

RESEARCHING THE CAPABILITIES OF INFORMATION TECHNOLOGIES FOR EDUCATION IN DESIGN, 3D MODELING AND VISUALIZATION OF THE WORKING OF COMPLEX MECHANISMS

ИЗСЛЕДВАНЕ НА ВЪЗМОЖНОСТИТЕ НА ИНФОРМАЦИОННИТЕ ТЕХНОЛОГИИ ЗА ОБУЧЕНИЕ ПО ПРОЕКТИРАНЕ, СЪЗДАВАНЕ НА 3D МОДЕЛИ И ВИЗУАЛИЗАЦИЯ НА ДЕЙСТВИЕТО НА СЛОЖНИ МЕХАНИЗМИ

S. Il. Antonov

Artillery, Air Defense and CIS Faculty – Shumen, "Vasil Levski" National Military University, Bulgaria
stamantonov@abv.bg

Abstract: This report explores modern means for researching automation of design and construction methods of engineering analysis and integrated production systems. The report is fully adapted for the need of knowledge and skills in the future work of engineering specialists in the field of machine-engineering.

Keywords: INFORMATION SYSTEMS, CLASSIFICATION, CAD SOFTWARE

1. Introduction.

The automation of the design is the systematic use of computer equipment and software in the process of engineering work (research, design, technological design, experimentation, planning and management of production processes) in the scientifically technical distribution of functions between the specialists and the electronic computing equipment (ECE). Additionally, including reasonably chosen methods for computer calculation of engineering tasks.

This means that the specialist is always leading in the design process. He solves the tasks that are creative. The ECE is tasked with the tasks that can be algorithmized i.e. provided with programs whose solving with the computer would be significantly more effective than manual execution.

As a creative process designing is an alternation of the mentally-creative and mentally-formal activities of the engineer. Formal types of activities are for example: information storage and search; processing the results of experiments; drawing up documentation, etc. These activities in the total design time balance can take up to 40-70% and are relatively easy to automate with the help of the ECE and appropriate software[13].

For a thorough study of modern means of automation of design and construction methods of engineering analysis and integrated production systems it is necessary to acquire knowledge in the fields of Materials Science and Mechanics, Mechanics, Resistance of Materials, Elements, Fluid Mechanics, Theory of Mechanisms and Machines, Methodology of Design, Technology of Mechanical Engineering, Engineering Graphics, Informatics.

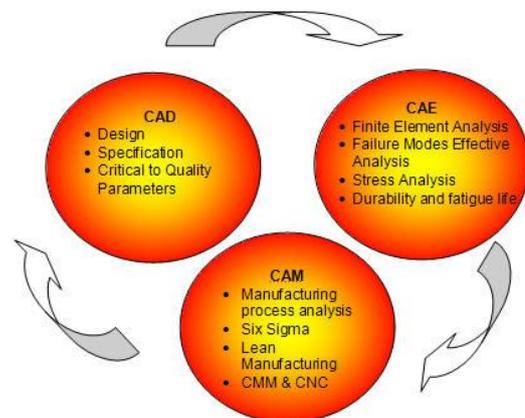
2. Researching the capabilities of information technologies for education in design.

Modern digital controllers (CNCs) offer advanced capabilities to increase productivity quality and implement an individual approach to each technical assignment. The programming and communication software based on a dialogue principle is the main focus. Undoubtedly the best form of organization of automated designing in the course of design training, 3D modeling, and visualization of the characteristic elements of armament are the automated design and manufacturing systems called Computer Aided Design (Computer Manufacturing), fig. 1.

Information Systems for Computer Design and Engineering (CAD/CAE) with their capabilities facilitate the acquisition of knowledge and practical habits in working with engineering

databases, engineering methods for calculation and analysis and simulation modeling in machine engineering.

The information support of the design and visualization of the distinctive armament elements is a set of activities for the creation and implementation in the work of machine-building organizations of computer networks and systems as well as various high-tech technical means (numerically controlled metal cutting machines, sensors, 3D printers, etc.) with corresponding information and programming capabilities in order to increase the efficiency and effectiveness of the management process and the life cycle of products.



