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Research paper

Prospects of the development of aerospace complex of Ukraine in conditions of a new industrial revolution and integration with the European union

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Abstract

The article examines the state of aerospace activity, the prospects of development and directions of increasing the competitiveness of aviation, rocket and space technology in the countries of the world and Ukraine in the context of the new industrial revolution and Ukraine's in-depth integration with the EU. It has been established that today both the aviation industry and the rocket and space complex of Ukraine need to change the priorities of development, reorganization, restructuring. There also exists the need for significant investments in order to modernise the production on the basis of advanced production technologies of the new industrial revolution (Key Enabling Technologies / Advanced Manufacturing) together with converged technologies. It is proved that considering the interests of Ukraine's national security under conditions of increased military threat, the air-space industry may, after a certain modernisation, play a leading role in the creation of a defence shield of the state. It is recommended that the Consultative working groups of the National Academy of Sciences of Ukraine, academic institutions and independent experts should be involved in forecasting and clarifying the priorities of the development of Ukraine's aerospace complex in the context of its integration into the world and European aerospace.

Keywords: *Aerospace Technology; Rocket and Space Technology; Aerospace Activity; New Industrial Revolution; European Integration of Ukraine.*

1. Introduction

Today, virtually all developed countries of the world are reviewing their opinion on the role of industry as the main tool of economic growth and see convergent technologies as the main tool to solve major global problems, to significantly accelerate the development of the social sphere and to raise it to the leading edge. The indicated problem is also acute for modern Ukrainian economy, especially in the context of association with the EU. As a result, many researchers are involved in studying the key factors of the new industrial revolution, the problems of meeting the level of development of the country's scientific and innovative potential with the requirements of this revolution, as well as prospects for the use of breakthrough innovative technologies of the 21st century, in particular: R. Freitas, M. Roco, W. Bainbridge, A. Ross, K. Schwab, N. Rambidy, V. Balabanov, M. Kovalchuk, G. Azoyev, Y. Golovin and others. [1-8]. At the same time, the study of modern development of aerospace activity (ASA), as well as the aircraft industry and rocket and space technology in Ukraine in the context of the new industrial revolution and integration with the EU needs further detailed study.

2. Prospects of the development of Ukraine's aviation industry in modern conditions

The current trends in the development of the world aviation industry (AI) of the 21st century are due to the following features: (1) increasing requirements for new aerotechnics (AT) and its functional capabilities as means of transportation and armament; (2) increasing complexity of AT, in the process of which creation advanced achievements in science and technology are accumulated (aerodynamics, gas dynamics, thermodynamics, materials science, construction mechanics and strength, radio electronics, technology of aircraft engineering, precision engineering, computer science, nanotechnology, etc.); (3) increasing requirements for flawlessness, reliability and durability of AT, for the working conditions of crew and comfort of passengers; (4) increasingly stringent requirements for ecological exploitation of AT and reduction of its negative impact on the environment; (5) high capital intensity of scientific research and development of new samples, preparation of production, serial production and maintenance of AT in operation; (6) considerable complexity of the serial production of AT and the associated increasing requirements for the quality of aviation products; (7) relatively low profitability of production (no more than 15%), which determines the return on costs only for significant sales of AT; (8) high energy prices on the world market [9-11].

These features in aggregate have led to the fact that in the world AI, processes of globalization were much more active than in the other sectors of the economy. In this context, the current development of the world's AI, as pointed out by V. Kupriyanova, has the following general tendencies: "... (1) the national consolidation, which was discovered in the merger or takeover of competitive companies, the reduction of independent producers, the formation of powerful national groups – consortia, corporations, concerns, reflected in the reduction of surplus production capacity; (2) the

expansion of cooperation and transnational integration found in the creation of large international associations able to develop and implement international systems and programs; (3) large-scale reorganization and restructuring of production, identified in the desire of the leaders of the world aviation industry to reduce costs due to rational changes in AT manufacturing technology, the introduction of new concepts of design and production, reduction of employment; (4) a significant feature of the current stage of the evolution of aircraft construction is the full use of modern information technologies throughout the life cycle – both at the production stages of the AT life cycle, and during its operation and maintenance; (5) the transfer of a significant part of the AT production as a whole, as well as aggregates, assemblies and component parts closer to promising markets is expressed in the desire of the leaders of the world aviation industry to meet the needs of promising capacious markets through the reorganization of service centres, as well as joint production on the basis of modern technologies" [10, p. 18-19, 11]. As a result of mergers and acquisitions, the number of leading manufacturers in the respective sectors of the market of aircraft significantly decreased. Thus, in the passenger airplanes sector, there are only two manufacturers left – the Boeing company and Airbus S.A.S., which have almost equally shared this sector of the world aircraft market [11, p. 38]. There are five leaders in the regional aircraft sector: Canadian Bombardier Inc., Embraer S.A., ATR European Consortium, Fairchild Dornier, mixed capital company, and Chinese CATIC. There are small producers on the market, but the market share of each of them does not exceed 10% [12].

Table 1 shows the forecast data of the named companies by 2026. The analysis shows that machines with a capacity of 60-100 seats will be in the greatest demand.

Table 1: Regional Turbojet Aircraft Market (Bombardier, JADC, Embraer, Airbus, Boeing Up to 2026) [13]

Number of seats on the aircraft of a certain manufacturer	The regions of the world			
	Europe	Western America	Asia Pacific (along with China)	Latin America, Africa, Middle East, CIS and others
60-99 seats Bombardier	1962	666	972	472
60-99 seats JADC	1960	901	956	385
61-90 seats Embraer	1445	620	395	490
70–85 seats Airbus	1016	907	370	491
50–98 seats Boeing	1880	450	630	740
Average value	1653	709	665	516

Table 2 shows delivery of passenger airplanes to the world regions according to Airbus forecasts by 2026 [13].

Consequently, the main tendencies of the development of the world aviation market are the increase in the supply of new aircraft and the growing rates of old AT disposal, the concentration of orders for new aircraft in a limited number of end-users, the globalization of markets, the need to provide high deductions for R&D (12-15% of output). More than 25 years ago, Ukraine had a developed AI, which now covers 72 enterprises of different forms of ownership and intended purpose, which employ more than 96 thousand people, and have virtually all components of the infrastructure that allow the development and construction of aircraft, aircraft engines, aircraft weapons, on-board radio-electronic equipment, aircraft units, carrying out research and development work in the field of technology of production and operation of AT, preparing personnel for work in the AI [11, 15, p. 259]. At the same time, under market conditions there was shrinkage in the volume of production of aviation products, the number of workers decreased for more than five times.

Table 3 shows data on the reaction of AT producers in Ukraine to change the conditions for the period from 1992 to 2014 [16-18].

