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NEW APPROACH FOR WEB BASED PROCESS PLANNING

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Abstract: *The basis for the survival on the world market include the increased integration of certain stages of development, planning and production of products, openness to potential partners, and distribution activities of all processes in real time. In today's collaborative work in many production and business organizations observed the trend of application specific infrastructure that provides global visibility of product data and automation of all relevant processes. Therefore, the basis for creating Web-based system for the process planning is an XML and STEP-NC representation of processes. Achieving these objectives in distributed production environment to a large extent can be accomplished by using the Internet and modern Web technologies.*

Key words: *web-based CAPP, XML, STEP-NC standards.*

1. INTRODUCTION

Globalization of world's market causes a high level of competitiveness, increasing agility, adaptation to rapid change and reconfiguration manufacturing and PLM systems [1]. As a bridge between computer aided product design (CAPD) and computer aided manufacturing (CAM), computer aided process planning (CAPP) represents an important role in computer integrated manufacturing (CIM). Planning of production process refers to the choice of parameters and sequencing of certain production activities (Fig.1), all with the aim to obtain the required product features with greater productivity, reduced costs of production, less production time, etc.

Integration of these systems does not only mean the ability to communicate, these systems must exchange data that is usually stored in different formats.

Instability and incompatibility of data integration mechanism between the existing software solutions affect on quality and neutrality of information, and consequently on effectiveness of the production system. Therefore, many CAPP models have been developed for specific activities of the planning process [2]. Among the most typical are mentioned CAM-I (cutting process planning), IMPPACT (production of the cast and sheet-metal parts), AAAP (for automated assembly and control processes in airplane industries), STEP AP213 and STEP AP224 activity models.

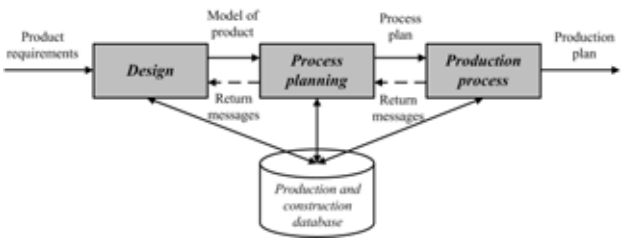

Fig. 1. Connection between design, planning and production process.

Planning process is not uniform and planning activities are changing so these models are usually built and adapted to specific requirements (tolerance analysis, assessment of total costs, etc.).

On the contrary, Web-based CAPP systems are based on server/client architecture and consist modules based on Web browser to visualize objects processing, remote service for planning process optimization, and display the results of optimization. In addition to these actions, modules perform search and management services for the planning process over the Internet [3]. Special modules are intended for data collection and storage of information of production equipment, cutting tools and costs in a single database [4].

In this paper we will present initial efforts in development of web based system for process planning. Some developed modules and services will be presented as a part of integral solution developed in Internet environment.

2. WEB BASED PROCESS PLANNING SYSTEMES

2.1. Structure of WBPPS

Web-based CAPP system that supports operations in the distributed environment as the primary uses STEP-NC format has characteristic network architecture (Fig.2). Databases were developed for generic and native product information storage. Information are described as XML representation, and output process plan is described via STEP-NC AIM standard. For the representation and exchange of CAD information neutral STEP AP-203 or AP-214 formats are used. In this system coexist different production database for CAPP data exchange [5].

Process of geometric and technological recognition of the workpiece is implemented using the declarative and procedural knowledge contained in the main database and in the knowledge database for features recognition. Contents of generic database refers to all types of mechanical systems and cutting tools.

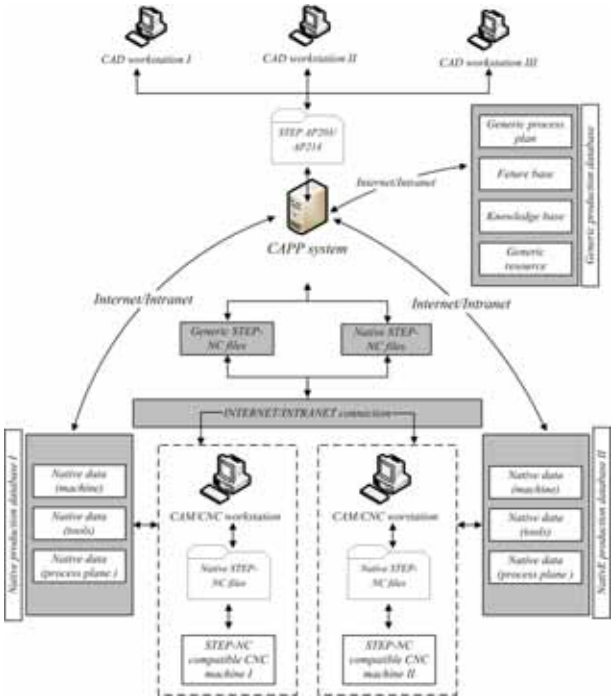

Fig. 2. Application of STEP-NC standard in distributed production – Web-based process planning.

Generic process plan, based on the resources generated from a generic database may not be always realized at the workshop level [6].

