ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 10, October 2024

Modern Engineering Programs in the Mechanical Engineering Industry

Shokirov Murodjon Qobil o'g'li

Director of LLC "TRANS NEW MILLENIUM", Tashkent, Uzbekistan.

ABSTRACT: Computer-aided design systems facilitate and speed up work, expand capabilities, ensure effective planning and management of a group of designers, data compatibility, consistency and timely updating, unification and standardization of design, technological, production, marketing, operational documentation. Software packages for automated design systems are among the most complex modern software systems, including modern means of computer graphics, mathematical modeling, programming in high-level languages, database management systems, information exchange technologies and distributed computing.

KEYWORDS: CAD, CAM, CAE, 2D, 3D, CATIA, KOMPAS, NX CAD

I. INTRODUCTION

Computer-aided design system - an automated system implementing information technology for performing design functions, is an organizational and technical system designed to automate the design process, consisting of personnel and a set of technical, software and other means of automating its activities.

CAD can be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces and solids in three-dimensional (3D) space [1].

CAD is an important link in industrial design, widely used in many industries, including the automotive, shipbuilding and aerospace industries, industrial and architectural design, prosthetics and many others. CAD is also widely used in the creation of computer animation for special effects. Because of its enormous economic importance, CAD has become a major driving force in research in the fields of computational geometry, computer graphics (both hardware and software) and discrete differential geometry. The abbreviation CAD (computer-aided design) is often used to translate CAD into English, implying the use of computer technologies in design. However, this phrase is given as a standardized English-language equivalent of the term "automated design". The concept of CAD is not a complete equivalent of CAD as an organizational and technical system. The term CAD can also be translated into English as CAD system, automated design system, CAE system. A number of foreign sources establish a certain subordination of the concepts CAD, CAE, CAM [2].

II. FORMULATION OF THE PROBLEM

Design work includes numerous aspects, each of which is responsible for a particular type of program according to its intended purpose. There are 3 types:

1. CAD (Computer-Aided Design) - the stage of actual design and construction of schemes. Intended directly for modeling two-dimensional or three-dimensional projects, as well as for creating technological and design documentation. The category includes the subcategories CADD and CAGD, the tools of which are responsible for creating drawings and forming geometric models, respectively.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 10, October 2024

2. CAE (Computer-aided engineering) - an engineering analysis program that calculates data. Products for simulating and studying physical processes, performing design calculations, dynamic testing and optimization of projects. A separate subcategory is CAA, including software for computer analysis.

3. CAM (Computer-aided manufacturing) - a module for managing the results of the two previous devices. They are used at the stage of preparing a product for release, used to control equipment with numerical control or flexible automated manufacturing systems for the manufacture of products.

It is worth noting that many CAD systems are a combination of two or more of the above aspects. The most common combinations are CAD / CAM, CAD / CAE / CAM and CAD / CAE.

In fact, all three technologies interact and provide the ability to carry out a full cycle of designing objects of any complexity in one program. The joint use of programs ensures efficient development and production.

Modern software packages for computer-aided design range from 2D vector drawing systems to 3D solid and surface models. CAD packages also often allow rotation in three dimensions, allowing you to view the designed object from any desired angle, even from the inside out [3]. Some CAD programs are capable of dynamic mathematical modeling. CAD technology is used in the design of tools and mechanisms, as well as in the design of all types of buildings, from small residential buildings to the largest commercial and industrial structures. The main goal of creating CAD is to improve the efficiency of engineers, including:

- reducing the labor intensity of design and planning;
- reducing design time;
- reducing the cost of design and manufacturing, reducing operating costs;
- improving the quality and technical and economic level of design results;
- reducing the costs of full-scale modeling and testing.

These goals are achieved by:

- automating the execution of documentation;
- information support and automation of the decision-making process;
- using parallel design technologies;
- unification of design solutions and design processes;
- reuse of design solutions, data and developments;
- strategic design;
- replacing full-scale testing and prototyping with mathematical modeling;
- improving the quality of design management;
- using methods of variant design and optimization.