At the same time, as the analysis shows, the exhaustion of the resource of the existing aircraft park operated by the airlines of Ukraine led to the decommissioning of aircraft An-24, Tu-134, Yak-40, mainly in 2005; in 2009 IL-76 terminated its flights, and in 2014 An-12 exhausted its last resource [11], [16-16].

Currently, Ukraine continues to accumulate problems in aircraft construction: (1) reduction in production, which, due to the preservation of surplus capacity, leads to a rapid increase in prices for domestic AT and its maintenance services; (2) enterprise profits do not allow effective implementation of programs of technical re-equipment; (3) single and small-scale production of componentry products at supplier enterprises also leads to a significant increase in prices of products, a decrease in economic interest in production, as well as to the termination of the production of components at the enterprises-subcontractors (also as a result of the termination of trade relations with Russia). In addition, failure to implement the "State Integrated Program for the Development of the Ukrainian Aviation Industry by 2010", failure to take into account the main provisions of the Strategy for the Development of the National Aviation Industry for the period up to 2020, chronic underfunding of the industry, the impact of other factors negatively affect the potential of the Ukrainian AI and the plans for the serial production of planes [19-21].

Thus, the high-tech aviation industry of Ukraine's economy is in a state of crisis: it needs reorganizing, restructuring, and large investments (up to USD 600 billion) to modernize the production base. Ukrainian aviation industry as a whole has lost its competitive advantages and due to relatively small volumes of production, today is not the locomotive of economic growth of the country as a whole. In order to overcome the abovementioned negative tendencies in the AI of Ukraine, it is necessary: (1) to ensure the transition of Ukraine's aircraft construction to new technologies through the differentiation of production, elimination of duplication and concentration of finishing processes on technological platforms with potential for growth; (2) to solve the problem of reducing production costs; (3) to increase productivity, quality and competitiveness of products (by introducing new technological processes at specialized production sites); (4) to increase production to a level that ensures the preservation and development of the industry [10], [22-24].

Table 2: Delivery of Passenger Airplanes to the World Regions According to Airbus Forecasts by 2026 [13].

Number of seats on planes	The regions of the world							
	Africa	Pacific region	CIS	Europe	Latin America and the Caribbean	Middle East	North America	Total
50 seats	80	352	78	590	183	19	1 264	2 566
70–85 seats	168	461	298	873	164	43	1 580	3 587
100 seats	174	219	85	617	237	63	976	2 371
125–210 seats	473	4 152	455	3 568	975	392	4 234	14 249
Small with 2 passages	153	1 368	78	929	196	410	733	3 867
Medium with 2 passages	53	781	27	341	24	162	227	1 615
Big	27	711	11	274	16	157	87	1 283
Total:	1128	8044	1032	7192	1795	1246	9101	29 538

Table 3: Dynamics of Airplanes Manufacture in Ukraine for the Period of 1992-2014, Pcs. [11, 16–18]

Indicator	Year																					
Military	47	14	2	7	2	2	1	*	*	3	*	*	1	2	*	4	4	*	1*	2-	1-	*	*

transport An-32																		*	plane**	plane**			
Cargo-passenger An-74	7	1	1	*	2	3	5	4	4	1	1	1	*	*	*	*	*	1	*	*	*	*	*
Transport An-124	1	1	*	*	1	*	*	*	*	*	*	1	–	–	–	–	–	–	–	–	–	–	–
Transport "Mriya"	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
Passenger An-140	–	–	–	–	–	1	1	1	1	1	3	2	3	1 – plane; 6 – aggregates				*	–	10 – aircraft kits			
Transport An-70	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	*	–	–	–	–	–
Passenger An-148	–	–	–	–	–	–	–	–	–	–	–	–	2	7 – centre wing 3 – wings				*	1	2	1	1	2	1
Passenger An-158	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	*	2	1	1	1
Transport An-178	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	fuse-lage
Instruc-tional HAZ-30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	*
Total ag-gregates and kits	*	*	*	*	*	*	*	*	*	*	*	*	*	17	6	*	*	*	*	* / 11				
Total air-craft	55	16	4	7	5	6	7	5	5	6	4	4	6	3	–	4	4	2	2/1 **	4 / 16 **	4 / 5 **	6	2

Marking: « – » not produced; * - information missing; ** - repair and upgrade for Indian Armed Forces.

The lack of a well-balanced state strategy for the development of the aviation industry, its substantial support and insufficient control over the current activities of Ukrainian aircraft and rocket-building enterprises have led to significant loss of competitiveness, emergence of the state of 'over-critical insolvency' and loss of prospects for this time. Without targeted government support, the aircraft industry has no prospect of getting itself out of crisis and finding internal development opportunities.

Taking into account the interests of Ukraine's national security and preservation of its intellectual potential, it is necessary to ensure the functioning of this branch of economy on any scale, first of all, providing widespread introduction of the latest NBIC-technology into the production of modern competitive aircraft.

The most promising examples of the latest developments of the DB "Antonov" are model range An-158 ... 178, An-132 as well as An-70, which use avionics and components of the developed crane. Moreover, the conflict in the east of Ukraine caused an urgent need for the development of unmanned aerial vehicles (UAV) and its own light helicopter, which has already prepared draft state programs for conducting the necessary research and further production of the indicated equipment. At the same time when creating UAV, a large number of leading high technologies were used, including: (1) modern structural materials (especially composites) using nano-coating; (2) multiprocessor data collection and storage systems; (3) the theory of automated control as a branch of cybernetics in conjunction with the theory of information transmission, encryption, archiving of data; (4) means and systems of space communication; (5) Earth remote sensing technology (radar, optoelectronic systems, multispectral sensors); (6) alternative energy technologies in high-capacity accumulators, solar energy converters, fuel cells; (7) means and systems of navigation using the automatic dependent observation; (8) geographic information systems [25-30]. Potential in the transition to modern production technologies, including the use of converged technologies, can turn aircraft construction into one of the most interesting features of Ukrainian economic future.

In early April 2018, the Ministry of Economic Development and Trade of Ukraine directed a draft Strategic Plan for the revival of aviation industry until 2022 for the Government's consideration. It includes seven points of support for the industry, which concentrates almost all components of the infrastructure that allows the development, testing, serial production of airplanes and propellers, aviation engines, special equipment, on-board radio-electronic equipment, aircraft units. It also enables carrying out modernization and repair of aviation engineering as well as training of highly skilled specialists. In support of the whole Ukrainian aircraft industry, Ukrainian officials are planning to transfer funds from the state budget in the amount of UAH 7.5 billion during the next five years. Moreover, in 2012, involved ministries and departments of Ukraine, together with leading enterprises of the industry, created a draft state target scientific and technical program for the development of aviation industry, which was supposed to direct a huge amount of money for its implementation; at that time, this amount made more than 8 billion dollars [31]. As one can see, there is a significant difference in numbers.

