Abstract: With competition in global markets, more and more enterprises seek to make up virtual enterprise or cooperate with each other in the manufacturing process in order to reduce cost of product and increase competitive ability. For this reason, some of the key technologies are developing in the field of collaborative work between enterprise; besides collaborative design, the collaborative process planning also very important among them. With process planning collaborative platform engineers whom belong to the different enterprise may be work more efficiently than before, and the manufacturing resource of virtual enterprise will be utilized more optimized. In this paper the model of system for process planning in collaborative environment are shown.

Key words: Collaborative systems, PLM, Process planning, CAPP

1. INTRODUCTION

Manufacturers are facing increasing challenges of better product quality with tighter delivery requirements for customers. Global competition is increasing with pressure on prices, smaller orders, shorter life cycles, more suppliers and increasing material and energy costs. These new business drivers make manufacturers follow more competitive manufacture model, such as collaborative manufacturing, to closely collaborate with their customers, suppliers, manufacturers and partners for the most advanced competitiveness by leveraging core competencies throughout the entire product lifecycle.

PLM systems support the management of data for products, processes and services from initial concept, through design, engineering, launch, production and use to final disposal. They coordinate and collaborate products, project and process information throughout the entire product value chain among various levels, internal and external to enterprise. They also support a product-centric and process-centric solution that unifies product lifecycle by enabling online sharing of product and process knowledge and applications [1].

In the age of heterogeneous markets, rapid expansion of technologies and excessive reductions in product life cycle, collaborative engineering has been recognized as a strategy for the total life cycle. This collaborative engineering is getting more and more important as manufacturing activities require more expertise and more involvement from a lot of people on networks, including design engineers, production managers, process planners, production engineers, delivery managers, customers and expert advisors.

2. COLLABORATIVE ENGINEERING

The traditional approach to product development and production is Sequential Engineering, SE. In this method, works are divided into many sub-tasks, and the optimization is defined by these task sequences (Fig. 1).

The opposite method is Concurrent Engineering, CE. It is a systematic approach to the integrated and concurrent design of products and their related processes. In the concurrent engineering approach, a complex, dependent and diverse model is used, and optimization is determined by task dependency, organization behavior and uncertainty.

One of the key words in current researches in concurrent engineering is Co-operation. This co-operation means Collaboration and it is becoming more and more important. Consequently, Collaborative Engineering means co-operating, sharing information and knowledge of global and multi-company engineering (Fig. 2) [2].
According to the functions and roles of users participating in a collaborative design activity, a collaboration product development system can be organised in either a ‘horizontal’ or a ‘vertical’ mode.

The horizontal collaboration puts the emphasis on gathering a design team from the same or different disciplines to carry out a task systematically.

The vertical collaboration can establish an effective communication channel between the upstream design and the downstream manufacturing simulation and optimisation tools, and it can enrich the principles and methodologies of concurrent engineering to link diversified engineering tools dynamically. Due to these different levels of collaboration and interaction between users, the collaboration can be generally categorised into three types (Fig. 3):

- Visualisation-based collaboration,
- Co-design collaboration and
- CE-based collaboration.

2.1 Visualisation-based collaboration

Visualisation-based collaboration has the advantage of facilitating collaborative and distributed product or process preview/review. In such an environment, a multi-disciplinary team involving a manager, designer, process planner, customer, etc., can be formed to look at or review the same visualised design model, which is often steered by a chief designer or chief planner. To alleviate the sluggish transfer of large-volume design models over the Internet, concise 3D formats for Web applications, such as virtual reality modelling language (VRML) or Extensible 3D standard (X3D), have been launched to simplify the models as triangular meshes for visualisation purposes. Under this collaboration, the communication can be maintained through either an asynchronous manner or a synchronous manner.