III. TYPES OF CAD SOFTWARE

A set of similar components forms a CAD support tool. The following types of CAD support are distinguished:

• Technical support (TS) — a set of related and interacting technical means (computer, peripheral devices, network equipment, communication lines, measuring instruments).

• Mathematical support (MS), which combines mathematical methods, models and algorithms used to solve automated design problems. According to the purpose and methods of implementation, it is divided into two parts:

- mathematical methods and mathematical models built on them;
- formalized description of the automated design technology.

• Software (SW). It is divided into general system and application:

- application software implements mathematical support for the direct execution of design procedures. Includes application software packages designed to service specific stages of design or solve groups of similar problems within different stages (pipeline design module, circuit modeling package, CAD geometric solver).
- General system software is designed to manage hardware components and ensure the operation of application programs. An example of a general system software component is an operating system.

• Information support (IS) is a set of information required to perform design. Consists of a description of standard design procedures, typical design solutions, components and their models, design rules and regulations. The main part of the CAD IS is the database.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 10, October 2024

• Linguistic support (LS) is a set of languages used in CAD to represent information about designed objects, the design process and tools, and data exchange between CAD hardware. Includes terms, definitions, rules for formalizing natural language, compression and expansion methods.

 In linguistic support, a class of various types of design and modeling languages is distinguished (VHDL, VERILOG, UML, GPSS).

• Methodological support (MS) is a description of the CAD functioning technology, methods for selecting and applying technological techniques by users to obtain specific results. Includes the theory of processes occurring in the designed objects, methods of analysis, synthesis of systems and their components, various design techniques.

• Organizational support (OS) is a set of documents defining the composition of the design organization, the relationship between departments, the organizational structure of the object and the automation system, activities in the conditions of the system's operation, the form of presentation of the design results.

In CAD as a designed system, ergonomic and legal support are also distinguished [4].

• Ergonomic support combines interrelated requirements aimed at coordinating the psychological, psychophysiological, anthropometric characteristics and capabilities of a person with the technical characteristics of automation equipment and the parameters of the working environment at the workplace.

• Legal support consists of legal norms governing legal relations during the functioning of CAD, and the legal status of the results of its operation.

