rail automobile (speed — 250 km/hour, capacity — 20 passengers) and reduced rolling resistance of a wheel make it possible to reduce the engine power by 200 kWt. It gives fuel savings in the amount of 50 liters per 1 hour or 250 tons per year (5,000 hours). Royalty (5%) is estimated as: 0.05×400 USD/t×250 t/year = 50,000 USD/year per 1 rail automobile.

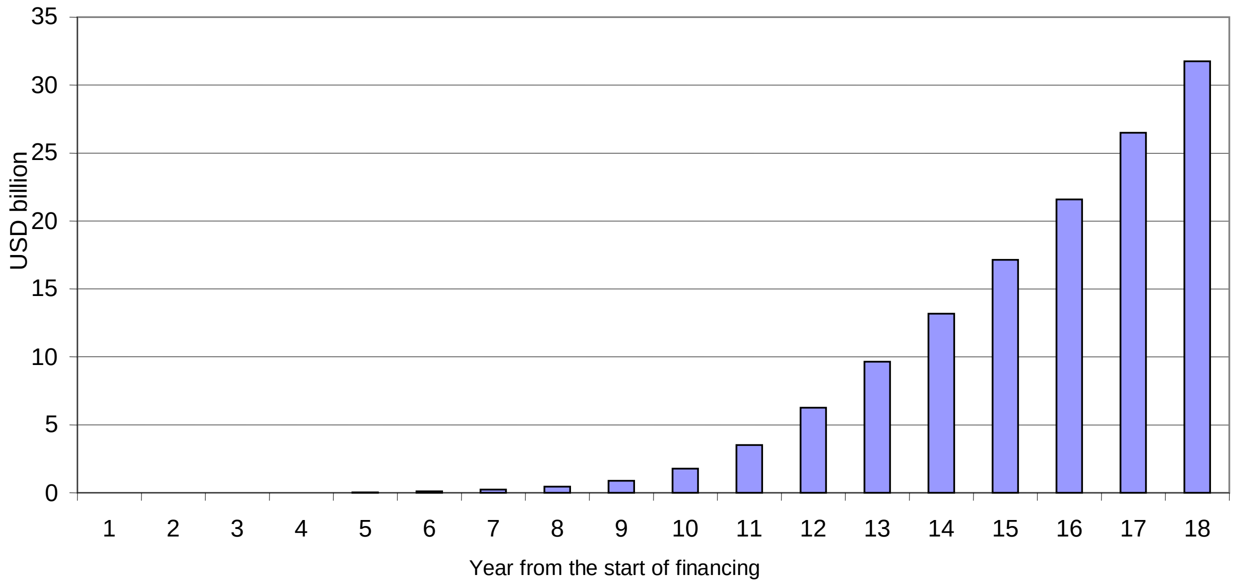


Fig. 21. Company's incomes

15.3. The Programme budget of expenditure

The Programme budget of expenditure was estimated on the basis of the following assumptions:

- financial requirements for SREDW were with a sufficient degree of accuracy calculated by the author and general designer of UST;
- personnel requirements were estimated based on the planned annual earnings per 1 worker equal to USD 50,000;
- investment requirements for the later stages were estimated based on the assumption that the cost of means of labour per 1 staff member amounts to USD 25,000 and their service life is 7 years;
- all taxes were included in the budget of expenditures in the course of estimating the net profit (income).

15.4. Cash flow

Cash flow was formed on the basis of assumption that Investor and Initiator will re-invest a part of the Company's earnings to finance the Programme within the required volumes.

Fig. 22—25 show monetary flows within the Programme as a whole and for Investor in particular (pessimistic alternatives). These flows also include discounts. Discount rate is accepted at the level of 20%.

Cash flows that were used as a basis to build the above given diagrams are given in Appendix 7.

The estimates show that the Net Programme Value (NPV) for the 18 year estimation horizon amounts to USD 9 billion.

NVP for Investor will be USD 4.5 billion. In this case Profit Index will amount to 14 900% and payback period — 6 years from the start of financing.

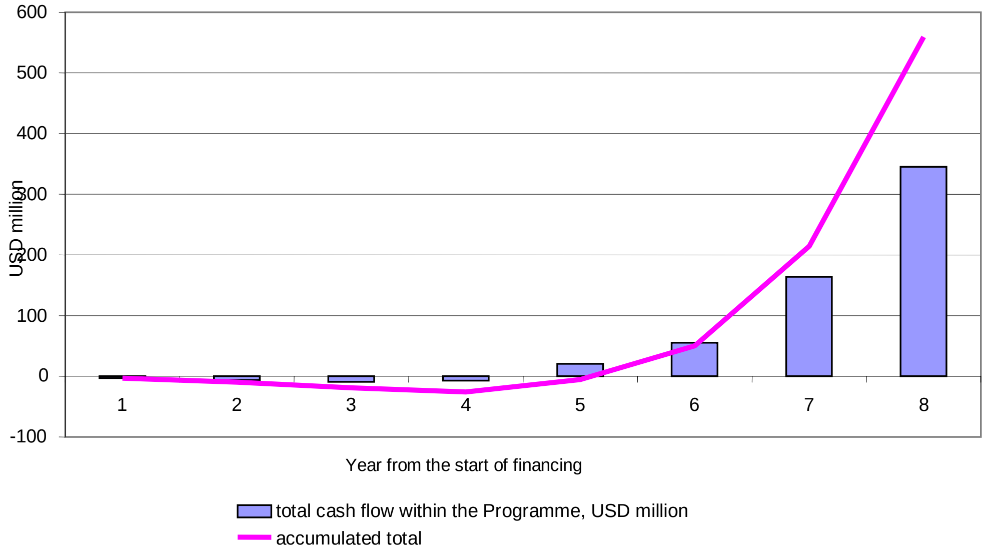


Fig. 22. Total cash flow within the Programme

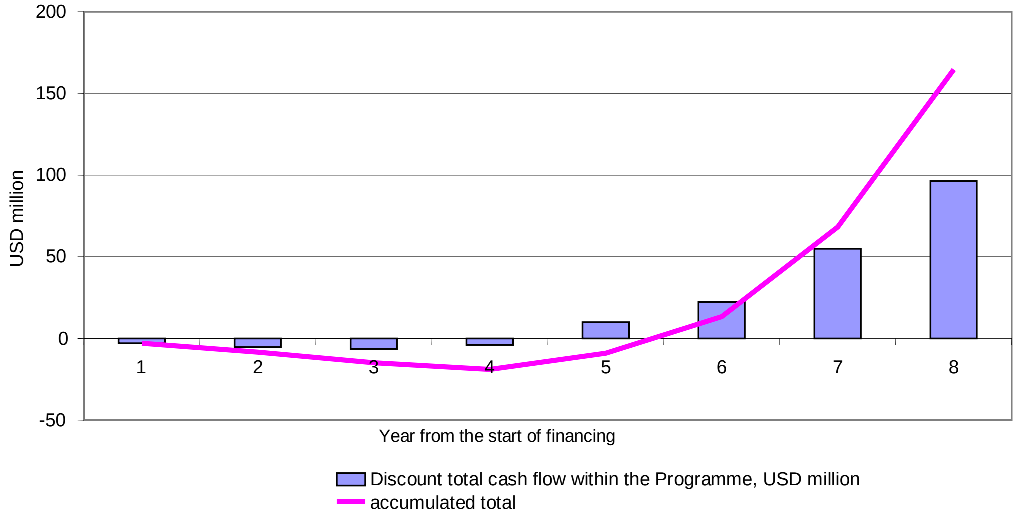


Fig. 23. Discount total cash flow within the Programme

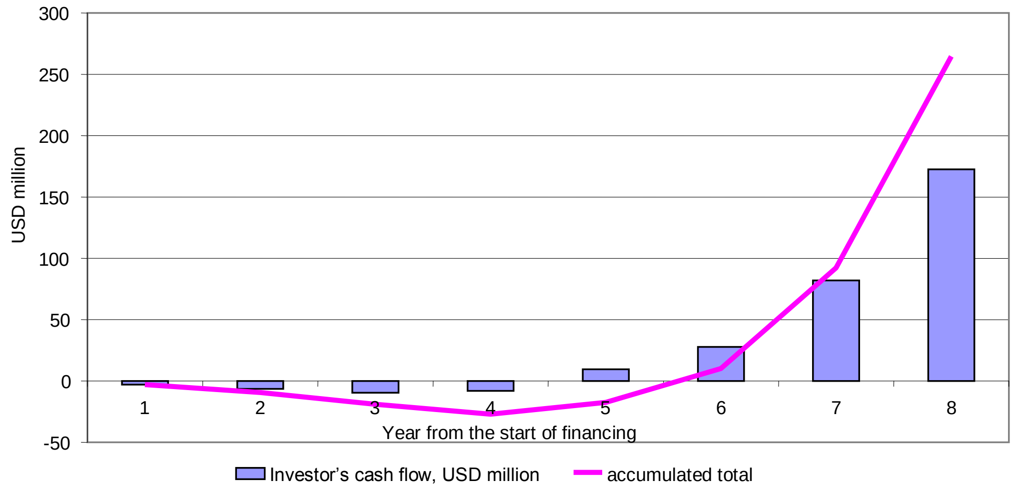


Fig. 24. Investor's cash flow

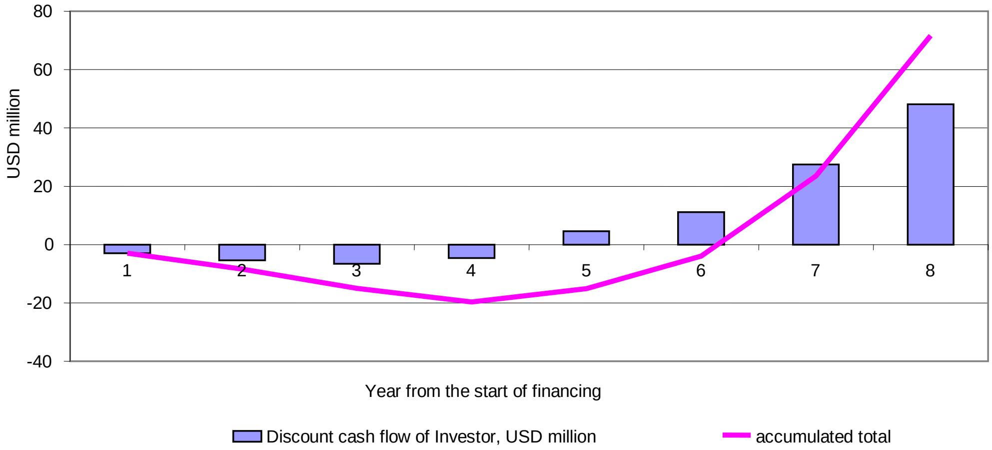


Fig. 25. Discount cash flow of Investor

16. Protection of "know-how"

First international application for the invention — a principal UST scheme was submitted to Geneva in 1994 with subsequent patenting in more than 10 countries of the world.

In order to implement the UST programme in Russia its author Anatoly Unitsky established in Moscow Regional Public Fund to assist in the development of a linear transportation system (1998), "Unitran" Fund to assist in the development of string transportation system (1999) (before that the author being a citizen of Belarus headed the works for the UST in various commercial organizations established by him in Belarus) and Unitsky String Transport Co Ltd (2004).