Today, in conditions of spreading technology and organizational principles of the new industrial revolution, the development and technical modernization of the airline industry is one of the main trends for technologically developed countries. Thus, the leaders of the world aircraft industry in the United States, EU countries and even Brazil and China have succeeded in the aircraft market thanks to state preferences and reinvestment in the development of aviation industry from state budget funds. In order to finance the development of its own aircraft, the Brazilian Government has directed lending resources in the amount of 20 billion dollars in recent years, with the establishment of a loan rate of 3-3.5%. Canada stimulates the development of aviation by funding RTD from the state budget, providing state guarantees, insuring receivables, providing marketing support, and in some cases by financing export operations. In the USA over the past 20 years, state subsidies for the industry have amounted to over USD 25 billion. And this is with the existence of federal and local privileges for the aircraft industry. In Ukraine, for all years of independence, the state has not provided financing for the preparation and launch of a full-scale mass production of aviation equipment. That is why today mass production of passenger aircraft is isolated, and assembly production is unprofitable [31], [32].

On May 10, 2018, the Cabinet of Ministers of Ukraine, on the initiative of the Ministry of Economic Development and Trade, approved the Strategy for the revival of Ukrainian aircraft construction up to 2022 [33]. Among the solutions proposed by the Strategy for the revival of Ukrainian aircraft construction are: (1) optimization and modernization of 'An' aircraft production, (2) modernization and production of 'Mi' helicopters, (3) import substitution of components from the Russian Federation, (4) structural reform of the aircraft industry enterprises. The strategy will be

implemented in the following areas: support of the national producer; increase in competitiveness of products of aviation engineering; structural changes, in particular privatization of enterprises, creation of integrated management structures of the industry; development of new aircraft and helicopters and modernization of existing types of passenger and transport aircraft, helicopters, modernization of existing types of aviation engines, and development of new aviation engines and other aviation equipment that will be in demand on the market; restructuring, modernization and technical re-equipment of production capacities of serial aircraft construction enterprises, centres of basic technical maintenance and repair of aviation engineering of Ukrainian production; creation of fundamentally new technologies, their means of realization and their further introduction into the serial production at the enterprises which construct aircraft, aviation engines, aggregates and systems or produce carbon composite materials, other samples and components of aviation equipment; creation of favourable conditions for the implementation of aircraft technology, introduction of effective schemes for its sale, in particular, using leasing schemes. As a result of the Strategy implementation, it is expected (1) to develop new models of transport aircraft, helicopters, unmanned aerial vehicles, as well as to modernize existing models of passenger and transport aircraft and helicopters, (2) to improve the quality of aircraft production to the level of the best world analogues, as well as to introduce international product certification systems, (3) to expand cooperation between the public and private sectors, and create favourable conditions for attracting investment in aircraft building [32], [33].

3. Development and prospects of adaptation of Ukraine's rocket and space complex to the conditions of the new industrial revolution in the context of association with the EU

The other side of the ASA is space activity (SA), which in recent decades has turned into an extremely beneficial business, in particular: (1) the whole world connects the systems of information transmission with the help of space systems; there is a need for launching hundreds of orbital objects; (2) not only developed countries are trying to launch their satellites, but also those that have only recently begun to engage in SA; (3) satellites are required to search for minerals, control the movement of planes, ships, cars, for environmental monitoring, etc.; (4) International Space Station with the permanent presence of people for the maintenance of which space transport systems are required; (5) space tourism is becoming increasingly popular.

In the generalized form, the basic conditions that the strategy of space activity development has to consider in the 21st century are given in Table 4, and the interdisciplinary forecast of development (optimistic scenario) of aerospace activity in the XXI century, based on four main and interrelated aspects (technical, social, social-natural and universal-evolutionary) are given in Table 5 [34, p. 277-295].

Table 4: The Basic Conditions That the Strategy of Space Activity Development Has to Consider in the 21st Century [34, P. 277-280]

The main aspects that the strategy of SA should take into account	New approaches, trends and forecasts	The most acute earthly problems of security and development	Priorities of socio-natural development
• goals, interests, needs of man, society, state, etc.; • opportunities, limitations and potential of the SA sphere; • socio-natural problems and restrictions in the era of globalization; • socio-political, socio-ecological, socio-cultural, economic, military and other problems and consequences of SA; • the need for new "rules of the game", primarily to ensure global security, development of extra-terrestrial natural resources and environmental protection; • asteroid-cometary danger, the need to protect; • problems of interplanetary flights, studies of Mars and other objects of the solar system, etc .; • opportunities and potential of new technologies (space technology, nanotechnologies, ecotechnologies, etc.)	• modern scientific picture of the world, evolution of the biosphere, global environmental problems, concepts of socio-natural development, systematic approach to the classification of disasters, etc.; • slowdown of growth and stabilization of the population of the Earth at the level of about 12 billion people, eliminating the need for mass resettlement outside the Earth, limiting the need for extraterritorial resources and SA; • near-ground extracurricular resources on the Moon and Mars make up about 11% of Earth's resources, therefore, under existing technologies (SA, transport, energy, ecological, etc.) one is not able to solve actual earthly problems; • passing under the current conditions of the main material production from the Earth (in the near-Earth space, on the Moon) is unlikely and inexpedient; • Pilot flights to Mars are too risky, cost-effective and too politicized; • it is expedient to preserve the Earth, to develop the near-Earth space, the Moon, the space of the heliocentric orbit of the Earth and its vicinity, limiting the resource requirements and the harmful impact on the environment	• provision of humanity with clean drinking water, ecologically safe food, affordable and decent housing, medical care, quality education; • continuous introduction of environmental technologies (based on biotechnology), eco-innovations, primarily waste treatment facilities and technologies; • conservation of the environment, natural ecosystems, natural and cultural heritage	• modernization, ecologization and adaptation of technology, the entire sphere of the SA taking into account socio-natural aspects and constraints on the basis of new knowledge and technologies; • achievement of the optimal balance of earth activities and SA, further development and expansion of SA taking into account social, ecological, economic and other problems, opportunities and constraints; • ineffective research, the use of near-Earth space, including the Moon, for the conservation of the biosphere, the entire Earth and the sustainable development of mankind; • acceleration of the creation of a system of protection of the Earth from dangerous space objects (asteroids, etc.) and other phenomena; • obtaining new knowledge about man, society, technology, the Earth, the solar system, the galaxy and the universe, creation of the potential and conditions for further space development

