EVALUATION OF THE POSSIBILITIES FOR JOINT OPERATION OF ENGINEERING DESIGN SYSTEMS AND OTHER NEW INFORMATION TECHNOLOGIES IN DESIGNING SPECIFIC MILITARY EQUIPMENT ELEMENTS

ОЦЕНКА НА ВЪЗМОЖНОСТИТЕ ЗА СЪВМЕСТНА РАБОТА НА АВТОМАТИЗИРАНИТЕ СИСТЕМИ ЗА ИНЖЕНЕРЕН ДИЗАЙН И ДРУГИ НОВИ ИНФОРМАЦИОННИ ТЕХНОЛОГИИ ПРИ ПРОЕКТИРАНЕТО НА ХАРАКТЕРНИ ЕЛЕМЕНТИ ОТ ВЪОРЪЖЕНИЕТО

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Abstract: *The report explores the possibilities for joint application of modern software packages for computer-aided design, engineering and manufacturing on the one hand and other ERP & MES information technologies on the other.*

KEYWORDS: INFORMATION SYSTEMS, INTEGRATION, ARMAMENT, ENGINEERING DESIGN.

1. Introduction.

Over the last few decades, CAD/CAM/CAE systems have reached a very high level of development and application primarily on the basis of the development of computing, applied mathematics, and information technology. From the first generation of engineering software known as "electronic drawing", they have developed into fully integrated design, manufacturing and engineering systems with rich functionality. Their use in the design of products and the accompanying technological processes led to an increase in the quality of the production, shortening the terms of the idea to product realization, flexibility in the market changes and the requirements of the consumers.

The productivity and capabilities of SAP/CAM systems are steadily increasing. Today, they offer a highly developed interactive graphical dialogue between the system and the user, extended kinematic simulation and capabilities to integrate up-to-date standards and good industry practices. Developers aim to achieve a more interactive presentation of projects to maximize the virtual product to real operational conditions. With powerful process simulation tools, the assessment of technology and detail perfection is possible at the earliest stage of the design process. All of these innovations give the consumers the shortest way to produce competitive products with high added value.

The idea of intelligence in production also covers innovations in CAD/CAM/CAE systems. The drive towards easier management is particularly prominent. More and more engineers, not just experts, are able to work with the products. As a trend, the software's maximum independence from hardware is also emerging. Modern CAD/CAM/CAE systems can be installed on different hardware platforms operating under the appropriate operating system and having the minimum required resources. This increases the decentralization of workplaces. There is also a growing interest in mobile applications and the use of a cloud model. Some software vendors already offer their clients a comprehensive portfolio of cloud services that are part of subscription programs and support services for purchased licenses. In this way, users can easily take advantage of the software when needed and pay only for actual time of use. Experts predict that this year more companies will overcome uncertainty about cloud computing and benefit from their advantages.

2. Possibilities for joint operation of engineering design systems and other new information technologies.

The integration of new technologies with modern CAD/CAM/CAE systems allows for the materialization of the design idea into a physical prototype at an early stage in the development of the new product. The production of prototypes, which are tested on various parameters in order to meet the requirements of the final product, reduces manufacturing errors, which in turn reflects on shortening the product's release time, improving quality while maintaining an acceptable level of investments. For this purpose, manufacturers today use different methods, including rapid prototyping, rapid molding tools and high-speed machining. In some of the methods, the prototypes obtained have characteristics close to those of the finished product, allowing functional tests to be carried out without the development of expensive tooling. Additionally, except for prototype production, the techniques under consideration can be used to produce molds and injection molds (tooling equipment) and even fully functional parts for end users. For small series and complex details these techniques are often the best available production capabilities.

The wide variety of on-board and system software on a wide range of design automation products, as well as on office automation software platforms, puts the issue of integrating and working together to increase performance accuracy and shorten timeframes.

2.1.Planning of the design and production with the TECHNOCLASS ERP & MES system.

TECHNOCLASS [1] is a complex integrated system designed to manage processes in companies with different organizational and territorial structure, subject of activity and volume of operations. ERP & MES (Enterprise Resource Planning, Manufacturing Execution System) is a flexible, powerful and versatile business management tool that empowers managers at different levels to develop, implement, and optimize their strategy and management tactics.

An advantage of the system built on Oracle E-Business Suite is the organic presence in the system of the tools needed to prepare the production: multivariate design, defining the structure of the products, technologies in their diversity, defining and normalizing basic and auxiliary materials , tools and equipment, as well as normalization of labor [1].