From the very beginning (1977) all works for the development of UST including the outcomes of SREDW, scientific publications, inventions, patents, "know-how" were registered in the author's name and are his ownership (except a number of Russian and Euro-Asian patents which alongside with Anatoly Unitsky indicate the names of second patent-holders — Dmitry Teryokhin and Alexandr Kapitonov). No intellectual property belonging to the author was transferred to companies set up by the author individually or together with Alexandr Kapitonov ("NTL", 1994, Minsk; NTL GmbH, 1994, Herten, Germany; NTL Ltd, 2002, Kiev) and Dmitry Teryokhin ("SPC of Unitsky" and six design, construction and other joint-stock companies — 2001, town of Ozyory, Moscow Region).

Most of the "know-how", technical and technological solutions, patents with Dmitry Teryokhin and Alexandr Kapitonov as co-owners, that were developed in 2001—2002 have lost their practical value because of the advance and outstripping independent developments made by Anatoly Unitsky in 2003—2005.

Maintenance of the UST testing unit built in the town of Ozyory, Moscow Region, is the responsibility of the Regional Public Fund with Anatoly Unitsky as its President because after the tragic death of Governor Alexandr Lebed in 2002 the agreement is still valid and the acceptance and approval certificate was not signed by the Administration of Krasnoyarsky Krai. At the present time the testing unit is located on the land rented by "SPC of Unitsky" and for 3 years has been without any protection.

From the year 2003 the most significant and advanced technical solutions were patented by the author independently and all "know-how" are thoroughly protected against their unauthorized use.

Appendix 1

Optimization of the transportation system

Today there are more than 300 known modes and alternatives of transportation systems but which of them is closest to the ideal? And what is it an ideal transportation system?

If freight is taken in point A, say, in London and delivered to point B, for example, Vladivostok its energy condition is not changed: in point B it has the same altitude and the same zero ground speed. Therefore, from the point of view of physics the useful transportation work in the Earth’s field of gravitation in this case is equal to zero and in the ideal the energy costs for freight transportation should be also equal to zero. However, as far as energy is consumed, from the point of view of mechanics, the efficiency coefficient of any real ground transportation system will be always equal to zero because division of zero by any number results in zero. Any ground transportation vehicle consumes energy not to do useful transportation work but rather to overcome environmental resistance and to break it. Therefore, it would be feasible to focus the works for transportation improvement rather on the reduced movement resistance and first of all high-speed movement (more than 200 km/hour as many types of resistance increase in proportion to the square and cubic travel speeds) than on the increased engine power, growing freight and passenger carrying capacity and increased speeds as it is done today.

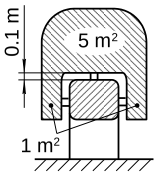
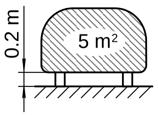
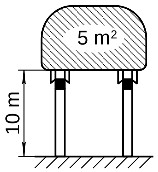
Table 1.1 gives the analysis of basic types of movement resistance of an average high-speed transportation module for travel speed of 100 m/s (360 km/hour), mass of 10 t and cross-section area (midsection) — 5 sq.m. In this case the main movement resistance is aerodynamic resistance which depends not only on the body shape of a module and the quality of its surface but also on the scheme of its distribution in relation to the track structure. Monorail suspension scheme used, for example, in “Transrapid” train on a magnet suspension (left scheme in the table) is characterized by the highest value of aerodynamic resistance coefficient C_x. At travel speed of 100 m/s its value could not be lower than 0.3 due to the availability of a “skirt” enclosing the bearing beam and a speed gradient in the air gap between the “skirt” moving at 100 m/s speed and immovable beam. Minimal possible value of C_x for a module located in the immediate vicinity of a carriageway (similar to a car) is 0.2 due to the screening effect created by the immovable road carriageway (middle scheme). In first case aerodynamic resistance capacity amounts to 1,120 kWt (equal to that of two tank engines), in the second case it is 620 kWt (equal to that of a maneuvering locomotive) and in the third case — 310 kWt (equal to a modern passenger car).

The difference between aerodynamic resistance capacities is especially significant if we take into account the scale factor. Suppose that 10 million high-speed modules are circulating within a road network with the length of 10 million km (1 module per 1 km of a route or 1 module per 600—800 residents, i.e. approximately 50 times less than the present number of cars). Then the annual fuel consumption for aerodynamics will be 12.2 billion tons for modules with a “skirt” and 6.8 billion tons for automobile-type modules. It exceeds the forecasted oil output — according to the data of the World Energy Council the world oil consumption in 2020 will amount to 5.3 billion tons. In this case the cost of annual fuel consumption by the high-speed transportation (based on the current average world price of 0.5 USD/kg) will be as follows: USD 6.1 trillion and USD 3.4 trillion in the first and second case, respectively. Only a wingless aircraft called by the author “unilet” will have the acceptable indices and this transportation will consume 3.4 billion tons of fuel per year with the total cost of USD 1.7 trillion. It approximately corresponds to the current world fuel consumption (taking into account electrified roads: railway, tram, trolleybus, underground, train on a magnet suspension, cable and monorail roads, conveyers and pipe transportation).

The difference in the annual fuel consumption between the first and third schemes will be 8.8 billion tons or in terms of cost — USD 4.4 trillion. Moreover, only a “skirt” that results in not less than 1 sq. m increase in the midsection of speed modules could contribute to the excessive consumption of fuel amounting to 2 billion t/year with the total cost of USD 1 trillion.

Table 1.1

Movement resistance of an average high-speed* transportation module

Indicator		Aerodynamic resistance**			Wheel			Magnet suspension + linear electric motor (40% efficiency)	Aerial suspension (air cushion) (30% efficiency)
		 0.1 m, 5 m², 1 m² $C_x^{min} = 0.3$	 0.2 m, 5 m² $C_x^{min} = 0.2$	 10 m, 5 m² $C_x^{min} = 0.1$	Rubber (K = 0.05)	Steel: Wheel pair with conic wheels (K = 0.001)	Steel: Wheel with an independent suspension without a cone (K = 0.0005)		
Single module	Resistance strenght, kWt	1120	620	310	500	10	5	1700	2600
	Fuel consumption, t/year	1220	680	340	550	11	5.5	1800	2800
	Fuel cost, thousand USD/year***	610	340	170	275	5.5	2.75	900	1400
Module fleet on the Planet (10 mln. vehicles)	Resistance strenght, mln. kWt	11200	6200	3100	5000	100	50	17000	26000
	Fuel consumption, mln. t/year	12200	6800	3400	5500	110	55	18000	28000
	Fuel cost, billion USD/year	6100	3400	1700	2750	55	27.5	9000	14000

* Average transportation module: travel speed - 100 m/sec (360 km/hour); mass - 10 t; carrying capacity - 25 passengers (6 tons of freight); usage coefficient - 0.5 (12 hours/day); fuel consumption - 0.25 kg/kWt·hour; maximum midsection of a saloon - 5 m^2

** Aerodynamic resistance strength: $W_{a.r.} = \frac{1}{2} \rho v^3 \cdot c_x \cdot f_m$

*** Average world cost of fuel - 0.5 USD/kg

Transportation modes that are using air cushions or a magnet suspension with a linear electric engine are also characterized by lower characteristics in terms of their aerodynamic qualities and high vulnerability to changing gap between the carriageway and a "skirt", thus, for example, increase in the gap of "Transrapid" (which should not exceed 10 mm) results in the rapid decline of gear efficiency which does not exceed 40%. Furthermore, such suspension is sensitive to gap pollution including snow and rain. Taking into account the efficiency of power plants generating primary energy, energy losses in power transmission lines and numerous transformer sub-stations, converters, cables, electric engines the summary efficiency of such system does not exceed 10% whereas the efficiency of a modern locomotive reaches 15%. Referring to fuel consumption its summary annual consumption in the latter case would be 18 billion tons with its cost amounting to USD 9 trillion. It is also necessary to add to that fuel consumption for aerodynamics.

A wheel has better characteristics among other systems with modules suspended in relation to the track structure. However, a rubber wheel is not quite suitable for the high speeds because at speed of 100 m/s its rolling resistance is increased to 0.05 (i.e. its efficiency is 95%). Therefore, to overcome this resistance (in addition to aerodynamic resistance) it will be necessary to increase the engine power of a module of 500 kWt which will require additional (5.5 billion t/year or USD 2.75 trillion) fuel consumption by the indicated world stock of the high-speed transportation vehicles.

Steel wheel has the best characteristics and is provided with an independent ("automobile") suspension and a cylinder base. Availability of a wheel pair with a left and right wheel of a variable diameter as well as a conic rest surface contributes to sliding of a wheel pair along the rail which increases its rolling resistance coefficient from 0.0005 to 0.001. The cost of this difference of 0.0005 for the aforementioned modules will amount to 55 million tons of fuel per year with the total cost of USD 27.5 billion. Over 100 years this difference will amount to 5.5 billion tons of fuel with the cost of USD 2.75 trillion, and all this could result from what seem "a trifle" — to use a wheel with 99.9% or 99.95% efficiency.

It is hardly possible to expect invention in the 21st century of a module driving mechanism with higher efficiency than 99.95%. Therefore a steel rigid wheel of high-speed transportation is likely to take the lead as economically justified and sound solution.

Super high economic efficiency of UST unibus is especially visible at low speeds, for example, 100 km/hour, traditional for car transportation. Under the established movement along a horizontal section of a track a 50-seat unibus with the weight of 10 tons will need an engine of 9 kWt power to maintain travel speed of 100 km/hour (out of which 6.6 kWt — for aerodynamic resistance and 1.5 kWt — for the rolling resistance of a steel two-flange wheel on a steel rail and 0.9 kWt — transmission losses). In this case fuel consumption per 100 km will be 2 liters (or 0.04 liters/100 pass.×km or 0.4 liters/1,000 pass.×km) which is 20—30 times more economically efficient than a passenger car (best cars consume 1—1.5 liters per 100 pass.×km at lower level of comfort, safety and ecological qualities), or 200—300 times — than aircraft (best 50-passenger aircraft consumes 500—700 liters of fuel per 100 km).

Development of the global high-speed road network in the 21st century will require great amounts of resources. Only Russia with ¾ of its total area occupied by marshlands, permafrost, taiga and mountains and which total territory is 1.8 times more than that of the USA needs not less than 5 million km of new roads just to catch up with the USA of the 20th century.

Basic resources necessary for the construction of 10 million of roads are given in Table 1.2. Among them land allocations constitute the most important resource. Ground roads will require about 50 million ha (500,000 sq. km) of lands which corresponds to the summary area of the following countries: Austria, Hungary, Greece, Denmark, Israel, Switzerland and Cuba. At the lowered price of this land — USD 200,000per 1 ha — the cost of this resource will be USD 10 trillion. Therefore, it is reasonable to build the roads above the ground and to install them on the supports at the second level.

There are two known approaches to design span structures between the supports: 1) using a rigid beam; 2) using a flexible thread stretched to high stress. As far as absolutely rigid systems do not exist a compromise was reached between the requirements for reduced material consumption of spans and requirements for maximum high rigidity value of a track structure under the impact of the estimated moving load as a result of which the worldwide designed relative span rigidity of bridges and overpasses was accepted at the level of 1/400—1/800.

Fig 1.1 shows a beam span structure of a single-track monorail road. A relative deflection of such beam is proportional to its square length and is in inverse proportion to its cubic height, material elasticity module and coefficient considering the cross-sectional shape of a beam. Therefore, the main task of a beam span design is to reduce the span length and to increase the beam height using materials with a high elasticity module. The figure shows optimal cross-section of a steel beam of a maximal lightened box type with a relative rigidity of 1/400 in a 50 m span under the impact of 10 ts load. Steel consumption for such beam amounts to 750 km/m (the total beam mass G = 37.5 t), cross-section area — 960 sq. cm. Temperature stress (temperature gradient 100°C from -50ºC in winter to +50°C in summer in the sun) in such beam could reach 2,400 ts, therefore the beam has a temperature joint and its ends are placed on the collar beam. As far as the top of the support is not fastened **μ** coefficient that identifies the reduced height of the support with regard to its load-bearing capacity is equal to 2.

