Personalized Product Design and Service System for Cloud Manufacturing

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Personalized Product Design and Service System for Cloud Manufacturing

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Abstract: Personalized product design system needs the support from cloud-manufacturing technology in order to promptly achieve. Based on the investigation on the characteristics of cloud-manufacturing system platform, a system architecture applied for the process of personalized product design service built on cloud-manufacturing platform was proposed, which was called Intelligent Cloud Manufacturing and Service System for Personalized Product Design (ICMSS-PPD), to connect both the customer needs and manufacturing resource for a better service.

1. Introduction

From a design perspective, the Product Service System (PSS) can be seen as a design-led system that integrates various services and manufacturing resources to design products that provide perfect service. In recent years, cloud manufacturing as a computing and service-oriented manufacturing model was proposed based on the purpose of resource-sharing in the manufacturing sector. Under the support of existing advanced manufacturing models, cloud computing, Internet of Things, virtualization and service-oriented technologies [1-2], cloud manufacturing aim at meeting growing demands for higher product individualization, broader global cooperation, knowledge-intensive innovation and increased market-response agility. Obviously, it is the trend that product design and service system only combine with advanced manufacturing systems—cloud manufacturing to achieve fast response to user demand for personalized design. For this purpose, Intelligent Cloud Manufacturing and Service System for Personalized Product Design (ICMSS-PPD) is proposed to explore the possibilities of an integration design service system combined with user-model and cloud manufacturing technology. ICMSS-PPD focus on providing the necessary technical support to improve design efficiency and quality during the process of personalized design service by well blend of information technology, design and manufacturing resources.

2. Theory and Methods

2.1. Product as a Service

United Nations Environment Planning Department first put forward the concept: Product Service System (PSS) in the 1990s, which also was called "functional product development". The aim of PSS is integrating type products and intangible services together as to a pre-designed system, which is concerning product PLC and sustainable development, maximize meet the specific needs of customers, to

improve the competitiveness of traditional business models. This concept “product” is rather viewed as a serial of combination of functional services than a single entity. This is not only involved users, but also extends the field of the product. The earliest researches of PSS were mainly concentrated in European countries, especially in Scandinavia and Germany. Early studies were mainly focused on conceptual definitions and theoretical models such as the influencing factors of development, environmental performance evaluation.

2.2. Service System of Industrial Products

After 21 centuries, researchers have proposed the industrial product service system based on PSS make the PSS research from theoretical to application methods. For example, from 1998 to 2002 a lot of research about the PSS processes and methods (MEPSS) carried through under the EU Fifth Framework Programme funded; Hockerts proposed six-step innovation model in development progress of eco-efficient services in 2002, marked the beginning of PSS design practice research. Applications of PSS are mainly concentrated in the areas of service function of white goods, office furniture.

Horst Meier gives IPS2 [3] the concept of deepened understanding of the PSS in 2005. IPS2 is engaged to construct a social system suitable integration knowledge of the interaction and interdependence in process of products and services as a whole services pack to meet the user. It not only follow with interest product quality by product service providers paying more attention to it, but also the user experience involved in product life cycle services. It improves product innovation ability, develops new market space and reduces capital investment by providing users with high-quality product services. Through specialized service sharing, the "win-win" of product service providers and users can be realized.

Technically, the definition "Crowdsourcing" fist published by Jeff Howe[4] in the United States "Connection" magazine in June,2006 provides a viable approach for users’ deeply involved in the way of resources share, and improve the whole process of product design and manufacturing, and thus was born a new mode of production organization. Crowdsourcing is the development and continuation of business models such as the development and continuation of outsourcing (outsourcing), open source code (open-sourcing).

By Internet, the term Crowdsourcing permits traditionally work usually supposed to be done by employees or external agencies will be openly assigned to a large group or community to complete, including the development of new technologies, design task, improving an algorithm or massive data analysis, full use of cognitive leverage collective intelligence and creativity to achieve massive information filtering, analysis and processing capabilities (such as voting mechanism), and have a certain degree of financial integration capabilities. Daren C. Brabham[5] puts forth a problem-based typology of crowdsourcing approaches: Knowledge Discovery & Management, Distributed Human Intelligence Tasking, Broadcast Search and Peer-Vetted Creative Production further explored crowdsourcing’s disruptive effect to traditional product development and manufacturing.

2.3. PSS model for cloud manufacturing

Cloud manufacturing is service-oriented, High-quality low-cost, and smart networked manufacturing model, providing access to the network at any time for manufacturing the product life cycle process, services all types of manufacturing activities.