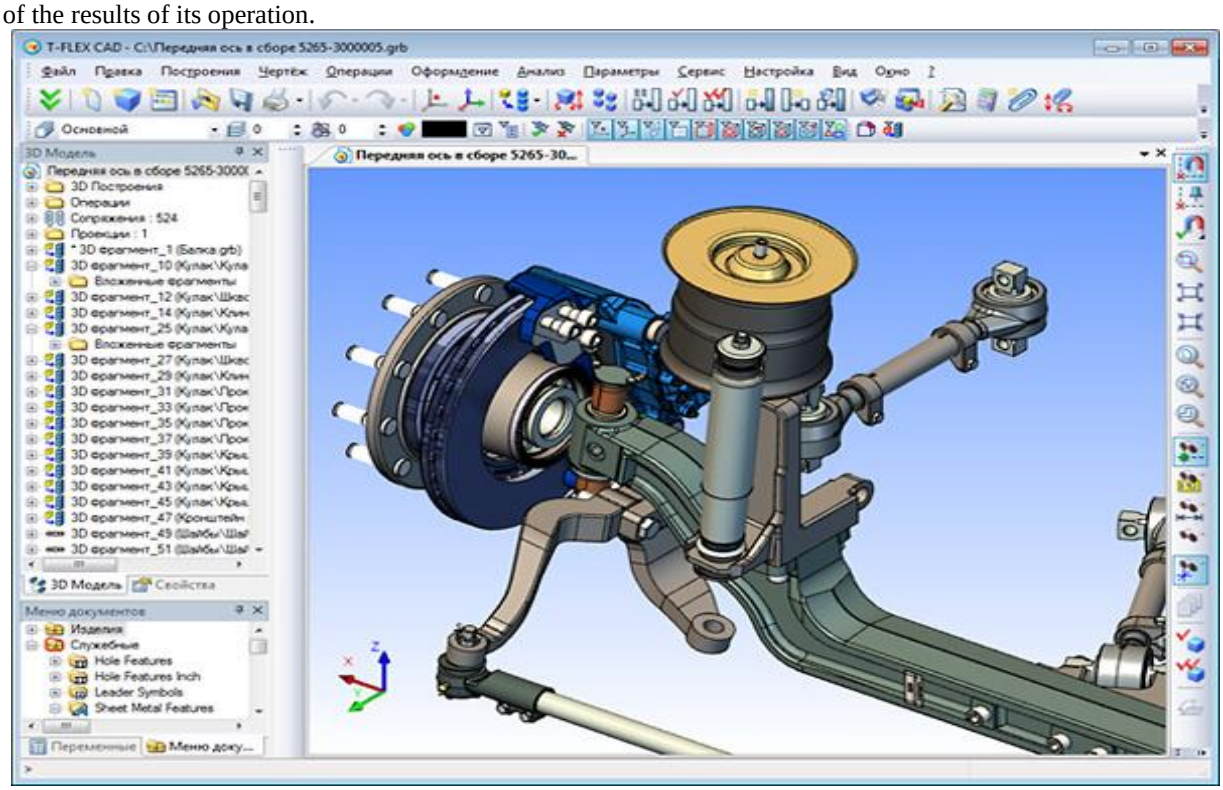


Fig. 1. Modeling in the CAD system.

The scope of application is determined by the industry purpose of a particular automation complex. According to this feature, the classification has 3 main types:

MCAD (eng. mechanical computer-aided design) – automated design of mechanical devices. These are mechanical engineering CAD systems, used in the automotive industry, shipbuilding, aerospace industry, production of consumer goods, include the development of parts and assemblies (mechanisms) using parametric design based on structural elements, surface and volumetric modeling technologies (SolidWorks, Autodesk Inventor, KOMPAS, CATIA, T-FLEX CAD);

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 10, October 2024

EDA (eng. electronic design automation) or ECAD (eng. electronic computer-aided design) – CAD of electronic devices, electronic equipment, integrated circuits, printed circuit boards, etc., (Altium Designer, OrCAD);

AEC CAD (architecture, engineering and construction computer-aided design) or CAAD (computer-aided architectural design) – CAD in the field of architecture and construction. Used for designing buildings, industrial facilities, roads, bridges, etc. (Autodesk Architectural Desktop, AutoCAD Revit Architecture Suite, Bentley MicroStation, Bentley AECOsim Building Designer, Piranesi, ArchiCAD, Renga) [5].

IV. ANALYSIS OF COMPUTER-AIDED DESIGN SYSTEMS

To work effectively with existing software and create macros and programs that automate the design process, the user must have an idea not only of the environment in which he works, but also of the principles that underlie it. Fundamental knowledge will help to quickly study any specific system with a specific environment and use it as efficiently as possible.

Recently, the problem of choosing CAD/CAM/CAE systems has become quite relevant. Let's consider some of the most common automated design systems:

1. CATIA is an automated design system from the French company Dassault Systèmes. The CATIA (Computer Aided Three-dimensional Interactive Application) system is one of the most common high-level CAD systems. It is a comprehensive system of automated design (CAD), technological preparation of production (CAM) and engineering analysis (CAE), which includes advanced three-dimensional modeling tools, subsystems for software simulation of complex technological processes, advanced analysis tools and a single database of text and graphic information. The system allows you to effectively solve all the tasks of technical preparation of production - from external (conceptual) design to the release of drawings, specifications, assembly diagrams and control programs for CNC machines. The latest version of the system was developed in 2018 and is called P3 V5-6 R2017 SP3.0. There are many online tutorials that will facilitate the learning process. In addition, the user interface is convenient.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 10, October 2024