Let us consider a span structure (Fig. 1.2). Relative deflection of such span is proportional to the load Q and inversely proportional to the string tension T. It is necessary to note that the relative deflection of a string span does not depend on the string material, its shape and cross-sectional dimensions as well as on the span length. To ensure the relative rigidity of 1/400 under 10 ts load the string tension should be 1,000 ts. As far as the span rigidity does not depend on the cross-sectional shape of a string it could be made of the high-strength wire with the designed tension stress of about 10,000 kgs/sq. cm (for example, SNiP 2.05.03-84 for bridges admits the standard tension resistance for reinforced cables K-7 amounting to 13,200—14,000 kgs/sq. cm). Then the cross-section area of a steel string will be 100 sq. cm and its mass — 78 kg/m (the total mass on a span — 3.9 t).

As far as the top of the support is fastened with a string (fixed to the track structure) **μ** coefficient that identifies the reduced height of the support is equal to 0.7. Therefore, the load-bearing capacity of a string span support with its height equal to that of a beam span will be 8 times higher (see bearing capacities of supports in fig. 1.1 and 1.2). Furthermore, the weight of a 50 m beam span is 37.5 ts and the weight of a string span — 3.9 ts, thus, the designed material consumption for the supports and spans of a string type will be approximately 10 times less. Similarly, the cost of string roads will be lower because the cost of high-strength steel wire is approximately equal to that of steel rolling amounting in Russia to USD 800—1,000/t (including VAT).

The cost of basic resources necessary for the construction of 1 km of average high-speed double-track string track will amount to about USD 700,000 which for a network of 10 million km length could result in the following savings as compared with other roads: USD 16.3 trillion — against highways with asphalt-concrete surface; USD 37.3 trillion — against highways with reinforced concrete surface; USD 19.4 trillion against railways; USD 89 trillion — against elevated motor roads; USD 36.2 — against monorail elevated roads; USD 78.7 — against elevated roads for trains on a magnet suspension (see Table 1.2).

The above given analysis makes it possible to conclude that the most reasonable way to develop the high-speed road network in the 21st century is associated with construction of strained track structures installed on the supports eliminating continuous carriageways. As a driving mechanism it would be reasonable to use a steel two-flange wheel with an independent suspension. Fuel energy could be converted to mechanic work immediately on board of a transportation module, for example, with the use of internal combustion engine. Such elevated transportation system is regarded as the optimal one from the point of view of exact sciences (physics, mechanics, building mechanics, material resistance, aerodynamics, economic analysis) and it got the name of "Unitsky String Transport" (UST). And it is hardly possible that any of the future ground transportation system including those described in science fiction literature (anti-gravitation ships, gravitation-flyers, flying saucers, etc.) will be able to compete with UST in terms of its technical-economic and environmental indices.

Table 1.2.

Basic resources necessary for the development of a network of high-speed multi-track roads with the total length of 10 million km

Resource	Unit of measurement	Ground track			Elevated road			
		Road bed		Rail track structure	Beam spans (steel)			String spans
					For wheel transportation		Magnet (air) cushion	
		asphalt concrete	reinforced concrete		road bed (elevated)	mono-rail		
1. Land allocations (including infrastructure) (USD 200,000/ha)	million ha USD billion	50 10,000	50 10,000	50 10,000	30 6,000	5 1,000	5 1,000	2 400
2. Excavation and earth moving works (USD 5/cub. m)	billion cub. m USD billion	200 1,000	200 1,000	200 1,000	20 100	10 50	10 50	5 25
3. Reinforced concrete structures (USD 500/cub. m)	billion cub. m USD billion	2 1,000	50 25,000	10 5,000	100 5,0000	5 2,500	10 5,000	2 1,000
4. Steel structures (USD 2,000/t)	billion tons USD billion	0.1 200	4 8,000	5 10,000	20 40,000	20 40,000	40 80,000	3 6,000
5. Gravel cushion (USD 20/cub. m)	billion cub. m USD billion	50 1,000	10 200	30 600	- -	- -	- -	- -
6. Sand cushion (USD 10/cub. m)	billion cub. m USD billion	50 500	50 500	20 200	- -	- -	- -	- -
7. Asphalt concrete pavement (USD 100/t)	billion tons USD billion	100 10,000	- -	- -	3 300	- -	- -	- -
Total (for the road network)	USD trillion	23.7	44.7	26.8	96.4	43.6	86.1	7.4
Total (for 1 km of a track)	USD mln./km	2.4	4.5	2.7	9.6	4.4	8.6	0.7
Average travel speed	km/hour	120	120	200	150	150	350	350

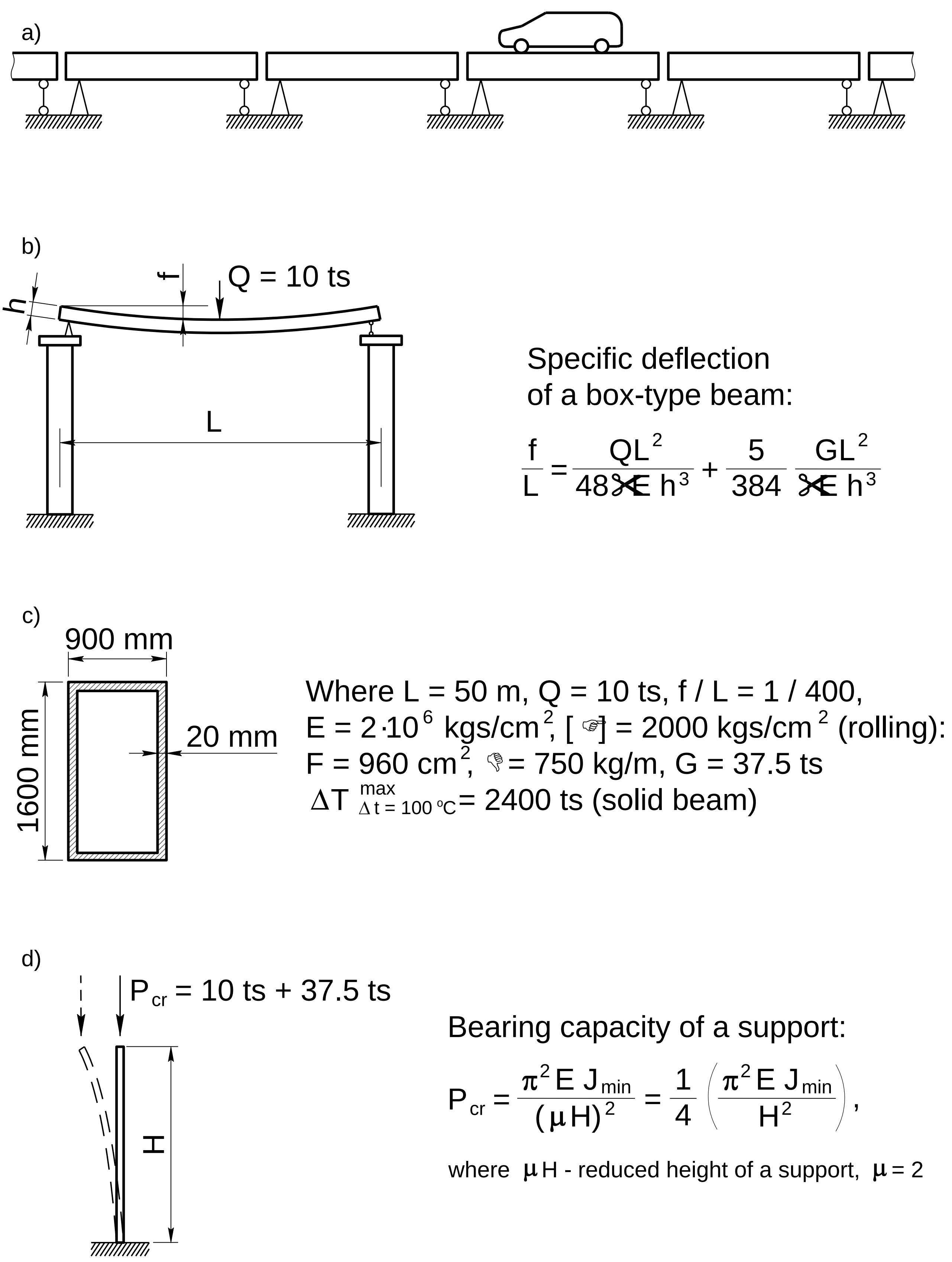


Fig. 1.1. Span beam structure
a) scheme of a beam elevated road; b) span beam structure; c) cross-section of optimal box-type beam; d) operation scheme of a span beam cross-section

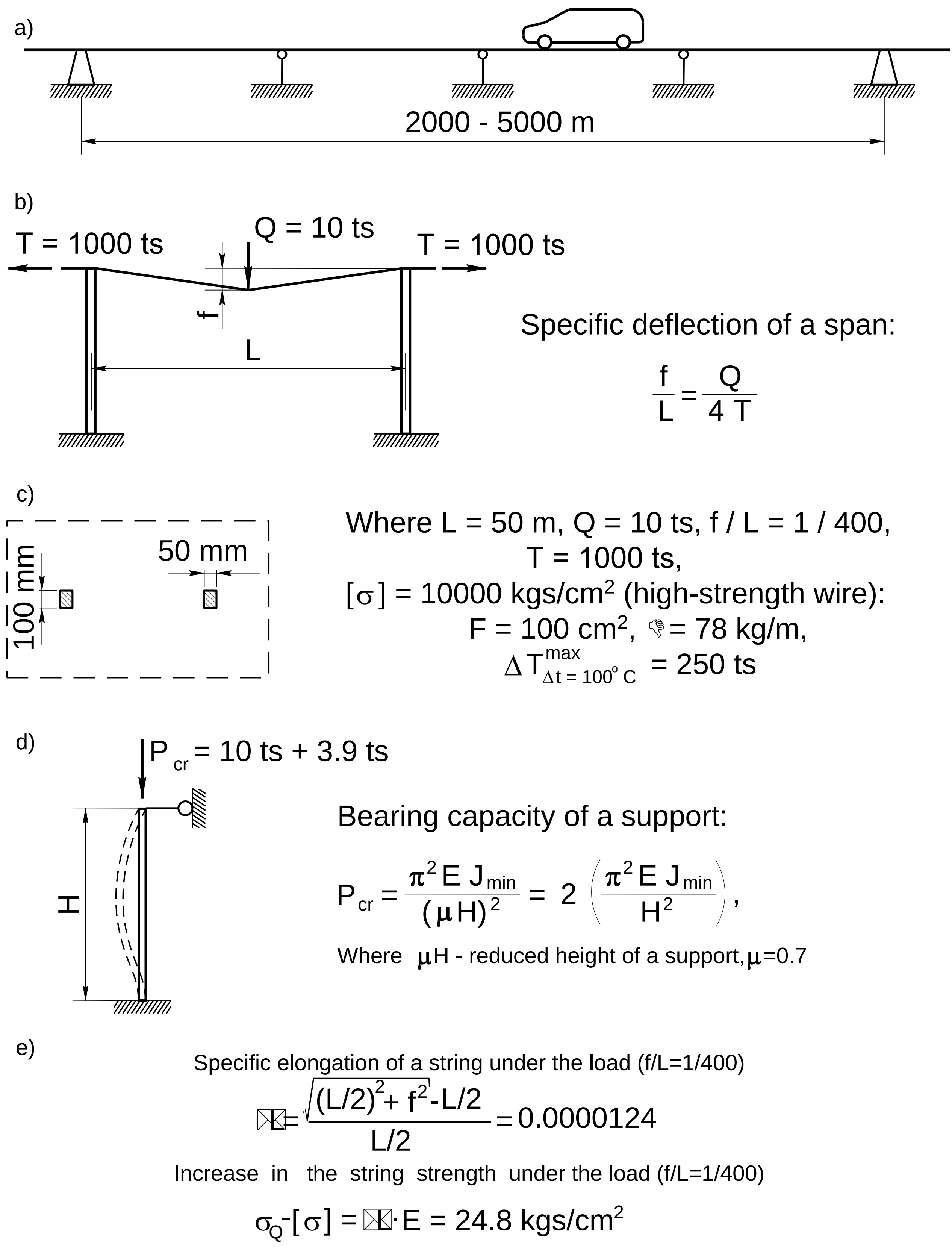


Fig. 1.2. String span structure

a) scheme of a string elevated road; b) string span structure; c) cross-section of a string track structure; d) operation scheme of a string span structure; e) relationships determining stressed-deformed condition of a string