CNC - computer (or computerized) numerical control

CMM - Coordinate Measuring Machines

Fig. 1 Connections between automated design systems modules of engineering.

The information support of the life-cycle management of the armament in the conceptual stage of designing of its individual details and mechanisms is expressed in assisting the engineering and designing activity by defining, forecasting and registering activities by assessing the suitability, feasibility and eligibility of the specified variants for the geometric description of digital models and computer simulation through the use of information systems[14].

The essence of the information systems in the private sector related to the maintenance of engineering solutions in the design of distinctive elements of the armaments in an organizational aspect can be defined as organizational-technical unification (complex) of bodies, automated workplaces, information resources (forces, means and systems), specialized peripherals, procedures and documents to ensure the handling, storage and provision of engineering support information at the design stage.

At this stage, there are many CAD/CAM/CAE systems that serve various functional areas of teams involved in the armament design process. The following section of the report presents the most used products for computer-engineered analysis and design.

2.1. Software products of Allplan Deutschland GmbH, Germany [1]:

- Allplan Engineering - integrated BIM / CAD design software.
- Allplan Architecture - object-oriented BIM/CAD software for designing all types of buildings.

2.2. Products of Altium, USA [2]:

- Altium Designer - CAD/EDA product for designing electronic circuits, embedded software, simulations, PCBs.

2.3. Autodesk Products, USA [3]:

- AutoCAD 2018 - a popular product for 2D and 3D design and construction on a global scale. The program offers innovations that provide more effective design and documentation that enables safer more accurate and seamless sharing of projects and drawings.

- AutoCAD LT 2018 - 2D drawing and detail design software with a focus on continuous productivity gain. Its comprehensive set of tools allows you to create, modify, and share drawings accurately and effectively. Using the original DWG file format ensures stability and interoperability when communicating with customers and colleagues.

- Autodesk AutoCAD Architecture 2018 - Special Software for Architects. Includes all the functionality of the standard 3D AutoCAD and adds specially designed architectural design tools that automate frequently recurring tasks and speed up the workflow. The DWG file format ensures seamless communication with colleagues and teams. Included visualization tools help ensure realistic presentation and early approval of the project.

- AutoCAD MEP 2018 - specialized CAD software for creating drawings in the water, electricity and HVAC section. Automates repetitive tasks by allowing engineers to create accurate documentation faster and communicate seamlessly with colleagues thanks to the DWG format.

- Advance Steel 2018 - a specialized product for designing structures. It allows the creation of BIM (Building Information Modeling) models and drawings of steel structures with integrated libraries and tools. Works as an AutoCAD upgrade. Version 2018 also includes AutoCAD 2018.

- Autodesk Revit - includes 3 modules with architectural, building and construction features:

- Autodesk Revit Architecture Module 2018 - BIM for architects providing integrated tools for building design and analysis. Shows each distinctiveness, drawing, 2D, and 3D view from the same database, automatically coordinating changes at all stages of project design and deployment. Helps to make more informed decisions in the early stages of the project.

- Autodesk Revit MEP 2018 Module - BIM for SIP, HVAC and HVAC Engineers. Provides special tools for design and analysis of building installations.

- Autodesk Revit Structure Module 2018 - a BIM-based design solution that provides custom-designed design, analysis, and documentation tools. BIM helps coordinate drawings, reduce

mistakes, and improves collaboration between the engineering and architectural team.

- Autodesk Revit 2017 includes Revit Architecture, Revit MEP, and Revit Structure as a single product for all majorities.

- Autodesk Robot Structural Analysis Professional 2018 - professional software for calculating building structures of all kinds. It offers functionality for thousands of analyzes, both static and dynamic, earthquake resistance analysis and hurricane winds.

- AutoCAD Plant 3D 2018 - 3D software for designing, modeling and documenting factory processes and industrial facilities (pipelines, equipment, bearing structures and other plant components, industrial buildings and wastewater treatment plants).

- Autodesk ReCap 2018 - Laser scanning data processing software initiated in digital CAD or BIM environments for building and refining specialized design software for renovation, reconstruction and rehabilitation projects.

