Distributed Process Planning through Web-based Collaboration

Mijodrag Milošević¹*, Aco Antić², Dejan Lukić³, Goran Jovičić⁴, Jovan Vukman⁵

Abstract: Advances in Internet technologies have enabled designers to more effectively communicate, collaborate, obtain, and exchange a wide range of design resources during development. Shared web-based virtual environments allow engineers in remote locations to analyze a virtual prototype, together and simultaneously in a center where the product is being developed. This paper presents a framework for distributed and collaborative environment, which could assist manufacturing organizations to evaluate, optimize, and select process plans for groups of manufacturing parts. The proposed web-based collaborative environment, dedicated to distributed process planning for manufacturing, represents another step in the direction of advancement of modern distributed manufacturing.

Keywords: Distributed Process Planning, Collaborative Engineering, Internet technologies, CAPP

1. INTRODUCTION

Worldwide/Globally distributed manufacturing, with development of information and telecommunication technologies, favor the development of virtual companies and virtual manufactories. Exchange and share of digital data, is necessarily related with the global computer network – Internet. Internet provide a range of standard internet protocols, for exchange and share of engineering data. Distributed virtual environments enable connection between geographically dispersed teams through the computer network in real time, as well as exchange of experience.

Within the modern environment, manufacture of complex products often takes place in a number of small and medium enterprises, taking the form of distributed manufacture. Single enterprises are specialized in partial manufacturing processes. Complex products consisting of a large number of parts, components, and modules, are assembled into functional units within a single enterprise but need not necessarily be produced under a single roof. Therefore, better coordination is in order between geographically dispersed teams collaborating on the same project.

2. DISTRIBUTED MANUFACTURING

Distributed manufacturing consider high degree of manufacturing automation and improvement of information and business flows, which required effective manufacturing organization. This include not only Internet-based technology, it is result of manufacturing process evolution and capability of technology adjustment to changing business environment. Distributed manufacturing is necessary and inevitable technology in the future for the manufacturing companies. Therefore, worldwide manufacturing companies, are developing systems and platforms for distributed process planning and manufacturing, which presents integration of manufacturing and business information environments. Successful implementation of this concept require a development of engineering platform, which is based on standards and collaborative engineering and it, is basic infrastructure for realization and integration of engineering processes (Fig. 1.).

One of the most important elements of distributed manufacturing is distributed process planning, as a base for effective manufacturing process.

2.1 Characteristics of Distributed Process Planning

The objectives to be achieved by applying the concept of distributed process planning is a logical consequence of the Internet’s impact to changes in engineering design, characterized by [3]:

- **Digitization**: Any manufacturing related information that can be digitized could be stored and accessed through Internet within or outside a manufacturing company.
- **Globalization**: The global nature of Internet provides manufacturing companies with the infrastructure to support their engineers, partners and customers with access to information, regardless of where they are physically.
- **Mobility**: Internet enables accessing information from any place and at any time, which can improve the agility and responsiveness of a company to customer needs.
- **Collaborative work**: Internet technology supports data sharing and work collaboration. Companies can create joint development teams, where members of the team can reside in different geographic areas. Project
information and interactive conversations can be hosted on the Internet. A variety of collaboration tools can be used, so the members of the team can effectively and efficiently communicate and share ideas, information and data.

- **Immediacy**: Engineers can have real time access to information whenever they need.

### 3. COLLABORATIVE ENGINEERING

Depending on the complexity of collaboration and connection complexity in engineering design, different collaborative strategies may be applied, as well as different levels of cooperation, (Fig 2):

![Fig. 2. Strategic level of collaborative processes](image)

The collaboration involves the exchange of information, distribution of activities and resources, and improvement of common capacities. The collaboration involves the exchange of information, distribution of activities and resources, and the promotion of common capacity. The qualitative difference compared to the cooperation is possibility that organizations or individuals actively share knowledge, learn from each other, and thus become better at what they do. It requires a high level of trust and organization in terms of risk sharing, responsibility and benefits.

Collaboration refers to the ability of connecting various sources of knowledge in order to find new opportunities for personal, group and organizational development [5]. It is structured recursive process where two or more people and/or systems work together by sharing knowledge in an attempt to achieve a common goal [1].

The strategy of manufacturing companies was oriented towards the fragmentation of knowledge sources that have worked independently. Then, the integration has occurred, wherein the sources of knowledge has been connected to each other and localized within the physical boundaries of the enterprise. Strategy for today's modern manufacturing company is focused on collaboration for displaced manufacturing infrastructure globally, and the need for rapid response to market demands [6], (Fig 3).

