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MAIN DIRECTIONS OF TRAINING HIGHLY QUALIFIED STAFF FOR THE OR-GANIZATION OF PRODUCTION AND OPERATION OF UNMANNED AERIAL SYSTEMS

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ABSTRACT

This article considers the main problems and directions of training highly qualified staff for the organization of production and operation of unmanned aerial systems (UAS) and unmanned aerial vehicles (UAV) on the basis of Moscow Aviation Institute (National Research University) (MAI) of the Ministry of Science and Higher Education of the Russian Federation. The complex of strategic activities of MAI is analyzed, which is structured into 5 main projects, through the implementation of which a stable position at aeromobility market in Russia can be achieved, including the direction of integrated training of highly qualified staff for the global transport markets. As a result of organizational and economic analysis, the conclusion was made that in the current innovative and economic conditions it is necessary to transform the educational process in order to increase the effectiveness of training programs for highly qualified staff for the organization of the development, production and operation of UAS and UAV through the introduction of advanced technologies and forms of learning, such as project-based learning, adaptive learning based on advanced information technology and artificial intelligence, hybrid learning as a symbiosis of learning with face-to-face and virtual seminars and lectures, etc.

Keywords: *Unmanned Aerial Systems And Unmanned Aerial Vehicles; Airomobility Market; Training Of Highly Qualified Staff; Basic And Additional Professional Training Programs; Professional Development Programs; Professional Training And Retraining Programs; Efficiency Of The Educational Process; Digital Human Resources Platform*

1. INTRODUCTION

Aeromobility market, including the market of UAS and UAV services, is at the stage of active formation with the potential for great growth. Therefore, in the current innovative and economic conditions, the further active development of this market requires competent specialists with ex-perience in the implementation of projects in the development, production and operation of UAS and UAV, specialized units for key UAS technologies and appropriate logistical and information base [1].

The unprecedented demand for UAS services is associated with global trends in technology and society. The volume of Russian UAV services market in 2020 was over 11 billion rubles at an average annual growth rate of 18%, where remote sensing and geodesy/mapping account for over 50%. In the next five years the market growth is expected to leap due to the development of commercial delivery and monitoring segments, in particular forestry. Exponential growth in the global market for UAS services after 2028 will be driven by the start of their application for pas-senger transportation. As a result of the industry's development, the volume of the Russian market may reach the level of over 290 billion rubles by 2030, and its share in the world may amount to about 5% [2].

The main problem that the authors solve in their study is the lack of a professional training system for a completely new direction in the aviation industry related to the development and operation of civilian UAV. Every year the number of tasks that are successfully solved by UAS is growing. The dynamic development of modern drones is significantly hampered by the lack of the required number of specialists with the necessary competencies not only in designing unique drones, but also knowing air navigation. To solve this problem, it is necessary to solve the following questions:

- to determine the main areas of application of civilian drones;
- to organize new educational programs for the training of future specialists;
- to form educational standards that meet the needs of employers;
- to highlight the necessary competencies for graduates of educational institutions.

However, at this stage of the industry's development, there are a number of regulatory and technological barriers, the reduction or leveling the impact of which should be aimed at strategic measures, such as:

- implementation of projects for the full-scale integration of UAS complexes into the transport system and airspace of the Russian Federation;
- development and implementation of a methodology for optimized design, production and operation of UAS complexes, as well as creation of digital services for aeromobility industry;
- development of a methodology for optimized design, production and operation of UAS complexes and creation of digital services for the airomobility industry;
- provision of human resources for existing and potential participants in airomobility market;
- formation of innovative environment for stimulation, support and further commercialization of start-ups, contributing to the development of airomobility market;
- formation of innovative test base for all sections of airworthiness standards;
- development of validation procedures for airworthiness standards to enable certification of small size of UAV;
- development of qualification requirements and standard training programs for highly qualified aviation staff for the design, production and operation of UAS and UAV [3].

The purpose of the study is to solve the scientific problem of improving the scientific and methodological support of the modern educational process for the training of highly qualified specialists in the field of production and operation of UAV. The scientific results obtained by the authors make it possible to create and approve new educational standards for the training of engineering and technical aviation workers. The authors conducted research only on the segment of civilian drones. We ignored the specific issues of using military drones.