As indicated by S. Krichevsky, the technical aspect of the ASA predictive development in the current century includes: (1) intensive and balanced development of aerospace technology, including aeronautics and other types and industries in cooperation with other sectors and fields of activity; (2) maximum satisfaction of the growing needs of man and society, with full coverage of the ASA surface and the atmosphere of the Earth and near-Earth space; (3) comprehensive (deep) environmentalization of aerospace technology and activities; (4) a radical increase in the effectiveness of aerospace technology and activities, the level of flight safety and safety of all ASA; (5) creation of integrated national, international (interstate) air defence systems; (6) establishment of asteroid impact avoidance (AIA) with the protection of the Earth, and in the future - the entire near-Earth space (including the Moon and space up to 1 million miles from Earth), the real use of AIA to counteract asteroids threatening Earth (7) creation of a permanent international research base – Solar Space Station, which is piloted on a heliocentric orbit at the point of Earth's libration – the Sun (~ 1.5 million kilometres from the Earth); (8) creation of a system of permanent scientific bases and settlements on the Moon; (9) an expedition to Mars, creation of a permanent scientific base and the beginning of Mars colonization; (10) creation of fundamentally new (including individual and massively available) means, technologies for rapid, economic, safe movement in the atmosphere of the Earth and near-Earth space; (11) creation of effective systems of life support and protection of the person from dangerous factors of flight and other negative influences and consequences of ASA, achievement of a radical continuation of healthy and active life of a person (people of dangerous occupations of ASA sphere, etc.), realization of technologies of transition to autotrophic food, permanent life of people outside the Earth, including reproduction; (12) the search for extra-terrestrial civilizations, traces of their activities, including the possibility of real contact with civilizations 'of extra-terrestrial origin' [34, p. 288-289].

Table 5: Interdisciplinary Forecast of Development (Optimistic Scenario) of Aerospace Activity (ASA) in the XXI Century [34, P. 288–295]

Technical aspect 1	Social aspect 2	Socio-natural aspect 3	Universal-evolutionary aspect 4
• intensive and balanced development of aerospace technology, including aeronautics and other types and industries in cooperation with other sectors and fields of activity; • maximum satisfaction of the growing needs of man and society, with full coverage of the ASA surface and the atmosphere of the Earth and near-Earth space; • comprehensive (deep) environmentalization of aerospace technology and activities; • a radical increase in the effectiveness of aerospace technology and activities, the level of flight safety and safety of all ASA; • creation of integrated national, international (interstate) air defence systems; • establishment of asteroid impact avoidance (AIA) with the protection of the Earth, and in the future - the entire near-Earth space (including the Moon and space up to 1 million miles from Earth), the real use of AIA to counteract asteroids threatening Earth; • creation of a permanent international research base – Solar Space Station, which is piloted on a heliocentric orbit at the point of Earth's libration – the Sun (~ 1.5 million kilometres from the Earth); • creation of a system of permanent scientific bases and settlements on the Moon; • an expedition to Mars, creation of a permanent scientific base and the beginning of Mars coloniza-	• solving two problems with the help of the ASA: security and development of society on Earth and creation of society outside the Earth ("Humanity-2"); • creation and implementation of the general "rules of the game" (legislation), a unified strategy and management system for the whole sphere of the ASA (including aspects of human rights, security, sustainable development on Earth and in space) at the national and international levels, integration with the International Space Aviation Agency under the UN auspices (similar to IAEA); • mass and effective use of the results of the ASA to meet the complex human needs in society, the transition to environmentally safe and balanced development on Earth and beyond Earth; • the mass availability of safe collective and individual movements, travel throughout the Earth, throughout the Earth's atmosphere in the near-Earth space (including the Moon) using technology and infrastructure of the ASA sphere; • creation of the World Association of "Space Volunteers" with the status of the official international structure ("Humanity-2") under the jurisdiction of the United Nations, the phased implementation of the projects of resettlement outside the Earth, the creation of a system of settlements with a permanent population in the near-Earth space, on the Moon, the first settlements in the	• development and implementation of an adequate strategy of ASA in the leading countries of the world on the basis of the socio-natural (convergent) concept, aimed at preserving the biosphere and the transition to an ecologically sustainable development of society in the co-evolution of the environment, the rational use of nature and the protection of nature on Earth and beyond the Earth, in all around Earth space as a global megaecosystem; • creation and implementation of adequate "rules of the game" (legislation), a unified system of international standards for the ecologization of all aerospace technology and activities in the full life cycle, on Earth and in the Cosmos; • elimination of environmental problems of ASA on Earth and near-Earth space (clearing and elimination of areas of falling missiles, elimination of 'kerosene lenses' in airfield and airport areas, clearing of near-Earth space from 'space debris', etc., including combustion firings in the Earth's atmosphere of large fragments of spacecraft, space debris, the prohibition of their dumping into the ocean, etc.); • creation of adequate "rules of the game" and realization of the concept of "rights of nature" at the national and international levels, on the Earth, the atmosphere of the Earth and near-Earth space (in the scale of the entire solar system) in the sphere of the ASA; • creation under the auspices of the UN of a unified system of natural territories and protected areas on Earth and beyond the Earth in the geospatial space in the regions of the Northern and	• aerospace technology, methods, means of activity, production used by the ASA sphere, realize the transition of humanity to ecologically safe (balanced) development, access to the trajectory of universal evolution and its further movement; • the scope of the ASA, as an important part of the activity and the component of society, in interaction with other spheres as a super-purposeful and final product, recreates society not only on Earth but also outside the Earth, being the leader and locomotive of human expansion into near-Earth and outer space; • the sphere of ASA produces a new 'extra-terrestrial' society, reproducing the extra-terrestrial higher intelligent life from the highest terrestrial life and society, using the resources and potential of earthly civilization, creates new socio-natural systems (the habitat), including a new social structure, technical infrastructure and components of the natural environment in an extra-terrestrial environment (in the near-Earth space, on the Moon, in the heliocentric orbit of the Earth, on Mars); • beginning of the creation of a mega society with the coverage of civilization on the Earth and new independent communities ("Humanity-2", etc.) outside the Earth.

tion; • creation of fundamentally new (including individual and massively available) means, technologies for rapid, economic, safe movement in the atmosphere of the Earth and near-Earth space;		Earth's heliocentric orbit.	

Continuation of Table 5

1	2	3	4
• creation of effective systems of life support and protection of the person from dangerous factors of flight and other negative influences and consequences of ASA, achievement of a radical continuation of healthy and active life of a person (people of dangerous occupations of ASA sphere, etc.), realization of technologies of transition to autotrophic food, permanent life of people outside the Earth, including reproduction; • the search for extra-terrestrial civilizations, traces of their activities, including the possibility of real contact with civilizations 'of extra-terrestrial origin'		South poles of the Earth (the Arctic and the Antarctic) and above them, in the future – in all around space, on the Moon, Mars, Venus, throughout the solar system – "space reserves"; • the introduction of a ban (moratorium) on the terraformation of Mars, Venus and other planets of the solar system, that is, 'man', society, technical infrastructure must 'fit' in with the natural environment, but not a planet must 'fit' in with man.	