Namely, the data of current conditions in some machines as well as information about available tools are in native database. This information are used for generic process plan optimization. Thus, STEP-NC file is amended and regenerated according to the native conditions, and it is ready for execution at the workshop level. Examined three-layer architecture of Web-based system allows flexible access to databases and the transition from native to the generic plan, and vice versa, creating the basis for the development of distributed collaborative production [7]. The role of CAM system in this system is to perform the integration and optimization of a generic plan, instead of tool paths and CNC code generation. This could be realized by built-in functions of implemented STEP-NC controller.

The possibility of effective user interfaces designing, application of software and Web browser greatly contributes to the interaction between the user and system. Generic information of available resources is in the database and CAPP system uses it for generating process plans. Presented model can be reduced (Fig.3) and basically characterized by three-layer network architecture:

- User layer,
- Layer of CAPP server and
- Databases layer.

User layer consists of a series of modules that provide required functions, as follows:

- User interface which shows 3D geometric information of STEP files,
- Module for structure analysis and conversion of STEP and STEP-NC file in XML,
- Module for production plans generation,
- Module for a new productive resources adding,
- Module for the conversion of native and generic information in XML format, and vice versa.

The core of this system is the CAPP server other than the traditional performing advanced tasks such as automatic features recognition, choice of system elements, optimization of regimes, etc.

Browsing of the actual plans from the XML database and display information about the geometry and the technology is also performed on the user level [8]. Due to manipulate with XML, XML DTD and XML schemes, and according to the user layer, as the most suitable framework for implementation of these modules are used the Web browsers set.

There are two models for optimization and generating process plans at the CAPP server layer, such as:

- Integrated model (Model I) and
- Interface model (Model II).

One of the first tasks for both models is the recognition of geometric features and automatic workpiece model decomposing (ISO 10,303, AP-203, AP-224) to the level of technological and geometric primitives. This way of reasoning is highly intuitive and agrees with the conventional technologists reasoning [9]. Integration model includes a new generation of native plan on the basis of existing production information from the native database (Fig.4). Control of the process planning involves the application of ISO 10303 AP-238 (STEP-NC AIM) standards, optimization algorithms and production base of native resources. Base of productive resources are data compatible with ISO 14649-111 and ISO 14649-121 standards. The link between the CAPP server and native resources is achieved via the Internet using XML STEP-28 record. Automatic assignation of existing resources (machines and tools) with a recognized model form, process planning module generates native program (STEP-NC AP-238).

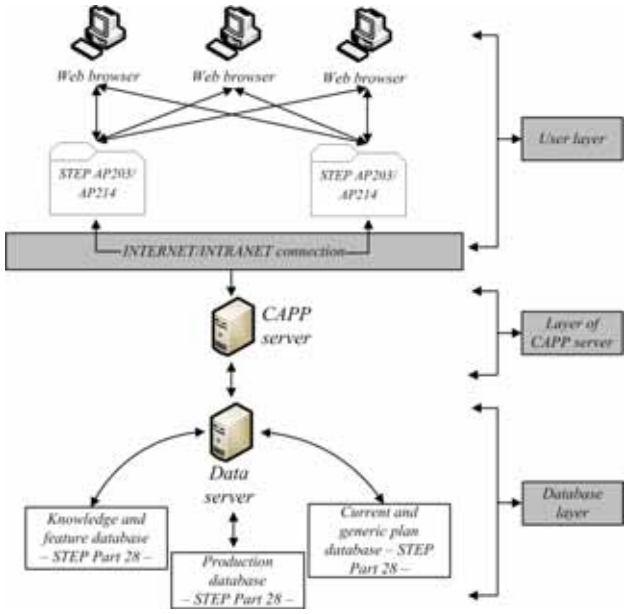

Fig. 3. Web-based process planning – reduced model of system.

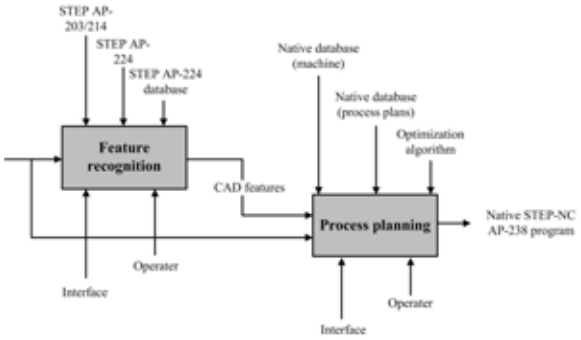

Fig. 4. IDEF0 model diagram for the CAPP server.

Processing program (generated native plan) in this case can be immediately implemented in the workshop level [10, 11].

At the level of data, Relational database management system - RDBMS system is applied. The information from the databases is available to CAPP server in the form of XML documents, viewable in a Web browser, and their transfer is done via the Internet. Interface model of CAPP server also generates a generic and native plan.

3. SOFTWARE SOLUTION FOR WEB BASED PROCESS PLANNING

With the demands of faster new product introduction and more complex, and customized products, local companies need to participate in global design chains and collaborate with each other and overseas partners to pursue competitive advantages. Web-based process planning is an Internet application for distributed and sharing process planning providing important support for virtual enterprises as well as classical enterprises.