As we can see from the above data, one of the most pressing problems in the development, production and operation of UAS and UAV is precisely the problem of training qualified staff [3].

2. THEORETICAL BASIS

In modern scientific literature, there is a sufficient amount of material related to the study of educational trajectories of specialists in traditional areas in the aviation industry. Not enough attention has been paid to the regulatory issues of the legal use of drones to increase air mobility. The authors presented new directions for the active development of the unmanned air taxi market, which requires a sufficient number of highly professional specialists with practical experience in implementing innovative projects in the development, production and operation of UAS.

On October 5, 2021, the presidium of “Priority-2030” program board approved the list of Russian universities that passed the second stage of the selection process and will receive a special part of the grant for the implementation of their development program. MAI was among the leading universities that successfully passed the selection. The model of MAI-2030 provides the transformation of the university into the driver for the development of prospective segments of the existing aerospace markets and the emerging markets of aeromobility and services based on space systems [4]. An important direction of the development program is the diversification of research activities of MAI through the transfer of technologies in information technology, general engi-neering, energy, road, rail and water transport, medicine, ecology and other industries [5].

Within the framework of this Program till 2030 MAI intends to implement three Strategic Projects.

Strategic Project №1 “Future Aerospace Markets-2050” envisages ensuring MAI global leadership in breakthrough technological areas of aerospace industry development, such as mathematical modeling, energy systems, polymer composite materials, avionics and space sys-tems, based on the model of the university's competence centers.

Strategic Project №2 “Aeromobility” is designed to ensure that by 2030 MAI will be scientific, technological and educational leader in the field of aeromobility in the Russian Federation and will implement promising educational programs, developments and new services in the field of un-manned technologies in the international market.

Strategic Project №3 “Digital Human Resource Platform” is aimed at creating a unified digital environment for advanced human resource development of industrial corporations and innovative companies in aerospace and other high-tech markets.

These Strategic Projects launch new business processes at the university, providing scientific and technological breakthrough and world-class training of complex engineers.

The peculiarities of MAI-2030 model will be the conduct of research work and staff training for key industrial projects at all stages of the life cycle of high-tech products. Along with the tra-ditional design and engineering competences for MAI, new areas in the field of modern production technologies, operation, service and after-sales service of aviation and rocket-space equipment, including UAS and UAV, will be developed [6].

However, ensuring technological leadership of the Russian Federation is impossible without training teams and change leaders. To this end, the development program of MAI includes transformation of engineering education aimed at training a new generation of specialists able to work in interdisciplinary teams and respond to the challenges posed by the industry. “At the same time, practical experience in complex projects in breakthrough areas of technology development plays a key role in training engineers”, - said Rector of MAI, Academician Mikhail Pogosyan, about the university's participation in the second stage of “Priority-2030” program [7].

Now we are going to look in more detail the Strategic Project №2 “Aeromobility”. The goal of it is to ensure that by 2030 MAI will be scientific, technological and educational leader in the field of aeromobility in the Russian Federation and to implement promising educational programs, developments and services in the international market [8].

Objectives of the Strategic Project are the following:

1. To join the world market in the field of development and services for aeromobility;
2. Formation of scientific and technological groundwork for the creation of UAS, necessary technologies and infrastructure for their effective operation;
3. Formation of the system of organization and promotion of the belt of innovative enterprises and start-ups of MAI in the field of UAS;
4. Formation and implementation on the basis of market, technological and staff forecasting of programs for advanced training of teams and change leaders in the field of aeromobility;
5. Organization of cooperation of MAI with scientific organizations, authorities, industrial partners and business leaders of Russia and the world in the field of aeromobility.

Expected results of the Strategic Project are the following:

1. Creation of a system for implementing complex aeromobility projects based on cooperation with market leaders;
2. Development of UAS application models and creation of systems for integration of UAS complexes;
3. Creation of UAS certification systems on the basis of MAI for the development of aeromo-bility services market in the Russian Federation;
4. Development of solutions for infrastructural support of aeromobility industry for the im-plementation of UAS-based services;
5. Forming a model for the commercialization and scaling of digital services in aeromobility market of the Russian Federation;
6. Ensuring that MAI will become one of the five leaders in the Russian Federation in the field of aeromobility in research and development (R&D) of UAS;
7. Ensuring entrance to the world market with complex products and services in the field of aeromobility.