The scope includes the preparation and updating of the technical documentation maintained under the ECtHR, ECtHR, GOST or internal norms.

The system offers two operational and product-oriented technologies for dealing with individual tasks and provides integration with dedicated CAD/CAM systems.

With the use of ERP & MES, TECHNOCLASS automates the processes of production management - MRP planning, dispatching planning and workshop orders, warehouse management, material

flows and the degree of loading of production capacities, formed at the factory and factory cost of production .

The system has process management tools using conjugated Gant charts - performance time / power load (Figure 1). This helps plan the tasks of a project and then tracks progress.

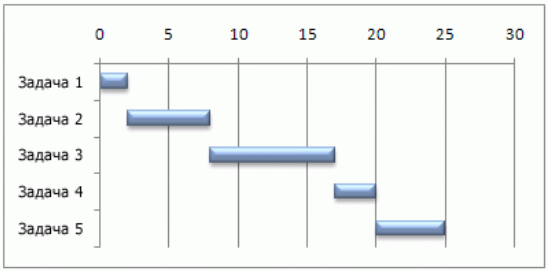

Fig.1. *Data presentation in Gantt diagram using Excel.*

The system has full functionality for managing both system and external documents: creating/entering documents; registration/ journal of documents: in conciliation, agreed, approved; maintenance of edits of documents; definition of routes and deadlines for coordination; classification of documents; reconciliation of documents; email distribution of communications and reconciliation documents; archiving.

The following additional functions can optionally be added to the TECHNOCLASS basic functional range:

• TECHNOCLASS Data Collection System;

• TECHNOCLASS Repairs Management;

• TECHNOCLASS Navigator.

2.2. Planning of CAD /CAM/CAE operations using MS Project.

The resources of a CAD/CAM/CAE system, as well as the necessary specialists for each specific design case, are determined by the problem to be solved. Contemporary market requirements, machine-building trends, and advances in technology make it imperative to refine the production planning system. The rapid deployment of high-tech engineering excellence suggests the need to use flexible approaches to planning and specifying technology operations and the use of available resources. This necessitates some modification of the existing ones and the introduction of new technologies in the planning and management of production processes, based on the use of CAD/CAM/CAE systems.

One way to bind and synchronize production results is through the use of MS Project [2] designing systems. Project management consists of developing a plan and tracking the implementation of its actions.

The project is defined as a temporary effort undertaken to create a unique product or service.

Calculating the duration

The task is an action carried out within the project to achieve a certain result. If the project contains many tasks they are merged into processes for their ongoing tracking.

The process of designing armament details consists of one or more tasks, resulting in the achievement of one or several desired outputs of the project. Consequently, the results achieved by the performance of each of the tasks is that from which the process forms the result.

If to achieve the required results of a task is only necessary to complete that task, then to achieve the result of a process is required to complete a group of tasks. This is the difference between the process and the task: its result sums up the results of the other tasks.

When planning activities, it should be taken into account that the more detailed the project plan is, the more accurate it will be.

Processes can contain both tasks and other processes.

The project breaks down into processes for the convenience of course and action controll.

In most cases, processes are executed sequentially. In some cases, certain processes begin before the previous one is completed. The use of intersecting planning processes is called fast tracking.

The breakdown of the process design allows them to be presented as a list of key results and dates when they should be received.

Each project is undertaken to achieve a specific purpose (design of a particular mechanism or whole armament) and can not usually be achieved without achieving intermediate desired states (completed 3D digital models of elements, details and prototypes).

Tasks resulting from the achievement of intermediate states are called milestones. Usually, the result of the process is to achieve an intermediate state, so the last task of the process, the outcome of which is achieved the result, is generally accepted to be a milestone.

Sometimes, if there is no such task, and the outcome of the process is achieved, for example the simultaneous completion of several tasks, then a fictitious milestone is to be created. The duration of such a task is equal to 0 days and no performers are assigned to it. It is present in the plan exclusively to indicate the moment to complete the process, which facilitates the tracking of the project plan.

The duration of the task is the amount of time that is planned for its execution. *Project* can work with tasks ranging from a few minutes to several months.

