

## Research on Modeling Product Service Network Oriented to Product Lifecycle

Ji Li

Key Laboratory of Contemporary Design and Integrated  
Manufacturing Technology, Ministry of Education  
Northwestern Polytechnical University  
Xi'an, China, 710072  
twoii@163.com

Rong Mo

Key Laboratory of Contemporary Design and Integrated  
Manufacturing Technology, Ministry of Education  
Northwestern Polytechnical University  
Xi'an, China, 710072  
twoii@163.com

**Abstract**—The merge and interaction of manufacturing and services trigger emergence of service-embedded manufacturing paradigm. Due to the development of this advanced manufacturing paradigm, product Service Network modeling is proposed in this paper. Firstly, the concept and characteristics of the network as well as the relationship between products and services were deeply analyzed. Then the BOM to meet the needs of the service-embedded manufacturing was established. The service-embedded manufacturing network model was constructed on this basis. The model includes design, manufacturing and maintenance and was oriented to product life. The network model will provide valuable information and research material to the service-embedded manufacturing both in theory and practice.

**Keywords**- service-embedded manufacturing, manufacturing network, product lifecycle, Bill of Material

### I. INTRODUCTION

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Servitization of manufacturing has become one of the development trends in today's world. In order to facilitate product sales, increase customer loyalty, create new market opportunities and Achieve new growth points, manufacturing enterprises started extensive service competition and tried to enhance competitiveness of products to create new values by providing services. This change refines the collaboration and division of labor among enterprises. The relationship between them becomes more network-like because they provide product services mutually how to create model in this context is a problem to be solved.

Service-oriented manufacturing is different from traditional manufacturing paradigm. It can integrate dispersed manufacturing and service more efficiently; Develop better innovative technology and create more value for enterprises and customers. Many studies about Service-embedded manufacturing have been done in recent years. Neely [1] proposed the concept of servitization. Chase et al [2] defined the concept of service-based manufacturing.

Berger et al[3] Put forward the concept of enhanced services, and explored the mechanism of Productive service.

in the micro organizational level Manley et al [4] pointed out that manufacturers could increase the additional value and extend the value chain by providing services. Che [5] proposed the enterprise service-oriented architecture (ESOA). The services layer in this system contained the necessary rules and Functions to combine multiple services into a single integrated service. Tang et al [6] defined the product service systems (PSS) based on the concept of the ESOA. Almeida et al [7] divided the product service system into product-oriented PSS, PSS for use and results-oriented PSS. The paper [8] Designed the manufacturing grid service discovery model based on the semantic web technology.

Based on existing researches, the manufacturing product service relationship on fronts the operations of service-oriented manufacturing system with a series of challenges.: 1) Providing services mutually on the product chain makes the service-based manufacturing network more complex; 2) The real time characteristic of service makes make the network more dynamic; 3) The characteristic of cross-border Makes resource utilization more complicated; 4) The intangible characteristics of service makes manufacturing more dependents on business knowledge and customer experience. These difficulties cause the need to model the service-oriented manufacturing network for researches on its formation, state, structure and characteristics, so as to provide the theoretical basis for service-embedded manufacturing. This paper analyzes the relationship between product structure and services, and Researches into the service-provider role of enterprises in the product life cycle also, on this basis defines the service-based manufacturing network, and finally constructs the network model.

### II. MEASURING AUTOBODY PANELS OF PRODUCT SERVICE NETWORK

#### A. Relationship of Product, Service and Enterprise

Product structure reflects the relationship between its components which are carrier of services. Enterprises provide services for each phase in product life cycle. A company Not only provide multiple product services, but also gets services from others as a service acceptor. In the product life cycle, product service relationship model is used to describe The relationship formed in mutually providing

products and services between companies. The model's main elements include: service provider, service accepter, service type, service carrier, ownership of service carrier, quality of service, timeliness of time and cost of service, etc. Shown in figure 1, a product comprises the software and hardware and hardware can be divided into parts, Spare parts and standard parts. These elements Can serve as service carriers. From this perspective, product services can be divided into the following types:

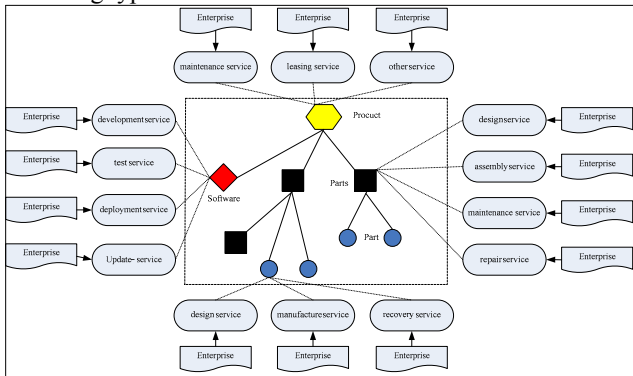


Figure 1. Relationship of enterprise, product and service

Spare parts related services: include design, manufacturing, transportation, maintenance and recycling;

Parts related services: include design, assembly, repairs and maintenance;

Software related services: include design, development, deployment, maintenance and upgrading;

Product related services: include design, manufacturing, sales, repairs, maintenance and leasing.

