International Journal of Advancements in Mechanical and Aeronautical Engineering – IJAMAE
Volume 1 : Issue 3 [ISSN 2372 –4153]
Publication Date : 30 September, 2014

TECHNOLOGICAL PREPARATION OF PRODUCTION ENVIRONMENT SYSTEM FOR AUTOMATION OF THE ENGINEERS WORK "PROTECH''

Prof. Dr-Ing. Stefan Kirilov Kartunov, PhD Ing. Rossen Ivanov

5300 Gabrovo, Bulgaria, TU, Hadji Dimitar Str. 4, Department MU,

Abstract: Present article, entitled with the following main subject – "System for automation of the engineers work "Protech". In this presentation the most important and major subject is – development of an integrated system for automation of the engineers work in technological preparation of production and its application in practice. Described are its main modules programming, planning and prototyping of production, structure and algorithm, methodology of work, interface and software. In this sense the system "Protech" falls in the focus of attention from work UACEE.

Keywords: technological preparation and planning of production, CNC machines, automation of engineers' work, PLM-programming.

1. INTRODUCTION

With the progress of modern technologies and machines appears the necessity of development of new software systems. The increasingly higher requirements of product quality and their short – dated production time are also the main reasons people to try to improve the technological process and optimize it. Therefore, it is necessary a process planning and an implementation of systems for planning and programming of automated manufacturing processes in manufacturing. According to these requirements it was given a start of a work on a system fulfilling all these requirements and standards. The main goal of the production processes automation is to reduce the production time and to improve the quality of the manufactured products. The entirely implementation of CNC machines enables fast setup and flexibility. Meanwhile it is worked on an automation of engineers' work because of the increasing market demands. Furthermore, these market requirements lead to short terms development of new sophisticated structures and technological processes. This is the most modern trend in the development of such systems, namely PLM - Product Lave Management.

2. EXPOSITION

Fig.1 shows the data exchange process between the separate modules of the "Protech" system. Here is especially emphasized on the planning, programming and manufacturing sector. The specificity and complexity of the produced details and products are rated by the technologists-programmers operating data base. The technological sequence of treatment depends on the completed performance evaluation. From this assessment, which is made by the technological specialists, depends the further sequences of the treatment process - Mazak – Mazatrol or Siemens – Sinumerik840D operating system machines. Operating programs are made for these concrete systems and machines. The necessary accessories, instrumental equipments and quality control devices should be prepared from an organizational perspective. The blanks material is determined, as in this case there is a permanent control and data exchange with the stock base. The optimum implementation time is determined after an evaluation of the complexity of the concrete product. The connection and data exchange between these three sectors are constant.

This kind of information transfer is made by personal employee's computers and they can be switched in a single local network. Each department has the necessary hardware and software to ensure a complete and adequate working process. The machines from the manufacturing department have an inside embedded computer and they are also connected in the same "Protech" local network. Thus it can be made an information transfer between the technologist - programmer personal computer and the machine. And in this case it wouldn't be necessary a personal presence on the machine because the connection between the person and the machine is made from distance. There is a program possibility, the same one to check and calculate the manufacturing time of the processing details. So, it can be estimated the implementation time of the concrete order. The program gives permanently information for each current and last quality control of the details and products, so people can understand the percentage of the tools which are well fitted and none well fitted for work. The estimated product quantity is registered during the preservation and the packing of the ready production and after that the ready for shipment goods go in the stock department.