Strategic Project №3 “Digital Human Resource Platform” is another Strategic Project that MAI plans to implement as a part of “Priority-2030” strategic academic leadership program. Its creation

is aimed at a fundamental change in the approaches to interaction with employers through the transition from the "customer-executor" model to a full partnership at all stages of staffing: from staff forecasting to staff training through flexible programs and individual educational tra-jectories (IET), as well as facilitating the adaptation of students at the workplace.

The project will create a unified digital environment by integrating the requests of industrial customers, educational service providers and young professionals and students, which will trans-form MAI into a leading mega-service university for advanced staffing of industries [9].

New platform will be able to formulate a request based on the forecast of technological de-velopment of the industry, form staff forecast and qualification requirements for future specialists with their translation into the content of flexible educational programs, prepare and select staff and employ students who meet the prospective needs of customers. Due to the availability of long-term staffing forecasts and the formation of IET, more effective and comfortable conditions for self-realization and development of talents will be created [10].

Implementation of the project on creating digital staff platform is based on the long-term work of MAI with traditional industrial partners: JSC Sukhoi Company, Russian Aircraft Corpo-ration "MiG", Ilyushin Aviation Complex, Joint Stock Company Tupolev, Komsomolsk-on-Amur Aircraft Plant named after Yuri Gagarin, Information Satellite Systems Reshetnev), as well as new companies working in the field of UAV (Kronstadt, Aeromax, International Aero Navigation Systems Concern, JSC (IANS)), industry competence centers (Additive technologies JSC "ATC", Rostec Robotics Technology Center), maintenance and repair providers and aircraft operators (A-Technics, Volga-Dnepr Group).

One of the most important elements of the project is to improve work with target students. Even today MAI, in close cooperation with the industry, provides an opportunity for senior students to become target students, preparing them for specific projects of customer companies. The mechanisms of students' selection for training in the interests of enterprises, IET for the target students, additional programs and modules tailored to the specific customer, motivational pro-grams for the target students and adaptation environment for young professionals are being formed.

The set of activities of MAI is structured into 5 projects, due to the implementation of which a stable position at aeromobility market in Russia will be achieved:

1. "MAI: integrator of UAS complexes";
2. "MAI: UAS test and certification center";
3. "MAI: integrator of UAS traffic control systems (UTM) and ground infrastructure";
4. "Development of digital services for aeromobility market";
5. "Comprehensive staff training for aeromobility market".

Now we are going to look in more detail the project "Comprehensive staff training for aer-omobility market".

Project goal is to provide companies in the developing aeromobility market with qualified staff.

Project objectives are the following:

1. Formation of staff forecast, including requirements for qualification of different types of staff for companies in the field of aeromobility, based on the market and technological forecast.
2. Development of digital educational technologies to enter Russian and international market.
3. Creation and implementation of advanced training programs in higher education (master's degree and elective courses), programs of additional professional education (APE) and training of aviation staff (aviation training center).

In accordance with the principles described in the educational policy, MAI UAV center, to-gether with digital human resources platform, will develop a range of advanced training programs, master's degrees, elective courses and online courses to staff aeromobility market for all target audiences: from schoolchildren to enterprise managers [11].

Now UAV field requires specialists from different fields of knowledge (aerodynamics, engine engineering, radio electronics, data processing, control systems programming, etc.), so, the training of students until 2026 is planned

through elective courses in undergraduate and graduate programs and implementation of IET. By 2028, when quite complex objects will be created, special training in the design of UAS, infrastructure, regulatory framework, etc. will be required, so, in 2024 it is planned to launch a separate master's program in the field of UAS.

From 2021 to 2022, the following topics are planned, which are implemented in a hybrid format, in APE and elective courses: introduction to UAS, UAS ecosystem and application models, UAS flight principles, UAS design, UAS control system, UAS power systems, UAV propulsion systems, UAV payloads, UAS lifecycle management and UAS regulatory support. In addition, within the framework of aviation training center, training programs will be created for aviation staff: UAS operator, UAS external pilot and UAS maintenance engineers. Also within the framework of the consortium work it is supposed to develop and implement joint programs of MAI and other universities - members of the consortium for the training of market participants.