Appendix 2

Agreement of Strategic Partnership

PROJECT

City ________________ "___"_________ 2005

We, the undersigned, citizen of the Russian Federation Anatoly Eduardovich Unitsky, on the one hand (hereinafter referred to as "Party 1"), and citizen __________________________________ on the other hand (hereinafter referred to as "Party 2"), together referred to as the "Parties", concluded this Agreement as follows:

1. Subject of Agreement

1.1. Parties agreed to undertake the joint implementation of innovative project aimed at design, testing, construction, development and operation of String Transport of Unitsky (hereinafter referred to as UST Project), the basis for which is provided by a principally new transportation system of "the second level" developed by Party 1 during the 1977—2005 period that in literature and patents has received the name of "String Transportation System" (hereinafter — STS).

1.2. Implementation of the UST Project implies, in particular, development, manufacturing and testing of pilot samples of constituent components and nodes of STS and a pilot STS track section and development of new technologies necessary for the construction and operation of STS the key parameters of which are as follows:

1.2.1. Technical/economic indices of STS of serial production shall exceed similar characteristics of the best samples of existing traditional transportation systems (in comparable indices: with equivalent travel speed, trip length, route carrying capacity, track elevation above the ground surface and other technical/economic parameters):

- fuel consumption — lower, not less than twice as compared with fuel consumption by freight and passenger motor transportation;
- cost of a transportation line —lower, not less than twice as compared with the cost of other known transportation systems of the second level such as: mono-rail, elevated trains on a magnet suspension and air cushion, highway and railway bridges and overpasses:
- durability and reliability of structural components — not lower than the relevant indices of highway and railway bridges, elevated mono-rail road and trains on a magnet suspension;
- resistance to natural impacts (earthquakes, floods, landslides, freezing, showers, heavy snowfalls and frost, hurricanes, dust storms and other weather conditions) — STS shall have superiority over highways and railways, aviation, mono-rail roads and trains on a magnet suspension;
- carrying capacity of one track — not less than that of one track of a railway or one lane of a highway;
- resource-consumption (metal, concrete, earth works, land withdrawn for STS route and other similar parameters) — lower, not less than twice, as compared with highways and railways, train on a magnet suspension and mono-rail;
- safety — not lower than that of aviation and railways;
- technical/economic characteristics of a serial STS should ensure the achievement of indices necessary to create a new niche in the global transportation complex and take the lead in the 21st century (requirements for STS of serial production are given in the Terms of Reference for the implementation of scientific research, experimental design and technological works for STS Project financed by the Strategic Partner, Appendix 1 of the present Agreement).

1.3. The outcomes obtained as a result of the STS Project performance should comply with the worldwide innovation requirements and be accordingly registered to ensure the mutual legal protection of the intellectual property by the Parties.

1.4. The Parties agreed that in order to initiate and finance the STS Project activities they shall establish a joint parent UST company (hereinafter referred to as "Company") with an authorized capital in the amount of USD 60,000,000 (sixty million US dollars) in which 50 (fifty) percent of property shall belong to Party 1 and 50 (fifty) percent of property shall belong to Party 2.

- 50 (fifty) percent of the authorized capital (USD 30,000,000) shall be formed during 12 months at the expense of the intellectual property of Party 1;
- 50 (fifty) percent of the authorized capital (USD 30,000,000) shall be formed gradually during 5 (five) years by Party 2 in accordance with the calendar schedule of financing the project activities (Appendix 2 of the present Agreement).

1.5. Party 2 is regarded as the Strategic Partner of Party 1 in the implementation of STS Project provided that funding of the STS project shall be facilitated according to the procedure established in items 2.2.1 —2.2.3 of the present Agreement.

1.6. The choice of a country to host the Company shall be made by mutual consent of the Parties proceeding from the need to optimize the achievement of goals and objectives envisaged under the present Strategic Partnership.

2. Obligations of the Parties

2.1. Party 1 under this Agreement shall undertake the following obligations:

2.1.1. To transfer to the Company previously developed technical solutions, “know-how”, inventions and other intellectual property being in its ownership within the time limits and in the amounts necessary and sufficient to implement the STS project.

In this case Party 1 shall indicate the investments made in the STS development by the third parties during the 1977—2005 period and ensure that all issues related to their possible involvement in the STS Project by the date of signature of the present Agreement have been settled and do not hinder conclusion of this Agreement. In the event of possible claims arising from the third parties in future, Party 1 shall undertake their settlement as soon as they arise without any damage to this Strategic Partnership.

2.1.2. To transfer to the Company market research materials including materials related to the international cooperation.

2.1.3. To develop, in collaboration with Party 2, and put into operation a system for registration, accounting and control over spending the monetary and material resources assigned for the STS Project performance.

2.1.4. To facilitate, as General Designer and General Director of the Company, the organization and performance of scientific research, experimental and design and technological works for the STS Project to be carried out within the implementation period specified for the indicated works with the aim to enable its serial application and putting into operation of first STS line.

2.1.5. To facilitate in the name of the Parties the adequate registration of the obtained outcomes of scientific research, experimental design and technological works performed under this Agreement to be regarded as the intellectual property objects (including inventions, useful models, industrial samples or any other form).

2.1.6. To enable the registration of the joint Parties’ rights to the intellectual property objects and “know-how” developed within the framework of the STS Project activities (invention, useful models, industrial samples, etc.) during the term of this Agreement, namely: protection documents (patents, certificates, other documents) for the intellectual property objects should be issued in the name of Party 1 and Party 2 simultaneously on condition that both of them are the joint patent holders in ratio: 50% (fifty percent) to 50% (fifty percent) (Party 1:Party 2). In this case Party 1 and Party 2 shall jointly transfer the rights to use the intellectual property objects of the Company.

In the event Party 1, in violation of conditions specified under this item, shall register the rights to the intellectual property objects or “know-how” individually and/or transfer them to the third party, Party 1 is liable to ensure the transfer of the rights to the use of the intellectual property objects to Party 2 on conditions similar to those of the joint patent holding in ratio: 50 (fifty):50 (fifty) (Party 1: Party 2). Provisions of this item shall not be applicable in case of refusal of Party 2 of performance of this Agreement in accordance with item 3.2. of the present Agreement.

In the event that under-financed sums shall occur (in accordance with item 2.2.3. of this Agreement) the distribution of rights established in item 2.1.6. shall be subject to the provisions of item 3.2.2. of this Agreement.

2.2. Party 2 within the framework of this Agreement shall undertake the following obligations:

2.2.1. To allocate funds in the amount of USD 30,000,000 (thirty million US dollars) for the provision of financial support to the STS Project in accordance with the payment schedule (Appendix 2). In this case taxes and duties paid by the Company in accordance with tax legislation of the host country, provided that the payment schedule has been fulfilled, are subject to compensation by Party 2. Taxes and duties as well as penalties, fines and other sanctions occurred as a result of the activity of the Company and/or Party 1 and subject to payment in accordance with the tax or civil legislation of the host country of the Company shall be accordingly paid by the Company or Party 1.

2.2.2. Parties shall understand financing as the transfer of monetary resources to the Company and irrespective of the source of their receipt to be used by the Company to accomplish (carry out) the works related to the STS Project performance.

2.2.3. To transfer monetary resources attracted for the STS Project financing by installments in accordance with the calendar timetable (hereinafter referred to as Timetable) (Appendix 2 of this Agreement) agreed by the Parties in accordance with the budget of expenditures and calendar timetable for the implementation of scientific research, experimental and design and technological works for the STS Project financed by Party 2 (Appendix 3 of this Agreement). A quarter (three calendar months) is established as the reported period within which Party 2 shall facilitate transfer of monetary resources in the amount established in the timetable for the given quarter. Monetary resources designated in the timetable for each reported period shall be transferred both in full volume and by installments during the whole reported period.

In the event that by the end of the reported period the amount of monetary resources allocated by Party 2 to finance the STS Project shall exceed 80% of the sum agreed in the Schedule for the said reported period, Party 2 shall attract the deficient monetary resources during the next reported period. In the event Party 2 fails to attract the monetary resources that were not transferred during the reported period both Parties within ten working days shall negotiate the relevant amendments and incorporate them in the Schedule. In the event Party 2 fails to transfer the deficient funds within ten working days of the date of incorporation of amendments in the Schedule, the said sum shall be deemed by the Parties as under-financing.

In the event that by the end of the reported period the amount of monetary resources allocated by Party 2 to finance the STS Project shall be less than 80% (eighty percent) of the sum agreed in the Schedule for the given reported period, the Parties within three working days shall negotiate the relevant amendments and incorporate them in the Schedule. In the event Party 2 fails to transfer the deficient funds within ten working days of the date of incorporation of amendments in the Schedule, the said sum shall be deemed by the Parties as under-financing.

2.2.4. Monetary resources attracted for the STS project financing shall be transferred upon the agreement with the Parties, Company and/or other persons indicated by the Company (hereinafter referred to as Beneficiary). Monetary resources shall be transferred to Beneficiaries under separate agreements with their terms and conditions being subject to preliminary negotiations with the Company except when otherwise is additionally agreed by the Parties.

2.2.5. Each transfer of monetary resources and their receipt by a Beneficiary shall be certified by the relevant act which is subject to submission and signing by Party 1 with one copy remaining with Party 1 and the other — with Party 2.

2.2.6. Together with Party 1 to develop and apply a system of registration, accounting and control over spending the monetary and material resources allocated for the UST Project implementation.

2.2.7. The necessary assistance shall be rendered to Party 1 to facilitate the adequate registration of the outcomes of scientific research, experimental design and technological works regarded as the intellectual property objects (including inventions, useful models, industrial samples and other forms).

2.2.8. Party 2 shall provide financial support to the STS project during 5 (five) years. Further promotion of the STS project shall be funded from the Company's incomes derived from its authorized activity.

2.3. The Parties agreed that the total profit generated by the Company as a result of its authorized activity (including the income derived from the implementation of civil and legal contracts in the host country) shall be distributed in the following ratio: Party 1 — 50 (fifty) percent of profit; Party 2 — 50 (fifty) percent of profit.

3. Ownership rights

3.1. All Company's property generated and/or purchased as a result of its authorized activity including the authorized capital, basic resources, material and non-material assets shall belong to the Parties in ratio: Party 1 — 50 (fifty) percent; Party 2 — 50 (fifty) percent.