Various work times can be set in the *project calendar* of a given project. By default, the work time in the calendar in Project is set from 08:00 to 17:00 with a break between 12:00 and 13:00, Monday through Friday, with evenings, Saturdays and Sundays are set as non-working hours. So if 16 hours of work are needed for one job and it is started on Friday at 08:00, it will be completed on Monday at 17:00. The calendar can be formatted according to the customer's needs and includes the option 24 hours, 7 days a week.

In the calculation of the tasks, two main things must be taken into account:

- the duration of a project is usually proportionate to the duration of its tasks - longer projects are usually made up of tasks the execution of which requires more time.

- In the calculation of tasks, the degree of aggregation of tasks is assessed - for projects, the monitoring of tasks with a duration of several hours is inappropriate.

In more voluminous projects, when there are groups of closely related tasks, it is more useful and convenient to organize them in *phases* that consist of a *summary task* and its *subtasks*.

Connect tasks

The tasks in the project plan are interrelated, for example one task can not be started until another is completed. In MS Project they are called Dependencies.

In the project plan, dependencies are denoted with the help of *links*, and these two terms - dependence and link - are used in the same sense, indicating the logic defining the sequence of the work in the project plan.

Since the projects must be run in a certain sequence, Project allows the creation of different relationships between the individual tasks. These relationships are four types: finish to start, start to start,

finish to finish, and start to finish. Relationships between tasks are visualized in several ways: in the Entry table; via the Gantt chart (Figure 2) or through a Network Diagram.

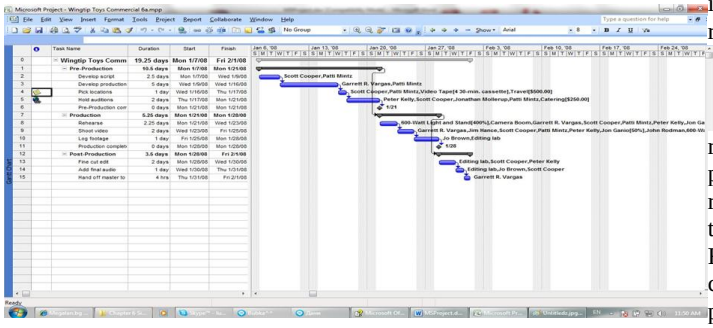

Fig.2.*Presenting the interconnections with a Gantt chart.*

Documenting tasks

Project allows you to record additional information to each task in a *note*. In this way short names can be assigned to tasks and the additional information is recorded in a note and so it is still readily available for reading or printing. Project notes support a wide range of text formatting options and the ability to connect or store images and other file types.

Hyperlinks can also be added to tasks, which allow the specific task to be linked to additional information outside the project plan such as another file, a specific location in a file, an Internet page or an intranet.

Checking plan duration.

Project allows for easy and convenient verification of project duration even if no overall length and start date is set. Project calculates the total duration of the project based on the total number of working days needed to complete the individual tasks. An easy way to check this data is through the Project Information dialog box.

Resource allocation.

There are three types of resources in the Project - work resources, material resources and cost. Working resources in turn can be people or equipment. The program deals mainly with two aspects of these resources: their availability and cost. Availability determines when specific resources can work on tasks and how much work they can do, and costs refer to how much money will be needed.

Allocation of human resources.

Project resources can be introduced as: Individuals identified by name, position, or function; groups of people with the same skills; or equipment. These options allow the user to enter resources in the most convenient and easy way.

Max. Units (maximum units) show the availability of the resource. When entering new resources, Project automatically sets a value of 100% in this field, which when it comes to people means that 100% of the person's time is devoted to the tasks of the project which are assigned to him.

Distribution of equipment.

The deployment of resources related to equipment is the same as the introduction of human resources. However, there is a very important difference in how these two types of resources can be planned. For example, most human resources have a working time of no more than 12 hours, but resource-related equipment may work around the clock. In addition, human resources are flexible in terms of the tasks they can perform, but those related to equipment are more specialized.

Allocation of material resources

Material resources are consumables that are used during project implementation. The main purpose of Project Material Resources is to track the rate of spending and associated costs. Although Project is not a complete inventory tracking system, the program can help raise awareness of how fast you spend your material resources.

Distribution of cost resources.

The last type of resources that can be used in Project is cost-related. Cost resources are used to present the financial part of a project task. While work resources have associated costs (hourly rates and fixed pricing for tasks), the sole purpose of the resource is to associate a specific type of expenditure with one or more tasks. Frequently used types of spending resources are the categories of costs that eventually are tracked in a project for accounting purposes, such as travel, entertainment, training, etc. as well as material resources, and costs do not perform any work and do not affect the schedule of tasks.

