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DIGITALIZATION OF PRODUCTION AT AEROSPACE ENTERPRISES: WHAT A UNIVERSITY GRADUATE SHOULD KNOW

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Abstract

The article is devoted to the problems of forming the educational policy of aerospace universities in Russia, taking into account the implementation in the country of the program for the development of the digital economy and the development of an end-to-end life cycle management system based on the Digital Enterprise platform. In addition to traditional design and technological training, university graduates must have the knowledge and skills to work with the software of a digital enterprise. Federal state educational standards do not regulate the construction of the educational process for the study of technologies and processes implemented in digital production. Therefore, universities should independently formulate educational policies in this area. For this, at the first stage, it is necessary to analyze the current state of the digitalization process of aerospace production. The article provides a brief description of the software of aviation enterprises – partners at the Komsomolsk-on-Amur State University, which trains personnel for them. The "Digital Enterprise" program is implemented at airlines as a complex of interacting informational 3 subsystems: computer-aided design, PLM lifecycle management and an electronic document management subsystem operating within an automated system on a single software and hardware platform. A brief overview of the composition of the digital enterprise software platform is given. It is noted that universities widely use computer-aided design programs (CAD), Computer Aided Engineering programs (CAE), Computer Aided Process Planning (CAPP), Computer Aided Manufacturing (CAM), which replaced the drawing board and calculator in the course of coursework and diploma projects.

Keywords: Digitalization, aircraft producers, university, software, engineer

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1. Introduction

The requirements for the level of training of a specialist in the aerospace industry remain unchanged. Traditionally, this is due to the complexity of the design and manufacture of aircraft. In recent years, a new factor has emerged – digitalization of production (Baranov, 2017; Krivosheev, 2017; Lockett et al., 2014; Qianping et al., 2015; Tertyshnik, 2013; Zhou et al., 2011).

The term "digital production" refers to the information environment of high-tech production, covering production technologies, new materials and providing information and organizational support for production (Avaliani & Dzhenko, 2018; Bykova et al., 2015). This environment includes information about all processes in production:

- design and technological documentation;
- production indicators and data on its quality;
- logistic operations;
- operational parameters;
- economic indicators.

2. Problem Statement

Since 2016, the Russian Federation has been implementing a digital economy development program and developing an end-to-end life cycle management system based on the Digital Enterprise platform (Avaliani & Dzhenko, 2018; Kochura et al., 2017; Sazonov et al., 2018). The goal of the program is to increase labor productivity at enterprises of various industries in Russia. In particular, for aircraft-manufacturing enterprises, with their multi-level structure and a large number of technological processes, the digitalization of the production environment should lead to technical re-equipment, a reduction in the resource intensity of technological processes, the implementation of modern management methods (Manturov & Efimova, 2012; Shabalkin et al., 2014).

In the process of training aviation specialists at universities, there is an uncertainty of information required for the development of educational programs and curricula for specialized training. This uncertainty is associated with the lack of a priori information about the participants in the interaction, with the complexity of relationships, the impossibility of describing the system using traditional methods, the predominance of qualitative information, as well as with the ambiguity of assessing certain phenomena.

3. Research Questions

Komsomolsk-on-Amur State University belongs to the group of universities, which have opened aerospace departments focused on training personnel for local enterprises in the industry. The advantage of the educational process in such universities is the integration of the educational and production environment, in which the professional competencies of future specialists are formed. As a rule, the educational process in senior courses for two to three days a week takes place directly at the base

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enterprises using production or training and production equipment with the implementation of final qualifying works on real topics.

3.1. Learning content

The training of aviation engineers began at the Komsomolsk-on-Amur State University (at that time – the Komsomolsk-on-Amur Evening Polytechnic Institute) in 1956. Initially, the training was conducted in the evening form of training in the specialty "Aircraft construction" (now specialty 05.24.07 "Aircraft and helicopter construction").

In 1960, the Department of Plane Construction (now the Department of Aircraft Construction) was created to train aviation specialists out of production. During the period of stable existence, which fell on the 70s–80s of the last century, the department carried out an annual enrollment in the specialty "Aircraft and helicopter construction" for the full-time department in the amount of 50 people, for evening and correspondence courses – 30 people each. The annual graduation of specialists was at least 80–90 people.

In the process of organizing the training of aviation specialists, there is an uncertainty of information necessary for the development of educational programs and curricula for specialized training. This uncertainty is associated with the lack of a priori information about the participants in the interaction, with the complexity of relationships, the impossibility of describing the system using traditional methods, the predominance of qualitative information, and also with the ambiguity of assessing certain phenomena (Danilaev & Malivanov, 2014).