3.2. In the event of refusal of Party 2 of further performance of this Agreement during the term of its validity this or that reason (including inability to perform its obligations) or in the event of the STS Project under-financing in accordance with item 2.2.3. of this Agreement, Party 2 shall transfer to Party 1 securities (shares) of the Company belonging to Party 2 in accordance with the following procedure:

3.2.1. Parties agreed that 1 (one) percent of the Company's securities (shares) corresponds to the amount of USD 600,000 (six thousand US dollars).

3.2.2. Each sum equivalent to USD 600,000 (six thousand US dollars) that was recognized as underfinanced in accordance with item 2.2.3. of this Agreement or that Party 2 failed to transfer to the Company by the date of giving notice of its refusal of further performance of this Agreement entails the transfer of 1 percent of securities (shares) to Party 1 by Party 2.

4. Duration of Agreement

4.1. This Agreement shall come into force from the date of its signature to be valid during the effective period of protection documents for intellectual property but not lees than till December 31, 2025.

5. Other conditions

5.1. If in the process of the Company's operation the Parties consider it reasonable to revise the distribution scheme of property and other rights indicated in section 3 of this Agreement it shall be only possible on condition of signing a new Agreement.

5.2. The Parties commit themselves not to disclose the information related to the present Agreement and take all measures to prevent its disclosure or accessibility for the third parties.

5.3. Any dispute and controversy arising out of or in relation with the present Agreement shall be settled by the Parties by way of negotiations with the reached decisions to be made in written form. In the event of failure to settle the controversy by negotiations it is subject to arbitration in accordance with the legislation of the host.

5.4. All additional agreements, supplements, appendices and amendments to the present Agreement are regarded as its integral part and are valid only when executed in written form and signed by both Parties.

5.5. This Agreement was done in Russian and in English, one copy for either Party.

6. Signatures by the Parties

Appendix 1
to the Agreement of Strategic Partnership
of “___“ _________ 2005

Terms of Reference for the implementation of scientific research, experimental and design and technological works for the project: “Unitsky String Transport (UST)”, financed by the Strategic Partner (Party 2)

As a result of the activities carried out at the expense of the resources provided by the Strategic Partner (Party 2) including scientific research, experimental and design and technological works for the project “Unitsky String Transport (UST)” the string transportation system (STS) proposed for serial production should meet the following requirements:

1. Technical/economic indices (for the conditions of serial STS production: length of routes — more than 1,000 km; production output of transportation modules — more than 10,000 vehicles):

1.1. Net cost of construction of 1 km of an average double-track light freight/passenger route (on a plain, not including infrastructure, height of supports — 3 m, length of spans — 25 m; rolling stock: single modules of 5 ton mass and axis load — up to 2 tons; in prices as of 01.01.2000):

- speed route (up to 150 km/hour) — not more than 0.7 million USD/km;
- high-speed route (up to 300 km/hour) — not more than 0.8 million USD/km;
- super high-speed route (up to 450 km/hour) — not more than 0.9 million USD/km.

1.2. Net cost of construction of 1 km of an average double-track heavy freight/passenger route (on a plain, not including infrastructure, height of supports — 0.5 m; length of spans — 6 m; rolling stock: rail car-trains with the total mass up to 200 tons and axis load — up to 5 tons in prices as of 01.01.2000):

- low-speed route (speed up to 60 km/hour) — not more than 0.5 million USD/km;
- high-speed route (speed up to 100 km/hour) — not more than 0.6 million USD/km.

1.3. Carrying capacity of a double-track route (in both directions):

- passenger — not less than 100,000 pass./24 hours (36.5 million passengers per year)
- freight — not less than 100,000 tons/24 hours (36.5 million tons per year).

1.4. Net cost of the rolling stock manufacturing in prices as of 01.01.2000:

1.4.1. Passenger module (capacity — 20 passenger, economic class):

- speed route (up to 150 km/hour) — not more than USD 80,000;
- high-speed route (up to 300 km/hour) — not more than USD 150,000;
- super high-speed route (up to 450 km/hour) — not more than USD 200,000.

1.4.2. Freight car-train (carrying capacity — 200 tons, speed — 80 km/hour) — not more than USD 250,000

1.5. Fuel consumption for transportation at the travel speed of 100 km/hour (at a horizontal section of a track):

- passenger transportation — not more than 0.2 liter/100 pass.×km
- freight transportation — not more than 0.5 liter/100 tons×km

2. Building and operation conditions of String transportation System (STS):

2.1. Height of a string track structure installation (height of supports) — from 0 m to 10 m

2.2. Maximal longitudinal slope of a track structure:

- traditional design — 100‰ (1:10)
- special design of a track structure and the rolling stock — 1,000‰ (1:1)

2.3. Maximum permissible range of temperatures for the track and rolling stock operation –100°C (for example, from –50 °C to +50 °C or from –70 °C to +30 °C or from –30°C to +70 °C, etc.).

2.4. Maximum permissible wind speed in the course of the track and rolling stock operation — 200 km/hour. If necessary, the route should be resistant to wind impact with the wind speed of 250 km/hour.

2.5. If required, the route should be resistant to the impact of freezing and snow. Maximum possible height of snow cover in the zone of route construction is 2 m.

2.6. The route should be resistant to the impact of showers with maximum permissible rainfall of 100 mm/per 24 hours in the course of the route and rolling stock operation.

2.7. The route should be resistant to the impact of high water in flooded zones, if necessary, with the rise of water up to 5 m.

2.8. The route should be resistant to the impact of earthquakes in zones of seismic hazard, if necessary, with the 9-magnitude by Richter scale.

3. Additional requirements.

3.1. STS should be predominantly based on materials, completing parts and equipment of serial production by industrially developed countries.

3.2. The string-rail design should provide for a possibility to install inside the track structure food-supply, energy and information lines including fibro-optical ones.

3.3. Design of a string track structure and supports should be based on the use of high-technologies and ensure the high speed line-flow construction (not less than 100 m per day).

3.4. STS track structure and supports should provide for a possibility to install solar and wind power plants.

3.5. Normative service life:

- STS routes as a whole — not less than 50 years;
- rolling stock — not less than 10 years.

3.6. Safety of transportation should meet the international safety requirements for ground transportation.

Appendix 2
to the Agreement of Strategic Partnership
of “___“ _________ 2005

Calendar timetable of financing of scientific research, experimental design and technological works for the project: “Unitsky String Transport” provided by the Strategic Partner (Party 2) (in prices as of 01.01.2000)

	Total, USD million	Including by quarters			
		I	II	III	IV
1st year	3.0	0.3	0.6	0.9	1.2
2nd year	6.5	1.4	1.5	1.7	1.9
3rd year	9.8	2.1	2.4	2.5	2.8
4th year	9.1	2.8	2.5	2.1	1.7
5th year	1.6	0.8	0.4	0.3	0.1
Total	**30.0**	—	—	—	—

Appendix 3
to the Agreement of Strategic Partnership
of "___" _________ 2005

Preliminary calendar timetable for the implementation of scientific research, experimental design and technological works and budget of expenditures for the project: "Unitsky String Transport (UST)" financed by the Strategic Partner (Party 2) (in prices as of 01.01.2000)

No.	Item of expenditures	Total cost, million USD	Cost of works by year of financing				
			1st year	2nd year	3rd year	4th year	5th year
1. Phase I. Low-speed STS (speed up to 150 km/hour)							
1.1.	Preparation of detailed terms of reference	0.1	0.1	—	—	—	—
1.2.	Design, manufacturing and assembly at the testing ground of testing units to carry out the field tests of a track structure and rolling stock necessary for certification of the low-speed STS	0.4	0.3	0.1	—	—	—
1.3.	Design and manufacturing of a pilot sample of the low-speed passenger module	2.0	0.8	1.2	—	—	—
1.4.	Design and manufacturing of a pilot sample of the low-speed freight rail car-train	0.5	0.2	0.3	—	—	—
1.5.	Design, manufacturing and testing of special instrumentation and technical equipment necessary for the construction of pilot sections of the low-speed STS and its certification	0.4	0.2	0.2	—	—	—
1.6.	Design and construction of a single-track pilot section of the light low-speed STS for single modules (in future this section shall be a part of the higher-speed and super high-speed pilot sections) with the length of 2 km including infrastructure components necessary for STS certification	1.1	0.4	0.7	—	—	—
1.7.	Design and construction of a single-track pilot section for the heavy low-speed STS (for rail freight car-trains with a mass of 200 tons and speed up to 100 km/hour) with the length of 2 km	0.6	0.2	0.4	—	—	—
1.8.	Implementation of a series of tests including the testing unit and pilot STS section, expertise, approval and certification	0.5	0.1	0.3	0.1	—	—
1.9.	Other works and unforeseen expenditures	0.4	0.1	0.3	—	—	—
	Total for phase I:	**6.0**	**2.4**	**3.5**	**0.1**	**—**	**—**
2. Phase II. High-speed STS (speed up to 300 km/hour)							
2.1.	Preparation of detailed terms of reference	0.1	—	0.1	—	—	—
2.2.	Design, manufacturing and assembly at the testing ground of testing units to carry out the field tests of a track structure and rolling stock necessary for certification of the high-speed STS	0.5	—	0.5	—	—	—
2.3.	Design and manufacturing of a pilot sample of the high-speed passenger module	2.5	0.2	0.5	1.8	—	—

No.	Item of expenditures	Total cost, million USD	Cost of works by year of financing				
			1st year	2nd year	3rd year	4th year	5th year
2.4.	Design and manufacturing of a pilot sample of the high-speed freight module	0.6	0.1	0.1	0.4	—	—
2.5.	Design, manufacturing and testing of special instrumentation and technical equipment necessary for the construction of a pilot section of the high-speed STS and its certification	0.5	—	0.2	0.3	—	—
2.6.	Design and construction of a single-track section of the high-speed STS with the length of 6 km (as the increase to the pilot section of Stage I; the total length of the track — 8 km) including the infrastructure components necessary for STS certification	3.0	—	0.5	2.5	—	—
2.7.	Implementation of a series of tests including the testing unit and pilot STS section, expertise, approval and certification	0.9	—	0.2	0.5	0.2	—
2.8.	Other works and unforeseen expenditures	0.9	0.1	0.3	0.4	0.1	—
	Total for phase II:	**9.0**	**0.4**	**2.4**	**5.9**	**0.3**	**—**
	3. Phase III. Super high-speed STS (speed up to 450 km/hour)						
3.1.	Preparation of detailed terms of reference	0.1	—	—	0.1	—	—
3.2.	Design, manufacturing and assembly at the testing ground of testing units to carry out the field tests of a track structure and rolling stock necessary for certification of the super high-speed STS	0.6	—	—	0.6	—	—
3.3.	Design and manufacturing of a pilot sample of the super high-speed passenger module	3.0	0.1	0.2	1.0	1.7	—
3.4.	Design and manufacturing of a pilot sample of the super high-speed freight module	1.0	0.1	0.1	0.2	0.6	—
3.5.	Design, manufacturing and testing of special instrumentation and technical equipment necessary for the construction of pilot sections of the super high-speed STS and its certification	0.6	—	—	0.6	—	—
3.6.	Design and construction of a single-track pilot section of the super high-speed STS with the length of 9 km (as the increase to the pilot section of Stage II; the total length of the track — 17 km) including the infrastructure components necessary for STS certification	8.0	—	0.1	0.9	6.0	1.0
3.7.	Implementation of a series of tests including the testing unit and pilot STS section, expertise, approval and certification	1.0	—	0.1	0.1	0.3	0.5
3.8.	Other works and unforeseen expenditures	0.7	—	0.1	0.2	0.3	0.1
4.	**Total for phase III:**	**15.0**	**0.2**	**0.6**	**3.8**	**8.8**	**1.6**
5.	**Total for phases I—III:**	**30.0**	**3.0**	**6.5**	**9.8**	**9.1**	**1.6**