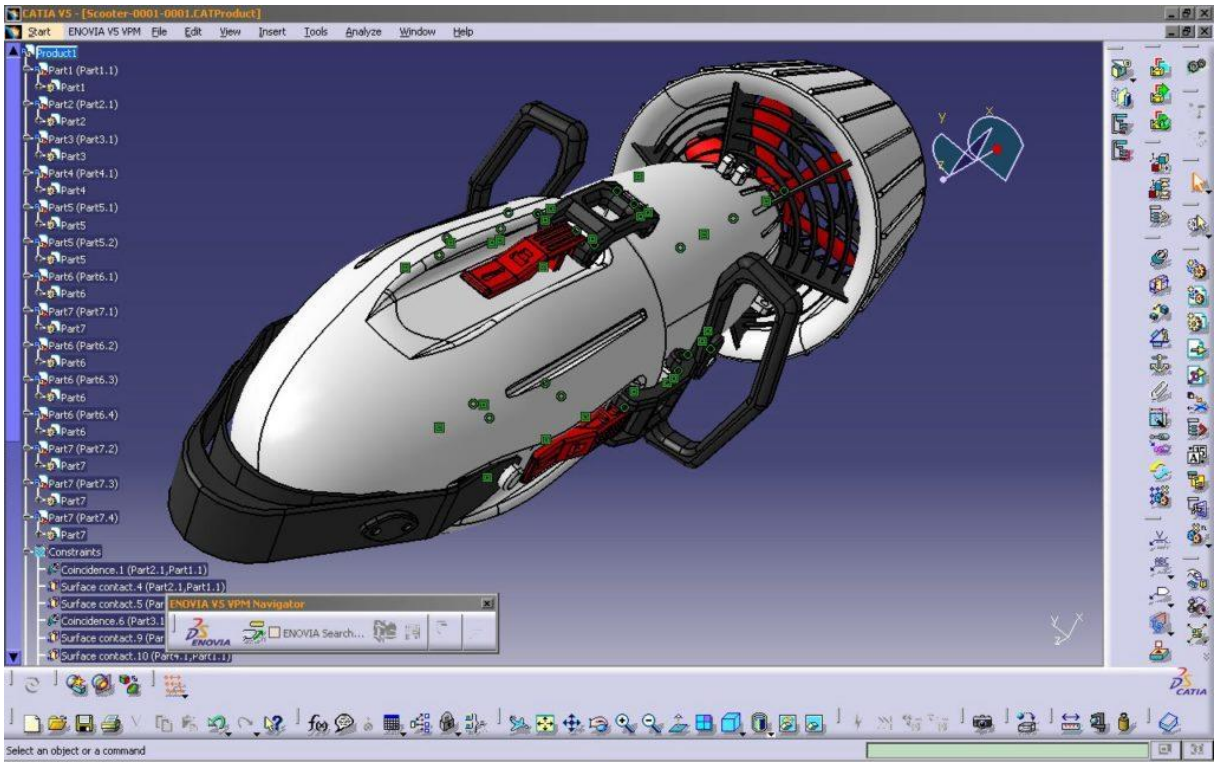


Fig. 2. Project in the CATIA system.

2. SolidWorks is a CAD software package for automating industrial enterprise operations at the stages of design and technological preparation for production. Provides development of products of any complexity and purpose. Works in the Microsoft Windows environment. Developed by SolidWorks Corporation.

