Outer Space, Education and Economy in the 21st Century: A Cybernetic Approach

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The problem of shortage of highly qualified personnel for the space industry of the Russian Federation has been reviewed. According to the author, in order to successfully explore space, the relevant specialists have to be trained from school. The demand for them should also be formed by the state, the strategy of which needs to include the study of the Universe, the desire to bring life to other planets. Such a system can be implemented through the introduction of an economic model that has a management and planning mechanism based on a cybernetic approach. A description of this model has been provided, its practical application and the effect it has on the development of the space industry as a whole and the training of personnel for this area.

Keywords: *digital economy, dynamic interindustry-intersectoral balance model (DIIBM), education, full employment, future professions, industry, space industry.*

Unemployment Among Graduates from Institutions of Higher and Secondary Vocational Education

Successful space exploration requires highly qualified specialists, whose training must begin from school. Since an early age, children should seriously study the Universe in order to become astronomers, design engineers, robotic engineers, space biologists and professionals in aviation and space medicine.

In the Russian Federation today, the training of specialists is not linked with either the goal or the strategy for the development of the space industry, which was updated by the State Space Corporation "Roscosmos" in 2021 and is aimed at ensuring the strategic security and independence of the state with space efforts and resources; improving the quality of life, the infrastructural unity of the country and the digital transformation of the economy; obtaining new knowledge about the Universe and the origin of life on Earth; access to unlimited space resources. Obviously, the implementation of these goals requires a large number of relevant personnel. However, only a few of higher education institutions are engaged in the training of such specialists (Bauman Moscow State Technical University, Moscow Aviation Institute, Voronezh State Technical University, Institute of Electronic Engineering and Instrumentation of Yuri Gagarin State Technical University of Saratov, Baltic State Technical University "VOENMEH" D.F. Ustinov, South Ural State University, Samara National Research University, Orenburg State University, Reshetnev Siberian State University of Science and Technology, Omsk State Technical University, Amur State University), as a rule, in one speciality – "rocket systems and astronautics". Moreover, the knowledge obtained in them lags even behind the existing technological development.

The declared goal of achieving excellence and leadership in the development of artificial intelligence generates a bias towards the training of IT specialists, while the material spheres of production, which includes the space industry, remain outside the attention of state policy. As a result, there is an acute shortage of senior and middle-level personnel for industrial enterprises, an overabundance of specialists in the distribution chain and, consequently, youth unemployment.

This is a serious problem, since every year tens of thousands of graduates leave educational institutions of various levels, who are trying in vain to find a job in their chosen major. Speaking about the classification of youth unemployment, it should be noted that it depends on educational programs. Thus, among those who graduated from higher education programs, 13.8 % of men and 11.5 % of women become unemployed. The highest value of this indicator was recorded among graduates of secondary vocational education programs (15.8 % of men and 14.5 % of women) and training programs for skilled workers and employees (15.3 % of men and 22.2 % of women) [1]. This statistics is catastrophic for our country [2].

Young people are less often choosing working professions, building a career in other areas, changing the major received at a college or technical school, due to the absence of demand in the market and the lack of job security after graduation. In addition, today there is no longer a rigid link between education and production, often undergraduate training in higher education institutions is nominal in nature, and students of technical colleges in rare cases, before graduation, apply their knowledge in practice outside of educational laboratories, if such have been preserved.

Let us review the reasons that prevent Russian graduates, which include young people trained in engineering

specialities (in particular, for the rocket and space industry), from finding a job and guaranteeing a comfortable life, as well as benefiting society with their work activities.

Personnel Problems in the Space Industry of the Russian Federation

Competitiveness and successful development of the space industry directly depend on innovations and new technologies, the decline of which is recorded in the Russian Federation. This trend was the reason that the country began to lose its leadership position in the international arena, taking in 2022 (based on the results of seven months) the third place in terms of the number of launches of space rockets [3]. China and the United States were ahead again.

Obviously, the success of competitors is due not so much to technology as to the activities of scientists. Here it is extremely important to note the contribution of young scientists and inventors to the development of the industry, because they are the main source of innovative ideas and technologies [4].

Unfortunately, in the last decade, the departure of promising personnel abroad has increased, despite attempts by the authorities to stop it. Young people leave mainly for the United States and the countries of the European Union [5]. Innovations depart along with scientists, which, in turn, leads to stagnation in the Russian scientific and industrial complex.