Appendix 4
to the Agreement of Strategic Partnership
of “___“ _________ 2005

Approximate structure of expenditures for the implementation of scientific research, experimental design and technological works for the project: “Unitsky String Transport” financed by the Strategic Partner (Party 2)

Item number	Item of expenditures	Expenditures, million USD
1.	Materials	3
2.	Equipment	4
3.	Salary for the project staff	8
4.	Work of other organizations and natural persons	8
5.	Rent of premises and land plots	1
6.	Mission costs	0.5
7.	Stationery and service costs	0.5
8.	Taxes	3
9.	Miscellaneous	2
	Total	30

Appendix 3

UST Programme financing from 1977 to 2004

No.	Year	Source of financing	Volume of financing, USD	Notes	Accomplished works, ownership rights
1.	1977 – – 2004	Own Author's resources and non-paid Author's labour activity as engineer, designer, technologist, estimator, expert in aerodynamics, ergonomics, patenting, economist, manager, constructor, chief and general designer.	1,680,000 (based on the average estimated volume of USD 5,000 per month)	Works were carried out in the cities of Gomel, Mozyr, Minsk, Kiev, Moscow	Accomplished works: principal scheme of a transportation system (track structure, supports, rolling stock), areas of application, standards (gauge width, two-flange wheel, geometry of a contact "wheel-rail" zone, etc.); comparative technical/economic analysis with other transportation systems; system optimization based on the engineering approaches ecological, economic, aerodynamic, safety and other considerations; alternative design of all basic nodes of a string-rail, anchor and intermediate supports, passenger and freight modules (low-, medium-, high- and super high-speed up to 500 km/hour), stations, terminals, freight terminals, depots; design at the level exceeding the world level (by the year 2005 there are about 50 patented inventions; about 50 more inventions — potential patent-holders); 5 published monographs, about 100 scientific and popular scientific articles. Created intellectual property is the ownership of Anatoly Unitsky.
2.	1986 – – 1988	USSR Federation of Cosmonautics	60,000	Costs for organizational works, missions, rent of premises, etc.	Organisation and holding in the place of residence of Anatoly Unitsky (city of Gomel, April, 1988) of the First All-Union Scientific and Technical Conference: "Rocket-less industrialization of cosmos: problems, ideas, projects", where UST was considered as the main project in the alternative enabling to go out into space (more than 400 participants including 2 astronauts of the USSR).
3	1988	Goskino of USSR	75,000	Payment of production, camera and montage works for the scientific popular film	Scientific popular film was made "On wheel to the sky" ("Belarus" film production, 30 min.), fully devoted to UST and its author; in 1989—1990 it was demonstrated in movie theatres of the USSR (2 versions are available in Russian and in English).

No.	Year	Source of financing	Volume of financing, USD	Notes	Accomplished works, ownership rights
4.	1988	Soviet Peace Fund	220,000	Grant (resolution of Board's bureau of the Soviet Peace Fund of May 25, 1988, No.34-88Б)	A range of scientific research for UST was carried out (executing organisation: "Star World" Centre of scientific and technical creative activity of youth — established and headed by Anatoly Unitsky in Gomel, 1988. Developed intellectual property belongs to Anatoly Unitsky.
5.	1989 – – 1990	"Star World" Centre NTTM (Gomel)	600.000	Author's resources	A range of scientific research for UST was carried out under the leadership of Anatoly Unitsky (Director, scientific supervisor and general constructor of the Centre). Created intellectual property is the ownership of Anatoly Unitsky.
6.	1990 – – 1992	"Unitran" Institute for social and scientific/technical innovations, Academy of New Thought (Moscow)	250.000	Author's resources	A range of scientific research for UST was carried out under the leadership of Anatoly Unitsky (Director, scientific supervisor and general constructor of the Institute). Created intellectual property is the ownership of Anatoly Unitsky
7.	1991 – – 1996	Agricultural Farm of Anatoly Unitsky (30 ha of land in Gomel Region)	80,000	Author's resources	A range of scientific research for UST was carried out under the leadership of Anatoly Unitsky (farmer, scientific supervisor and general constructor). Created intellectual property is the ownership of Anatoly Unitsky
8.	1992 – – 1997	"Uni-Ar" Firm (city of Gomel)	120,000	Author's resources	A range of scientific research for UST was carried out under the leadership of Anatoly Unitsky (Vice-President, scientific supervisor and general constructor of the Firm).Created intellectual property is the ownership of Anatoly Unitsky
9.	1994 – – 1996	A.A. Kapitonov, entrepreneur (Minsk)	80,000	Kapitonov's resources	Operational model of a UST transportation module was produced at scale 1:5, its wind tunnel tests were carried out. Created intellectual property is the ownership of Unitsky.
10.	1997 – – 1998	"Unitran" research centre (city of Gomel)	50,000	Author's resources	A range of scientific research for UST was carried out under the leadership of Anatoly Unitsky (General Director, scientific supervisor and general constructor of the Centre). Created intellectual property is the ownership of Anatoly Unitsky.
11.	1998 – – 2000	Private investments (more than 100, ranging from USD 10 to USD 10,000)	60,000	Resources under the agreement of joining concluded between each investor and Anatoly Unitsky	A range of scientific research for UST was carried out under the leadership of Anatoly Unitsky. Created intellectual property is the ownership of Anatoly Unitsky. The author committed himself to issue UST securities to each investor in future based on the annual rate of 20% or to return money on the same terms.

No.	Year	Source of financing	Volume of financing, USD	Notes	Accomplished works, ownership rights
12.	1998 – – 2003	Regional Public Fund to assist in the development of a linear transportation system (Moscow)	160,000	Author's resources	A range of scientific research for UST was carried out under the leadership of Anatoly Unitsky (President, general constructor and scientific supervisor of the Fund).Created intellectual property is the ownership of Anatoly Unitsky.
13.	1998 – – 2000	UN-HABITAT	180,000	Grant (project "Sustainable Development of Human Settlements and Improvement of their Communication Infrastructure through the Use of a String Transportation System"	Executive: Regional Public Fund to assist in the development of a linear transportation system, project manager — Anatoly Unitsky. Created intellectual property is the ownership of Anatoly Unitsky.
14.	2000 – – 2002	Dmitry Teryokhin, entrepreneur (Moscow)	1,470,000	Financing under the agreement of strategic partnership	Modeling works were carried out (operational model of a route, scale 1:5, length — 60 m; 3 wind tunnel tests were conducted); personnel potential was formed for two design bureaus (for a track structure and for the rolling stock), construction company, scientific research and design firms; pilot UST section built in the town of Ozyory, Moscow Region. Created intellectual property is the ownership of Anatoly Unitsky (D. Teryokhin is the owner of material part and the second patent-holder of a number of UST patents).
15.	2001	Administration of Krasnoyarsky Krai (Personal Fund of Governor Alexandr Lebed)	300,000	Contract for the implementation of SRDEW	Executive: Regional Public Fund to assist in the development of a linear transportation system. Financial support made it possible to build a pilot UST section in the town of Ozyory, Moscow Region (as a result of under-financing from the strategic partner D. Teryokhin the works for the pilot UST section were stopped). Created intellectual property belongs to A. Unitsky (pilot UST section is still under the financial responsibility of the Regional Public Fund with Anatoly Unitsky as its President, because after the tragic death of Governor Alexandr Lebed the contract remained not closed and acceptance and approval certificate for the implemented works not signed by the Administration of Krasnoyarsky Krai).

No.	Year	Source of financing	Volume of financing, USD	Notes	Accomplished works, ownership rights
16.	2002 – – 2004	UN-HABITAT	30,000	Grant (project "Provision of Sustainable Development of Human Settlements and Urban Environment Protection through the Use of a String Transportation System")	A number of research were carried out to investigate UST application in human settlements, manager of works — Anatoly Unitsky. Created intellectual property is the ownership of Anatoly Unitsky.
17.	2002	Alexandr Kapitonov, entrepreneur (Kiev)	90,000	Kapitonov's resources	Project-design works were initiated to build a 3 km module UST section in the town of Gostomel, Kiev Region. Created intellectual property is the ownership of Anatoly Unitsky.
18.	2003 – – 2004	Nadya Kosareva, entrepreneur (Moscow)	220,000	Kosareva's resources	High-speed transportation module U-361 was created to be used as a basis to create more than 20 modifications of passenger, freight and freight/passenger modules; more than 50 alternatives of a string-rail, and more than 10 alternatives of intermediate and 5 alternatives of anchor supports (including relevant calculations) and a new type of string anchoring were designned; progressive assembly technology was proposed for string-rail and stretching strings of great length (up to 10 km); pilot testing units "String — rail" and "Wheel — string-rail" were designed; prototype solutions were proposed for UST application under various geographic and climatic conditions (North of Russia, desert, etc.). UST design bureau was equipped with necessary technical and computerized devices and bureau's work was organized. Created intellectual property is the ownership of A. Unitsky. The author commit-ted himself to issue UST securities to each investor in future based on the annual rate of 20% or to return money on the same terms.
Total			**5,725,000**		
Total, in current prices (taking into account the increased value of money in time at the rate of 20% per year and risk compensations)			**60,000,000**		

Appendix 4

Material consumption and the cost of UST route

Material consumption and net cost of 1 km of average serial double-track UST route built in a flatland site of Russia are given in the table. The route parameters are as follows: height of supports — 6 m; distances between intermediate supports — 25 m, anchor supports — 2 km; gauge width — 2 m; gauge tension — 500 ts (string rail tension — 250 ts); location of stations and platforms for emergency stops with the cost of USD 200,000 every 10 km, terminals with the cost of USD 2 million — every 100 km; designed travel speed — up to 300 km/hour.