Cloud manufacturing has received more and more attentions. In China, a national high-tech research and development programme named ‘Key Technologies in Cloud Manufacturing Platform’ [1,2] was in place across academia, industry and government; In Europe, a project supported by European 7th Framework Programme called ‘ManuCloud’ aimed at developing distributed cloud product specification and establishing supply chain manufacturing execution infra-structure, Another on-going European Union (EU) project, CAPP-4-SMEs, is expected to realise collaborative and adaptive process planning for sustainable manufacturing environments. In the United States, Defense Advanced Research Projects Agency (DARPA) Manufacturing Experimentation and Out reach (MENTOR) programme funded a project to ‘develop an integrated, distributed cloud-based design and manufacturing

infrastructure that can support a progressive set of prize challenge competitions through integrated computer-aided design and manufacturing tools'. Based on the reviews, it has been found that most current literatures are focused on discussion about theoretical framework such as concepts and architecture, the key characteristics are not well understood[5,6]. There still lack research advances on cloud manufacturing, which would provide theoretical references for system implementation especially for personality product design. More importantly, from a practical perspective, more cloud manufacturing applications are needed to showcase the concept and push this new area forward. To address these issues, this paper presents an over-view of key characteristics of cloud manufacturing; then, under the analyses of infra-structure of cloud manufacturing to clarify main activities and relative resources involved in personality design process. A personalized product design-oriented cloud manufacturing and service system (ICMSS-PPD) is proposal. Finally, User model-driven personalized products and services module is illustrated.

3.Results

ICMSS-PPD is a user-centric-design service system integrated manufacturing information, digital virtual design resources, and cloud computing to provide most adequately resource utilization. Similar to the concept of cloud computing, where the service to customer of providing product function has become the main purpose, that is, the most important terms are whether customer needs and service abilities is available. Therefore, to adapt to cloud the inevitable trend of development, the user-driven product design and system development, new product concept that is transplanted to the cloud services platform manufacturing technology.

3.1. Cloud-manufactured technology platform product service system and characteristics

Tao Fei[3-7] consider the following typical characteristics of cloud manufacturing: the demand for services and manufacturing; uncertainty in the manufacturing; user participation manufacturing; transparent and integrated manufacturing; Active Manufacturing; supports multi-user manufacturing; support on-demand and pay-use manufacturing; low threshold, outsourced manufacturing; agile manufacturing; specialized manufacturing; share -based manufacturing capacity and transactions; manufacturing knowledge–based; groups of innovative manufacturing; green carbon-based manufacturing.

Meng Xiangxu[8] believed that cloud manufacturing embrace both the nature and characteristics of cloud computing and manufacturing infrastructure model. So that the basic services rramework of cloud computing as a service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS) features , such as the basic framework for the cloud model provides the service of data process. As one of manufacturing resources, cloud manufacturing reveal the essential characteristics of self-organization, collaboration, demand-driven and so on.

In addition to the above characteristics of cloud manufacturing, this paper argues that cloud manufacturing also has its own uniqueness, Such as：a) " Product as service" ； b) Multi-network collaboration services;c) " Crowdsourcing" terms ； d) User-centric design and ability available to quickly respect to individual users.

In addition, the research and application of cloud manufacturing service system is still at an initial stage, many questions have not been fully considered. For example, according to the literature [1-2][8] research point of view, the ideal cloud manufacturing system is desirable to provide a self- service resource organization optimization process, without human intervention and management. However, the responsibility for the needs of the business process may cause some problems such as safety, cost estimates, services billing and accounting , all these can not be ignored. If managed well, it could cause a system panic disorder, For concerns both customer or resource provider would trust in traditional product manufacturing way rather than cloud manufacturing system. Therefore, we consider it is necessary to establish a personalized design service cloud manufacturing systems in the cloud services platform, to be responsible for the link up between customer needs of individual design and the cloud manufacturing system.

3.2. Personalized design services for cloud manufacturing service system architecture

According to the study of Li Bohu, Zhang Lin , Tao Fei et al[9][11], system architecture of cloud manufacturing technology platform must contain three levels of resources: physical resources layer (P-Layer), cloud-manufacturing service layers of virtual resources , cloud application layer. In this hierarchy of three basic resources, personalized design is of the application layer and an intervene services ranging from a cloud service model to cloud manufacturing platforms. It needs to integrate user needs and demands and classify to determine which available service mode will be carried out, and which admissibility resources about design or manufacturing might be involved in. After the above analysis, to meet the resource-sharing characteristics of cloud manufacturing, personalized product design-oriented cloud manufacturing and service system shown in Figure 1.