Forbes magazine provides the following statistics on the number of young engineers in the Russian Federation: annually, the country produces an average of 454,000 specialists, which makes it the absolute leader among the other 124 states included in the study (does not contain data for China and India). The United States, which holds the position next to Russia, produces almost half as many engineers – 238,000. The remaining eight places from the top ten countries are occupied by: Iran – 234,000, Japan – 168,000, South Korea – 147,000, Indonesia – 140,000, Ukraine – 130,000, Mexico – 114,000, France – 105,000, Vietnam – 100,000 [6].

According to the report of the Federal State Statistics Service, only slightly more than half (about 55 %) of graduates go on to work in their profession. Considering the narrow area of expertise of rocket and space specialities, it is safe to say that this percentage is even lower among them [7].

Thus, the rocket and space industry is experiencing a shortage of qualified personnel. One of the most important factors that reduce the prestige of engineering and technical professions, including those in the area in question, is the low level of wages at the beginning of the career, therefore in Russia there is an outflow of such specialists to other industries [8], which, unfortunately, are not related to the real sector of the economy and are subject to deep transformation under the influence of market mechanisms.

Transformation of Economic Sectors

A very fast and chaotic transformation of economic sectors is currently taking place. Due to the constant emergence and destruction of economic ties, the spontaneous distribution of investments in more profitable industries (computer technology, manufacture of clothing, internet trading), the lack of a single goal for the development of the state economy, professions are constantly disappearing and new ones are emerging, sometimes not requiring knowledge and skills to work in material production sectors, which are the basis of any economy.

With the development of information technologies, the products of which parasitize on the surplus value created in the sphere of material manufacturing, the emergence of a number of new professions servicing the IT sphere is predicted. The professions of the future, according to the futurists from the Russian Agency for Strategic Initiatives, include a time manager, a game master, an operator of medical robots, an urban gardener, an eco-leader, an eco-auditor, a digital waste disposal operator, an operator of automated agricultural machinery, a cross-logistics operator, a clothing processing specialist, a cryptocurrency bank operator, an augmented and virtual reality engineer, a cross-cultural communication manager, a robotics concierge (in tourism) [9]. These professions have nothing to do with the real sector of the economy, which provides people with material benefits: they are not strategically important for the life support and sovereignty of the country, since they do not produce products (do not perform work, do not provide services) that are strategically important for the defense capability and security of the state, protection of morality, health, rights and legitimate interests of citizens of the Russian Federation.

By defining the development of digital technologies and artificial intelligence systems as one of the priority areas for achieving leadership in this domain [10], the development of other industries is disproportionate, including the space industry, for which information technology performs only an auxiliary function.

Implementation of a Dynamic Interindustry-Intersectoral Balance Model to Ensure Full Employment Among Youth

It is worth reminding that in order to achieve space, and hence industrial leadership, it is necessary to restore and increase the volume of industrial production. We are talking here about the entire industry, since its sectors are linked into many production chains that serve the implementation of strategic space goals.

To bring the labor market in the segment of graduates of technical schools and colleges from the Brownian motion to the trajectory of ensuring full employment, as well as to supply the space industry with highly qualified personnel of various levels, it is necessary to change the approach to the strategic planning of the economy. First of all, it is required to outline the goal – the growth of the social product, which is created only in material production and entails the growth of the public good. After setting the goal, there will be a need to determine the capabilities of sectors, including the space industry, to achieve it, which involves calculating the availability of labor resources in the sectors.

There is already a tool capable of doing such calculations. It was created at the Department of Strategic Planning and Economic Policy of Moscow State University. This is an artificial intelligence system built on the basis of the dynamic interindustry-intersectoral balance model (DIIBM) and using cybernetic feedback from all business entities. Unlike predictive mathematical models, which suffer from a number of errors due to the incompleteness and insufficiency of the statistical data used and the formalization of the algorithms, the DIIBM has strict requirements for the collection and processing of information, complex algorithms that describe the actions of all participants in economic relations. As an example, the Figure below shows the logic of calculations of the DIIBM for solving the problem of optimizing air transportation. The principle and architecture of neural networks may not be useful here; perhaps the work of programmers will be needed to create a fundamentally new approach, architecture, code and programming language.