Introduce rates to pay for resources.

Monitoring and managing cost information enables the project manager to answer important questions such as:

- What is the expected total cost of the project?

- Are costly resources used for work that can be done with cheaper ones?

- How much will a particular type of resource or task cost during the lifetime of the project?

Rates are entered for work and material resources in the field Std. Rate, the default unit of work is the dollar per hour, and for the material is the dollar per unit (unit).

Set up working time for specific resources

Project uses different types of calendars for different purposes. The resource calendar controls the working and non-working time of a resource. The program uses these calendars to determine when a particular resource can be assigned to work. They are only applicable to work resources - people and equipment. The default work schedule calendar is set from 08:00 to 12:00 and from 13:00 to 17:00 Monday through Friday, but in most cases some of the resources are subject to exceptions to the working hours in the standard calendar. In these cases, the Change Working Time window is used to enter - when and why a resource is unavailable.

Documentation of resources.

As with tasks, here too you can enter a note on a resource. For example, if some resource has flexible skills that can help the project, it's a good idea to write this in a note. This way it is in the project plan and can easily be viewed or printed.

Assign resources to tasks.

Resource assignment is what you call assigning a resource to a task which it works on. When working with Microsoft Office Project, it is not necessary to assign resources to the tasks, it can be done with tasks only. By assigning resources to tasks, however, some questions can be answered, such as:

- Who on what tasks should work and when?

- Is there a sufficient number of resources to complete the amount of work the project requires?

- Is a resource expected to work on a job at a time when it is not available for work (for example, when it is on leave)?

- Is a resource assigned so many tasks that it exceeds the amount of work it can do?

- Is the resource overall located?

Assigning resources to MS Project is achieved by clicking the Assign Resources field on the Tools menu. Assigning resources are few types, according to the resource that is being assigned.

Appointing work resources to tasks

Appointing this type of resource allows you to see the progress it makes while working on it. If the corresponding payment is introduced, MS Project will also automatically calculate the cost and the tasks for which it will be used.

The working capacity of a resource, regardless of what it is, is measured in units and recorded in a field named "Max. Units ". MS Project is set up to assign 100% of the resource units to the current task. This means that the program assumes that the entire working time of the resource is intended to work on this task. If we also want to use the resource in another task, then we should manually change those 100% to what we want to be used in the task and the remainder between the full commitment of the resource (100%) and what we have deemed to be required , to remain for our second (upcoming) task.

When assigning work resources to certain tasks, there is an option to allocate additional resources. The resources assigned of this type allow you to achieve several things:

- reducing the execution time of the task;

- Improving the quality of the product produced by the task.

When using both assigned resources at 100%, the task execution time can be reduced by half. For example, if one work resource (human) was used for one task and it is to be completed within 6 working days, then the assignment of another resource (human) and if the use of both resources is 100% or the implementation time the task is reduced to 3 days, or the quality of the product produced by the assigned task is higher than the product that would be produced with only 1 assigned resource (human).

Assign material resources to tasks

By assigning this kind of resources, it is possible to monitor the materials that are used up by the respective tasks and the materials that remain in our warehouse. Generally speaking, in this way, we monitor what material resources we have and predict whether we will need new or if the available ones will suffice. This also has an impact on the available financial resources and the budget we have.

Assigning cost resources to tasks.

Cost resources are used to represent financial costs associated with a particular task in a project. Both material and cost resources can not work and do not affect the schedule of the task. Cost resources may involve multiple costs for which certain funds must be set aside and can thus be tracked for both accounting purposes and for the personal purposes of the contractor. Generally speaking, there is clarity and "transparency" about where the costs are being spent.

By assigning this type of resource, MS Project automatically calculates the cost of the project (what it will cost) in relation to the work program and the assigned material and labor resources.

Forming and printing a plan.

MS Project also lets you change the shape of the documents and the way they look when they are printed on paper. *Views* and *reports* are the most commonly used ways to view or print data in a project plan. In both cases, the program allows formatting of the data at the discretion of the user.

The reports are designed to print MS Project data. Unlike the views that can be used directly on the screen, tabular reports are only for printing or viewing in the "print preview" menu. Data can not be entered directly. There are many types of reports, by different metrics - cost, task, resource, shared reports that bring together several things in one, etc. After the report is produced, the program also allows the insertion of a picture / logo / into the report.