### B. Definition of the Servicing Manufacturing Network

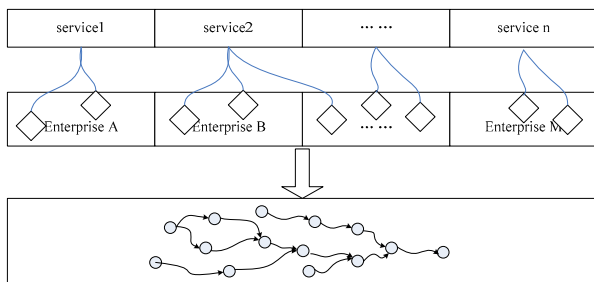


Figure 2. Product Service Network

In the product life cycle, each service can be divided into a number of service nodes. The product service chain is formed according to the logical order between them. service-provider candidate can announce their services publicly and service recipients can select service providers for each service node. When all nodes in the chain have their unique provider, this service is accomplished, as shown in Figure 2. In the process, many companies cooperate together to form a service network. Enterprises apply labor division and cooperation, share complementary advantages and mutually provide production services to achieve capacity building and

rapid response to the market. This paper defines Servicing Manufacturing Network: Service providers and recipients are mapped to Network nodes; the mapping relationship between them from the service provider node to The service recipient node forms an edge of the network. As multiple service relationships may exist between a service provider and a service recipient, the connection between two nodes may not be unique.

### C. Characteristic of the Servicing Manufacturing Network

1) Navigability. As the core of service-based manufacturing, the network can navigate and control the entire product service process.

2) Stage. The network is constructed dynamically. Because there are phases of task release, design, manufacturing, maintenance and recycling in the manufacturing process, the network Corresponding has phase changes.

3) Global property. The network exists as the core of service-oriented manufacturing system and it enables the overall control and schedule.

4) Dynamicity. As the service process is dynamic, the corresponding service-oriented manufacturing network is dynamic correspond along with the emergence and demise of the service.

5) Distributive property. The network throughout the service-oriented manufacturing field is used to schedule and track productive service manufacturing sites.

6) Service. The network aims at servicing during the entire product life cycle by implementing global data and resource in this process to achieve cost, schedule, and quality control management of the service enterprises.

### D. Classification of Servicing Manufacturing Network

Service-oriented manufacturing network can be divided into two categories: single and composite manufacturing network. Single service-oriented manufacturing network is built for a single specific manufacturing task. It includes dynamic, complex service task assignment, design, manufacture, maintenance, upgrades, etc And will form the network diagram based on timing. It contains the core business process services as well as extended enterprise of customers throughout the entire product life cycle. Composite service-oriented manufacturing network includes dynamic, complex directed network graph which is composed of the entire network services provided by suppliers, customers. It is formed by several single service-oriented manufacturing networks. Single service-oriented manufacturing network is a basic form of service-oriented manufacturing, and is the support of services in the product lifecycle. Because of the complexity and diversity of modern industrial products, the complex relationship forms a variety of composite service-oriented manufacturing network.

### III. DATA PROCESSING MODELING THE SERVICING MANUFACTURING NETWORK ORIENTED TO LIFECYCLE

Because of noise in the course measure, data from optical triangular scanners is preprocessed, which includes smoothing, removal noise and deleting exceptional points,

before reconstructing surface is cable of identification clouds and process, the minimum distance is found automatically and tandem compound to acquire point group. Cut point group along a certain direction to obtain cross-section these are continuous and in a sequence [4].

Modern products generally experience several basic life-cycle stages of conceptual design, structural design, detailed design, process planning, manufacturing and marketing. In different stages, service needs are different. Enterprises should provide service-based design, manufacturing and the service to facilitate product maintenance. In order to provide these services, the service-oriented manufacturing network which is product-based, dynamic and effective is constructed to best meet the demand of users and increase the service value.