The efficiency of the programs is to be ensured through the introduction of new educational technologies as a part of the educational policy and digitalization of the approaches to program development implemented within the digital staff platform project. As a result, MAI as an inno-vative educational platform will provide the staff trained on time, with the required qualifications and quantity to support current and prospective projects, including international ones [12].

Nowadays one third of all the students of the Russian Federation study at MAI in 24.00.00 “Aviation and Rocket-Space Engineering” enlarged specialty group. Consolidation of MAI's po-sition on staffing the full life cycle of products is supported by the opening of programs within 25.00.00 “Aeronautical Navigation and Operation of Aviation and Rocket-Space Engineering”.

3. LITERATURE REVIEW

A lot of works by specialists of Ministry of Industry and Trade of the Russian Federation and Ministry of Education and Science of the Russian Federation, as well as other scientists are devoted to the issues of effective human resources provision of the organization of development, produc-tion and operation of UAS and UAV. Among them, there is the article “Provision of Industrial Enterprises with Staff” on the Internet portal of the Ministry of Industry and Trade of the Russian Federation, published on November 24, 2017, https://budget.minpromtorg.gov.ru/citizens/post/view/obespecheniye-promyshlennykh-predpriyatiy-kadrami, where the results of the survey of industrial enterprises for high-tech sectors of industry in 2017 are noted. The results of the survey as a part of the project “Regional Standard of Industrial Growth Staffing” revealed that 65% of 429 surveyed companies are satisfied with the level of theoretical knowledge of college graduates, 67% of employees received higher education. However, the practical skills of the graduates of the system of secondary APE satisfied only 42% of the employers, the same indicator among the graduates of the universities was only 29%. Therefore, the transformation of the staff training system for these enterprises, taking into account modern trends of digitalization and innovative development, is very important [13].

Order of the Ministry of Industry and Trade of the Russian Federation of April 20, 2018 №1570 “On Approval of the Federal Aviation Regulations “Requirements for Specialists According to the List of Specialists of Aviation Staff for Experimental Aviation. Procedure for the Training of Aviation Staff Specialists of Experimental Aviation. Requirements for the Order of Development, Approval and Content of Training Programs According to the List of Specialists of Aviation Staff for Experimental Aviation with Amendments and Additions” of August 11, 2020, signed by Minister Manturov D.V., https://base.garant.ru/71958900/#friends (November 27, 2021), estab-lishes the general requirements for the level of qualification, knowledge and skills of relevant spe-cialists.

To acquire these qualifications, knowledge and skills, the leading higher educational institu-tions in the field of aviation, including MAI, develop the most effective educational programs using advanced teaching methods and information technologies and systems.

Thus, on the information portal Aviaru.net there is the information that “MAI will receive a special part of the grant under the program “Priority-2030”, published on October 5, 2021, https://www.aviaru.net/pr/63842/ (November 27, 2021) considered the main directions of the strategic development of the university until 2030, the basic projects, including in terms of ensuring to

2030 the scientific, technological and educational leadership MAI in the direction of airomobility in the Russian Federation and implementation of promising educational programs, developments and new services in the sphere of unmanned technologies on the international level [14].

Another key Strategic Project of MAI is considered in Mai.ru that "MAI is digital staff platform for training of aviation industry specialists" published on November 19, 2021, https://mai.ru/press/news/detail.php?ID=161853 (November 27, 2021): "Digital staff platform", which the university plans to implement within the framework of strategic academic leadership "Priority-2030". Its creation is aimed at a fundamental change of approaches to interaction with employers through the transition from the "customer-executor" model to a full partnership at all stages of staffing: from staff forecasting to staff training through flexible programs and IET, as well as assistance in the adaptation of students at the workplace.

The Internet portal of MAI UAV center, https://uav.mai.ru/sertification/, (November 27, 2021) considers the main directions, projects and complex solutions for the development, production, certification and operation of UAS and UAV for a wide range of tasks. The issues of specialists training in this area are also reflected.