With the help of algorithms of iterative balance calculations according to the real-time model, the correlation of professional training opportunities with the requirements of the space industry and other sectors of the economy is achieved under the condition of full employment, which is incorporated in the DIIBM [11]. Within the framework of short-, medium- and long-term plans, created on the basis of the DIIBM, there is a coordination of the volumes and directions of training in various majors in vocational training institutions and the number of employees in the respective enterprises. The dynamic model covers all sectors of the economy: industrial and non-industrial ones.

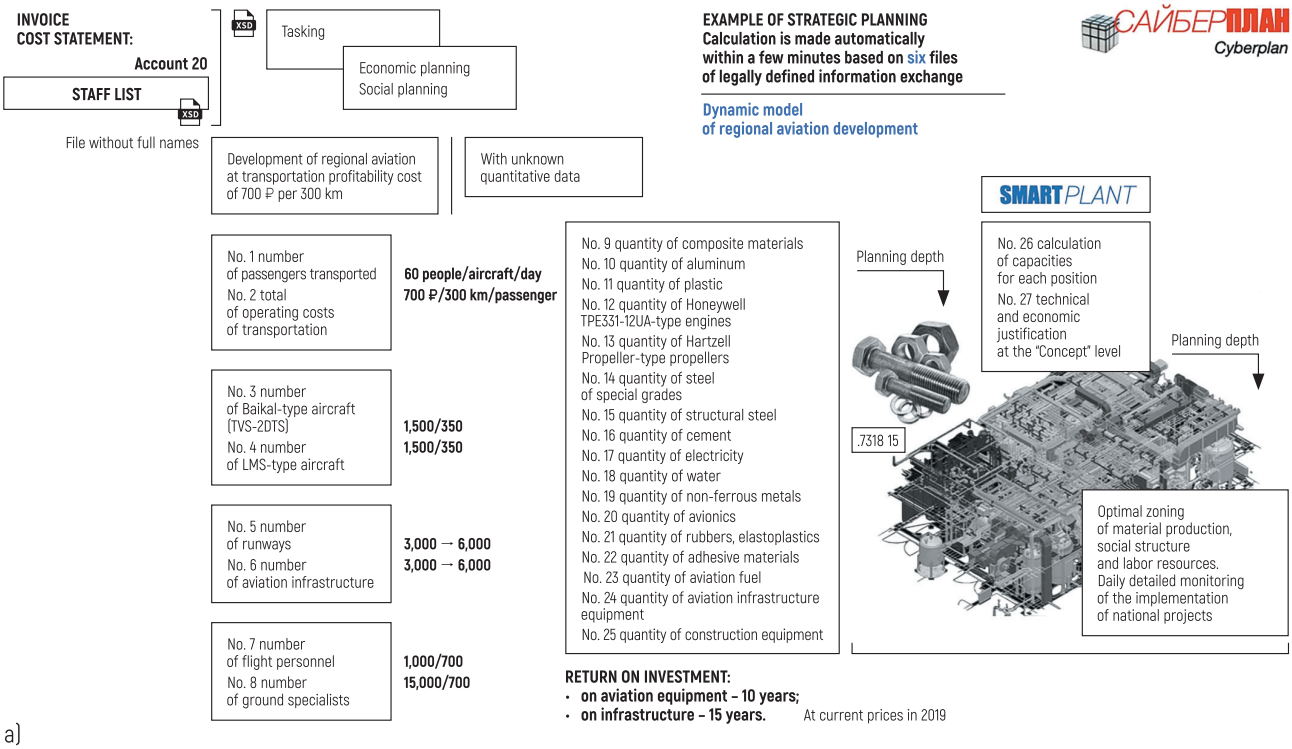
Thanks to such planning, it is possible to increase the interest of young people in professions in demand by the space industry through social support too – a kind of investment in labor resources: providing housing for young professionals, free programs for advanced training and additional professional education, direct financial support for young families, development of the general level of culture and morality, etc. The costs of these activities are also included in the model and calculated in accordance with the strategic objectives of the state and feedback from citizens.

Such calculations in the context of secondary vocational and higher education are especially necessary for managers of industrial enterprises and other business units related to the space industry, as they must be sure that, while planning their activities for the short-, medium- and long-term, they will receive from higher and secondary vocational education institutions the required number of personnel ready for qualified work, requiring not retraining, but an organically built mentoring system at an industrial enterprise. Since planning according to the model is alive, the issue of retraining in a major is solved much easier and faster than using modern predictive models.