- Autodesk Navisworks Simulate 2018 - combines design data from various specialists, including BIM and digital prototypes (DPs), in an integrated model that allows analysis and visualization of the project, as well as simulation of building processes for timely detection of errors.

- Autodesk Navisworks Manage 2018 - includes project review tools and more effective communication that combine multidisciplinary design data, including BIM or digital prototypes. Helps to detect inconsistencies prior to the construction phase, which reduces the cost and time to process the project.

- AutoCAD Mechanical 2018 [4] - Includes all the features of AutoCAD, as well as comprehensive automation tools for mechanical engineering tasks such as machine tool generation, sizing and distinctiveness of materials. AutoCAD Mechanical has a library of over 700,000 standard elements, supports multiple international drafting standards, and allows users to create details and documents using Autodesk Inventor-created digital prototypes. AutoCAD Mechanical makes engineers more competitive by helping them save hours of effort they can use for innovation rather than drawing. AutoCAD Mechanical for machine design offers users up to 70% faster performance than AutoCAD.

- AutoCAD Electrical 2018 [5] - a specialized version of AutoCAD designed distinctively for electrical engineering and automation, AutoCAD Electrical incorporates all AutoCAD tools plus a complete set of CAD design features for electrical design. Extensive libraries with ready-made components and tools for automating tasks in electrical engineering and automation help save hours of effort to allow engineers to devote more time to innovation.

- Autodesk Inventor Professional 2018 - 3D Parametric Modeling Tool. The only product on the market that has a 100% garnet relationship with two-dimensional drawings in original DWG format. It enables the creation of a complete digital prototype allowing the machine to be tested and optimized before it is produced. Inventor provides a vast array of tools for easy 3D design, error elimination and machine and detail optimization. Provides users with tools for dynamic simulation, cable, tracking, and pneumatics in 3D, as well as the ability to create and test tooling. With Inventor's capabilities, you can be more effective, reduce errors and create innovative projects at times faster.

- Autodesk Fusion 360 - Cloud-based platform for 3D CAD, CAM and CAE design of machines and products. Fusion 360 combines mechanical design capabilities, simulations, tools to improve collaboration, and the ability to prepare components for CNC machines. The Fusion 360 works in iOS for Mac and Windows PCs, allowing the use of the client's preferred operating system. Fusion 360™ is part of the AutoDesk product family for machine and product design and one of the core products in the Product Design Collection software package.

- Autodesk Vault Family 2018 - The Vault Series products help support teamwork as well as individual designers. Autodesk Vault works directly from Autodesk applications, such as AutoCAD and Inventor, allowing for secure storage of engineering data, sharing and sharing, retaining previous versions, approving changes, and more.

- Autodesk Nastran In-CAD 2018 - is a built-in CAD module for simulations using the Finite Elements method. Taken from Autodesk Nastran® Solver, this product offers users multiple analytics, including linear and non-linear stresses, dynamic simulations, and heat exchange. The product is available through network licensing, providing users with trouble-free work, eliminating the need for multiple individual simulation software. It delivers high-quality simulations in the CAD environment so you can test and create great products.

- Autodesk Inventor HSM is a solution that works in addition to Inventor Professional software and provides users with an integrated CAM system with 2.5 and 5-axis processing for CNC machines.

- Autodesk Alias 2018 - Product Designed for Machine Building and Product Design. Alias is used by 99% of all automotive manufacturers to create complex surfaces and shapes. In machine building, this program combines perfectly with the parametric model of Inventor and serves as a tool for modeling difficult by traditional methods such as propellers, screws, spirals,

- Autodesk Moldflow 2018 - Specialized Plastic Product Simulation Software, part of Autodesk's Digital Prototyping solution. This software offers tools that help manufacturers of plastics to test, optimize and validate their products and related manufacturing processes. Many companies use Autodesk Moldflow Adviser and Autodesk Moldflow Insight to reduce the need for costly prototypes, reduce the risk of potential manufacturing defects, and generally shorten the production process and bring their products to the market.