Another interesting article for the training of highly qualified staff for the organization of the development, production and operation of UAS and UAV is the article by R. Obraztsov "Problems of pilots training for UAS control" [15]. This article considers the main directions of implementation of the action plan (roadmap) of the national technological initiative in the direction of "Aeronet", approved by the order of the government of the Russian Federation of April 3, 2018 №576-r, namely, it defines the requirements for organizations carrying out educational activities for the training of aviation staff of UAS, as well as the procedure for certification of such organizations, requirements for a candidate for a certificate of aviation staff specialist, procedure for testing the candidate for such a certificate, forms of issuance of this certificate, terms and frequency of training of aviation staff of UAS and recommendations for transformation of relevant educational programs.

4. METHODOLOGY

During the analysis of the main problems and directions of training highly qualified staff for the organization of development, production and operation of UAS and UAV on the basis of MAI the following methods were used: theory of managerial decision-making, methods of logical, economic, statistical and system analysis, method of expert evaluations, methods and procedures of information and production management.

The main sources of information were normative and instructive-methodological documents of the government of the Russian Federation, Ministry of Industry and Trade of Russia and its institutes, Ministry of Transport of Russia and other agencies, Ministry of Education and Science of Russia and MAI; state programs of the Russian Federation regulating the development, production, testing and operation of UAS and UAV, air traffic safety, certification standards, etc., training of highly qualified staff, as well as other materials of Russian and foreign scientific print and electronic media [16].

5. RESULTS

To improve the efficiency of the basic educational process at MAI, it is planned to introduce such advanced technologies and forms of learning into the programs as:

- project-based learning: topics of a real team project are determined by industrial partners, laboratories and competence centers of MAI or initiated by students;
- adaptive training on the basis of artificial intelligence: using a system, which takes into ac-count the data about a student and suggests corrections in the trajectory of it, methods and terms of mastering the disciplines;
- VR/AR-technologies allowing skills to be practiced on a virtual simulator before admittance to real machines and equipment;
- chatbots as a tool to support the student in terms of feedback functions, administrative and educational functions;
- robotic complexes for performing virtual practical and laboratory works, including distance learning;
- hybrid learning as a symbiosis of learning with face-to-face attendance and virtual seminars and lectures.

The key task in the field of professional development is to ensure the implementation of new approaches and technologies in the industry. MAI APE and training programs for the benefit of industrial partners can be formed on the basis of models of integration of R&D and training:

1. Development of a project or a separate technological solution (for example, digitalization of production), including training of staff in the application of new technologies;
2. Preliminary training of enterprise staff with development of R&D terms of reference (for example, development of mathematical models for tests) in the framework of pro-ject-oriented training;
3. Development of business models and work organization schemes with the participation of MAI experts in the format of a consulting and implementation project within the training programs (for example, development of a model for the organization of serial production of small satellites).

The dissemination of these models and the achievement of the target indicators of APE programs volume are achieved through a number of mechanisms:

1. Interaction with corporate universities of industrial partners (Rostec Corporate Network Academy, corporate universities of aircraft building holdings, Roscosmos Corporate Academy);
2. Development of APE programs for students and industry specialists as a part of the IET through digital staff platform
3. Launch of new programs for employees of companies entering new markets (aeromobility, small spacecraft, etc.);
4. Entry into new segments of the training market for MAI in the field of aircraft and UAV operation and development of aviation training center;
5. APE programs based on technology transfer to related industries (shipbuilding, agricultural engineering, metallurgy, etc.);
6. Development of retraining programs for seniors in promising professions;
7. Training programs for teachers of specialized universities of the Russian Federation and the world.

6. DISCUSSION

6.1. MAI Educational Policy

MAI educational policy is focused on training teams and change leaders-complex engineers capable of solving practical project tasks by integrating knowledge from different fields. The content of educational programs is focused on the balance between the formation of traditional engineering competences, future competences and personal development, which allows not only to carry out current staffing, but also to form the core of the industry from new teams of specialists to enter new markets.

In addition to basic knowledge and skills, the key competences of a modern engineer are integrated project management and mastery of modern technologies, including product lifecycle management methods, design for a given cost, parallel engineering, systems engineering, etc.