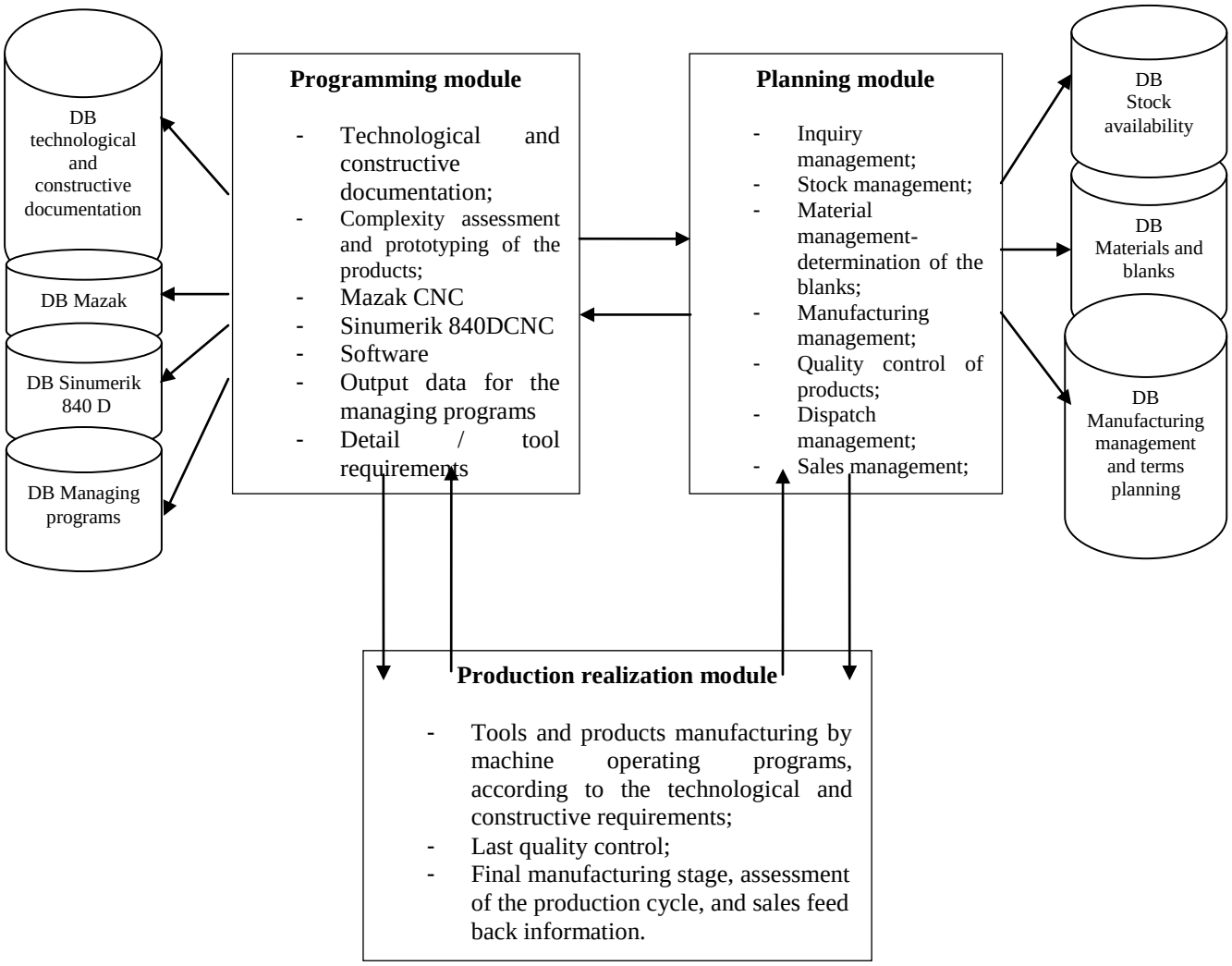
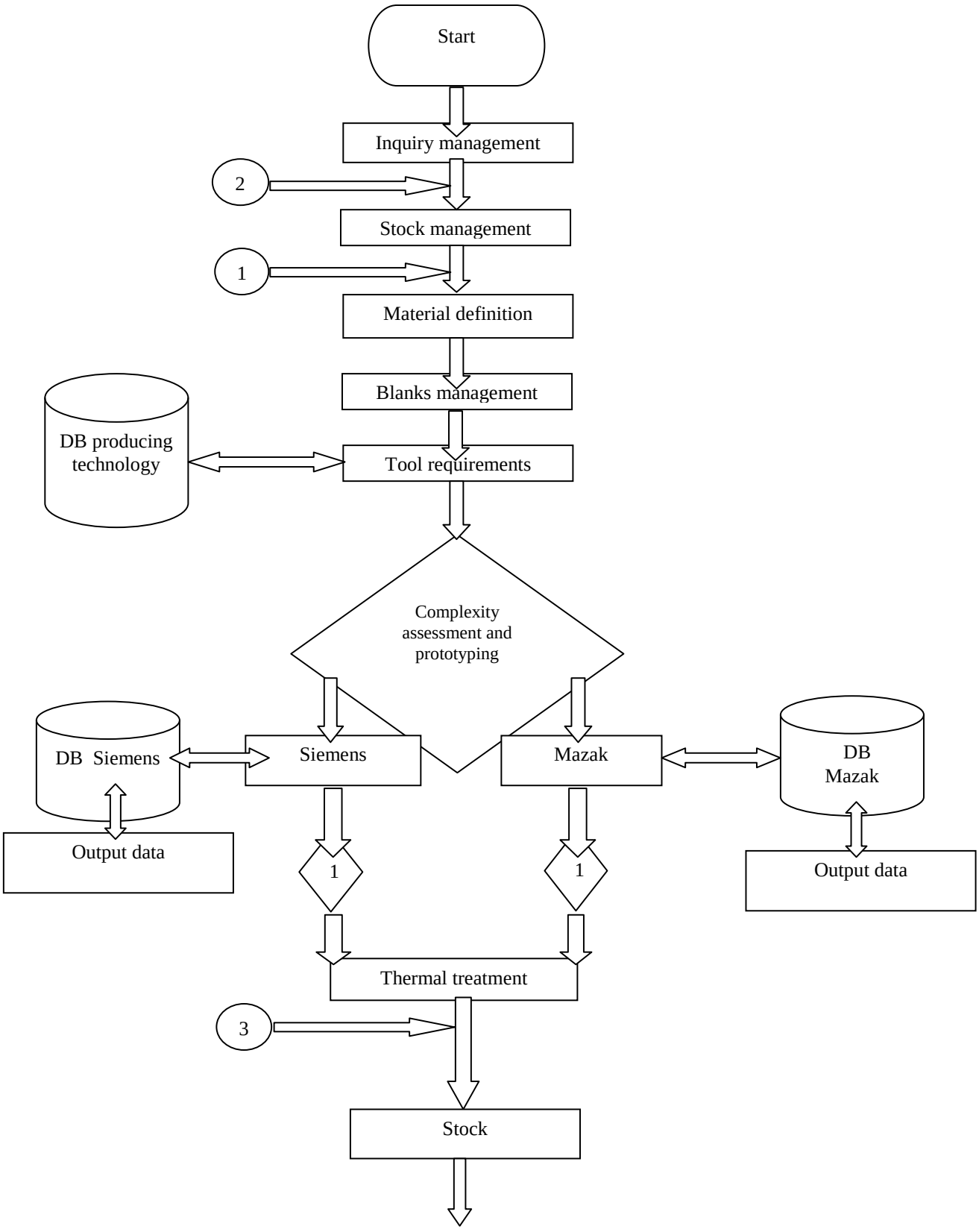