3.2. Partner aircraft manufacturing companies

The educational process at the Department of Aircraft Construction is organized with a focus on close scientific and educational contacts with leading Russian designers and manufacturers of aircraft. Among the partners of the department are such organizations as: Branch of Sukhoi Design Bureau in Komsomolsk-on-Amur, a branch of PJSC Sukhoi Company Komsomolsk-on-Amur Aviation Plant named after Y. A. Gagarin, a branch of PJSC Irkut Corporation" – " Regional aircraft"(formerly Komsomolsk-on-Amur branch of Sukhoi Civil Aircraft JSC) – as well as Progress Arsenyev Aviation Company. The department organized additional individual training of students under contracts with enterprises, for which graduates plan to go to work after graduation from the university.

4. Purpose of the Study

4.1. Current state of digitalization of aviation enterprises

In recent years, the partner aircraft manufacturers have been switching to digital technologies in the design and production of aircraft. At the Komsomolsk-on-Amur Aviation Plant, thanks to electronic document management, the volume of movements of workers for approving documentation in 2019 has been reduced by 90 %, the costs of duplicating paperwork have been reduced by 56 %, 100 % of all control orders are closed in electronic systems, the possibility of errors when making changes to paper documentation was reduced by 40 %, 76 % of paper copies of regulatory documents were written off (Levina, 2020). For comparison, earlier, with paper workflow, duplication of a regulatory document in 1

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copy. each division, on average, required 2.5 thousand packs of paper, 500 sheets each, that is, a stack of paper three Leaning Towers high.

The Digital Enterprise program is implemented at the partner airlines as a complex of interacting information subsystems operating within an automated system on a single hardware and software platform. It is necessary to analyze the composition of the software of information subsystems in order to introduce the relevant disciplines into the curricula of universities.

5. Research Methods

The specialized software was analyzed according to its functional characteristics: CAD systems, PLM (product lifecycle management) systems and electronic document management systems. The list of CAD software is shown in Table 1.

Table 1. CAD software used in partner aircraft manufacturers

Name	Purpose	Where used
AutoCAD by Autodesk (USA)	Designed for 2D and 3D modeling in the design of mechanical engineering products, buildings, etc.	At airlines it is used to create 2-dimensional drawings, sketches, simple tracing. It was actively used until 2005.
Nano CAD by Nanosoft (RF)	Three-dimensional computer modeling for the design of mechanical engineering products, buildings, etc.	The software was released in 2008. It has an AutoCAD-like interface. Designed to replace AutoCAD as part of import substitution.
Siemens NX by Siemens PLM Software (Germany/USA)	An interactive system designed for three-dimensional modeling of a product of any degree of complexity, computer-aided design and product calculations	The task is, within the framework of import substitution, to replace Siemens NX with domestic software with similar functionality, in particular, with T-FLEX CAD.
T-FLEX CAD, by Top Systems (RF)	Computer-aided design system	The latest version of T-FLEX CAD 16 offers new possibilities for parametric drawing, tools for working with assembly units, design in virtual reality, etc.
Compas 3D by Askon (RF)	Computer-aided design system	Engineering design system. The system offers tools for top-down and bottom-up design.

The list of PDM software, ECM systems and electronic document management systems is presented in Table 2.

Table 2. PDM, ECM systems and electronic document management systems used at the partner aircraft enterprises

Name	Purpose	Where used
Teamcenter by Siemens PLM Software (Germany/USA)	PLM (Product Lifecycle Management) system software	Combines all CAD-systems data in a single design environment, created, among other things, in other CAD-systems. Reduces time and improves product development.
ISU TPP by local developer (RF)	Information system for the management of technological	Allows searching, coding, controlling and transforming information for different levels,

	preparation of production	registration of technical documentation. Provides manufacturability of structures, design of technological processes, design and manufacture of technological equipment.
KSED 3.0 by KROK (RF)	Corporate content management system) complex electronic document management system	Approval of documents, management of financial and technical documentation, interdepartmental document flow, control of the execution of orders, etc.
1C:Enterprise by 1C (RF)	Automation system for accounting and management accounting	Database software shell for automating accounting and management accounting, economic and organizational activities of an enterprise.
T-FLEX CAD, by Top Systems (RF)	Computer-aided design system	The latest version of T-FLEX CAD 16 offers new possibilities for parametric drawing, tools for working with assembly units, design in virtual reality, etc.

6. Findings

The software used by the aircraft manufacturers is quite diverse. The developers are both local and international IT companies.

7. Conclusion

The analysis of the composition of the software used in the digital enterprise showed that at present, the universities widely use computer-aided design programs, i.e. CAD (drawings and electronic models), CAE Computer Aided Engineering (engineering calculations), CAPP (Computer Aided Process Planning) (development of technological processes), CAM (Computer Aided Manufacturing, programs for CNC machines) from the Table 1, while the programs for PDM, ECM systems and electronic document management systems are not studied enough. This is explained by the fact that in the curriculum a large proportion is occupied by coursework and diploma projects on the design and production technology of aircraft, for which computer-aided design programs have become a modern natural and universal toolkit for calculating and building electronic models of individual parts and assembly units, replacing the drawing board and a calculator. Programs that implement the technology of product lifecycle management PDM, ECM-systems and electronic document management systems are highly specialized tools, the study of which is possible only within the framework of the relevant special disciplines.

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