Such competencies are most effectively formed using project-based learning; therefore, en-gineering education in MAI is built around practical disciplines through involving students in real research and design developments. In this regard, key priority of the educational policy is the development of master's degree programs in priority areas of technology development. The pro-grams are formed around the implementation of projects of laboratories and competence centers, which are in demand of industrial partners. The groundwork for the implementation of the pro-ject-based learning model is formed at the joint of MAI and leading aerospace universities. For example, within the framework of the master's program with Shanghai Jiao Tong University, students directly participate in the creation of the Russian-Chinese wide-body aircraft CR929. Within the programs of school of management, school of service, and lean-school of MAI, students contribute to the development of Strategic Projects of corporations and innovative companies by studying together with the “talent” pool of enterprises [17, 18].

The development program envisages the addition of the fundamental core as a base for en-gineering education:

- competencies in project management, basic skills of building business models and market research;
- personal competencies (softskills): communication and interpersonal skills,

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adaptability, etc., also formed within the framework of youth policy activities;
- digital competencies.

The list of professional competences is updated with the participation of industrial expert councils and is supplemented with future competences formed on the basis of the technological forecast.

The target structure of MAI educational process content is shown in the Figure 1.

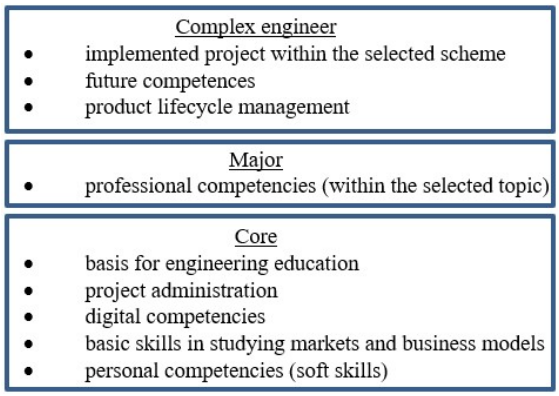

Figure 1. Targeted structure of MAI educational process content

The measures for modernization of education also include opportunities for each student to identify it with the technological direction and consciously choose his/her trajectory in interaction with the tutors of MAI and potential employers:

- by products types (aviation technology, engines and power plants, rocket technology, etc.);
- by major systems (avionics, radar, control systems, etc.);
- by stages of the product life cycle (development, production, operation, utilization).

6.2. *Educational Programs and Contingent*

In terms of optimizing the number of educational programs, the following priorities and principles have been defined:

- consolidation of bachelor's degree programs (from 110 to 35-40 specialties) and specialist's degree programs (from 57 to 15-20 specialties);
- updating of master's degree programs and its increase in admission twice;
- twice increase in full-time admission of international students from 545 to 1 050
- introduction of a multistage individualization model.

6.3. *Master's Degree*

MAI development program provides for the full-fledged formation of complex engineer's competences at the master's degree level due to the greater flexibility of the curriculum for the implementation of project-based learning. Increase in master's enrollment is achieved by launching new programs of advanced training in priority areas of technology development (within the framework of Strategic Project №1), responding to the industry challenges and determining the international positioning of MAI.

The tasks of MAI master's programs are training of technological leaders and specialists, as well as training of researchers and formation of scientific schools. To this end, two types are im-plemented: engineering-technological and research based on a new flexible model consisting of the following modules:

- 35%: core professional courses (major);
- 15%: courses at the choice of the student to form professional and personal competencies;
- 25%: internship at the laboratory/competence center/industrial partner to participate in R&D or conduct their own project;
- 25%: dissertation (advanced research, development and startup).

This model makes it possible to implement types of master's programs within one program due to the flexibility in terms of internships, elective courses and thesis. Master of research focuses on research work and master of engineering focuses on development within the chosen field. Leading scientists, including those of international level, are supposed to be the faculty members and su-pervisors in the research master's program. The further trajectory of the master-researcher is built within the framework of postgraduate studies and the activities described in the scientific policy.

6.4. *Bachelor and Specialist Programs*

Program consolidation is based on the following criteria:

- demand for programs in the industry based on the results of the staffing forecast, orders from the staffing agency (under Strategic Project №3) and the availability of targeted students;
- demand for applicants: reduction of programs with small groups;
- level of applicants: reduction of programs with a low average score of the state exam on the results of admission;
- cost-effectiveness: consolidation of small programs within one area.

