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# Experience of the organization of digital agro-engineering education in Astrakhan State University

Ravil Arykbaev
*Faculty of Agribusiness, Technology and Veterinary Medicine*
*Astrakhan State University*
Astrakhan, Russia
ravilarykbaev@mail.ru

Alexey Rybakov
*Institute of Physics and Mathematics*
*Astrakhan State University*
Astrakhan, Russia
rybakov_alex@mail.ru

Olga Bespalova
*Faculty of Agribusiness, Technology and Veterinary Medicine*
*Astrakhan State University*
Astrakhan, Russia
bespalovaon@mail.ru

***Abstract*—The article presents the rationale for the prospects for the development of digital technologies in relation to the agricultural production sector, actualizes the problems of training highly qualified specialists to reduce the staff shortage in the digitalization of the agro-industrial sector. The organization of training for agroengineering education with international competence of a specialist in the field of digital agriculture is considered on the experience of the project being implemented at Astrakhan State University. Examples of the successful solution of the first tasks of the international project on the internationalization of agro-engineering education are given - the Agromechatronics master program has been opened, aimed at training personnel in the field of agro-robotics using the best European experience in methodology and content of courses to improve the quality of educational activities and competence characteristics of specialists graduates. Examples of targeted areas for the implementation of the following priorities, which are to create an international educational platform in the field of agro engineering within the framework of the Caspian Digital Engineering Education Platform to gain practical skills at partner universities, are given.**

***Keywords—agroengineering education, development activities, innovative activities, the digital educational technology.***

## I. Introduction

Digital transformation of agriculture, implemented through the introduction of digital technologies, puts forward new requirements for the mass acquisition of digital competencies by agricultural enterprises and the quality of human capital [1]. The agro-specialists of the near future need systemic thinking, developed organizational skills and knowledge in the field of bio-IT technologies, there is a need to think like innovative entrepreneurs and apply new technological solutions that increase the efficiency of farms [1; 3].

The agro-industrial complex (AIC) of Russia is currently demonstrating an increase in the production of agricultural crops and their productivity. To further improve the efficiency and develop the potential of domestic agriculture, it is necessary to use the opportunities of the digital economy: the introduction of new information technologies and the transfer of innovative solutions. It is revealed that over 50% of the costs of agricultural enterprises can be optimized using digital technologies. According to the Information and Communication Technology (ICT) Development Index, Russia is now in 45th place in the world. In terms of investment in innovative projects, the agrarian sector ranks second in Russia in 2018, but this is still not enough. Accelerating the penetration of information technology into the agricultural industry is critical today. One of the effective steps in this direction could be mass training of specialists in digital technologies for agriculture. Only in this case, the Russian agro-industrial complex will be able to compete adequately in global markets [2].

Comprehensive digitalization of domestic agricultural production will allow producers to reduce costs by 23%. Thus, the average cost savings in land use with the use of GPS navigation technology is 11-14%, with differential fertilization - 8-12%, and thanks to parallel driving systems - 8-13%. "With inefficient use of agribusiness tools, up to 40% of the crop is lost" [4].

The qualitative exchange of available and reliable information is necessary for agricultural producers not only at the production stage, but also during the promotion of their products on the markets, including export ones. In the world, work on the study of markets (product, geographical), the analysis of the impact of global trends and customer preferences have a very strong influence on the profitability of both individual producers and the industry as a whole. Reliable information about consumers is expensive today, but whoever possesses it certainly has a significant competitive advantage over its neighbors. It is equally important for product promotion (especially premium) to be sure that it is your product (and not counterfeit) that will be delivered to the consumer, on time and in a salable form [2].