In the modern world space goods and services market, there is a process of active development of low-orbit satellite systems of various purposes, which can be divided into three main segments: (1) satellite communication systems (telecommunications, telephone communication, e-mail, etc.); (2) remote sensing of the Earth (operational observation, meteorology, search and rescue, etc.); (3) scientific research (astronomy, study of near-Earth space, geology, microgravity, space technology, etc.) [35], [36].

Today, the development of the market for space launchers is rapidly changing along with the concept of the market for spacecraft, that is, there is an inextricable link between these two segments of the high-tech rocket and space industry. This market is characterized by excessive rockets offered for launching commercial cargoes and by fierce competition due to the cost of multiple carrier rockets and the ability to develop new technical solutions. In addition, the situation was affected by the growth of the resource and reliability of the apparatus: now the spacecraft in orbit fail many times less than anticipated, and therefore, there is no sharp need for their replacement [36]. The trend to reduce the number of launchers worldwide is very clear and will continue until the need for the launch of the next group of low-orbital communications satellites or groups of communications satellites of the new generation appears [37].

Thus Table 6 shows data on the number of launched communications satellites and transponders in 1991-2000, 2001-2010, as well as in 2011, 2012, and 2013 [38], [39].

Table 6: The Number of Launched Satellites and Transponders in the Period of 1991-2013 [38], [39]

Year	1991 – 2000	2001 – 2010	2011	2012	2013
Number of launched satellites	302	185	20	24	16
The average number of spacecraft in 10 years	30,2	18,5	-	-	-
Total number of transponders	5436	6936	836	1144	810
Average number of transponders and spacecraft	18	37,5	42	48	51

Today, development of rocket and space technology (RST) is constrained by the high cost of bringing the goods to orbit, and therefore, reducing mass characteristics of its products (reducing the mass of the spacecraft by 1 kg provides an economic effect of about USD 20 thousand) together with ensuring their functional properties is one of the main problems of the production of RST. As a result, nanotechnology and NBIC-technology in general are increasingly used in rocket and space technology.

Table 7 shows perspective directions of using nanotechnology in aviation and rocket and space technology [40], [42].

Due to the similarity of the construction principles and operation of distributed systems at different levels of the structural organization, as well as the processes and new features arising there, a number of analogies between systems constructed on the level of nanosizes and macroscopic distributed systems are revealed. The most striking example is the work being done in developed countries (first of all in the USA) on the creation of systems of pico- and nanosatellites. These systems promise a serious breakthrough in space exploration capabilities. In recent years, the possibilities of miniaturization of spacecraft have increased dramatically. Significant progress in semiconductor planar technology, the rapid development of MEMS systems and the emergence of new structural materials have led to the emergence of spacecraft in a wide weight range. In connection with this, in recent years, the classification of satellites by weight has developed. Standard satellites are called cosmic systems weighing more than 1000 kg, small ones – weighing from 100 to 1000 kg, micro – 10 to 100 kg, nano – 1 to 10 kg and a pico – less than 1 kg. Among them, the most attractive were pico- and nanosatellites on the basis of which prospective and methodologically new space research program could be developed. Usually nanosatellites are launched as additional payload. They can be located in a special compartment for additional satellites within the rails of the instrument compartment, but can be docked to a space platform that may also be the satellite itself. Recently, they are developing standard space platforms, that is, those that would fit a number of different carrier rockets, and they would be able to accommodate a large number of satellites. compartment for additional satellites within the rails of the instrument compartment, but can be docked to a space platform that may also be the satellite itself. Recently, they are developing standard space platforms, that is, those that would fit a number of different carrier rockets, and they would be able to accommodate a large number of satellites.

Ukraine belongs to the cosmic powers not only by the characteristics of space potential, but also by the level of ability to practically realize modern space projects, in particular the unique international project "Sea Launch". After the abandonment of nuclear weapons, modern space technology is one of the few factors that determine the strategic location of the state and the availability of deterrents. Access to outer space objectively increases the importance of Ukraine in its relations with strategic partners, processes of integration into European structures. The exercise of space activities is also an instrument for implementing an active regional policy in establishing cooperation with the countries of the Baltic Sea-Black Sea region.

In 2011-2012, a number of government documents were adopted, in which the conceptual directions for the development of the space industry of Ukraine for the first third of the XXI century were approved [42, 43]. The concept of state policy in the field of

space activities for the period up to 2032 is expected to be implemented in four phases (first phase - 2011-2017, second - 2018-2022, third - 2023-2027, and fourth stage - 2028-2032 years.)

Table 7: Perspective Directions of Nanotechnologies Applications in Aviation, Rocket and Space Technology [40], [41]

Areas of application	Examples	New perspectives
• new methods of reducing the size and mass of spacecraft; • increasing the efficiency of launch systems	nanostructured materials and devices	• light, strong and heat resistant parts of airplanes, rockets, space stations and research probes for long-range space flights; • research (and production in future) in the conditions of outer space (absence of gravity, high vacuum) of nanostructures and nanosystems that can not be obtained on Earth
Development of high-quality computing equipment	computers	low-power computing and radiation-resistant
	silicon gyroscopes, accelerometers, pressure sensors, valves, microdes of energy, micro drives and microdrives	• MEMS, created on the basis of miniaturization and integration, have very good product properties for space technology: portability, high durability (extremely small masses of elements minimum vibration and inertial overloads), low power consumption, easy maintenance and replacement; • MEMS will allow to reduce the size, mass and energy consumption of spacecraft; • drives and engines created by MEMS technology will be able to provide significant forces and torques, replace conventional mechanisms and become key in the creation of micro-satellites, microprobe and microplanetwork
	systems of chemical and biological analysis	• miniaturization of bioanalytic devices, suitable for use on other planets; • instruments that include miniature capillary electrophoresis systems, DNA detectors, chemical sensors and biosensors for biochemical research
Creation of nano equipment for miniature spacecraft	• electrostatic drives as micro switches of microwave signals; high-frequency optical and mechanical filters and high-frequency keys; • optical devices based on the use of micro-mirror arrays, whose orientation can be controlled to change	• micro switches of microwave signals are promising for use in space communication systems built from picosatellites. These switches have the following benefits: low loss; high quality; low power consumption; high frequency isolation and low cost. Manufacturing of electromechanical switches on one crystal with microelectronic components allows to create systems with higher functionality; • micro switches of microwave signals are promising for use in space communication systems built from picosatellites. These switches have the following benefits: low loss; high quality; low power consumption; High frequency isolation and low cost. Manufacturing of electromechanical switches on one crystal with microelectronic components allows to create systems with higher functionality; • arrays of micro-mirrors, forming a single mirror, are used as microminating spatial modulators of light. Microdes can modulate the amplitude or phase of the incident light signal by changing the direction or length of the optical path of light. Electrostatic drives are an effective way to control the position of the micro-mirror, providing a minimum mass of product
	nanoparticles for aviation engineering	"Smart surface" with active control will be available for airplanes and spacecraft
Development of nano-sensors and nanoelectronic devices for aviation and space technology	• nano-satellite SNAP-1 modular design, weighing 6.5 kg; • microresistant engines with dimensions 12x15x2,5 mm, creating a thrust of up to 1 kg; • picosatellites of mass up to 250 g; • Planet masses of several kilograms	The distinctive feature of space technology of the future will be its structure, which, like living organisms, will have integrated into a single whole parallel and distributed tens of thousands of miniature adaptive and intelligent cells such as sensor-processor-activator. Such cells, characterized by a single principle of construction, will have specific features due to their purpose, they will differ in the set of sensors and activators, as well as the performance and type of control microprocessor. The use of such cells will significantly expand the functional capabilities of existing products of space technology, as well as create fundamentally new types of pico and nano satellites, planetary devices, devices of space designation
Creation of thermal insulation and wear-resistant coatings on the basis of nanostructured materials	coating on the basis of nanostructured materials	Thermal and wear-resistant coatings with properties that were not available for traditional materials and methods of their application.