6.5. Targeted Enrollment Students

Staffing of state enterprises ordering targeted training requires greater flexibility. In this connection it is supposed to introduce two-level system with the following enrollment parameters:

- development of the enrollment dynamics for targeted training from 400 people per year in 2021 to 600 people per year in 2025, which provides the basic need of partner enterprises;
- introduction of the mechanism of target training at senior courses in order to provide staff for strategic industry projects through the mechanism of student contracts: up to 1000 persons per year by 2025 (depending on the needs of enterprises).

New model of work with target students has been worked out within the Rostec Wings project and since 2021 applies to the programs of eight regional aerospace universities that are part of the Project №3 “Digital Human Resource Platform”. Thus, the educational policy takes into account the work with the contingent of students from the regions where aerospace enterprises are located.

6.6. International Programs

In 2021, 16 bachelor's and master's degree programs, including those implemented in English, passed international professional and public accreditation. The programs are marked with certificates confirming their high level of quality at the national and global levels and are included in the official registers of the Association for Engineering Education of Russia, European Network for Accreditation of Engineering Education, Washington Accord Programs (Qualification checker WA), European Federation of National Engineering Associations (FEANI).

International master's programs make the positioning of MAI as a leader in the field of aerospace education, confirmed by a more than threefold increase in the enrollment of international students. A further increase in enrollment by 2030 (by 100 people for bachelor's degree and by 450 people for master's degree) will be carried out through the development of new Eng-lish-language programs in priority areas of technology development on the basis of competence centers (within the framework of Strategic Projects №1 and №2).

Improving the quality of programs for foreign students, including Russian-language ones, is achieved through:

- interaction with Russian and foreign companies involved in international projects and de-termination of professional and educational trajectories of students;
- formation of partnerships with universities to launch joint scientific and educational programs;
- implementation of individualization mechanisms;
- formation of a multilevel student selection system;
- integration of international students into MAI ecosystem by forming joint study groups, project teams and youth policy events.

6.7. IET

IET system in MAI is based on the formation of employee competence model: description of the requirements for knowledge, skills and abilities to perform work at a particular workplace in the medium and long term, formed on the basis of the digital human resources platform. This model allows the student and the employer to determine the degree of readiness of the graduate and the depth of mastering competencies in more detail. The model of individualization in MAI is based on the following key mechanisms:

- selection and deepening of the chosen direction (example: engineering - aircraft engineering - production technology - composites);
- trajectory within the chosen direction (example: engineer in competence - research engineer - managerial engineer - engineer - entrepreneur);

- students' rating tools and stratification by levels based on their success in mastering disciplines and involvement in additional activities are applied;
- use of academic mobility;
- elective zone to form a unique set of competencies ordered by the industrial partner or by the student's choice.

6.8. Educational Technology and Teaching Staff Development

To improve the efficiency of the educational process, the introduction of advanced tech-nologies and forms of learning into the programs is envisaged:

- project-based learning: topics of a real team project are determined by the industrial partners, laboratories and competence centers of MAI or are initiated by the students;
- adaptive learning based on artificial intelligence: using a system that takes into account student data and suggests adjustments to the student's trajectory, methods, or deadlines for mastering the disciplines;
- VR/AR-technologies allowing skills to be practiced on a virtual simulator before admittance to real machines and equipment;
- chatbots as a tool to support the student in terms of feedback functions, administrative and educational functions;
- robotic complexes for performing virtual practical and laboratory work, including distant work;
- hybrid learning as a symbiosis of learning with face-to-face attendance and virtual seminars and lectures.

Development of technologies and training of teaching staff takes place in the laboratory of education, which is formed within the framework of the digital human resources platform.

6.9. APE

The key task in the field of APE is to ensure the implementation of new approaches and technologies in the industry. Since 2017, MAI's APE programs for the benefit of industrial partners have been formed on the basis of R&D and training integration models:

1. Development of a project or a separate technological solution (for example, digitalization of production), including training of staff in the application of new technologies;
2. Preliminary training of enterprise staff with development of R&D terms of reference (for example, development of mathematical models for testing) in the framework of project training;
3. Development of business models and work organization schemes with the participation of MAI experts in the format of a consulting-implementation project within the training pro-grams (for example, development of a model for the organization of serial production of small satellites).