The SolidWorks software package includes the basic configurations SolidWorks Standard, SolidWorks Professional, SolidWorks Premium, as well as various application modules:

- Engineering data management: SolidWorks Enterprise PDM;
- Engineering calculations: SolidWorks Simulation Professional, SolidWorks Simulation Premium, SolidWorks Flow Simulation;
- Electrical design: SolidWorks Electrical;
- Development of interactive documentation: SolidWorks Composer;
- Mechanical processing, CNC: CAMWorks;
- NC verification: CAMWorks Virtual Machine;
- Quality control: SolidWorks Inspection;
- Manufacturability analysis: SolidWorks Plastics;

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 10, October 2024

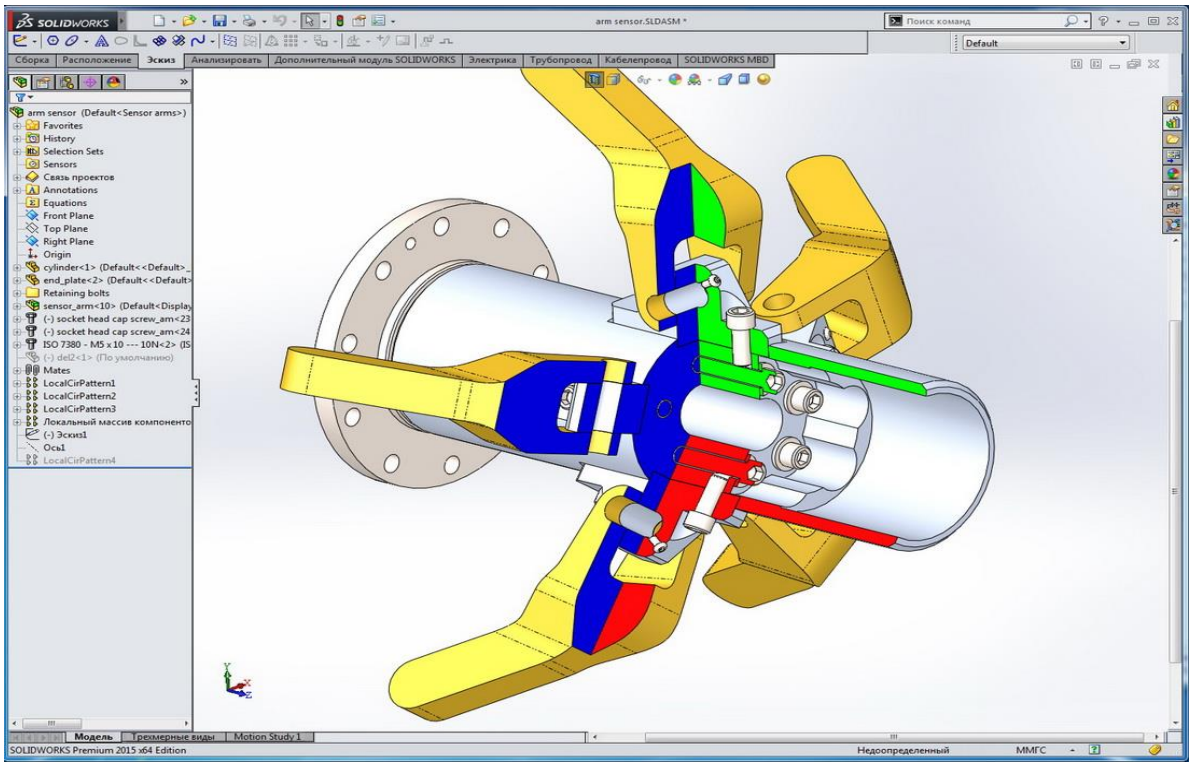


Fig.3. Project in the SolidWorks system.

3. "Kompas 3D" is a family of automated design systems, a universal automated design system that allows you to quickly produce product drawings, diagrams, specifications, tables, instructions, calculation and explanatory notes, technical conditions, text and other documents.

Developed by the Russian company "Ascon". The name of the line is an acronym for the phrase "complex of automated systems". The trademarks are written in capital letters: "KOMPAS".

