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FUNDAMENTAL RELATIONSHIP BETWEEN MAIN PARAMETERS OF THE TRANSPORT PRODUCT

Physical nature of the mutual relation between the basic components of transport product is analyzed, meaningfull characterization for delivery speed are given.

Keywords: domestication, drawn by animal, onerary transport, power, speed, mechanical move.

Statement of the problem. *Contemporary economic statistics of transport sector is characterized by a number of fundamental problematic symptoms being seen among professional experts traditionally as the natural state of things – the usual, recognized and objectively conditioned. It is about the key economic indicators, by which quantification of the transport production in economic systems is provided: the volume of traffic, reduced turnover, the average distance of transportation, length of network infrastructure. Thus services for moving the goods and the passengers as resulting economic efforts of shipping and transport-construction industries are measured by empirically formed approaches, which admittedly have no fundamental scientific and theoretical explanation.*

Reduction interpretation (see [1 - 3]) of the branch technology as a spatial displacement, which is based on the usual mechanical interaction reveals some significant differences of approach to parametric estimation acceptable by classical physics studying the fundamentals of life. Forming the economic approaches for analysis of social processes and phenomena beyond the basic picture of the universe is often the cause of wrong decisions, erroneous interpretations as well the occurrence of views located far from science. The general principle of objective knowledge – the consistency of the total science system is broken in this case, that is totally unacceptable.

Specific result of this state in transport economy is the lack of clear consensus among the community of experts even concerning the investigated object: systematization of the transport sectors, attempts to include the energy transport systems into consideration and rejection of that. Administrative and institutional fragmentation and non-systemic government policy of regulating the transport directly reflects the shortcomings, which unfortunately have become an attribute of the one of the most important economy sectors.

This situation not typical only for domestic science. Another consequence, which is manifested in the transport statistics of developed countries, is a complete intertype mismatch of the parameters, by which product is evaluated and, logically, of local evaluating indicators systems themselves. Thus, EU industry-wide summary of transport data are: by road and rail – in tonnes, tonne-kilometers and wagon-kilometers; pipeline – just in tonne-kilometers; sea and air – alone in tons

[4]. It should be noted that the relevant national approach formed by the Soviet statistical school, despite the greater degree of unification as well has no reason to claim absolute objectivity for the same reason, it is absence of the balanced theoretical and practical bases.

Analysis of research and publications. *Having not enough convincing attempts of other authors [1, 5] for the development of non-contradicting to the basic sciences quantitative assessment methodology leads to a detailed study of the physical nature of the transport product emergence as an economic outcome.*

Purpose. *The above has given rise to the need for a study, the results of which are set forth in this article.*

Consideration is carried out on the basis of the first established in the time sub-sector of transport – the cart (drawn by animal) transport, which though in modern terms has turned into an anachronism and ceased to be part of the economic system, but is able to clearly express the meaning of structural proportions inside of the transport product, including the speed component. For the same reasons has been held the parallel to the sport achievements, that is able to highlight fundamental relationship "distance - speed" significantly.

The main material. *Domestication of the wild animals played a key role in formation of a transport sector. As in the partial case of animal use in general economic activity (Tab. 1), human work efficiency largely had been improved by the use of animal physical efforts in moving cargo and passengers. This raised meeting the transportation needs to a qualitatively new level. On the one hand, laying transport functions on the animals freed people from having to use their own muscles to exercise movements over long distances, depriving performers of boring exhausting unskilled work, and dismissed, in turn, their time for other tasks that need higher skills. On the other hand, appeared entirely new opportunities for increasing the weight of sending units and enhancing the second key parameter of the transportation process that is the speed.*

Attention is drawn to the fact of that in the list of domesticated animals that were in use of people as draft power in a particular period of history, in certain geographical area or continue to be in use at present (Tab. 1), we can find a representative one, which has lower than a human's lift power, it is a dog. This "defect" could be eliminated by increasing the number of harnessed to a vehicle animals. However, no animal has the movement speed less than that of a human. Index rate, which a dog of breed Greyhound can reach from a standing start is up to 90 km/h, while velocity of the dog-team racing is around 70 km/h. Even the elephant with a "narrow specialization" to carry the cargo operations (average sized adult animal can raise by a trunk weight to one ton) can move with an identical to the men's speed parameters: short distances running – 35 km/h, slow walking on large distances – 6.5 km/h. [10] Estimated average walking speed of an adult man is 6 km/h.