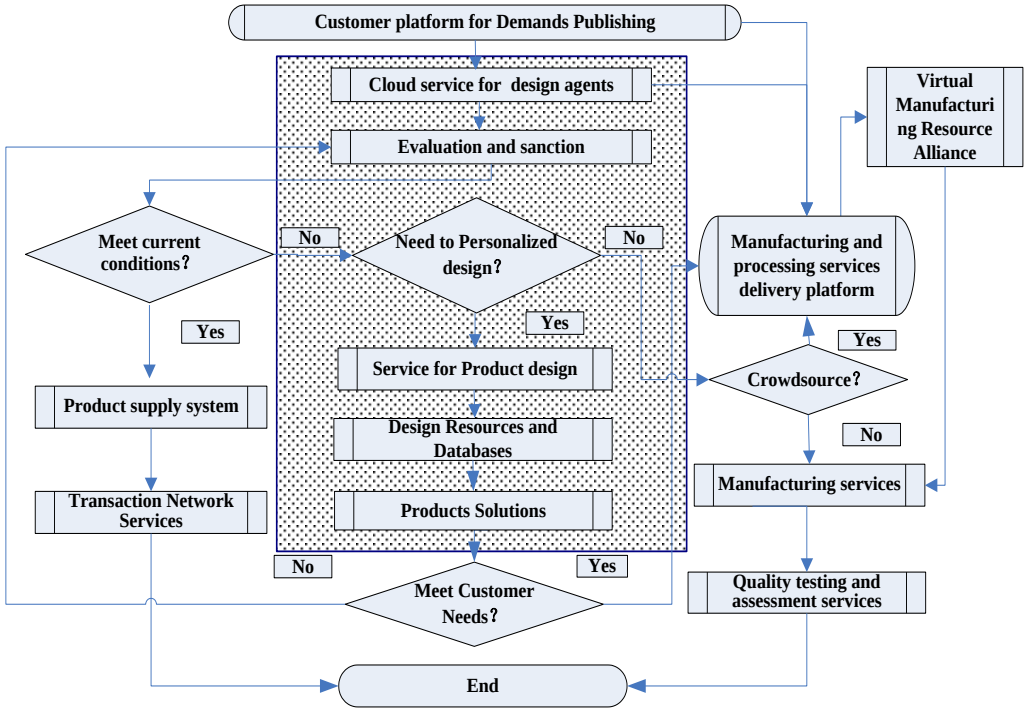

Figure 1. personalized product design-oriented cloud manufacturing and service system

4. Discussion

PSS need to establish a pre-designed program to quickly respond to the individual needs of Customer. That is design for User Model-Driven Personalized Products and Services Module (UMD-PDSM, Black in Figure 1). Cloud service for design agents (CS4DA) actual execute the function of UMD-PDSM. This part I have done in other literature [12][13], here is just a brief description of to the relation part to Personalized design services cloud platform based on the manufacture. CS4DA would be adequate for this job and consist of the design service Clouds which are part of cloud resource providers, personalized products design and services module must be considered to build a common structural model for personalized products. Its purpose is to give the design services cloud with the necessary knowledge and tools to quickly responded with the received request from Customer platform for Demands Publishing, and for further progress as organize, evaluate and allocate design resources and tasks to candidate collaborator in cloud manufacturing platform. Cloud service for design agents (CS4DA) also undertake the tasks including released crowdsourcing demand information to Manufacturing Service Platform, selection suitable partner, assessment the ability, services quality, every partner's distribution for this remands request and keep the service information with user. Detail of tasks include accepting demands—evaluation task—request for design services—request for manufacturing

Resources—process routes identified—assembling and addressing optimal—Evaluation and closing of the transaction and so on.

First step, as soon as confirm the customer request, CS4DA evaluation its' degree of innovation and rationality. If there is an available product service for ready-made, CS4D will inform Customer and transfer request task to transaction platform.

Second step, is to judge preference and creativity. Design services to solve things quickly identify and design requirements according to personas template, required design specifications and relevant Products Database. If not to find related templates to reference, generate new specific template (the highest level of customization) and follow the analyses according to customer needs. So here are three basic functions needed to support. The first is a typical example templates library, which can be invoked; The second is a rich role template library, which can provide design support functions of similar types of product template, diversified selection or partial improvement (a small amount of customization design); the third is that no design template and similar Personas template can be found to reference. CS4PD need to set up a new exception for this new user request, which tools supporting designer to analyses and rapid generate universal design specification are necessary. Figure 2 show a Subsystem of Personalized design services based on user model, more detail discussion could be review at literature.