Fig. 1. Block diagram of the interrelationships between the separate modules of the "Protech" system

The system automates the general logistic chain - from purchasing and distribution up to manufacturing and logistic/ shipment. The object-oriented architecture (i.e. orders processing, specifications, delivery documents, etc) and it's program assurance, witch is developed on the base of standards, gives opportunities for integration with all COM – compatible program components. That type of architecture is appropriate for prompt reaction when product or process changes are needed by the clients and there is no need of special programs for standart software development. The modular structure of the system contains of the main blocks for production logistics, order management, accounting, supplying management and base program assurance for the peripheral modules of the system [1]. Combined with the "orders management", it accomplishes the production control and servs to realize the planing of the needs of resources, interests and competences which are always into competition in the real production circumstances. The main instrument of the block system is the following module – management – and it is designed for solving the operational tasks of distribution, management, control and communication. This block receives from the "request management" block instructions such as earlier start of the manufacturing process or delayed manufacturing term, because it is connected on-line (in a real time) with the modules for information services and work management. Consequently, it is in a permanently connection with all of the updated data of the company manufacturing status. The information flow spreads by strategic varieties which can be set and confirmed in real time according to customer demands and according to specified rules and parameters (e.g. time, dynamic outside priorities, measurements and production rhythm). An important advantage by solving the task of resource management is the fact that all types of demand resources such as capacity, instruments, production devices and tools, can be synchronized with the requested manufacturing deadlines. For this purpose are used the following functions - compounding of request and technological processes, combining of different requests, changing of deadlines, and also increasing of the production capacity. Figure 2 shows the algorithmic working scheme of the production programmable and planning system "Protech".