In the integration of an intellectual, or "digital," approach to the agricultural sector, there are both undeniable benefits and tasks that need to be addressed in the near future. On the one hand, the economic effect increases, labor productivity increases 3-5 times, and the marginality of agribusiness increases. New technologies allow for an effective inventory of land and land use. On the other hand, agricultural commodity producers inevitably face difficult tasks when introducing precision farming technologies - these are issues of integrating new systems with existing business processes, and the lack of a comprehensive solution that would provide automation and transparency of all business processes. A whole block of personnel issues arises: a lack of IT specialists adapted to the agro-sphere, a shortage of agronomists who are able to work with

computer programs and applications, low qualification of people who will have to service the new equipment [4].

The solution of personnel issues is possible only through the emergence of new specialties [3], such, for example, as an operator of automated agricultural machinery. A specialist who manages automated equipment on a farm, including sensor systems, drone, and agro-robot, such a specialist will have to possess not only special competencies, but also super professional skills and abilities. These include lean production, that is, the management of the production process, based on the constant desire to eliminate all types of losses. This involves the involvement in the process of optimizing the business of each employee and the maximum consumer orientation, programming, managing complex automated complexes, working with artificial intelligence, environmental thinking.

Agro-cybernetics, agro-informatics, agro-mechatronics are highly qualified specialists in the introduction of new technologies who are engaged in informatization and automation of agricultural enterprises using superprofessional skills and abilities: the ability to manage projects and processes, system thinking (the ability to identify complex systems and work with them, system engineering), programming, management of complex automated complexes, work with artificial intelligence, environmental thinking. In accordance with the atlas of new professions [3], such specialists will be in demand by 2020, which means now!

## II. Proposals and Main Results of Implementation

Modern requirements are applied to modern engineers in terms of the development of such qualities as leadership, ability to work in a team, to ensure resilience to changes, risks, well-coordinated and often networked work with employees. The curriculum should include disciplines aimed at the formation of these qualities [5].

In the future, it is likely that there will be a need for fluency in English at an advanced level and, given the development of translator's programs and applications, in several European and Asian languages at a basic level (only basic grammar and sentence construction algorithms). Computer translation allows you to maintain correspondence in any language now, so a modern engineer must own several at once, understand the national and cultural context. In terminology - ASI "Multilingual". In the curriculum for engineers, it is necessary to lay down a mandatory in-depth study of English and basic (primitive) study of at least 2 additional languages (preferably Asian and European, given the unique geographical location of Russia and our region) [6, 7].

A modern engineer should be able to search, accumulate and analyze a huge amount of information, using the capabilities of information networks (local, international) and, more and more, special software, decision support systems. It is necessary to organize the study of such methods and software.

It is already impossible to imagine an engineer who does not use computer and network resources for his tasks. However, the presence of only basic knowledge (computer science) is clearly not enough for the full use of modern computing resources. In the future, it is necessary to have knowledge of programming languages as means of communication with artificial intelligence, ensuring the full use of enormous computing power.

For a modern engineer of any training direction, knowledge of languages and programming tools of the lower and upper levels (working with hardware and, for example, developing simple mobile applications and software) is necessary. The engineer should be distinguished by a special psychology, implying the ability to respond quickly to changing tasks, stress resistance, creativity and the ability to work in the most productive mode for a long time [8]. It is necessary to develop such competences within a special block of disciplines (for example, studying the flexible methodology of Scrum). As in the case with the structure of the curriculum, there are several options for the "implementation" of project activities in the educational process. Analysis of the available options allowed us to make a choice on the modular arrangement of disciplines and the principle of "spikes" or merging, when about 75% of the time allotted for modular disciplines, courses are taught separately, and the last few weeks of the discipline are combined into a single project. This makes it possible for students to understand that in order to solve a real problem, the task must be to use communication and technological aspects from different disciplines [9].

For each project assignment, a chart of interdependence of the studied disciplines and "input" and "output" competencies is compiled. For educational disciplines of the "Agromechatronics" direction, an example of a design task can be the development of a mobile 3-wheeled robot for use as a universal platform with a given carrying capacity, maximum speed, dimensions, while moving along a given type of surface. Also specified are the dimensions of the support site, the connecting dimensions, the connection interface for the installed additional equipment. A feature of the design task is the presence of the components of all academic disciplines included in the module. The implementation of this project assignment involves the possession of the competencies of all these disciplines. Using this approach is aimed at ensuring the readiness of students to demonstrate deep practical knowledge of the technical foundations of the profession. Within the framework of the engineering training concept, it is proposed to develop the project method using the following classification (Table 1) [6, 10].