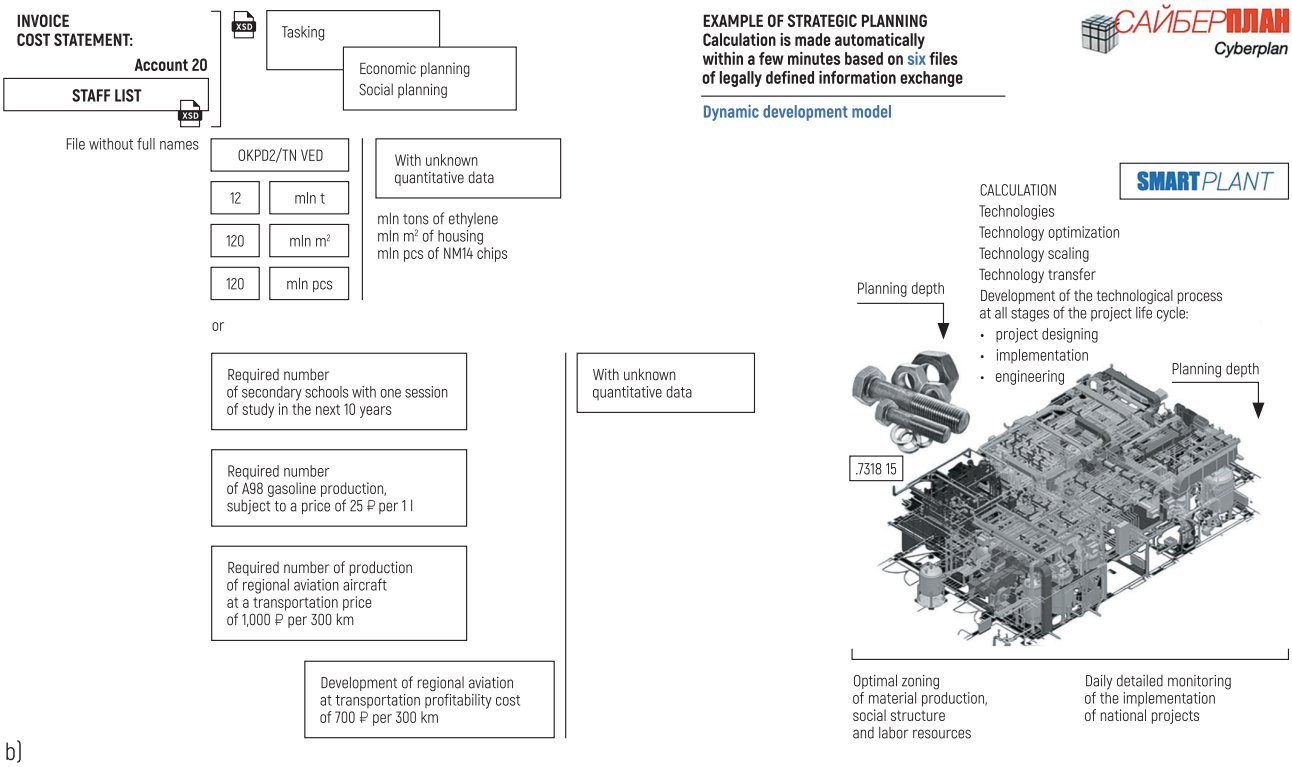
Conclusions

The answer to the question "What should education be like for the space industry in the 21st century?" is the following statement: one that will provide the state with leading positions in the study and exploration of outer space, comprising those with the help of non-rocket geocosmic systems [12]. To win the designated positions, it is necessary to restore and develop all segments of industrial production on the territory of the Union State, including the use of domestic robotics and automation systems.

If the state sets further space exploration as one of the strategic goals, automatically there will be a need for planning, which can only be carried out with the help of DIIBM. Competent planning will comprehensively provide economic entities engaged in the implementation of the space goals of the Union State with employees of the required qualifications, and provide young professionals, who have received specialized education, with high-quality jobs, which will give them confidence in the future.



a)



b)

Figure – The logic of the DIIBM calculations for solving the problem of optimizing air transportation:
a – the logic of the dynamic model in the problem of developing regional air transportation;
b – the logic of setting tasks in the calculations of the dynamic model

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