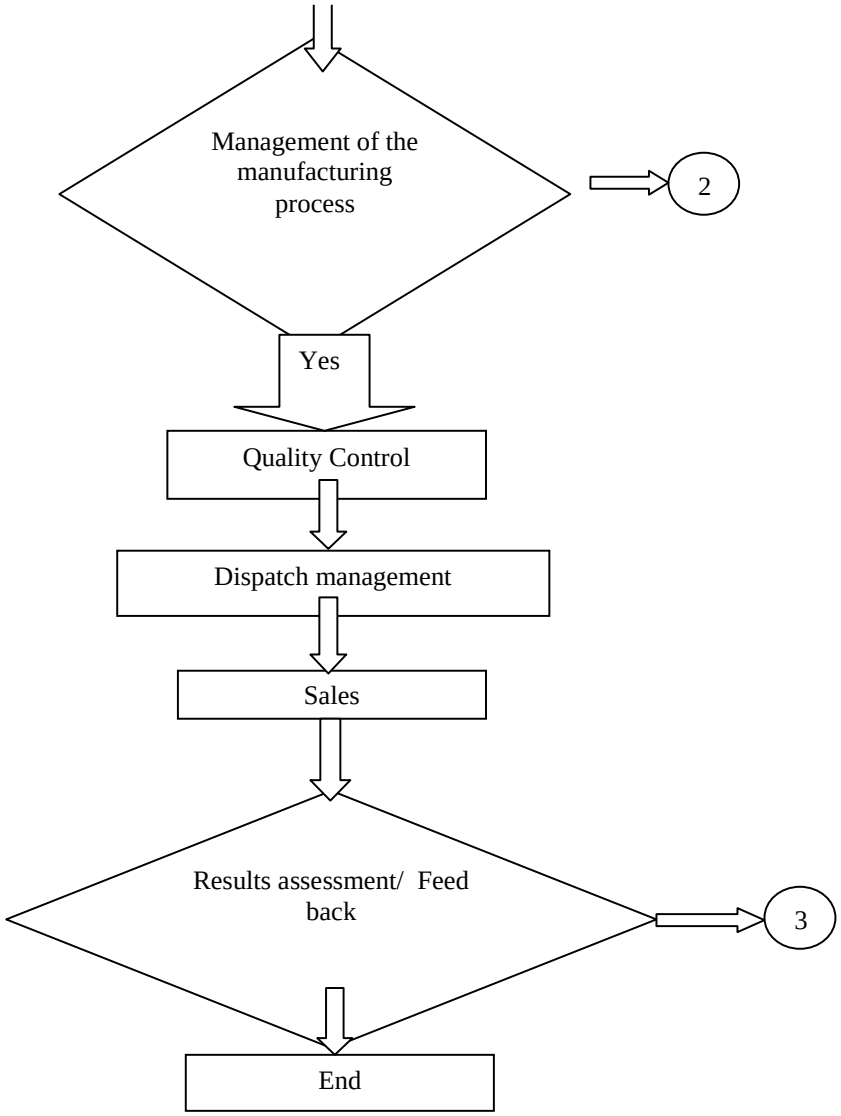


Fig. 2. „Algorithmic type of "Protech" system

In general, the algorithmic sequence of the "Protech" system represents the following functions:

- beginning of the program - producing process; take in orders, and management of product requirements;
- submitting and processing information regarding to the stock availability;
- determining the material type;
- defining blanks (according to the technological documentation);
- detailing client requirements (designed according to the constructive – technological documentation);
- complexity assessment and prototyping of products – made by technologist-programmers who are writing all of the operating programs for CNC machines;
- tool guidance to Mazak or Sinumerik 840D after a technological complexity assessment;
- detail thermal treatment after finish of the mechanical treatment;
- stocking of the ready products;
- forming and planning of the manufacturing process;
- quality control;
- dispatch management;
- sales management;
- assessment of the economical, technological and manufacturing results feedback;
- finishing of the program-planning process "Protech".

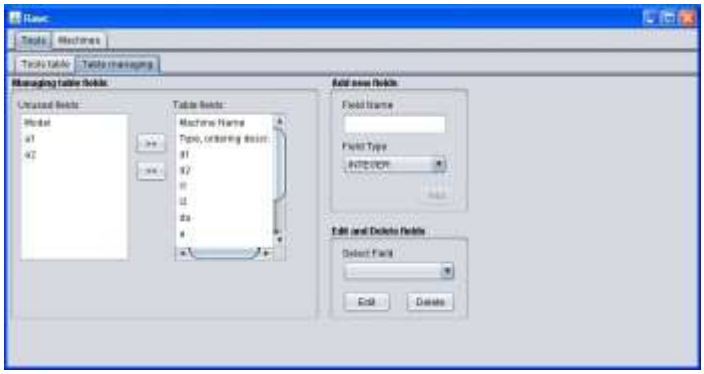
The software product is currently in its development process and only part of the hitherto designed software is considered in the present report. These are the modules for provision of the tool equipment, method for input and processing of the parameters of the tools, which will take direct part in the production cycle of the details and work-pieces. The other modules, which are still to be defined, are: - module for warehouse

management and availability, module for machine provision and the respective equipment, and the module for planning and management of the manufacturing process. The names and definition of the tools are fully compliant with the requirements of the systems for management and programming of CNC machines. When a metal-processing tool is added to the program, its operational modes are also to be defined, taking into account the specified and recommended cutting modes, according to the type of the processed material, used by some of the most reputable cutting tools manufacturing companies in the world (Walter, Kennametal, Ceratizit). Within the tool addition process there is an integrated image of the specific tool, so that the programmer setting-up the CNC machine is able to see and evaluate whether the respective tool configuration will be efficient for the particular work process. The software product integrates basic information about machines and systems with CNC control, and this option enables the operator to quickly find more accurate technological decision concerning the sequence and basing of new articles and details in the production process.

The machines with software control are some of the most efficient facilities for automation of the production processes. Their main use is mechanical processing of blanks and details in the conditions of serial, small-number and single item fabrication processes. In its broadest sense, the term software control denotes the expedient definition and the sequential bringing to action of the required operation cycles of the production machine and the simultaneous control of their actual performance and implementation of the processing modes, which provide achieving the quality indicators and productivity designed for the implemented technological operation [2].

In brief, the goal of the design automation is to increase the quality of the very process, to reduce the cost, to shorten the deadlines for designing and hence, the deadlines for implementation of the article, as a whole. At the present stage, this is implemented by different in complexity, scope and field of application systems for automated design, called generally CAD/CAM systems [3]. For the development of "Protech" integrated engineering automation system – automated programming and planning of the production, we used the module for input, operation and analysis of two of the most widely spread systems for control of metal-cutting machines with computer and numerical control (CNC) made by the companies Mazak and Siemens - Mazatrol – Integrex IV and Sinumerik 840D, respectively. They are extensively applied in the modern machine-building industry and provide a serious pre-requisite for technological development and progress in the sphere of automated design engineering and production. The high technological and technical capacities and the favourable financial factor of these systems for control make them some of the most preferred areas for programming and control in the modern machine-building industry [4].