Table

Material consumption and net construction cost of an average serial double-track UST route with the length of 1 km (in prices as of 01.01.2000)

Structural element	Material	Consumption per 1 km of a route		Net cost including construction and assembly works, thous. USD
		mass, tons	volume, cub. m	
1. String-rail, total including:				290
1.1. Head	Steel	52	—	62
1.2. Body	Steel	64	—	78
1.3. String	Steel wire	60	—	90
1.4. Filler	Composite	—	45	35
1.5. Other		—	—	25
2. Intermediate supports, total including:		—	—	80
2.1. Pillars	Reinforced concrete	—	90	30
2.2. Connection straps, braces	Reinforced concrete	—	20	8
2.3. Upper structure of supports	Steel	8	—	10
2.4. Foundation	Reinforced concrete	—	48	24
2.5. Other		—	—	8
3. Anchor supports, total including:		—	—	85
3.1. Body of support	Reinforced concrete	—	50	20
3.2. Foundation	Reinforced concrete	—	120	40
3.3. Metal structures	Steel	2	—	5
3.4. Anchor fixing	Steel	2	—	10
3.5. Other		—	—	10
4. Earth works		—	—	20
5. Control systems, stops, other costs		—	—	125
Total				**600**

Appendix 5

Key environmental characteristics of transportation systems

(passenger flow more than 1,000 pass./hour, freight flow more than 1,000 t/hour)

Mode of transportation	Environmental indices: Specific energy-resource consumption (litres of gasoline per 100 passenger/km or tonnes/km)		Noxious emissions kg/100 passenger×km (or 100 tonnes×km)	Land requirements, ha/100 km
	Passenger traffic	Freight traffic		
1. Railways (up to 80 km/hour):				
• arterial	1.1—1.4	0.7—1.0	over 0.1	300—400
• local	1.2—1.5	0.9—1.4	over 0.1	300—400
• city-wide:				
- underground	1.3—1.7	—	over 0.1	—
- tram	1.9—2.1	—	over 0.1	50—100
2. Motor transportation (100 km/h):				
• individual car:				
- within the city limits (average load of 1.6 passengers)	4.7—6.3	6.6—11.1	over 1	200—300
- beyond the city limits (average load of 3.5 passengers)	1.5—1.7	5.1—9.2	over 1	300—500
• bus				
- within the city limits	2.1—2.3	—	over 1	200—300
- beyond the city limits	1.4—1.7	—	over 1	300—500
• trolleybus	1.9—2.5	—	over 0.1	200—300
3. Air transportation				
• long-distance (900 km/hour)	6—10	50—75	over 10	20—50
• local (400 km/hour)	14—19	150—200	over 50	10—20
4. Sea transportation (50 km/hour)	17—19	0.38—0.95	over 10	5—10
5. River transportation (50 km/h)	14—17	0.57—1.4	over 10	2—3
6. Oil pipelines (10 km/hour)	—	0.51—0.57	over 1	50—100
7. Gas pipelines (10 km/hour)	—	5.7—6.1	over 1	50—100
8. Conveyer transportation (10 km/h)	—	4.7—9.2	over 1	50—100
9. Hydro-transportation (10 km/h)	—	2.3—4.7	over 1	50—100
10. Cable-rope roads (10 km/hour)	0.3—0.5	0.95—1.9	over 1	20—30
11. Train on a magnet suspension (400 km/hour)	3.5—4.5	—	over 1	100—200
12. High-speed railway (300 km/h)	2.5—3.5	—	over 1	300—500
13. Monorail (100 km/hour)	1.5—2.5	—	over 1	50—100
14. String transportation: (passenger — 20 seats; freight— 10 tonnes of freight) at the speed of:				
- 100 km/hour (30 kWt engine power)	0.3	0.6	below 0.001	10—20
- 200 km/hour (70 kWt engine power)	0.35	0.7	below 0.001	10—20
- 300 km/hour (150 kWt engine power)	0.5	1.0	below 0.001	10—20
- 400 km/hour (300 kWt engine power)	0.75	1.5	below 0.001	10—20
- 500 km/hour (450 kWt engine power)	0.9	1.8	below 0.001	10—20

Appendix 6

Technical and economic indices of transportation systems

The key average technical and economic indices of various transportation systems as compared with UST (at passenger flow more than 1,000 pass./hour and freight flow more than 1,000 t/hour) are given in the table.

Mode of transportation	Technical and economic indices			
	Cost of route including infrastructure mln. USD/km	Relative cost of the rolling stock, thous. USD per 1 seat	Net cost of transportation	
			Passenger, USD/ 100 pass.·km	Freight, USD/ 100 t/·km
1. Railway (up to 80 km/hour):				
• arterial	2—3	10—50	2—4	1—2
• suburban	1—2	5—10	2—4	1—2
• urban:				
- underground	50—100	5—10	2—4	1—2
- tram	2—3	5—20	2—4	1—2
2. Automobile (up to 100 km/h):				
• individual car:				
- within the city limits (average loading 1.6 pass.)	3—5	1—5	3—5	5—20
- beyond the city limits (average loading 3.5 pass.)	2—5	1—5	3—5	5—20
• bus (60 km/hour):				
- within the city limits	3—5		2—4	10—20
- beyond the city limits	3—5	5—10	2—3	10—20
• trolleybus (60 km/hour)	3—5	5—10	2—3	10—20
3. Air transportation:				
• long-distance (900 km/hour)	0,5—1	100—200	10—20	15—40
• local (400 km/hour)	0,1—0.5	50—100	5—10	20—50
4. Sea transportation (30 km/h)	0,1—0.5	20—50	2—5	1—2
5. River transportation (30 km/h)	0,1—0.2	10—20	2—5	1—2
6. Oil pipelines (10 km/hour)	1—3	—	—	0.5—1
7. Gas pipelines (10 km/hour)	1—3	—	—	0.5 — 1
8. Conveyer (10 km/hour)	2—5	—	—	1—2
9. Hydro-transportation (10 km/hour)	0,5—1	—	—	0.5—1
10. Cable-rope roads (10 km/h)	1—2	1—2	5—10	2—5
11. Train on a magnet suspension (400 km/hour)	20—50	100—200	2—5	1—2
12. High-speed railway (300 km/hour)	10—20	20—50	10—20	10—20
13. Monorail (50 km/hour)	5—20	20—50	10—20	10—20
14. String transportation (passenger module — 20 seats, freight — 6 t of cargo)	0.9—1.5	3—5	0.5—1.5	0.4—0.8

Appendix 7

Cash flows within the UST Programme (pessimistic alternative)

Year	Cash inflow from operational activity*	Investor's investments, USD million	Company's income re-investment, USD million	Requirements for additional capital investments, USD million	Total cash flow within the Programme, USD million	Discount total cash flow within the Programme, USD million	Cash flow of Investor, USD million	Discount (20%) cash flow of Investor, USD million
1	0.0	–3.0	0.0	–3.0	–3.0	–3.0	–3.0	–3.0
2	0.0	–6.5	0.0	–6.5	–6.5	–5.4	–6.5	–5.4
3	0.5	–9.8	0.0	–9.8	–9.3	–6.5	–9.6	–6.6
4	7.6	–9.1	–5.5	–14.6	–7.0	–4.1	–8.1	–4.7
5	32.2	–1.6	–10.0	–11.6	20.6	9.9	9.5	4.6
6	110.5	0.0	–55.0	–55.0	55.5	22.3	27.8	11.2
7	239.0	0.0	–75.0	–75.0	164.0	54.9	82.0	27.5
8	445.0	0.0	–100.0	–100.0	345.0	96.3	172.5	48.1
9	890.0	0.0	–250.0	–250.0	640.0	148.8	320.0	74.4
10	1 780.0	0.0	–500.0	–500.0	1 280.0	248.1	640.0	124.0
11	3 510.0	0.0	–1 000.0	–1 000.0	2 510.0	405.4	1 255.0	202.7
12	6 260.0	0.0	–1 500.0	–1 500.0	4 760.0	640.6	2 380.0	320.3
13	9 650.0	0.0	–1 500.0	–1 500.0	8 150.0	914.1	4 075.0	457.0
14	13 170.0	0.0	–1 000.0	–1 000.0	12 170.0	1 137.5	6 085.0	568.7
15	17 140.0	0.0	–1 000.0	–1 000.0	16 140.0	1 257.1	8 070.0	628.5
16	21 590.0	0.0	–1 000.0	–1 000.0	20 590.0	1 336.4	10 295.0	668.2
17	26 490.0	0.0	–1 000.0	–1 000.0	25 490.0	1 378.7	12 745.0	689.4
18	31 750.0	0.0	–1 000.0	–1 000.0	30 750.0	1 386.0	15 375.0	693.0

* see Appendix 8 — "Incomes and capitalization of the Company"

Appendix 8

Incomes and capitalization of the Company (pessimistic alternative)

Year from the start of the project	Cost of orders for UST routes, USD million (equal to the route length in km)		Production output of the rolling stock, USD million		Company's income, USD million						Company's capitalization, USD million
					From routes and infrastructure			From the rolling stock		Total, per year	
	Per year	By increment (Σ UST)	Per year (UST)	By increment	Design (0,05 Σ UST)	Construction (0,4 Σ UST)	Royalty (0,03 Σ UST)	From sales of the rolling stock (40%)	From fuel savings (royalty 5% from fuel savings)		
1	—	—	—	—	—	—	—	—	—	0	0.5
2	10	10	—	—	—	—	—	—	—	0	5.5
3	40	50	—	—	0.5	—	—	—	—	0.5	30.5
4	150	200	4	4	2	4	—	1.6	—	7.6	30.5
5	300	500	16	20	7.5	16	0.3	6.4	2	32.2	530.5
6	500	1000	60	80	15	60	1.5	24	10	110.5	530.5
7	1000	2000	120	200	25	120	6	48	40	239	5530.5
8	2000	4000	200	400	50	200	15	80	100	445	5530.5
9	4000	8000	400	800	100	400	30	160	200	890	5530.5
10	7000	15000	800	1600	200	800	60	320	400	1780	25530.5
11	10000	25000	1600	3200	350	1600	120	640	800	3510	25530.5
12	12000	37000	2800	6000	500	2800	240	1120	1600	6260	25530.5
13	14000	51000	4000	10000	600	4000	450	1600	3000	9650	25530.5
14	16000	67000	4800	14800	700	4800	750	1920	5000	13170	25530.5
15	18000	85000	5600	20400	800	5600	1100	2240	7400	17140	75530.5
16	20000	105000	6400	26800	900	6400	1530	2560	10200	21590	75530.5
17	20000	125000	7200	34000	1000	7200	2010	2880	13400	26490	75530.5
18	20000	145000	8000	42000	1000	8000	2550	3200	17000	31750	75530.5
Total	**145000**		**42000**		**6250**	**42000**	**8862.8**	**16800**	**59152**	**133064.8**	**75530.5**

Income was estimated with due regard to the time gap from getting the order for concrete UST route to earning of Company's income from design — 1 year, construction — 2 years, sales of the rolling stock — 3 years.

Appendix 9

List of main scientific papers and publications

List of main scientific papers by Anatoly Unitsky within the Programme “Unitsky String Transport” in a chronological order as of May 27, 2005.

1. Anatoly Unitsky. Linear transportation system. Patent of the Russian Federation No. 2080268, cl. B 61 B 5/02, 1994.
2. Yunitsky Anatoly. Linear Transport System. Patent of Republic of South Africa No. 95/2888, classification B 659, 1994.
3. Anatoly Unitsky. Linear transportation system. Patent of Ukraine No. 28057, cl. B 61 B 13/04, 1994.
4. Anatoly Unitsky et al. Analysis of fluctuations in span structures of string transportation system / Belorussian Congress on theoretic and applied mechanics “Mechanics-95”. Theses of the reports, February 6—11, 1995, Minsk. — Gomel: IMMS ANB, “Infotribo”, 1995. — pp. 253—254.
5. Anatoly Unitsky et al. Towards string transportation system dynamics / Belorussian Congress on theoretic and applied mechanics “Mechanics-95”. Theses of the reports, February 6—11, 1995, Minsk. — Gomel: IMMS ANB, “Infotribo”, 1995. — pp. 254—255.
6. Anatoly Unitsky. String transportation systems: on Earth and in Cosmos. — Gomel: Infotribo, 1995. — 337 p.: ill.
7. Anatoly Unitsky. High-speed ground transport NTL / Resource- and energy-saving technologies in transportation and construction sector: Theses of the report at the international scientific-practical conference — Gomel: BelGUT, 1995. — pp. 69—70.
8. Anatoly Unitsky. String transportation systems — new technologies in the high-speed ground transportation. Dissertation in the form of a scientific report for the scientific Doctoral Degree in the field of information technologies (transportation). — Minsk, 1996. — 26 p.
9. Anatoly Unitsky. Rail for string transportation systems. Patent of the Russian Federation No. 45523, cl. 12-03, 1996.
10. Anatoly Unitsky. Transportation vehicle for string transportation systems (two alternatives). Patent of the Russian Federation No. 45722, cl. 12-03, 1996.
11. Anatoly Unitsky. Transportation vehicle for string transportation systems (two alternatives). Patent of Republic of Belarus No. 220, 1996.
12. Anatoly Unitsky. Rail for string transportation systems (two alternatives). Patent of Republic of Belarus No. 221, 1996.
13. Anatoly Unitsky. Rails for string transportation systems. Patent of Ukraine No. 1995, cl. 25-01, 1996.
14. Anatoly Unitsky. Transportation vehicle for string transportation systems. Patent of Ukraine No. 1996, cl. 12-03, 1996.
15. Anatoly Unitsky. Rail for string transportation systems. Patent of Republic of Kazakhstan No. 114, cl. 25-01, 1996.
16. Anatoly Unitsky. Development of a string transportation system “Paris — Moscow” / Development of communication system Paris — Berlin — Warsaw — Minsk — Moscow / Proceedings of the international conference, October 28—31, 1997, Minsk. — pp. 81—84.
17. Anatoly Unitsky. String road in the 21st century / ”Transport of Russia” newspaper, Moscow, December 27—31, 1999, No. 52. — p. 2.
18. Anatoly Unitsky. Innovative project “String transportation system” / “Conversion in machine-building” Journal, Moscow, 2000, No. 2. — pp. 59—61.
19. Anatoly Unitsky. Road to the 21st century / “National Safety and Geo-policy of Russia” Journal, Moscow, 2000, No. 6—7. — pp. 43—49.
20. Anatoly Unitsky. Report on the project of the UN Centre for Human Settlements No. FS-RUS-98-S01 “Sustainable development of human settlements and improvement of their communication infrastructure through the use of a string transportation system”. — Moscow: Gosstroy of Russia, 2000. — 179 p.
21. Anatoly Unitsky. Report on the project of UN Centre for Human Settlements No. FS-RUS-98-S01 "Sustainable development of human settlements and improvement of their communication