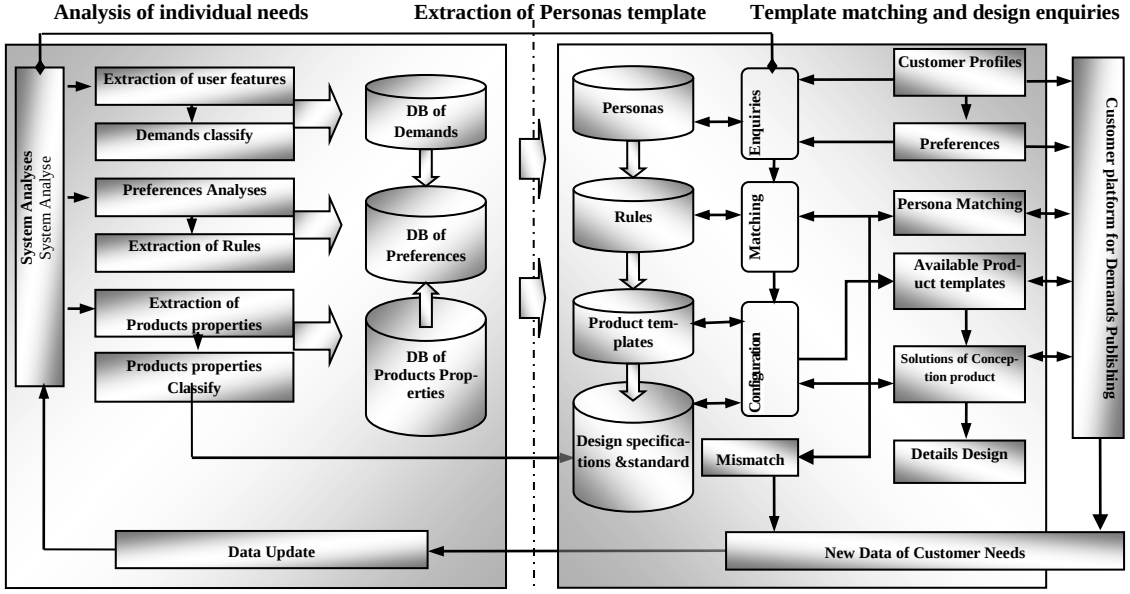

Figure 2. Subsystem of Personalized design services based on user model

After design services available, the full profile view of product design must to be determine as soon. CS4PD will be responsible for the relevant component or subsystem design of the requirements and technical details, distribute crowdsourcing information to seek collaborators, choose partners consist of Virtual Collaboration Services Unit (VCSU), formally place an order to meet the specific personality demands. CS4PD, virtual collaboration services Unit and user will sign contract or charge a certain deposit for design services charge and responsible for the user at this demands task. participating resources and Design Center for a one-to-one relationship,

Subsequent manufacture, assemble part manufactured by the design center in the cloud platform to find and form a virtual team, every member participating in this VCSU is a one-to-one relationship with CS4PD. For the sake of security, CS4PD have right to approval temporary connection between members in VCSU under its permissions if necessary helpful for further collaborative relationship.

Terms of geographic between members participating in VCSU must be considerate seriously at evaluation on service ability of VCSU in machining processes and parts were transferred and final logistics.

5. Conclusion

PSS theory regards product design and manufacturing as a more active service mode to provide users with the whole product life cycle(PLC). And it is very suitable for the design of personalized products. Building personalized design manufacturing system platform is a necessary means to ensure the rapid response and realization of personalized design. It is also a necessary means to integrate products, services, participants, networks and infrastructure. Intelligent Cloud Manufacturing and Service System for Personalized Product Design proposed in this paper can improve the productivity of personalized products design and application mode on cloud manufacturing platform. In order to better realize its functions, it is necessary to further construct a service evaluation system to evaluate the quality of service of virtual resources involved in the whole process of personalized design and cloud manufacturing services, One is to help the design service cloud agent center to effectively evaluate the selection of appropriate virtual manufacturing alliance members for users, and the other is to evaluate the value of contribution which service of every virtual resource member meet user needs after task, such as efficiency, utility and cost etc. In addition, all the evaluation of data would also provide an important credit score to every virtual resource member for next accession to cloud manufacturing platform system. Due to space limitations, this section will detail in our next paper.

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