When planning and implementing of all main stages of operation with the Protech automation system the input-output data within the system is updated and processed aiming at full efficiency and continuous interdependence between the component modules and the staff operating the system. One of the main advantages of this program is the opportunity to be further developed and upgraded in any software aspect. Each module containing the fundamental data base can be "updated" with new information concerning new articles or details, by adding to them the respective module and data about the necessary new tools and devices, which were not used hitherto in "Protech", or in the machined production. Furthermore, inputting of new technological-programming and structural parameters is also possible using this function. One of the main advantages of this program is the exchange of data between the individual modules of the "Protech" system, and in this case the accent was put on the sectors for planning, programming and production. The specifics and complexity of articles and details manufactured are evaluated using the data base, which the technologist-programmers operate. The technological sequence of processing is built on basis of this evaluation, designed mainly for machines with a system for control Mazak - Mazatrol or Siemens – Sinumerik 840D [5]. Operational programs for the respective systems and machines are compiled, and from an organizational point of view, the necessary appliances, tool equipment and quality control devices must be prepared. The material of the blanks is defined, and in this case there must be a permanent control and information exchange with the warehouse base. The optimum period for implementation of the order is defined upon evaluation of the complexity of the article. During the entire planning, technological and production process of the manufacture, processing and exchange of information between these three sectors is continuous. Detailed block diagram and main operational algorithm for interaction of the above-specified information processes and data transfers can be seen in the article [5].



Options of programs menu:
1 – Overview of the main menu;
2 – Description of the tool module;
3 – Management of the tool inter changeability;
4 – Overview of the machine module.

Fig. 3. Overview of the main menu of the program

General advantages of the software product: 1 – Flexibility of the software product – easy to use, configured and adapted to the specific needs; 2 – Planning - allowing planning and optimizing of the processing technology from start to finish; 3 – Control and management – better quality and quick production results.

DESCRIPTION OF THE TOOL MODULE-Management of the main menu of the program. The internal sub-menu **Tools managing** provides you with the possibility to create a separate sub-window of the **Tools managing** table. This enables creating new fields, which are suitable for the particular requirements of the user. There are two combined windows of the menu - **Unused fields** and **Table fields**. They enable and disable the visibility of the fields in **Table fields**, by moving within the individual menus using the buttons << and >>. The user can add, edit or delete fields with the tool data, depending on the complexity of the tool configuration, (fig. 4).

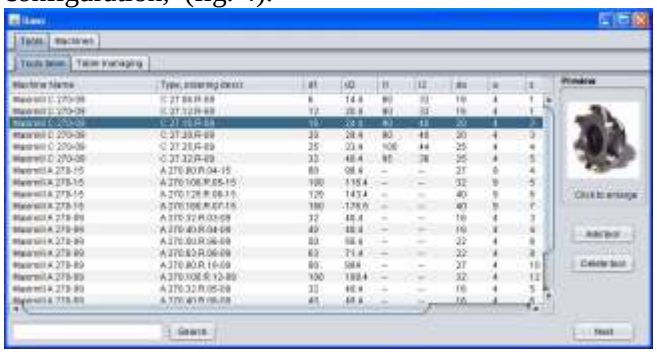


Fig. 4. Tools table

Fig. 5. Adding new tool

When the application is started, it allows you to use the default tool library (Tools table). The table provides detailed information about every tool. From within the preview window, one can see more about the shape of the tool by clicking on the image, obtaining thus full information about the particular metal-processing tool. There is also an option for adding or removing tools from the given menu. This is possible using the buttons **Add tool** and **Delete tool**. Even greater convenience is the button **Search**, through which every match and tool search criteria can be verified.

