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DATA PROCESSING OF TECHNOLOGICAL PROCESSES IN MECHANICAL ENGINEERING

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***Abstract* -** during intensive process of industrial manufacturing engineers has to find new ways and services for creation of modern manufacturing equipment.The problem of setting the peculiarities of interconnections parameters of the multiparameter technological systems in mechanical engineering is set and solved in the work. The article describes the developed mathematical model of dependencies of input and output data for the technological system in the field of machine-engineering.The stages of data collection, analysis and processing of information for the creation of machine-building products are presented. The main result this is to take into account the peculiarities of the receipt information flows about the essence of the project of manufacturing the product of mechanical engineering.

***Keywords* - input parameters, factor model, mechanical engineering, planning process, technological process.**

Introduction Planning of the production process is an important stage in modeling and implementation of products. It allows to optimize the work of multi-parameter technological systems. During planning process it is essential to create a detailed work breakdown structure before the product is presented to the customer.The current state of automation of modeling stages requires thorough planning, data processing and data management during mechanical engineering products manufacturing. Modern computer technologies contain a wide range of programs that allow to automate each stage [1]. Manufacturing starts from collecting of maximum amount of product or a series of products data that are going to be created [2]. One of the components of planning process is the process of data collection for the production part, design development and a graphical part that can be considered as part of the production process[3,4].These stages are included in the manufacturing process, which is described as a multi-parameter system.

The influence of many parameters on the technological process requires the construction of a conceptual clustered model, whichcontains determined relationships between all parameters and their impact on the model being created.

One of the key factors in the world of mechanical engineering is usage of the CAD/CAM/CAPP systems [4, 5], since such systems allow to plan certain steps in machine modeling and engineering. It is important to construct afactor model that establishes relationships between the parameters of the technological process of parts processing and also to represent the input data by means of CAPP systems.

In mechanical engeneering industry [6,7], when building relationships of different parts of the technological process it is very important to take into account specifics of technological process itself.

Problem Statement Analysis and research of multi-parameter technological systems requires the use of detailed algorithms that allow processing of input data and help to predict output data.The designer acts as a manager, combining two roles - a developer and a problem solver.

In the process of solving problems, he encounters many challenges, faces non-typical problems and still needs to make a decision for solvingtrivial orcomplex task. In manufacturing decision making and acting should be immediate and accurate to avoid resources utilization issues. For an engineer, the process of decision-making and problem-solvingcontains of following steps:

1. Identify the problem
2. Perform root cause analysis and collect relevant all data.
3. Create arelationship diagram of the parameters causing the problem.
4. Determine technical means for achieving the goal.
5. To choose a fast and optimal path for problem solving.

Related Works For a mechanical system it is important to research how to decrease it weight and guarantee best parameters in strength, stiffness, stability, load on structural elements. On initial design stage, a sufficient amount of input data. which ensures further design of technological equipment in analized. In the mechanical system the adjustments object is imfluenced by both stimulating and regulating actions. Control system controls numeric parameters and keeps them aligned with technological process requirements.One of the key components is organizing and planning of the manufacturing process, in particular, setting up of the engineering part in production, which is formed by multiple factors.

Let's determine keylife-cycle stages of machine-engineering products: processing the order, that is, data analysis, creation of 3D models, working drawings, compiling a mathematical model. As a result of data analysis, a technical task is formed, which determines the effectiveness of further cooperation between the customer and the engineer. The next stage is the selection of methods and tools for project implementation, in particular, the selection of the CAD/CAE/CAM and CAPP systems, the DFMA methodology, which is effectively used for technical experiments to demonstrate to the team of designers the features of the product structure, reduce costs, improve and simplify the structure of production, eliminate inefficiencies in product design. Next is the process of manufacturing, selling a product or a series of products. Serial production of products begins after approval by the customer of the final version of the technical documentation. The manufacturer also makes technical specifications - a normative document that defines the requirements for the product, further support of production. Management and implementation stages includefollowing components: determine production conditions, provide appropriate technical equipment for employees of manufacturing line (turners, electricians, etc.), work with staff and customers, sales, analysis of products of competitor manufacturers, representation of the company on the market, waste management without harm to the environment. One of key components in the life cycle of a product is the stage of geometric modeling and processing of the part, executed in CAD/CAE/CAM environment. Let’s analyze the process of designing machine equipmentand mechanisms by means of CAPP systems.

The first step is to create a sketch project, which in turn is a step of the process of geometric modeling of parts. Such systems allow users to control the process of creating the product, detect and promptly correct errors, create new and leverage existing databases. Qualitative improvement of constructions of mechanical engineering products - is the result of processexecution. Product construction parameters, such as characteristics of strength, durability, interchangeability, processability, simplicity of manufacture, etc. are key components of the developed conceptual model.