Tab. 1 – Timeline of animal domestication by human [6 - 9]

Animal	*Wild ancestor*	*Start of domestication, thousand years BC*	*Place*
dog	*canis lupus (wolf)*	*13 - 10*	*Middle Asia*
neat	*bovinae (buffalo, aurochs, yak)*	*5,5 - 5*	*various regions*
horse	*equus ferus (tarpan)*	*5 - 4,5*	*steppes of Eurasia*
*Asian elephant**	*elephas maximus*	*4*	*ancient civilization of the Indus River*
donkey	*equus africanus (Nubian and Somalian subspecies)*	*4 - 3*	*Egypt, Ethiopia*
camel (dromedary or Arabian camel, bactrian)	*camelops hesternus (extinct common ancestor of modern camels)*	*3 - 2*	*Somalia, Arabia*
llama	*lama guanacoe (guanaco)*	*3 - 1*	*mountainous regions of South America*
reindeer caribou	*rangifer tarandus*	*1*	*Siberia*

*Note: * – domestication without selection changes of population aimed to adapt animals to maintenance in captivity and human use*

It is well known that the rate of movement of any creature depends on a number factors. Among the group of internal ones, that are directly involved in the transport process, first should be singled out the distance of move. In Table 2 as an example are given the maximum speed (records) indexes for runners at the different distances, the ratio of them can be the benchmark for the average speed parameters for homo sapiens. Data in the Table 3 give an idea of correlation between maximum speed of move in the water and distance of swimming.

Tab. 2 – Speed changes of man's movement depending on the distance [12, 13]

Distance of race, m	*Speed record, km/h*
100	*37*
400	*33*
800	*29*
1 500	*26*
3 000	*25*
5 000	*24*
10 000	*23*
15 000	*22*
20 000	*19*
42 195	*17*
100 000	*15*

Obviously, the second factor of this group is the weight load on the moving creature. Increasing the quantity of transporting cargo makes achieving values of speed the same that without load impossible.

In general, it should be noted that all three of these factors (speed, distance and load weight (of cargo or passengers)) in transport calculations are interrelated. For example, draft or pack animal (or runner) moving with faster speed can cover a smaller distance. By even increasing the load for them, this distance will be further reduced. The increase of transported load also will inversely affect the size and the achieved speed.

Made by humanity shift to using the mechanical systems with an active wheel in performing the transport process had changed the situation somehow. So the maximum speed available for self-propelled vehicles had been fixed as defined by the characteristics of the engine and all of its design parameter. However, such changes are not essential by their nature.

Power of a device that basically provides the motion of a car, locomotive, boat, aircraft, etc. is taken as its fundamental characteristic. In accordance with the system of knowledge in physics, as commonly known, it is given by formula:

$$N = \overline{F} \cdot \bar{v} \cdot \cos\alpha, \qquad (1)$$

with N the power, W; $\overline{F}$ the force applied to the body, N; $\bar{v}$ the velocity of the body (speed), m/s; α the angle between the vectors of force and movement of the body [15].

Tab. 3 – World record in swimming (pool 50 meters, male) [12, 14]

Distance, m	*Result, s (min)*	*Sportsmen, country*	*Year of establishment*	*Speed,*	
				m/s	*km/h*
free style					
50	*20,91*	*César Cielo, Brasil*	*2009*	*2,39*	*8,60*
100	*46,91*			*2,13*	*7,67*
200	*1.42,00*	*Paul Biedermann, Germany*		*1,96*	*7,06*
400	*3.40,07*			*1,82*	*6,55*
800	*7.32,12*	*Zhang Lin, China*		*1,77*	*6,37*
1500	*14.31,02*	*Sun Yang, China*	*2012*	*1,72*	*6,19*
backstroke					
50	*24,04*	*Liam Tancock, GBritain*	*2009*	*2,08*	*7,49*
100	*51,94*	*Aaron Peirsol, USA*		*1,93*	*6,95*
200	*1.51,92*			*1,79*	*6,44*
breaststroke					
50	*26,67*	*Cameron van der Burgh, South Africa*	*2009*	*1,87*	*6,73*
100	*58,46*		*2012*	*1,71*	*6,16*
200	*2.07,01*	*Akihiro Yamaguchi, Japan*		*1,57*	*5,65*
butterfly					
50	*22,43*	*Rafael Muñoz, Spain*	*2009*	*2,23*	*8,03*
100	*49,82*	*Michael Phelps, USA*		*2,01*	*7,24*
200	*1.51,51*			*1,79*	*6,44*
complex sweeming					
200	*1.54,00*	*Ryan Lochte, USA*	*2011*	*1,75*	*6,30*
400	*4.03,84*	*Michael Phelps, USA*	*2008*	*1,64*	*5,90*
relay-race / free style					
4 x 100	*3.08,24*	*USA*	*2008*	*2,12*	*7,63*
4 x 200	*6.58,55*		*2009*	*1,91*	*6,88*