The system has been designed on Client-Server architecture and implemented on the server web server supported for with server for process planning. The system has been designed to provide a user-friendly interface for web based software for process planning. System has been developed as web application. Server side user database is maintained using MySQL. All computationally extensive tasks are carried out on server while client end handles lighter tasks like GUI etc.

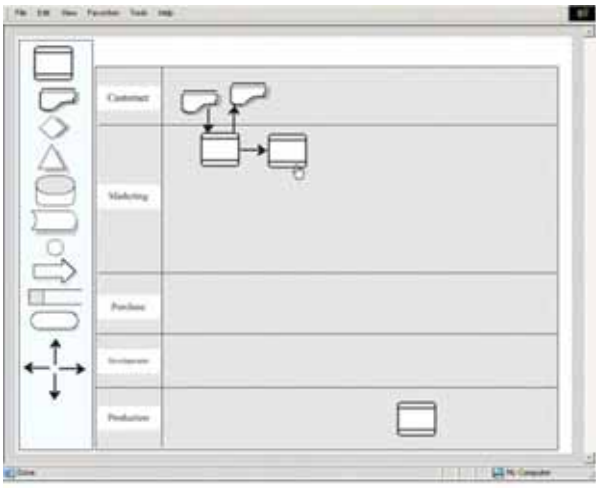

Fig. 5. GUI for software soultion for web based process planning.

Then users of system have intuitive graphical user interface in order to create complex process composed of activities and sub processes (Fig. 5). Each activity in the life cycles in the product life could be presented and documented with all documentations (technical documentation, documentation of the quality system as well as STEP or G-code file). CAPP system could generates rough process plans using pre-defined templates, which could be manually modified in order to ensure that full flexibility and fulfilment of demands of different processes.

The developed module for visualsation could provide full views and insight of 3D or other technical information (like it was presented on Fig. 6). A user can observe the design model in the Web-based system. He can change the visualization mode of the part, for example, hiding the meshes, highlighting a feature and retrieving its parameters, rotating and zooming the part, etc. System supports conversion between different files. It is posssible to conbverte STEP files into XML format. XML format could be used, as neutral format, fo interchange of data and infomration between heterogeneus systems or to provide communication in neutral form.

STEP implementation performs in number of chategories. Converter takes data for existing systems and data bases and covert them in STEP AP modeled data. One module converts non-STEP data in STEP data. Other module takes STEP data as input and perform different operations using these data and process different outputs. Example is when application takes partial data from different sources, as well as geometry from CAD system and configuration from CM system and complet them in documentation for exchange. XML file contains different information such as:

- indetification,
- assembly features,
- colours and materials of model,
- form feature types and their parameters,
- form feature relationships,
- VRML presenatation.

Therefore, it can be concluded that the development of Web-based CAPP system supported by multiagent systems converge to core objectives, as well as a reliable and quality plan generation and shareable model development in collaborative work among different teams and industries.

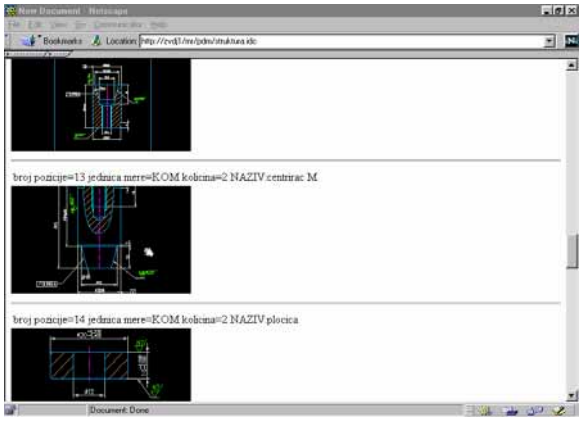

Fig. 6. Technical documentation for specific product.

Fig. 7. Conversion of STEP to XML: *a* – Segment of STEP file; *b* – Segment of target XML file; *c* – XML file in web browser.

Converting neccesary information into XML format is very usefull because enables full capacity for exchange of information within enterprise or exchange of information between distributed parts of companies or even between nodes in networked organizations network (Fig.7).

4. CONCLUSIONS

Regardless to all advantages of Web-based systems for process planning and it's remote implementation, the physical absence of workers (executor program) from the place of processing is only one limiting factors for their implementation.

A large part of the activities related to technological process design has empirical nature and requires using of knowledge of experts. We should emphasize that correct collection, presentation, archiving, maintenance and use of knowledge significantly affects to quality, efficiency and performance of production processes. Although, initial introduction of Web approaches requires a significant investment, the overall effects are positive. Solutions generated with mentioned approaches eliminate subjectivity of technologists and depend on the knowledge embedded in the appropriate database.

A Web-based process planning system has been developed at Faculty of Mecahnical Engineering, Kragujevac, Serbia within CIRPIS (Center for Integrated Product and Proces Development and Inteligent Systemes) center to support distributed system. The system is in the early stage of development but contains some important features such as: automatization of process planning, manual tuning, visualization of the models and file conversion.

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