In the modern product manufacturing, the division of labor and cooperation between enterprises is more refined. More Enterprises focused on their core competence (agile, flexible, efficient) adopt production methods to provide customers with product and application solutions through producer service and service production. Correspondingly, the service-oriented manufacturing network is large-scale with more user demands and more requirements on innovation management of innovation. Product BOM is the main transmission media of information between enterprises. The service-oriented BOM is built with directory services technology around the product BOM. As a distributed core component of the service-embedded manufacturing network, the service-oriented BOM should be managed as a whole and be presented through a fully integrated single network view. Corresponding to the traditional mode, the service-oriented manufacturing BOM includes not only design and manufacturing process information, but also a variety of service information, such as: types of services, service start time and service costs. In the design phase, the product design BOM is established according to the customer requirements. The BOM not only includes geometry, features, functions, knowledge and other design information, but also manages the design, testing, trial service information and other services. In the manufacturing stage, the manufacturing BOM is generated by succession evolving related to the design BOM. The manufacturing BOM manages process, tooling, assembly and other production preparation and production of performance information and contains machining, casting, testing, manufacturing services and integrated information management. at the same time, the product maintenance BOM inherited the design BOM and manufacturing BOM's maintenance information. The BOM is a collection of information which contains the maintenance of demand planning, routine maintenance, and fault recovery, repair and maintenance services. Each service in the BOM is an edge of the service-oriented network, and each service recipient or provider is a node of the network. Thus, the service-embedded manufacturing network model is constructed with the information of the BOM. Based on the service information of design, manufacture, maintenance BOM, three basic service-oriented manufacturing forms of design, manufacture, and MRO-based maintenance can be mapped out of the service-driven network model as shown in

figure 3. Figure 3a shows the service-driven network model is established by the design BOM in the design phase. Figure 3b shows the service-driven network model is established by the manufacturing BOM in the manufacturing phase. The model in maintenance phase is showed in figure 3c. the service-embedded manufacturing network model is composed of three models oriented to product lifecycle.

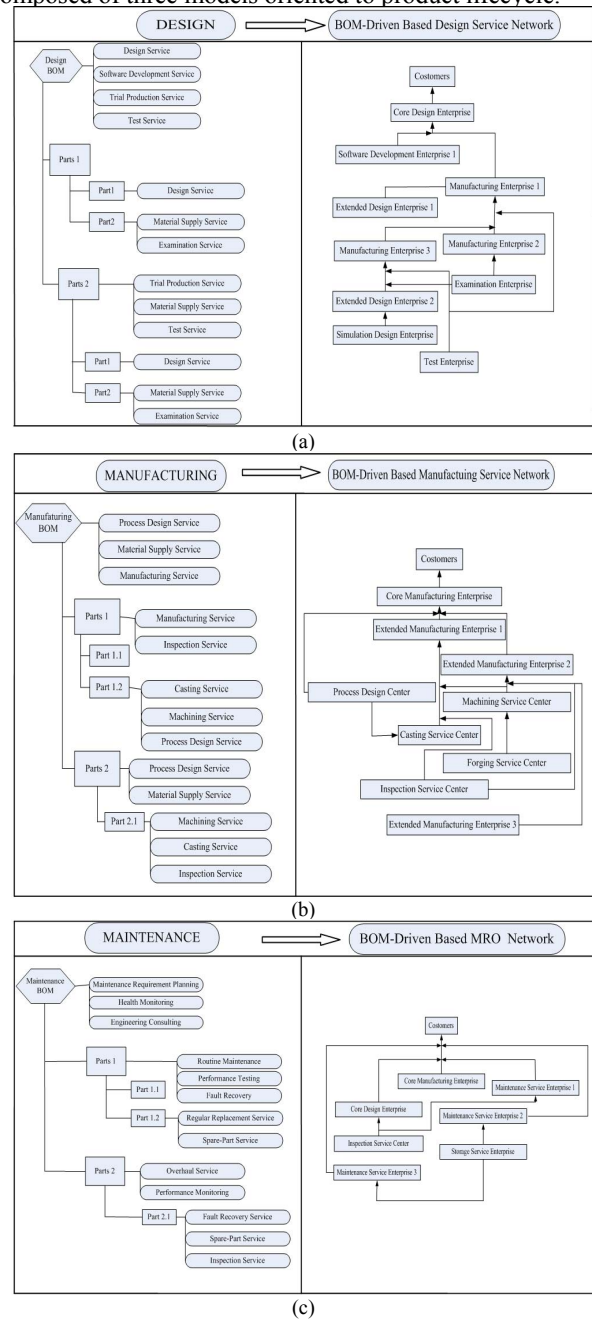


Figure 3. Product Service Network framework oriented product lifecycle

#### IV. CONCLUSION

This paper presents a new service-based manufacturing network modeling method Oriented to product life cycle. Dependent on demand of the service evolution, the BOM Which meets the requirement of servicing manufacturing is constructed based on product BOM and then three basic forms of design, manufacture, maintenance in the network are mapped out. On this basis, the model of servicing manufacturing network is established. This model can enhance the core competitiveness of enterprises and promote the process of business servitization.

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