- Autodesk CFD 2018 - Specialized fluid simulation software - heat pumps, streams, swirling, etc. Designed for designers in their day-to-day work with a menu in familiar AutoCAD and Inventor environments. Autodesk CFD offers the ability to make calculations both on a local computer and in Autodesk Cloud Space. Works with models from all three dimensional CAD formats.

2.4. Autodesk Manufacturing products that provide effective control over a wide range of NC machines - lathes, 2-5 axis milling centers, wire erosion machines, Swiss lathes, robots [6]:

- PowerMILL - a high-end control system for milling NC machines.

- FeatureCAM - control of milling, lathe, lathe and wire erosion machines.

- PowerSHAPE - modeling system for surface and solid geometric objects.

- PowerINSPECT - Product Inspection Product and Equipment.

- ArtCAM - a system for modeling and production of artistic forms.

2.5. Bentley Systems, USA [7]:

- MicroStation (MicroStation, MicroStation PowerDraft, Bentley View) - one of the most popular global 3D CAD / GIS infrastructure design solutions.

2.6. Products of Dassault Systemes, France [8]:

- CATIA - high-end engineering solutions for 3D design and manufacture. They allow users to simulate the whole cycle of industrial process modeling, from the original idea, through product design to virtual assembling.

- 3DEXPERIENCE - an engineering and business platform for managing development and production projects. Provides access to project information through regulations for all project participants (constructors, production technologists, economists, project managers) as well as centralized storage and controlled information management.

- SIMULIA - high-end simulations.

- ENOVIA – Lifecycle and Management of Products.

- DELMIA - Production Management.

2.7. Products of Dassault Systemes Solidworks Corp., USA [9]:

- SOLIDWORKS - SOLIDWORKS 'CAD solutions cover all aspects of a product development process with a seamless, integrated workflow - design, verification, communication and data management. The main SOLIDWORKS software applications are as follows:

PRODUCT DATA MANAGEMENT (PDM): Allows you to easily find and redirect files, details and drawings, automate workflow, and secure production with the correct version of the tech. product data.

ELECTRICAL DESIGN: Combines the functionality of electrical circuits from SOLIDWORKS Electrical Schematic with 3D design capabilities of SOLIDWORKS Electrical 3D.

SIMULATION: Allows you to simulate a different real environment for pre-production product testing in the virtual environment of the program.

3D EXPERIENCE: SOLIDWORKS Mechanical Conceptual Makes Conceptual Design Your Business Advantage. Innovation in an instinctive, powerful modeling environment that allows for freedom in design.

2.8. Products of DP Technology Corp [10]:

- Esprit CAM - Automated, reliable and easy to use high-speed 3-axis and 5-axis CAM software. Using the knowledge of material handling, residual material, integrated simulation and ESPRIT testing provides fast, safe, and reliable CAM software for a wide variety of 3D operations. ESPRIT's high performance and capabilities include processing of any kind of solid geometry (Solid, Surface or Wireframe), universal postprocessors generate a G code for any machine on the market, the ability to simulate and verify programs gives optimal quality and integrity detail. ESPRIT is 100% compatible with Windows and provides a convenient and familiar environment for maximum productivity.

2.9. Products of EPLAN Software & Service GmbH & Co. KG

- EPLAN Electric P8 - an electrotechnical CAD system for designing circuits in electrical design and automation. The product covers all the needs of the electric designer when preparing the technical and installation documentation. The program can be designed with multiple automated functions, has large array of macros and technical information for products that are used in such projects.

2.10. Products of HCL Technologies

- CAMWorks - a fully integrated SOLIDWORKS CAM control system for all types of CNC machine tools.

2.11. Products of SIEMENS PLM Software [11]:

- NX - a high-end CAD / CAE / CAM solution for 3D modeling, engineering analysis, CNC and CMM control. NX encompasses and accelerates the whole process chain in the creation and production of end-to-end products - design, design and system engineering, design, FEM / FEA simulation and optimization, production drawings, technical preparation, off-line programming CNC machines, measurement procedures and robotized production.

- NX CAM2PART & MOLD - a comprehensive solution for machining parts, including CNC and robot programming, CNC machining simulation and CNC program validation, DNC and integrated metrology control.