The dissemination of these models and the achievement of the target indicators of the volume of APE programs are achieved through a number of mechanisms:

1. Interaction with corporate universities of industrial partners (Rostec Corporate Network Academy, corporate universities of aircraft building holdings, Roscosmos Corporate Academy);
2. Development of AEP programs for students and industry specialists as part of the IET through the digital staff platform;
3. Launch of new programs for employees of companies entering new markets (aeromobility, small spacecraft, etc.);
4. Entry into new segments of the training market for MAI in the field of aircraft and UAV operation and development of aviation training center;
5. AEP programs based on technology transfer to related industries (shipbuilding, agricultural engineering, metallurgy, etc.);
6. Development of retraining programs for seniors in promising professions;
7. Training programs for teachers of specialized universities of the Russian Federation and the world.

6.10. Implementation of Professional Retraining Programs

Taking into account digital transformation of production and business processes, wide spread of computer modeling mechanisms, optimization and automation of design, testing, production and operation of products, retraining and advanced

training in digital competencies is necessary for 30-40% of employees of core high-tech companies.

The program of MAI development provides for the implementation of a wide range of ad-vanced training programs in the field of digital technologies for industry specialists. The devel-opment and implementation of such programs will be carried out with the participation of the digital economy companies on the basis of the trade community formed by IT center of MAI.

7. CONCLUSIONS

The authors conducted an organizational and economic analysis of the rapidly developing world market for UAV. The successes of Russian developers who have created and are starting to operate the most technologically advanced remotely controlled aviation systems are highlighted.

Practical measures are proposed for the implementation of national projects for the full-scale integration of UAS into the unified transport system of Russia. The personnel forecast of potential participants in the global air mobility market is presented.

The expected effects of the educational process transformation policy in terms of their impact on the achievement of national development goals of the Russian Federation for the period up to 2030 are as follows:

- "Development of opportunities for self-realization and development of talents": by for-mation of a system of work with talents among children and youth and model implementa-tion of individualization of education;
- "Quality of general education": by developing innovative approaches in MAI pre-university center and engineering classes;
- "Achievement of digital maturity of key industries": by formation of digital competencies of the aerospace industry staff within the framework of main educational programs and APE.

The proposed policy has an effect on the priority areas of the strategy for scientific and technological development of the Russian Federation in the field of connectivity of territories, digital technologies and new materials, environmentally friendly and resource-saving energy, etc.

This policy of transformation of the educational process affects the socio-economic devel-opment of Moscow, providing:

- increasing the quality of human capital by improving the quality and accessibility of educa-tional services in Moscow;
- improvement of the quality of the economic potential through the development of the in-novative aerospace cluster by means of training and retraining;
- modernization of the existing enterprises by means of developing the enterprises' projects within the framework of the project-oriented education in the master's Degree program and within the programs of advanced APE.

Being the supporting university for the aircraft building industry, MAI provides all the key subprograms of the state program "Development of Aviation Industry" with the staff: "Aircraft Building", "Helicopter Building", "Aviation Engine Building", "Aviation Units and Devices", "Aviation Science and Technologies", "Integrated Industry Development". MAI has a similar role in Russia's federal space program for 2016-2025. Also MAI solves the problem of staffing shortages in the regions where aerospace companies are located (for example, Ulan-Ude, Yekate-rinburg, Komsomolsk-on-Amur, Blagoveshchensk, etc.).

Influence on other areas of MAI development is the following:

- research policy and policy in the field of innovation and commercialization of developments: in terms of training young scientists, entrepreneurs and startup developers;
- youth: in terms of development and support of young scientists and formation of softskills and entrepreneurial competencies;
- financial: in terms of forming a significant contribution of revenues from the educational program and APE to the total budget of the university;
- digital transformation: in terms of creating conditions for the digital transformation of the university through the development of digital competencies and implementation of new educational technologies.

Thus, the availability of competent specialists with experience in the implementation of UAV projects (MAI has already developed and produced

more than 50 types of UAV), specialized units for key UAS technologies, including UAV center created in 2019, and the material and technical base creates the groundwork for the leading role of MAI in the field of airomobility in Russia.

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