infrastructure through the use of a String Transportation System. — Moscow: Gosstroy of Russia, 2000. — 160 p.

22. Anatoly Unitsky. String Transport of Unitsky / Project: “Noospheric transportation systems of Siberia and Far East”. — Novosibirsk: Publishing house NGAVT, 2000. — pp. 641—674.
23. Anatoly Unitsky. String transportation system / ”Science and Technologies in Industry” Journal, Moscow, 2001, No. 3. — pp. 55—56.
24. Anatoly Unitsky. Rail of transportation system of Unitsky (alternatives) (2 inventions). Euro-Asian patent No. 003484, cl. E 01 B 5/08, 2001.
25. Anatoly Unitsky. Rail of transportation system of Unitsky. Euro-Asian patent No. 003485, cl. E 01 B 5/08, 2001.
26. Anatoly Unitsky. High-speed transportation module. Euro-Asian patent No. 003490, cl. B 62 D 35/00, 2001.
27. Anatoly Unitsky. High-speed transportation module. Euro-Asian patent No. 003533, cl. B 62 D 35/00, 2001.
28. Anatoly Unitsky. High-speed transportation module. Euro-Asian patent No. 003534, cl. B 62 D 35/00, 2001.
29. Anatoly Unitsky. High-speed transportation module. Euro-Asian patent No. 003535, cl. B 62 D 35/00, 2001.
30. Anatoly Unitsky. High-speed transportation module of transportation system of Unitsky. Patent of the Russian Federation No. 2201368, cl. B 62 D 35/00, 2001.
31. Anatoly Unitsky. High-speed transportation module of transportation system of Unitsky. Patent of the Russian Federation No. 2201369, cl. B 62 D 35/00, 2001.
32. Anatoly Unitsky. Rail of transportation system of Unitsky (alternatives) (2 inventions). Patent of the Russian Federation No. 2201482, cl. E 01 B 25/00, 2001.
33. Anatoly Unitsky. High-speed transportation module of transportation system of Unitsky. Patent of the Russian Federation No. 2203194, cl. B 62 D 35/00, 2001.
34. Anatoly Unitsky. High-speed transportation module of transportation system of Unitsky. Patent of the Russian Federation No. 203195, cl. B 62 D 35/00, 2001.
35. Anatoly Unitsky. Rail of transportation system of Unitsky. Patent of the Russian Federation No. 2204636, cl. E 01 B 25/00, 2001.
36. Anatoly Unitsky. Rail of transportation system of Unitsky, production and assembly tech-niques (2 inventions). Patent of the Russian Federation No. 2204637, cl. E 01 B 25/00, 2001.
37. Anatoly Unitsky. Rail of transportation system of Unitsky. Patent of the Russian Federation No. 2204638, cl. E 01 B 25/00, 2001.
38. Anatoly Unitsky. Rail of transportation system of Unitsky and its production technique (2 inventions). Patent of the Russian Federation No. 2204639, cl. E 01 B 25/00, 2001.
39. Anatoly Unitsky. Rail of transportation system of Unitsky. Patent of the Russian Federation No. 2204640, cl. E 01 B 25/00, 2001.
40. Anatoly Unitsky. Rail of transportation system of Unitsky. Patent of the Russian Federation No. 2208675, cl. E 01 B 25/00, 2001.
41. Anatoly Unitsky. High-speed transportation module of transportation system of Unitsky. Patent of the Russian Federation No. 2211781, cl. B 62 D 35/00, 2001.
42. Anatoly Unitsky. Transportation system. Patent of the Russian Federation No. 2211890, cl. E 01 B 25/00, 2001.
43. Anatoly Unitsky. High-speed transportation module of Transportation system of Unitsky. Patent of the Russian Federation No. 2217339, cl. B 62 D 35/00, 2001.
44. Anatoly Unitsky. String transportation system /City-generating technologies of the 21st century /Theses of the reports and presentations of the international scientific and practical conference, September 11, 2001, Moscow. — pp. 12—14.
45. Anatoly Unitsky. String transportation system — transport of the future /”Industrial and Civil Construction” Journal, Moscow, 2002, No. 1. — pp. 36—39.
46. Anatoly Unitsky, V.G. Sokolov, V.A. Vlasov. Investment avant-project for the development of a high-speed string transportation route River port — Academ-city in Novosibirsk / ”Siberian Financial School” Journal, Novosibirsk, 2002, No. 1. — pp. 6—14.
47. Anatoly Unitsky, Alexei Kosilov. String transportation system / Modernization of industrial transport / Proceedings of scientific-technical conference, February 12—13, 2002, Moscow. — pp. 129—132.

48. Anatoly Unitsky. Transportation system of Unitsky (alternatives) and ways of its construction (4 inventions). Patent of the Russian Federation No. 2220249, cl. E 01 B 26/00, 2002.
49. Anatoly Unitsky. Transportation system of Unitsky (alternatives) and ways of its construction (3 inventions). Patent of the Russian Federation No. 2223357, cl. E 01 B 26/00, 2002.
50. Anatoly Unitsky. Transportation system of Unitsky (alternatives) and ways of its construction (3 inventions). Patent of the Russian Federation No. 2224064, cl. E 01 B 26/00, 2002.
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For information: the list includes 41 patents, 67 inventions, 32 reports and publications including 5 monographs.

Appendix 10

Assessment of the intellectual property

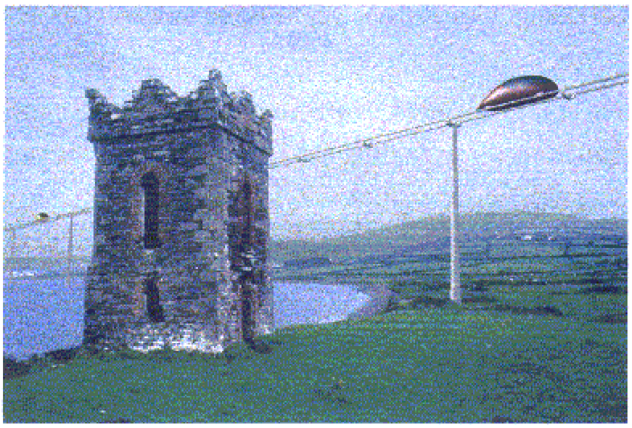
Extract from the report: "On the Assessment of Intellectual Property Object "System of Communications of Unitsky "Unitran" (by "Centre for Professional Assessment", Moscow, 2000, pp. 59—60).

Translation of this document is given below

59

5. СЕРТИФИКАЦИЯ ОЦЕНКИ

5.1. Сертификат рыночной стоимости



Настоящим удостоверяется, что в соответствии с имеющимися у оценщиков данными и исходя из их знаний и убеждений:

- Все факты, изложенные в настоящем отчете, верны и соответствуют действительности.
- Сделанный анализ, высказанные мнения и полученные выводы действительны исключительно в пределах оговоренных в настоящем отчете допущений и ограничительных условий и являются персональным, непредвзятым, профессиональным анализом, мнением и выводами.
- Оценщики не имеют ни в настоящем, ни в будущем какого-либо интереса в оцениваемой собственности, а также не имеют личной заинтересованности и предубеждения в отношении вовлеченных сторон.
- Вознаграждение оценщиков ни в коей мере не связано со значением стоимости объекта оценки.
- Оценщиками была произведена личная инспекция оцениваемой собственности.
- Проведенный анализ, мнения и выводы были получены, а настоящий отчет составлен в полном соответствии с нормативными актами, действующими в оценке интеллектуальной собственности.
- Оценочная стоимость признается действительной на дату оценки: 25 апреля 2000 года.

Выводы относительно текущей стоимости:

1. Инвестиционная стоимость пакета прав на «Систему коммуникаций Юницкого (СКЮ) «Юнитран» объективно находится в диапазоне от 700.000.000 USD до 1.200.000.000 USD.

2. По мнению оценщиков, конкретное значение рыночной стоимости по состоянию на 25.04.2000 равно 970.000.000 USD (Девятьсот семьдесят миллионов долларов США).

Генеральный Директор
Центра Профессиональной оценки — А.А. КУШЕЛЬ

Исполнители

Эксперт по оценке интеллектуальной собственности, профессор АНХ при Правительстве РФ — Н.Н. КАРПОВА

Эксперт по оценке интеллектуальной собственности, преподаватель Российского института ИС — Ю.Б.ЛЕОНТЬЕВ

Эксперт Центра профессиональной оценки — О.Н. СИНЕВА

Translation:

5. Certification of assessment

5.1. Certificate of the market cost

This is to certify that in accordance with the available data and knowledge and conviction of appraisers:

- All data presented in the given report are correct and comply with the reality.
- The analysis made, opinions presented and conclusions drawn are valid exclusively within the assumptions and limiting conditions specified under the present report and are regarded as personal, unbiased, professional analysis, opinion and conclusions.
- Appraisers have no interest either at present or in future in the assessed property either they have no personal interest or prejudice in relation to the parties involved.
- Appraisers' fee is in no way related to the value of the object of assessment.
- Property assessment was undertaken by appraisers as their personal inspection.
- The analysis made, opinions and conclusions drawn as well as the present report are in full compliance with the effective normative acts applied for the assessment of intellectual property.
- The assessed cost is deemed valid for the date of assessment: April 25, 2000.

Conclusions related to the current cost:

1. Investment cost of a package of rights to the "System of Communications of Unitsky (SCU) "Unitran" is objectively located within the diapason ranging from USD 700,000,000 to USD 1,200,000,000.
2. According to the appraisers' opinion concrete value of the market cost as of 25.04.2000 is equal to USD 970,000,000 (nine hundred seventy million US dollars).

A.A. Kushel, General Director, Centre for Professional Assessment

Executives:

N.N. Karpova, Expert in Intellectual Property Assessment, Professor, Academy of National Economy under the Government of the Russian Federation

Yu.B. Leontyev, Expert in Intellectual Property Assessment, Professor, Russian Institute of Intellectual Property

O.N. Sineva, Expert, Centre for Professional Assessment