- Solid Edge - Provides 3D CAD/CAE/PDM technologies from product design: Convergence Modeling, Reverse Design, Integrated Fluid Analysis, 3D Printing Tools. Synchronous technology for direct editing of own and external models. Solid Edge ST10 has built-in product data control (PDM) and Cloud collaboration.

- Tecnomatix - software for simulation and management of manufacturing processes and programming of robots. A complete portfolio of digital production solutions that enables product engineering, production engineering and manufacturing to be synchronized.

- Teamcenter - a software platform for digitization of businesses in manufacturing enterprises. Teamcenter centralizes product data management, manages team collaboration, and automates processes throughout the product's lifecycle - from conceptual ideas, through design, technical preparation to service servicing, and recycling of materials.

- SIMCENTER 3D - Provides a unified, scalable, open and expanded environment for 3D CAE simulations and engineering analysis with links to design, simulation, testing and data management. Simcenter speeds up the simulation process by combining the best-in-class associative geometry modeling tools with a wide range of FEM / FEA / CFD simulations. Helps engineers use the available 3D CAD geometry to quickly prepare the analysis. Unique management architecture in Simcenter 3D allows more efficient creation, assembly and management of large models, even with 3D details from multiple CAD systems, incl. CATIA, SOLIDWORKS, PRO-E / CREO, INVENTOR, STEP and IGES.

- PROCESS / TOOL SIMULATION PORTFOLIO - Operating alone or integrated with Solid Edge, NX, Catia, SolidWorks, PTC and other CAD solutions, these products extend the scope of engineering engineering beyond the typical CAD / CAM / CAE boundaries and ensure the most important competitive advantages for a manufacturing company: shorter time to realization of the order; lower cost of production; higher quality and reliability.

2.12. Products of Vectorworks, Inc., USA:

- Vectorworks Fundamentals - a basic CAD package that provides excellent 2D and 3D modeling capabilities combined with an intuitive and easy-to-use interface.

- Vectorworks Designer - gives you the freedom to design without the need for additional applications. The program provides a competitive advantage by offering a wide range of modeling tools in an intuitive interface.

- Vectorworks Architect - software for designers, architects and designers, providing creative freedom throughout the whole process - from idea / sketch to complete BIM (Digital Model Building). Unlimited 2D and 3D modeling is complemented by solid BIM functionality, excellent documentation and various intelligent tools such as the world-famous Parasolid 3D and Cinema 4D.

2.13. Autodesk CAE (USA) [3]:

- Autodesk Robot Structural Analysis Professional - software for static and dynamic analysis of building structures using the finite element method, sizing, constructing, detailing and generating drawings and reports. It offers engineers tools for in-depth BIM analysis and design, for easier understanding of the work patterns of different constructions and verification of compliance codes. The product uses BIM technology and supports a two-way connection with Autodesk Revit.

2.14. Additive manufacturing technologies and 3D printing of 3D SYSTEMS [12]:

- ProX - the production and professional 3D printers offer the benefits of additive technology to produce a wide range of functional prototypes, spare parts, small and medium series of plastic details, dental and surgical products, and more. The 3D printing capabilities in metal, with solid, thermoplastic plastics and elastomers offer a real alternative to manufacturers looking for competition. 3D Printers ProX Direct Metal Printing produces metal parts and nodes with high precision and high metal density (96% - 100%) of a wide range of metallic powders with proven mechanical properties. The ProX DMP 100, 200 and 300 printers include the most flexible industry parameter control settings. The ProX DMP 320 complements the range of metal printers with the ability to build large-scale titanium alloy models and manage from one controller the parallel operation of 3 printers.

- Creaform's 3D scanners for reverse engineering and inspection

- 3D Stratasys printers - designed for conceptual design, prototyping and direct production, based on FDM and PolyJet technologies.

3. Conclusion.

The analysis of the listed products for computer-engineered analysis and design gives reason to summarize that different CAD/CAM products provide a variety of management databases, system and application software. However, they are compatible (or have integration capabilities) with Microsoft products as well as MS Project and MS SharePoint products, and this facilitates training, training and the work of engineering staff.

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