At the beginning of 2015, as a result of the interaction between the National Academy of Sciences of Ukraine and the State Tax Administration of Ukraine, a number of important strategic results were achieved, including: (1) Sich-1 spacecraft (1995), Koronas-Foton (2001), Sich -1M "(2004)," Sich-2 "(2011); (2) program of scientific experiments for the STS-87 mission (1997); (3) the Cyclone-4 (2007), Vega (2012), and Antares (2013) projects were launched. Today's Ukrainian-made satellites occupy a small niche in the global layout of spacecraft, but they are one of the cheapest in the world. The specified circumstance should be used by Ukraine as much as possible, for example, when creating microsatellites with masses of tens of kilograms, units of pounds and less than one kilogram. To create systems based on super-satellites, the development of new technologies will be required in many areas: communication, laser systems, digital and interactive television, NBIC-technologies, computer systems, control systems based on artificial intelligence, principles of remote sensing organization, etc. [44].

Such a promising direction for Ukraine can become the basis for the construction of a multifunctional satellite grouping, which should become a national-level task for the rocket and space industry. For its effective solution, new approaches will be needed not only in the development of micro-satellites, but also in the creation and use of space vehicle carriers. In order to solve problems of remote sensing of the Earth, it is necessary to form a group of 8-10 satellites for the study of the Earth from outer space in various ranges (optical, radar, etc.) by the year 2032. In addition, the CB "Pivdenne" develops a concept for the creation of new "Mayak" carrier rockets, which involves the creation of a whole family of "Mayak" rockets - light, medium and heavy classes - on

the basis of solutions already tested earlier in the creation of the Zenit rocket and "Cyclone". The ideas embodied in the "Mayakov" implementation are used to create (together with partners from the USA) the American missile "Taurus-II" [45].

Ukrainian scientists have created a number of nanoscales that can be used in space technology: samples of heat-resistant nanodisperse aluminum composites (promising material for spacecraft); technologies of obtaining coatings in the nanostructural state (the stability and durability of gas turbines blades and structural materials greatly increase); technology of obtaining and sintering of barium titanate nanopowders for ceramic based multi-layer capacitors; solid, radiation-proof, electrical conductive lubricants for space and ground use based on intercalated nanosystems; nanocomposites for light emitting diodes; materials for high-capacity lithium batteries, conversion of solar energy to other types of energy, etc. [46].

Traditionally, scientific institutions of the Ukrainian National Academy of Sciences take an active part in conducting scientific space research in Ukraine and in the world. In particular, the Decree of the Ukrainian National Academy of Sciences Presidium dated December 23, 2011; No. 353 approved the Target Complex Program of Ukrainian NAS for Scientific Space Studies for 2012-2016 [39]. At the same time, the limited funding of scientific space research within the framework of nation-wide targeted scientific-technical space programs of Ukraine has delayed the timing of implementation of individual projects and the actual cessation of promising space research and development. Under these conditions, in October 2012, NAS of Ukraine, in order to consolidate the efforts of scientists and engineers-designers to identify and implement existing and prospective space projects of Ukraine, signed the General Agreement on Scientific and Technical Cooperation with SE "CB" Pivdenne "in the field of rocket and space technology. A promising plan for joint scientific and technical activities was also approved and a Coordinating Council for the organization of joint work was established, which was put into effect by the special decree of the Presidium of the National Academy of Sciences of Ukraine in October 10, 2012 "On the development of cooperation between the National Academy of Sciences of Ukraine and the State Enterprise" Design Bureau "Southern »To them M. K. Yangel [48].

The most significant results of the implementation of the "Target Complex Program of the Ukrainian National Academy of Science for Scientific Space Studies for 2012-2016" for the period 2012-2015 are given in the Table 8 [49].

Table 8: The Most Significant Results of the "Target Complex Program of the Ukrainian National Academy of Sciences for Scientific Space Research for the Period 2012-2016 [49]