The listed features of such interaction are reflectedby implemented conceptual model of the organization of the engineering part in manufactuing (Fig. 1).

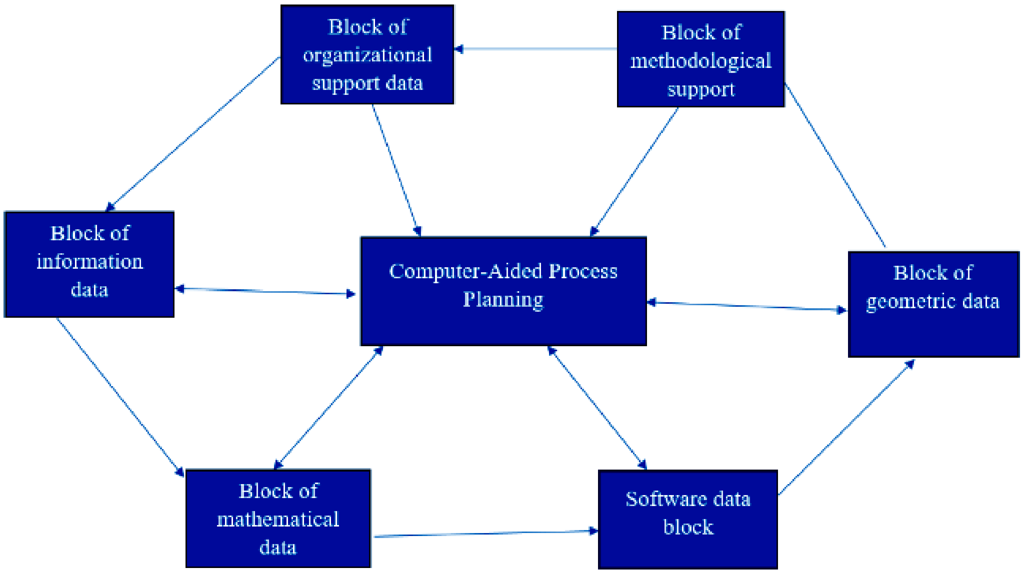

Figure1. Conceptual model of the organization of the engineering part in manufactuing

The proposed structure allows promptly to receive the optimal result of the work of CAPP systems, as it contains a full spectrum of functional nodes,neededby a technologist to ensure organization and further planning of the production process, such as: project metadata, results of data analysis contributing to the order, data processing and data flow, creation of databases.The block of mathematical data - is a mathematical model of the task, calculations, as well as relationships of input and output parameters of the investigated process of product manufacturing. The conceptual model provides relationships between data clusters for different types of CAD systems provisioning.In the "Information Data" block, project description and metadata, scientific research, analysis of order data, description of technical task implementation and process of creation of the database should be provided.Mathematical description blockcontains mathematical models and interconnections of various parameters of a technological object.The software package block contains executable applications, including CAD/CAE/CAM environment for building 3D models, as well as CAPP systems, allowingto create technological process of parts processing.The geometric modeling block is connected with product design, in particular via sketch design.The sketch designing stage contains visual model of a technical detail or equipment.This block consists of 2D- and 3D-modeling.Implemented model of the detail is imported into CAPP environment, where its processing is executed.The following block contains methodical support.At this stage product requirements and specifications are created including, but not limited to: technical documentation, environmental conditions, functional and non-functional requirements.These requirements should not contradict with industry standards.The organizational support block contains contact information of developers and staff that support project life-cycle, as as the list of technical components that quarantee production process execution. A very important rolein implementation of production modelingapplications and machine-building products manufacturing -plays the creation of a data center for this cluster, which stores all project related data and metadata.Such data structure allows to increase the efficiency, performance and quality of data processing, as well as improve intercation with data interaction withinthe cluster.We compiled a factor mathematical model, *Mod*, which describes the relationships between the data parameters:

$$Mod = (Is, Gkom, Tn, Mid, Fop), \tag{1}$$

Is – is a set of input data,neededfor creation of project's technical specification;

Gkom - is a graphical component, which contains the results of sketch design, and 3D modeling, in particular;

Tn – is a set of time units for capturing and processing data flows;

Mid – is a set of primary results, obtained after processing of the input data, in other words, results of manufacturing, testing and enhancing of the prototype, etc.;

Fop – is a set of organizational factors that affect design, processing, and manufacturing of engineering models.