MS Project also offers a feature to draw and add notes to the project plan. This is to clarify some of the steps or simply to take notes to help the plan user to perform the tasks.

Tracking the progress of tasks

So far, the focus has been on project planning - developing and information transfer about them before their implementation begins. When the project implementation starts, the next phase of project management begins: the tracking process. Tracking means recording details of the project, for example, who did what job, when it was done and at what price. These data are often called actuals.

Tracking actual values is essential for proper project management, unlike ordinary planning. The manager thus understands how well the team works and when to take corrective action. Proper tracking of the project and its comparison with the original plan allows us to answer some questions such as:

- "Do tasks start and finish according to the plan?" If not, how will this be reflected on the date of completion of the project?

- Do the resources take more or less than the time planned to accomplish the tasks?

- Are tasks with higher than expected costs increasing the total cost of the project?

MS Project offers several ways to track progress. The choice of the tracking method depends on the level of depth or control that the project manager has decided to lead. Different levels include the following:

- Record work on the project as planned. This is useful when everything in the project happens as intended;

- Record the completion rate of each task - either as exact values or as changing values increasing by an amount, such as 25, 50, 75 or 100%;

- Record the actual start, end, job and actual and remaining duration of each task or assignment;

- Time tracking job tracking(idk). This is the most detailed level of tracking. Here are actual values for actual work per day, week, or other interval.

Sometimes different types of tracking may be required for different parts of the project or a combination of several of them might be needed in a single project.

The original project plan, the one that is used for comparison, is called a base or simply a baseline. The comparison between the base frame and the actually executable frame can be done by MS Project automatically.

Exact assessment of the state of the project can be a complex task. The following issues need to be emphasized:

- For many tasks, it is very difficult to calculate the completion rate. When can it be said, for example, that the program code for a software module is 50% complete?

- The completed time from length of the task is not always equal to the amount of work done. For example a task may require relatively little effort initially, but more work may be needed over time. This is called a back-loaded task. Thus, when 50% of the duration of the task has elapsed, much less than 50% of the total work has been done.

- The resource allocation criteria assigned to a task for its implementation may differ from those of the project manager or resource assigned to the subsequent tasks.

With the help of good project planning and good communication, these and other problems that arise during the project implementation can be reduced or avoided. Well-documented and properly concerted performance criteria should prevent unpleasant surprises. However, large and complex projects will almost certainly deviate from the baseline.

From what has been said so far, it is good to emphasize that the baseline needs to be defined before starting the project. It gives us a "snapshot" of the original plan, which can later be compared to the actual progress. It's also one way to see if everything in the project is on track. MS Project is a unique software product, which allows you to monitor how processes are running, at what level they are executable, how they are implemented, and at what level they replicate the given user pre-set data.

Drawing up a plan for the implementation of the actions of the components of a command as a whole consists of describing the actions of each of them in the form of tasks, the available resources and the identification of relationships between them by appointment.

MS Project planning is based on the desired strategic outcome, the operational results sought for its achievement and the associated tactical results.

The main aggregate task describes the desired strategic outcome. Then, the operational results that will lead to its implementation are introduced. Similarly, under each operational result the tactical results achieved by each of the components that contribute to its completion are introduced. To achieve these, it is necessary to plan specific actions of each of them, allocated over time and provided with the appropriate resources. For this purpose, in order to achieve a sought out tactical result, an aggregation of based on time actions are planned out.

To accomplish all of this, the following mechanism is proposed:

- taking into account the deadlines for achieving the operational results, the deadlines for the implementation of the planned tasks (actions) are introduced;

- introduces the necessary duration to implement any specific action that results from modeling and expert judgment;

- define the interrelationships and the sequence of tasks, while respecting the deadlines for achieving the results.

In this way, it is possible to seek compensation for time deficiency through additional resources.

III. Conclusion.

On the basis of the analytical overview, it can be summed up that the joint work of software packages for engineering design and new office automation information technologies such as MS Project and ERP & MES systems can achieve a balance of production capacities and their binding with a production program.

BIBLIOGRAPHY:

[1] https://techno-class.com/

[2] https://products.office.com/en-us/project/project-and-portfolio-management-software

[3]https://www.theprojectgroup.com/en/ms-project-solutions/business-solutions-ms-project/integration-project-management-erp.html