TABLE I. Types of Projects of Students in Engineering Areas

| Classification criteria | Types of projects |
|---|---|
| Scope of the project | Material projects: production of prototypes, models, devices, stands |
| | Environmental projects: collection and use of secondary raw materials. |
| | Service projects: collection, registration, presentation of information, provision of services, etc. |
| | Complex projects include material, environmental and service components |
| Dominant direction of project activities | Information projects require the collection of information about any object, phenomenon, familiarization with information, its analysis and synthesis |
| | Research projects require a well-thought-out structure, designated goals, relevance, subject of research, social significance, thoughtful processing methods |

| | |
|---|---|
| | Creative projects do not require a detailed structure of joint activities of the participants: it is only planned and developed further, subject to the genre of the final result |
| | Practice-oriented projects require a clearly defined result of activities focused on the social interests of the participants themselves |
| | Role (game) projects require a planned open structure, distribution of roles that mimic social or business relationships |
| The nature of the contacts of participants in the project activities | Internal projects: among students of one group |
| | Regional projects: among the participants of the city, region, country |
| | International projects (telecommunications): with the participation of representatives of other countries |
| Subject-content area | Subject projects are carried out on the material of a particular subject (discipline) |
| | Interdisciplinary projects are carried out on the basis of several academic subjects |
| The duration of the project | Short-term (mini-projects): small projects carried out during several sessions |
| | Medium-term projects are carried out from several months to six months |
| | Long-term projects are carried out from six months to a year or more |
| Number of project participants | Individual project |
| | Group project |
| | Collective projects |

Astrakhan State University is currently participating in the Erasmus + program, Key Action 2 - cooperation in order to develop the potential of higher education - a continuation of the Tempus program sponsored by the European Commission (CES), and coordinated by the Technical University of Ilmenau (Germany) [1].

The project brings together several Russian universities: Astrakhan State University, South-Russian State Polytechnic University (NPI) them. M.I. Platova, Stavropol State Agrarian University, Volgograd State Technical University, South Ural State University (Chelyabinsk), Iranian universities: University of Agrarian Sciences and Natural Resources Sari, Babol University of Technology and European Universities: Ilmenau University of Technology (Germany), Lakvill University (Italy), Agricultural University of Nitra (Slovakia). The implementation of the main objectives of the project should contribute to the modernization and internationalization of higher engineering education in Russia and Iran. It is necessary to create an international level master's degree program that promotes integration and interregional cooperation in order to provide opportunities for knowledge sharing in the future, to facilitate the organization of cooperation between universities and non-academic partners in the EU, Russia and Iran. This will provide an opportunity to actualize and increase the effectiveness of innovative capabilities of partner universities. In general, it will help make agricultural education more attractive, motivate the creation of new jobs and promote youth employment in agricultural enterprises in rural areas and the formation of engineering digital education, through the creation of excellence competencies in the field of agriculture - agricultural mechatronics, artificial intelligence, alternative energy and pr. [1].

So, now the priority objectives of the project have been fulfilled in Astrakhan State University - the international master's educational program “Agromechatronica” has been opened, the main professional educational program of higher education and the curriculum of the master's educational program have been developed, including such disciplines as:

- digital technologies in the agro-industrial complex;
- automated technical means in the agro-industrial complex;
- operation of technical systems in the agro-industrial complex;
- mechatronics and robotics;
- measuring and information devices;
- microprocessor systems;
- design of robotic systems for the agro-industrial complex.