Let's review the information stream Is (1). Information about the project can be received from individual streams $I_1, I_2, \ldots, I_s$, as well as from multiple streams of input data I_q

$$I_q = \sum_{i=1}^{s} I_1 + I_2 + \cdots I_i + \cdots + I_s. \tag{2}$$

Cloud data services not only can be used for client-server data transfer and exchange needs, but also they allow to effectively process and store the data.The model of work of engineer-mechanic by means of Cloud services is very important in the process of creating the product (Fig. 2).

Engineers can leverage following Cloud services for developing of their mechanical details models: A360, GstarCAD, CADPockets, AutoCAD360 PRO and Fusion 360 (Fig. 2).

The presented model describes the process of interaction between engineer and client as well as engineering team and a client, who design product models in CAD / CAE / CAM systems, based on various input parameters.It is highly recommended to store preliminary results of all stages of development in cloud environment.

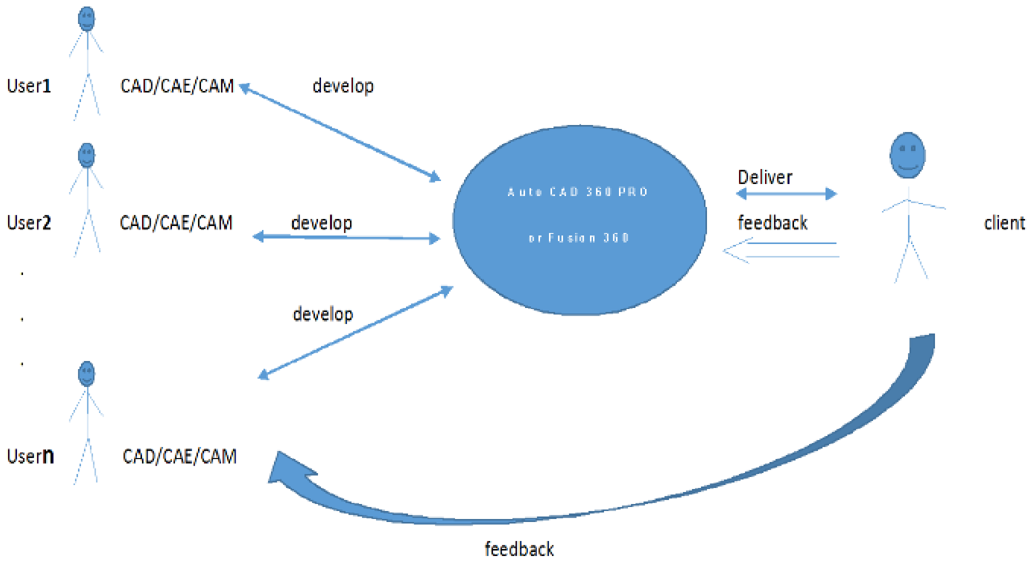

Figure 2. The model of implementation of mechanical details design inCloud environment

By means of cloud services and their capabilities, the client can promptly interfere in development process, provide valuable feedback, add improvements and enhancements, thus improving time-to-market.

Cloud environment can not only be used for modeling, transferring schemes and drawings, but also as a primary way of interaction with client, as well as for creation and maintenance of project documentation and supporting materials.

In result of modeling all received information, data and metada about the project as a whole is being processed.

Let's analyze the time component *Tn*, which can be described by the following time streams in the system: the time of receiving initial information about the project, initially received data processing time, time of obtaining of the results, results exchange and verification time, ("developer-customer" dialogue), production time, etc.

Thus, the time component T_k can be represented as multiple streams of time data:

$$T_k = \sum_{i=1}^{k} T_1 + T + \cdots T_i + \cdots + T_k, \quad (3)$$

or each individual time flow can be described separately $T_1, T_2, \ldots, T_i$, …, T_k .

Model application example. Let's reviewan example of creation of technical process of parts processing in the CAPP system. The first stage involves graphic modeling and creation of working drawings and 3D models in CAD system environment and their further importing into CAPP Vertycal (Fig. 3).