2.2 Co-design collaboration

Co-design collaboration targets a more interactive collaboration activity for a conceptual or detailed design with more complex requirements of co-ordination and organisation among users. Co-design can be conducted either asynchronously or synchronously. An asynchronously collaborative Technologies and methodologies for collaborative product development systems activity can be organised in a hierarchical assembly structure, through which a chief designer outlines the assembly configuration and the detailed component design tasks are assigned to individual designers to carry on separately. Managements, co-ordination and project review of tasks, which can be assisted by some advanced project management or PDM systems, are vital to the whole process. A synchronous collaborative activity is conducted in a way such that a group of designers are dedicated to the same task actively. Teamwork techniques, such as user commitment, roles and responsibilities, are crucial to guarantee this simultaneous co-design activity.

2.3 CE-based collaboration

CE-based collaboration extends the CE principle, which is based on the integration of design and the related manufacturing processes for a life-cycle consideration, to support distributed applications, and geographically dispersed users, systems and resources can be integrated in an Internet/Intranet environment beyond the traditional boundaries of physical and time zones. In a CE-based collaborative system, product design systems and some evaluation or simulation service tools diversified in terms of functionalities, communication protocols, programming languages and data structure representations are integrated as a multi-disciplinary environment for optimising design. In such a system, application services in product design, process planning, engineering analysis and simulation, can be conveniently embedded as Application Service Providers (ASPs) for remote invoking and manipulation.

2.4 Product lifecycle collaboration

As such, a new technology solution, called, ‘product lifecycle collaboration’, is required. Functions of to enable product lifecycle collaboration include, but not limited to (Fig. 4) [1]:

- Product portfolio management,
- Collaborative product customization,
- Collaborative product development,
- Collaborative product manufacturing,
- Collaborative component supply and
- Extended product service.
In particular, the collaboration protocol, which provides different companies with general regulation to facilitate real time collaboration throughout the entire lifecycle, is imperatively required. This collaboration protocol includes different layers of collaboration alignment, such as goal, process, method, event, message and information.

3. FRAMEWORK OF COLLABORATIVE PROCESS PLANNING SYSTEM

An integrated manufacturing process planning framework includes process planning activities and integration with other application systems (Fig. 5).

Operations selection function selects manufacturing operations according to part and feature information, material, tolerance, etc. Routing planning function generates and sequences processes, selects machines for each process. Setup planning generates and sequences setups, selects fixtures for each setup, sequences operations within each setup. Operations planning function selects cutting tools and cutting parameters, etc. Manufacturing resource management module provides the necessary capabilities to define the required resources and the capabilities to enable the implementation of the operations selection, route planning, setup planning and operations planning functions. Operations selection function normally integrates with the CAD system to retrieve the defined manufacturing features and select the corresponding manufacturing operations. Route planning, setup planning, and operations planning functions usually interact with the ERP/CPS systems by providing the necessary manufacturing process routings, setups, and operations for project, production and shop-floor scheduling. Setup planning and operation planning functions communicate with the CAM system by providing setups, and operation information, which includes cutting tools and cutting parameters to generate the NC codes.

The conceptual framework of process planning collaborative system are shown in the Fig. 6. On the server side, a collaborative server program is running for the entire request from the client side. It composed of process planning module, collaborative simulation module and collaborative discussion and optimization module.

At the beginning, the process plan for the part is created within the CAPP system that uses an internal Knowledge Base and Manufacturing resource Database. After that, the process planner engineers are operating on the client side to do process planning work, they can collaborative discuss the process plan of the part, and finally select suited equipment, machine tools, cutting tools, fixtures, cutting parameters from the manufacturing resource database.
On this way, process engineers collaboratively make optimized manufacturing process of the part. When the process plan is finished and optimized then it is stored on the Product Process Repository in order to future use.

4. CONCLUSION

To satisfy new collaborative business requirements in modern e-manufacturing era, particularly, the increasing needs in collaborative product lifecycle management, a model of collaborative process planning system has been proposed. This model provides a platform for engineers to view, evaluate and optimize a process plan through dynamically invoking remote collaboration system.

With this system the young engineer will be advantaged from the system and other professional engineer, on the other hand, the partners of the enterprise will be benefited from the view and sharing manufacturing resource.

5. REFERENCES


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