Thus, the power caused by the mechanical specifications of the device nodes depends on the driving force or torque created by the output of the vehicle in complex. Other things being equal, an increase of this force requires lowering the velocity of movement, and vice versa: maximizing the speed is possible in condition of decreasing one of the components that determine the force, this is weight.

It should be noted that the second component of force quantification that is the acceleration at the same time has direct proportional interconnection with the velocity (reducing acceleration makes the velocity of movable vehicle less):

$$\bar{a} = \frac{dv}{dt}, \qquad (2)$$

simultaneously

$$\bar{F} = m \cdot \bar{a} \cdot \cos\alpha, \qquad (3)$$

with $\bar{a}$ the acceleration given to the body, m/s^2; t the time of force acting, s; m the body mass [15]. For the purposes of complex regulating the "transport force" are used mainly the change of energy consumption intensity (in the rotor, gas turbines, electric and jet engines) and as an addition, switch of the gear torque (in steam, external and internal combustion engines, including diesel).

Therefore, the speed of the vehicle, in addition to factors of external interaction (friction or resistance of the environment), also depends on the amount of energy consumed, as well as on the weight (mass) of vehicle along with the cargo. But distance is determined by the source of energy quantity available onboard, besides, parameters of durability and longevity of a vehicle are to be considered as that are determined by its structural features. We believe here exists the direct analogy with codependency among the factors of the transport processes which use biological systems as a base (muscle-power, onerary and cartage). Indeed, movement as in biological structures needs energy produced by chemical disintegration of its carrier (nutritional food). For a useful output of the system is its movement due to the expended energy consumed at the input (the consumed energy source). In biota the main means of energy production for the move is breath. In general, zoological life-form itself embodies the ability to use chemical element oxygen in its molecular form as an oxidizer splitting organic compounds with the purpose of extracting the energy for motion. Obtaining large amounts of energy for instant use in moving distinguishes the animal kingdom from the flora. Although it should be noted, that plant life form is the beginning of the vast majority of the food and energy chains, and ultimately, it is the creator of the oxygen component of the whole atmosphere.

The reason for this similarity probably should be seen in the principle similarity of man-technical systems and the nature systems that already existed before the human. As an exception could be considered the use of artificial transport systems based on electromagnetic fields and nuclear fission, but currently all the technological cycles of they production without exception begin with traditional forms of oxidation energy processes.

In the same way appeared the principle of measurement of mechanical power devices using the criterion of "horsepower". This way the assessment of ratio of the coal weight which is able to be picked up by one working in the coal mine pony horse, the depth and speed of the lift, served as the basis for a Scotsman James Watt's proposition to use this measurement which is similar to "kilogram-force – meters per second". [16]

At the same time, the main reason of similarity of purely biological and anthropogenic transport processes probably has to be seen inside of the use of the same form of motion that is mechanical one. Although the rotational movement itself could be recognized as the specific human invention, not previously existed in nature.

We should note also that researching the complex relationship "weight - length - velocity" and optimizing the ratio of its components, focused on specific subjects taking into account structural features, conditions of travel and other nuances of some transport system represent a separated matter. These investigations are not within the scope of the author's interest in this publication.

Conclusions. *The study of fundamental relations in economic evaluation of transport product, which is a mechanical moving the goods and the passengers, allows directively to consider the influence of the transport process factors: they are internal mutually exclusive value of speed and weight, as well as complementary external independent action of the distance and the environmental resistance.*

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