In the first section of the tool equipment menu are described the types of metal-processing cutters, drills, sink-tools, reamers, and the leftmost column contains the name of the tool, in this case – where the blue marker Maximill C 270-09 is – that is the name (model) of the given tool according to the technical and catalogue documentation of the manufacturing company, and every company has its own name coding. The next column describes in abbreviated manner the geometric parameters of the tool – C 27.16.R-09, in this case the letter **"C"** means that the cutter is of shank type (the letter **"A"** denoting shell-end cutters), designed for clamping in collet holder or holder of Weldon chuck type (based on autonomous fastening to a specially made site on the oblong part (shank) from the cutter body), the number 27 is the model of the milling tool, the number d1=16 mm is the diameter of the cutting inserts relative to their frontal direction, d2=24.4 mm - the diameter of the inserts in radial direction, l1=90 mm is the length of the entire milling tool including the brazed carbide cutting inserts mounted onto it, l2=40 mm is the length of the working part of the cutter, da=20mm diameter of the cutter shank, a=4 mm is the height of the bevel of the cutting edge (below 45 grad relative to the front-end and diameter of the cutting edge), z=2 the number of the replaceable carbide cutting inserts fixed onto the cutter. When the application operator selects the desired tool and image of it is shown

in the right half of the **Tools table window**. Upon completion of the development of the tool module, the codes of the tools names will be described in detail according to their manufacturing company, along with all the parameters required for programming and setting-up of machines with CNC control. Using this menu one will also be able to monitor the availability of a given model of tools and when their quantity runs low or is depleted new tools will be ordered.

Fig. 5. clarifies the steps for inputting new tool, where by clicking on the menu **Add tool** a sub-window with the respective name opens, where one can define and store the parameters of the new tool. The operator can first define the name of the metal-processing tool in the option **Machine name**, and the next stage is **Type ordering descry**, which option allows him to select which geometric parameters shall be entered – d1, d2, l1, l2 etc. in compliance with the configuration of the tool. Once these positions are defined, the operator can click on the button **Apply** from the program menu so that the data about the new tool will be entered into the data base of the tool module, analogical machines, materials etc. At the final stage of this manipulation the operator can close the sub-window of the menu using the button **Close**. The overall methodology for system "Protech" is described in [6].

Fig. 6. Program menu to define new machine configuration

Fig. 7. Menu-editing machine configuration

3. CONCLUSIONS

Permanent control, exchange and information update of the manufacturing process/ cycle in real time is the main point of the whole process. These program functions can provide monitoring of each stage of manufacturing of the products, the product quality, and deadlines for implementation, stock availability and sales management. „Protech" system was developed in collaboration with PhD Ing. Rossen Ivanov and therefore is a conference organized from IRED. The authors are open for discussion, consultation and presentations on the topic.

References

[1.] Kurtunov S., Engineering logistics, Gabrovo, University Publishing house „Vasil Aprilov", 2008, ISBN 978-954-683-377-8, (in Bulgarian)
[2.] Kartunov S., Manual on programming and application of metal-cutting machines with computer and numerical control, Gabrovo, Publishing house of the Technical University – Gabrovo, 1996, ISBN 954-683-044-5 (in Bulgarian)
[3.] Kartunov S., Rachev P., Automated planning and management of the production. Computer integrated production (CIM), Gabrovo, Printing base of the Technical University – Gabrovo, 1997, ISBN 954-683-057-7 (in Bulgarian)
[4.] Ivanov R., Kartunov S., Working with modules for programming of control applications for CNC machines Mazak – Integrex IV and Siemens – Sinumerik 840D in the "Protech" system environment, XXI international scientific-technical conference "Automation of discrete manufacturing" ADM – 2012" – Sosopol, 2012
[5.] Ivanov R., Kartunov S., Programming, planning and prototyping of serial production in the "Protech" integrated system for automation of engineering design environment, 9th International conference "Standardization, prototyping and quality: Balkan conference", Tirana – 2012
[6.] Кьртунов С., Р. Иванов, „Методика за работа със система PROTECH", Созопол, МНК АДП-2013, Созопол, МНК АДП-2013, ISSN 1310-3946, стр. 561 (in Bulgarian)

About the author

Prof. Dr-Ing. Stefan Kartunov, TU Hadji Dimitar Str. 4, Department MU, Mechanical Ingeneering, Tel.++35966827365, Lab. Micro- and Nanotechnologies

Research interests: Technological process of micro- and nanoelements, CAD/CAM/CAE-studies, simulations and animations befor/in the production