"Kompas" is released in several editions: "Kompas-Graphic", "Kompas-Builder", "Kompas-3D", "Kompas-3D LT", "Kompas-3D Home". "Kompas-Graphic" can be used both as a fully integrated module for working with drawings and sketches in "Kompas-3D", and as an independent product providing tools for solving 2D design problems and issuing documentation. "Kompas-3D LT" and "Kompas-3D Home" are intended for non-commercial use; "Kompas-3D" does not allow opening files created in these programs without a specialized license.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 10, October 2024

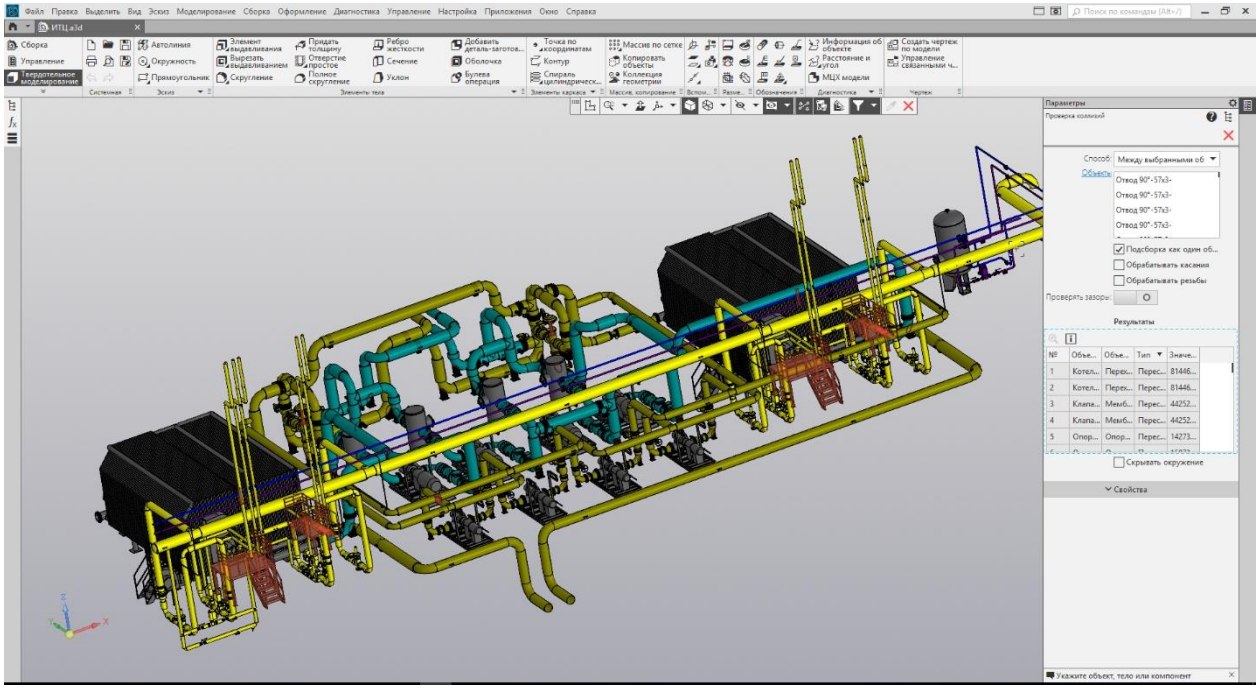


Fig. 4. Project in the Compass-3D system.

4. NX CAD (formerly Unigraphics) is a tool for two-dimensional and three-dimensional design of parts and assembly units of products, as well as preparation and release of design technological documentation. NX CAD is a CAD/CAM/CAE system produced by Siemens PLM Software. The program uses the Parasolid geometric modeling kernel. NX supports a wide range of operating systems, including UNIX and Linux, Mac OS X, Windows with the ability to simultaneously use several operating systems.

NX software has been successfully implemented and used in many industries, its capabilities for production have been tested in the aerospace industry, automotive industry, in the production of medical equipment, the manufacture of molds and stamps, as well as in mechanical engineering.