The structure of the magistracy program, which includes three main blocks, is structured in such a way that during the period of study the undergraduate learns the skills to solve the following professional tasks:

- design of robotic systems for the agro-industrial complex. formulation of requirements for technical conditions affecting the choice of design and parameters of elements of technical systems and robots for the agro-industrial complex; synthesis of complex agro-industrial technical, mechatronic and robotic systems with subsequent analysis and improvement of characteristics; development of design and technical documentation for agro-industrial technical, mechatronic and robotic systems;
- formation of output parameters of the application of innovative developments in the production and processing of agricultural products; analysis of existing technologies for the production and processing of agricultural products, taking into account the application of innovative developments; development of technologies for the production and processing of agricultural products, taking into account the use of innovative developments;
- implementation of the search and analysis of available technologies for technical maintenance of technical, mechatronic and robotic systems; formation of the task of technical maintenance of mechatronic and robotic systems; development of technical maintenance methods for technical, mechatronic and robotic systems in the agro-industrial complex;
- search and analysis of domestic and foreign scientific and technical information; determination of research methods and techniques; research of technical, mechatronic and robotic objects; processing, analysis and presentation of research results.

The field of professional activity, according to the Register of the Ministry of Labor of the Russian Federation, master graduate, who mastered the basic professional educational program of higher education 35.04.06

Agricultural engineering “Agromechatronica” is agriculture in the field of organization and implementation of technical modernization of agriculture, and the types of tasks of professional activity - design and technological, i.e. participation in the development of innovative technical means and technologies and their application for the agroindustrial complex, ensuring the effective use of technical means and technological equipment for the production and processing of agricultural products, ensuring the operability of machinery and equipment using modern diagnostic technologies, maintenance and repair. In education and science, the type of tasks solved by the professional activities of a master graduate is focused on a research approach, solving problems in the development of science, the development of new machine technologies and technical means.

To date, the university has supplied equipment for use in educational and scientific purposes by undergraduates of the “Agromechatronika” training program - the KUKA robotic complex. A new international program for the preparation of undergraduates in the 2019-2020 academic year has been announced to be recruited at Astrakhan State University. The training of specialists in this area provides for obtaining international competences with the development of the principles and purpose of mechatronics and robotics; understanding the role of mechatronics and robotics in the science-production system; global positioning technologies (GPS) geographic information systems (GIS), yield assessment technologies (Yield Monitor Technologies) and variable rationing (Variable Rate Technology), the formation of professional knowledge and skills about the general principles of operation of devices and means of mechatronics and robotics, an objective view of the relationship "Man-machine".

So far, in Russia in the direction of "Agromechatronica" not trained. The experience of ASU here is innovative, moreover, unlike other project participants, the Astrakhan State University combines two faculties under the new master program - engineers, specialists in the field of robotics will work together with experts in the field of agronomy and agroengineering, preparing unique personnel. The process of forming the educational content of the virtual summer school “Summer - 2019” “Sustainable Agriculture” (Sustainable Agriculture) with the participation of partner universities is also underway. The purpose of creating a summer school is to model the scientific community of the University, with the help of graduate students, graduate students, young and distinguished scientists to attract gifted schoolchildren to research work, as well as the development of language and academic skills through design and creative activities. As a rule, in international summer school programs, such work leads to enriching the vocabulary of students, preparing students for studying subjects in foreign languages of partner universities.

## III. Conclusion

Thus, in Astrakhan State University all the necessary conditions are created for the creation of an international educational platform in the field of agroengineering within the framework of the Caspian digital engineering education platform. In the future, the opening of directions - agrocybernetics and agroinformatics, with the preparation of highly qualified specialists in the introduction of new technologies for informatization and automation of agricultural enterprises, logistics with the use of "green" technologies and artificial intelligence.

The strategic goal of the development of agro-engineering education at the university, with the introduction of the competencies of the digital approach in agriculture, is the creation by 2020. a scientific and technological educational platform that is capable of conducting fundamental and applied research, experimental development, and ensuring the financial self-sufficiency of higher education at the global level.

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