Year	Direction Programs	The most significant result	Practical value
1	2	3	4
2012	Development of principles and creation of promising measuring and informational means for experimental research of the parameters of the near-space	The possibility of creation without loss of sensitivity of ultra-small light transmitters of a magnetic field intended for conducting scientific experiments onboard small spacecraft is investigated.	Creating ultra-small light transmitters of magnetic field
		The development of the current layout of the new on-board diagnostic system for ionospheric plasma, as well as amorphous magnetic conductors for high-sensitivity ferromagnetic magnetometers, has been started.	Onboard ionospheric plasma diagnostic system, high sensitivity ferritic magnetometers
		The scientific principles for creation of perspective research systems, in particular, satellite gravimetry, systems of management of small research spacecraft, spectral devices on the basis of acousto-optical filters, as well as new control systems for obtaining materials in microgravity conditions have been developed.	Scientific fundamentals for the creation of perspective research systems
	Astrophysical, cosmological problems of the hidden mass and dark energy of the universe	The quantum-cosmological approach to the problem of the initial singularity and origin of the universe is developed. The manifestations of the hidden mass on the scale of stellar and galactic systems were studied and a numerical simulation of the chemodynamic evolution of galaxies was carried out, the problems of nucleosynthesis and the chemical evolution of the universe	Numerical simulation of the chemo-dynamic evolution of galaxies
		Materials for detectors of elementary particles of a new generation have been developed. A horizontal solar telescope with an ATSU-5 double-diffraction monochromator was put into operation, which, according to its spectral characteristics, is one of the three best telescopes in the world of this class.	Materials for the detectors of elementary particles of the new generation
		With the help of Grid-clusters of the academic network, collection, archiving, processing and transfer of large volumes of data is provided. The studies conducted on the basis of regular monitoring showed that the effects of radio stars of active stars have a widespread character in the galaxy.	Investigation of the effects of the type of radio stars of active stars
	Investigation of solar-terrestrial connections and their influence on the functioning of Geocosmos geosystems	New models of magnetic storm forecasting have been constructed, which allow to predict their origin in 5-7 hours, as well as new methods for determining the spectral and energy characteristics of perturbations of the ionosphere on the basis of one-point satellite measurements	New models of magnetic storm forecasting
		Created a system for monitoring emergency pollution at sea, tested and implemented at the State Enterprise of Maritime Telecommunications of Ukraine	Monitoring system for emergency pollution at sea
		Experimental studies of the effects of energy exchange in the system "atmosphere-ionosphere-magnetosphere" with the help of the created and put into operation of the electromagnetic complex	Research in the system of "atmosphere-ionosphere-magnetosphere
	Modernization of UTR-2 radiotelephone and promising development of low-frequency radio astronomy in Ukraine	An additional 25-cell sub-lattice was manufactured and installed, proving the number of elements of the GURT system to 275. The new economy-on the technology of mounting elements of the antenna system was first applied. New devices of synchronization of signal recorders and antenna control, algorithms and programs of experimental data processing, which enable effective allocation of useful signals against obstacles and analysis of detected effects, are introduced.	Improvement of the radio telescope UTR-2 and other radio telescopes

Continuation of Table 8

1	2	3	4
2013	Research on the problems of the dynamics of spacecrafts, the astro-drawing, space flight mechanics	The scientific and technical substantiation of the optimal system of automatic docking of spacecrafts on active optical markers and a backup system on a laser interferometer is carried out.	Optimal system of spacecraft automatic docking

		The structure and spatial distribution of currents and particles in an artificial magnetosphere near a rigid body in the supersonic flow of sparse plasma have been experimentally investigated. It is shown that the structures of the spatial distribution of charged particles of electric currents, according to the Chapman-Ferraro model, are characteristic of an empty magnetosphere	Investigation of currents and particles in an artificial magnetosphere in a stream of rarefied plasma
	Research on natural sciences with the use of space vehicles and technologies	The statistical connections of the solar activity indexes with the indices of large-scale atmospheric circulation in the Atlantic-European region are established. The study of turbulent processes in cosmic plasma has shown that on the Sun two types of turbulence are implemented that correspond to different processes	Investigation of the solar activity influence on atmospheric circulation in the Atlantic-European region
		The databases of the International Center for Observation of VIRGO gravitational waves have been expanded with data from optical and gamma bands. Maps for the distribution of optical, hard X-ray and gamma radiation and maps for the distribution of dark matter were constructed.	Distribution maps of optical, hard X-ray and gamma-radiation
		The distribution of matter on the near and cosmological scales of the universe and the interactive tools of its visualization were created.	Visualization of the distribution of matter at different scales
		As part of the study of the kinematics of the Galaxy with the use of own movements of the modern catalogs stars, the necessary catalogs choice and attraction and creation of the database was carried out. The catalog of positions and own movements of celestial objects on the basis of Shmidt plates is created	Catalog of positions and own movements of celestial objects
	Development of new materials, structures and technologies of the space industry	Methods of calculation of dynamic processes in constructive elements of spacecraft under the influence of pulsed loads are developed.	Calculation of dynamic processes in constructive elements of spacecraft
		With the help of the developed thermostat chamber, the methods of optical pyrometers have determined the thermo-optical characteristics of the real shell material in temperature ranges corresponding to the conditions of operation in the near-Earth orbit	Thermo-optical characteristics of shell material for conditions of near-Earth orbit
	Space instrumentation	A complex of laboratory and experimental equipment was developed for making adjustments to the calculated parameters of the transformation process and determining the nature of the stress-strain state of structures of the volume to be converted at long-term exposure in the near-Earth orbit	Complex of laboratory and experimental equipment
	Use of space vehicles and technologies to solve scientific and practical problems	Structural, functional and molecular features of pea mitochondrium roots under conditions of simulated microgravity are investigated.	Growing peas in microgravity
		The interaction and conditions of binding of simulants of lunar and Martian soils and dust to the nervous terminals of the brain and mammalian platelets were studied.	Influence of lunar and Martian soil on mammalian brain and platelets
	Scientific, legal, economic and social aspects of space research	Recommendations for improving the legal regulation of ecological and legal relations in the field of space activities are developed	Recommendations on legal regulation of ecological and legal relations in the field of space activities
	Investigations on the problems of the spacecraft dynamics, astronomy-mica, space flight mechanics	The dynamics of the interaction of a magnetized spacecraft in the plasma (ionosphere and interplanetary space) is investigated, an analysis of the the spacecraft behavior in the ionosphere of the Earth at altitudes of 800 to 1000 km has been carried out, mathematical models of the dynamic processes of rocket carrier elements in interaction with subsonic and supersonic gas flows have been constructed.	Dynamics of the magnetized space vehicle in plasma interaction
2014		The influence of microgravity on cells and root cytoplasmic membrane, as well as the influence of the simulants of the lunar and Martian soil and dust and their individual components on the processes related to intercellular interaction was investigated.	Influence of micro-gravity, lunar and Martian soils on plant root cells
	The use of space vehicles and technologies to solve scientific and practical problems	A system for collecting, processing and analyzing terrestrial and on-board space GPS / GLONASS observations for monitoring, research and the full electronic content simulation of the ionosphere in the framework of the international project "Ionosate-Micro"	GPS / GLONASS surveillance system for ionosphere research
	Space instrumentation-building	A substantiation of the alternative laser system of docking CA, the possibility of its optimization and modeling has been proved.	Development of an alternative laser system for docking CA

Continuation of Table 8

1	2	3	4
	Space instrumentation	A new concept of the intelligent laser system of docking of spacecraft with the use of active markers was proposed and the prospects of laser location technologies application in orbital spacecraft were analyzed.	Laser location technology in orbital spacecraft
2015	Development of new materials, structures and technologies of the space industry	The study of the dynamic instability of rocket carriers in the supersonic gas flow has been carried out. The investigation of the dynamic processes of shell composite elements under the action of high-speed shock loading	Investigation of rocket carriers dynamic instability in supersonic gas flow
	Space instrumentation	Sketchy documentation of a prototype optical-mechanical block of the on-board satellite polarmeter Scan-Pol for field tests was made and the main units of the block were made.	Nodes of the optical-mechanical unit of the on-board satellite polarmeter Scan-Paul
	Space instrumentation	The methodical workings out for the purpose of creation of research equipment for the space project "Morfos-V" were carried out, test experi-	Methodological developments for the creation of research equipment

	ments were carried out, simulating the studied process in weightlessness	for the space project "Morphos-B"
Scientific, legal, economic and social aspects of space research	The analytical report "International legal principles of space protection from nuclear power sources" was prepared and recommendations were made on improving the mechanism of space protection international legal regulation from nuclear power sources and law enforcement practice in the relevant field.	Improvement of the international legal regulation mechanism of the protection of outer space from nuclear power sources