### 4. WEB-BASED COLLABORATIVE ENVIRONMENT FOR DISTRIBUTED PROCESS PLANNING

From the analyzed web-based collaborative environments developed in recent years and its main elements, new conceptual model of collaborative systems for distributed design process planning is proposed.

The basic elements of the model include the parent company A, whose primary task is to design process plans of manufacturing products that ordered by external companies B, C, etc. The parent company has based its work on the distributed design and production and in its structure may own company A whose manufacturing plant is carrying out direct production. Taking into account the concept of modern distributed production, it has envisaged that the parent company is integrated into a distributed network of enterprises, organizational units and experts that participate in collaboration and using the Internet as an efficient communication infrastructure. Therefore, the envisaged collaborative system operates within the extended enterprise, (Fig 4).

![Fig. 4. Collaboration within extended enterprise](image)
Anticipation is that the parent company uses CAPP system for the automation of process planning oriented to its own production program. In addition, it is assumed that the parent company or extended enterprise operates on the principles of concurrent engineering while simultaneously using different CAx systems for development and analysis of product life cycle phases. The proposed model and planned collaborative software solution system will enable process planning for a given technological equipment of the parent company, as well as for technological equipment chosen by experts as participants in the collaborative process.

Collaborative system model includes two main groups of professionals involved in the process of collaboration, namely:

1. engineers and experts belonging to the parent company and
2. displaced engineers and experts who are in the organizational structure of the extended enterprise.

Engineers and experts within the parent company participating in production planning based on the needs of external companies, then in proposing a new technological solution, as well as interact with CAPP and other CAx systems used in design and analysis. On the other hand, displaced engineers and experts are involved in the evaluation of proposed solutions, as well as in the improvement of existing and proposing new ones, in their opinion, better manufacturing process plans. Knowledge of all stakeholders in collaboration is collected and organized in the repository of knowledge, available not only to manufacturing but also to the organizational structures, and to the management of companies. Accumulated knowledge is used in the implementation phase of specialized CAPP system with automated design of technological solutions for future new products.

Internet presents basic information infrastructure for this system. Using the Internet and Internet technology improves the efficiency in the preparation of production and eliminate the limiting factors related to space and time. Collaborative system, through the Internet, allow access to a complete process plans to all actors involved in the design and evaluation of technological solutions, no matter where they are geographically positioned. In addition, the system should enable Two-way communication, where will over the Internet to gather knowledge of experts and stored within the system. In this way, it is possible to create ad hoc virtual team of recognized experts and engineers, and experts in the field of process planning.

Information infrastructure in a collaborative system includes various flows of information and knowledge, as well as the procedures for collecting engineering and expert knowledge, (Fig.5). It is clear that the development of the model structure requires the implementation of modern management systems, organization and distribution of data. In addition to the required dynamic manipulation of complex information structures, database system must provide adequate protection information pertaining a business secret at the level of the extended enterprise.

Fig. 5. Workflow activities and information flow in the Web-based process planning collaborative platform [4]
This collaborative system provides expert analysis, discussion, and evaluation, which results in an optimal process plan for the given production conditions. Furthermore, experts are not expected to use any of the commercially available software systems for process planning or interaction with collaborative environment, because the collaborative process takes place exclusively through a web browser. (Fig.6).

Fig. 6. Access to the distributed process planning platform through an enterprise portal

5. CONCLUSION

The effective use of new engineering and manufacturing technologies is only possible in a flexible and collaborative working environment. In addition, Internet technologies are changing the way of thinking and doing business in the manufacturing industries. Displaying web-based environment designed for collaborative and distributed design of technological processes, is another step towards the improvement of modern distributed manufacturing.

REFERENCES


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Authors addresses

Mijodrag, Milošević, Dr, University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovića 6, Novi Sad, Serbia, +381 21 4852346, mido@uns.ac.rs

Aco, Antić, Dr, University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovića 6, Novi Sad, Serbia, +381 21 4852312, antica@uns.ac.rs

Dejan, Lukić, Dr, University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovića 6, Novi Sad, Serbia, +381 21 4852331, lukicd@uns.ac.rs

Goran, Jovićić, MSc, University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovića 6, Novi Sad, Serbia, +381 21 4852473, goran.jovicic@uns.ac.rs

Vukman, MSc, University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovića 6, Novi Sad, Serbia, +381 21 4852473, vukman@uns.ac.rs

Contact person

Mijodrag, Milošević, Dr, University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovića 6, Novi Sad, Serbia, +381 21 4852346, mido@uns.ac.rs