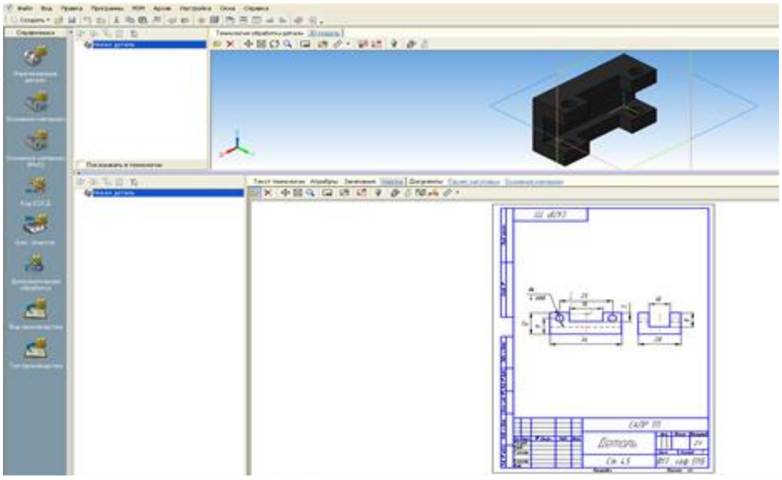

Figure 3. Creation of drawing and 3D model in CAD system

The next step is to analyze the structure of the details. The engineer-mechanic should analyze all received information and project data in accordance with (2), think over the technological path of details processing and manufacturing prior to its creation in the CAPP system.So, one needs to work out several steps in advance before starting to create a technological process. Then it is necessary to enter the processed data into the CAPP system and form a set of technical documentation.All steps of creating of technological process the engineer-mechanic analyzes based on (3) and later he can gradually create a technological path. Fig. 4 illustrates results of holes formation stageimplementation.

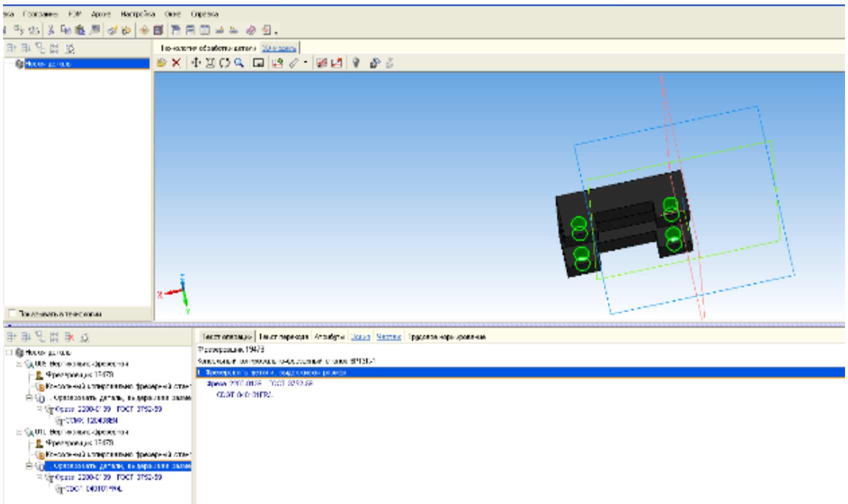

Figure 4. The stage of forming the holes

The engineer has to choose the appropriate tool that meets the technological requirements for the construction, such as dimensions of the holes and their location within this detail. Among all available tools in the system (Fig. 4), the spiral drill was selected (Fig. 5).

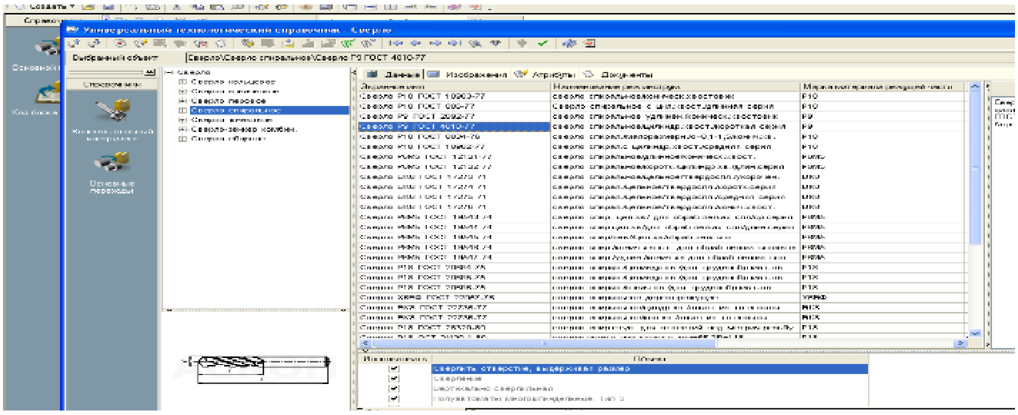

Figure 5. Choosing a tool for hole formation

The technologist also selects a specialist who will perform this operation, for example, a driller (Fig. 6).