In January 2015, the CB "Pivdenne" and DK "Ukroboronprom" signed a joint decision to strengthen and expand cooperation in the field of the creation and production of rocket-jet and other types of weapons in order to strengthen Ukraine's defense capability. In particular, the combat operational tactical rocket complex "Sapsan" is being developed for the needs of the Ukrainian Armed Forces: in 2009-2010, enterprises and institutions of the State Tax Administration completed the first stage of the project, and today the state target defense program for the creation of this complex is at the stage of its approval by the government.

On 25 February, 2015, the State Space Agency of Ukraine (DKA of Ukraine) and the NAS of Ukraine signed an agreement "On further deepening of cooperation in the field of scientific research and use of outer space", which will enable to intensify cooperation in the creation of advanced space technology and technologies, to ensure joint planning and implementation space research, to develop terrestrial space infrastructure and geographic information systems based on the use of space data [49].

In May 2015, the Order of the Head of the of Ukraine dated 21 May, 2015 No. 100 approved the Strategy of Ukrainian Space Activity until 2022 [50]. The main expected results of the strategy implementation are: (1) the launch of the space communication devices and broadcasting "Lybid" and "Lybid-2", the spacecraft of the remote sensing of the Earth "Sich-2-1", "Sich-2M", " Sich-3 ", scientific-technological spacecraft" Ionosat "; (2) expansion of cooperation and membership of Ukraine in the European Space Agency, in particular, it is planned to ensure the use of information from the global navigation satellite systems GPS / US /, GALILEO / EU / for the state needs of the information, and Ukraine will extend the zone of high-precision differential correction provision of EGNOS / EU /; (3) the commencement of the commercial exploitation of the Cyclone 4 missile complex and the expansion of the geography of the launch pads under it; (4) restoration of the Marine Launch and Ground Launch projects with Zenith-3SL, Zenith-3SLB and Zenith-3SLBF missiles; (5) the participation of Ukrainian enterprises in international projects Dnepr, Antares, Vega, as well as in the European program of research and innovation "Horizon 2020" on space subjects. In addition, the task is to increase the prestige of space activities in society, and the salary in the industry has to double twice the country's average [51], [52].

In addition, on 12 November, 2017, the European launch vehicle Vega with a Ukrainian engine successfully launched from the Kuru Space Center in French Guiana. The rocket engine RD-843 4 rocket carrier was developed by the State Enterprise "Design Bureau" Pivdenne "and manufactured by the state enterprise" VO "Southern Machine-Building Plant named after. OHM. Makarov ". As VEGA is a lightweight rocket carrier, since 1998 is being developed jointly by the European Space Agency and the Italian Space Agency.

In addition, the same day, 12 November, 2017, from the Center for Space Flight on the island of Wallops (USA), a modernized missile carrier (Antares) was launched, the construction of the first stage of which was designed by Yuzhnoye CB and manufactured by "Yuzhny Machine-Building Plant named after them. OHM. Makarov "in cooperation with Ukrainian enterprises. Antares launched into the orbit of the Cygnus cargo ship, which delivered 3350 kg of payload to the International Space Station, which is the maximum cargo that is being orbited for all previous missions [53].

Hence, the high-tech rocket and space industry of Ukraine's economy is somewhat in better financial condition than the aviation industry. But it also needs to change the development priorities and significant investments for the modernization of the production base. Like the aviation industry, the rocket and space industry today, due to relatively small volumes of production, is not the engine of economic growth in Ukraine.

At the same time, taking into account the interests of Ukraine's national security and preserving its intellectual potential, it is necessary to ensure the functioning of economy on any scale this branch. In the context of the increased military threat posed by the conflict in eastern Ukraine, the missile and space industry, after a certain modernization (taking into account the introduction of the latest NBIC-technologies), may, above all, play a leading role in the creation of a defense shield of the state.

4. Conclusions

1) It is proved that the introduction of converged technologies in Ukraine is due to the need to increase the competitiveness of domestic commodity producers in the external and internal markets in conditions of the country deep integration, first of all with the countries of the European Union, and implementation of the Association Agreement between Ukraine and the EU. Under these conditions, the need for research and commercialization of their results, aimed at increasing the innovation activity of the subjects of production activity, is exacerbated.
2) It is proved that the aviation industry of Ukraine is in crisis today: it needs restructuring, restructuring and large investments (600 billion dollars) for the modernization of the production base. The Ukrainian aviation industry as a whole has lost its competitive advantage, and as a result of relatively small volumes of production, today is not the locomotive of the country economic growth as a whole. Taking into account the interests of Ukraine's national security and the preservation of its intellectual potential, it is necessary to ensure the functioning of this economy branch on any scale, first of all, ensuring the widespread introduction of the latest NBIC-technologies into the production of modern competitive aircraft. Potential in the transition to modern production technologies, including the use of converged technologies, aircraft building can turn into one of the interesting economic future of Ukraine.
3) The high-tech rocket and space industry of Ukraine's economy is in better financial condition than the aviation industry. But it also needs to change the development priorities and significant investments for the modernization of the production base. Like the aviation industry, the rocket and space industry today, due to relatively small volumes of production, is not the engine of economic growth in Ukraine. At the same time, taking into account the interests of Ukraine's national security and preserving its intellectual potential, it is necessary to ensure the functioning of this branch of the economy. In the context of the increased military threat to Ukraine, the missile and space industry, after a certain modernization (taking into account the introduction of the latest convergent technologies), may, above all, play a leading role in the creation of a defense shield of the state.
4) The definition of research priorities in convergent technologies in Ukraine is as yet unsystematic and does not correspond to the priorities of budget financing. It has been proved that there is a need to establish Consultative Working Groups from the staff of the National Academy of Sciences of Ukraine and other scientific institutions, and with the participation of independent experts with a certain experience in a particular direction of research, for analyzing the current implementation of convergent technology development programs, forecasting and clarification. Priorities of

the development of convergent technologies in the aerospace complex of Ukraine. The indicated measures will enable more efficiently direct the costs of limited budget funds and manage relevant research aimed at restructuring the industry and increasing the competitiveness of Ukraine's economy as a whole.

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