The NX system implements the concept of an adaptive interface that can be adjusted to the needs of any user, depending on the tasks performed and the level of mastering the system.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 10, October 2024

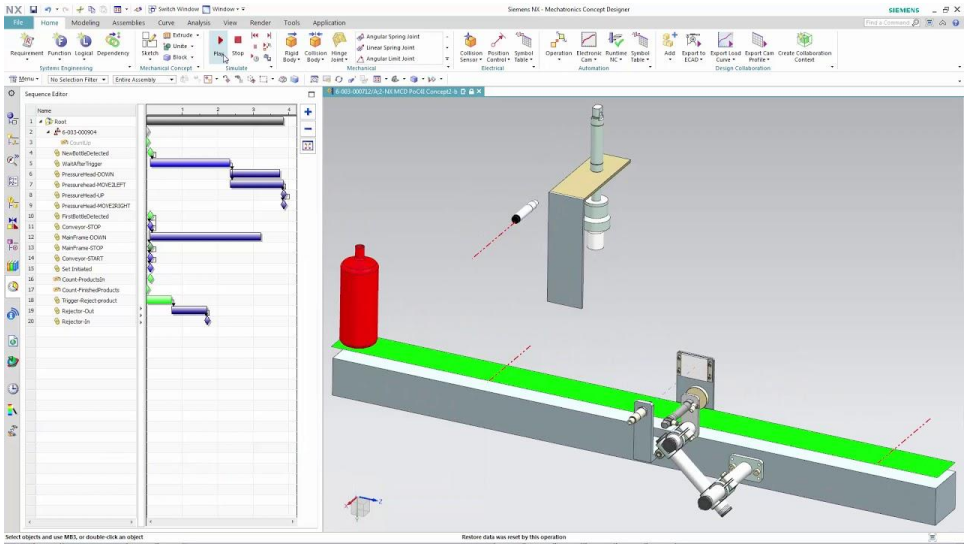


Fig.5. Project in the NX system.

V.CONCLUSION AND FUTURE WORK

Modern businesses cannot survive in the global competition unless they can produce new products of better quality, at a lower cost, and in less time. Therefore, they seek to use the enormous power of computers, their high speed, and the possibilities of user-friendly graphical interfaces to automate and link previously tedious and completely unrelated design and manufacturing tasks. In this way, the time and cost of developing and releasing a product are reduced.

Computer-aided design, computer-aided manufacturing, and computer-aided engineering or design technologies are used for this purpose.

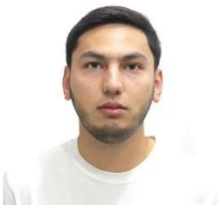
The astonishing growth in computer processing power and the widespread use of design and manufacturing software have meant that engineers can use computer-aided design systems to solve everyday problems, not just to prepare visual illustrations. International competition, an increasing number of experienced specialists, and increased quality requirements are forcing business owners to automate design and manufacturing.

REFERENCES

[1] Kunwoo Lee. Principles of CAD/CAM/CAE: The Computer Aided Engineering Design Series. 5st Edition. Addison Wesley Longman, USA, 2015.
[2] Gu N. (ed.). Computational Design Methods and Technologies: Applications in CAD, CAM and CAE Education. – Igi Global, 2012.
[3] Machado C., Davim J. P. (ed.). Industry 4.0: Challenges, trends, and solutions in management and engineering. – CRC press, 2020. P 273.
[4] Chaturvedi D. K. Modeling and simulation of systems using MATLAB and Simulink. – CRC press, 2017. P 693.
[5] Chang K. H. Product design modeling using CAD/CAE: the computer aided engineering design series. – Academic Press, 2014. P 409.
[6] Madsen D. A., Madsen D. P. Engineering drawing and design. – USA: Cengage Learning, 2016. P 1030.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 10, October 2024

AUTHOR'S BIOGRAPHY



Shokirov Murodjon Qobil o'g'li
was born February 03, 1998 year in Tashkent city, Republic of Uzbekistan. Has more than 8 published scientific works in the form of articles, journals, theses and tutorials.