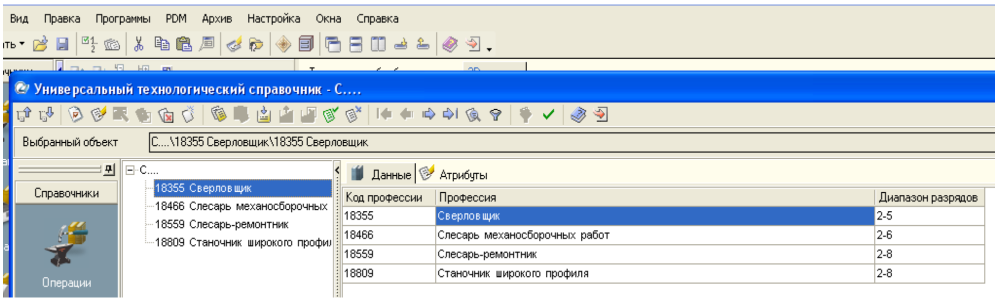

Figure 6. The choice of a specialist

These data are necessarily added to the overall technological process description.

Also you can specify the factory and inventory number, repair date, workshop number and site number, etc in the Attributes tab of this directory.

All data contained in the Attributes section for each instance of equipment are made in the form of directories. The set of attributes depends on the type of equipment. These attributes can be entered and changed by the engineerbut he must have access rights to the attributes of the technology system.

Fig. 8 shows a part of a technological process. It includes the names of technological operations and transitions, information about equipment, tools, personnel. This systemhelps the designer to organize the "engineer-client" received information flows for the implementation of the project.

Conclutions The main result this is to take into account the peculiarities of the receipt information flows about the essence of theproject of manufacturing the product of mechanical engineering. The model of interaction of elements in the "engineer-client" system is developed. A model of the life cycle of machine-building products has been created. This model allows to take into account sufficient for engineering calculations the number of interconnections of parameters that are important at the stage of development and production of quality products and support the production process. As a result the conceptual model of the engineering part in the production is created.

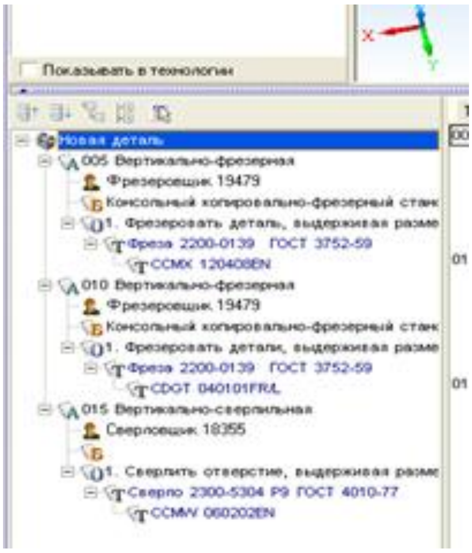

Figure 8. The created part of thetechnological process

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ОБРОБКА ДАНИХ ТЕХНОЛОГІЧНИХ ПРОЦЕСІВ У МАШИНОБУДУВАННІ

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Анотація

В роботі поставлено і розв’язано проблему встановлення особливостей взаємозв’язків параметрів багатопараметричних технологічних систем у машинобудуванні. Показано, що у процесі інтенсивного розвитку промислового виробництва, зокрема потокового виробництва, виконання спеціальних замовлень передбачає широке залучення інформаційних технологій для створення сучасних засобів виробництва. Встановлено, що важливими постають питання взаємозвязків вхідних даних та їх вплив на зміну одержаних вихідних технологічних параметрів. Розроблено та описано математичну модель залежностей вхідних та вихідних даних для технологічної системи у галузі машинобудування.

Подано етапи збору даних, аналізу та оброблення інформації для створення виробів машинобудування, зокрема, електронної промисловості.

Ключові слова: вхідні параметри, математична модель, вироби машинобудування, процес планування, технологічний процес.

ОБРАБОТКА ДАННЫХ ТЕХНОЛОГИЧЕСКИХ ПРОЦЕССОВ В МАШИНОСТРОЕНИИ

Лясковская С. Е.

Аннотация

В работе решена проблема определения особенностей взаимосвязей параметров многопараметрических технологических систем в машиностроении. Показано, что в процессе интенсивного развития промышленного производства, в частности поточного производства, выполнения специальных заказов предусматривает широкое привлечение информационных технологий для создания современных средств производства. Установлено, что важными являются возникающие вопросы взаимосвязей исходных данных и их влияние на изменение исходных технологических параметров. Разработаны и описаны математические модели зависимостей исходных и выходящих данных для технологической системы в области машиностроения.

Представлены этапы сбора данных, анализа и обработки информации для создания изделий машиностроения, в частности, электронной промышленности.

Ключевые слова: исодные параметры, математическая модель, изделия машиностроения, процесс планирования, технологический процесс.