Social Manufacturing Realizing Personalization Production: A state-of-the-art Review

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***Abstract*—Traditional manufacturing researches are mainly focusing on one concrete technology application, such as production model, supplier management, advanced automatic equipments etc.. Rapid developments and advances in information, manufacturing and management areas make the social environment of manufacturing change much. The global competition and multifarious customer demands are more and more universal phenomena. The difference and evolution in the advanced manufacturing systems need to be researched deeply. In addition, the relationships and functions among these social factors and the automatic manufacturing systems should be investigated in detail. Social manufacturing provides a new paradigm for the enterprises to capture the value. In this article, recent researches in social manufacturing are reviewed.**

Keywords—social manufacturing; socialization; review; personalized production

I. INTRODUCTION

Since the 1920s, the mass production was a common production style in many manufacturing industries in America, such as in motor company, woodworking industry, bicycle industry etc. [1]. In 1970 a completely new idea, production for individuation, was proposed by Alvin Toffler in his book: 《Future Shock: The Third Wave》 [2]. The production mode really embodying customer requirements is firstly expressed as "mass customization" by Stanley in his book 《Future Perfect》 [3]. It is an alternative to differentiate companies in a highly competitive and segmented market [4]. Joseph pointed out that the keys in mass customization are the variety and diversification of products instead of the increase of the product cost corresponding [5]. In essence, the scope of mass customization is mass production of customized products [6].

Recently, with the rapid development of computer and internet, the social media play a more and more important role in manufacturing [7]. The consuming habits of citizens are mainly transforming to individual consumption. It is much possible that a product is produced for only individual person. The emerging of new technologies in manufacturing, information and management are also changing the existed rules of market competition [8]. Enterprises are facing new pressures and challenges. So it is necessary that companies should bring a new mode of manufacturing under this changing social environment [9].

The increasingly networked global economy is nourishing some possibilities of the new production modes. Social manufacturing is a newly proposed manufacturing mode in resent 3 years or so [10]. The main goal of social manufacturing is to systematically process information and resources so to supply more flexible and timely service for rapidly changing needs of customers [11]. This makes enterprises evolve to intelligent ones which are able to satisfy the changing demands of mass customization. Therefore social manufacturing is to link up social needs and social resources actively, promptly and organically, so as to realize the conversion between demands and supplies effectively [9].

A new manufacturing paradigm, social manufacturing, will become dominant in the near future under the trends of socialization, personalization, and servitization. Therefore the aim of this paper is to depict the development process of the social manufacturing and present a literature review on social

manufacturing. It is an academic try to provide a framework to understand the several developments that emerged in the literature in the past 5 years.

II. CONCEPT OF SOCIAL MANUFACTURING

Social manufacturing can be defined narrowly or broadly. The broad, visionary concept was first coined by Wang [12] and promotes social manufacturing as the ability to implement social network as a super-computing sever. Using the pseudo severs, social manufacturing can help us design and analyze products and digital data and provide products and services with linked additive manufacturing equipments or other digital apparatuses. Tao et al. pointed out that in manufacturing the sharing of manufacturing resources and capabilities, the value creation carriers, the value measuring criteria, the composition of the value chain and enterprise collaboration, and the user participation in manufacturing are all moving towards socialization with the social network deeply involved[13-15]. Social manufacturing system is a kind of service-oriented intelligent system which is driven by specialized production outsourcings/crowdsourcing and based on mass socialized manufacturing services self-organization [11, 16, 17]. Figure 1 shows the process and flow path of social manufacturing.

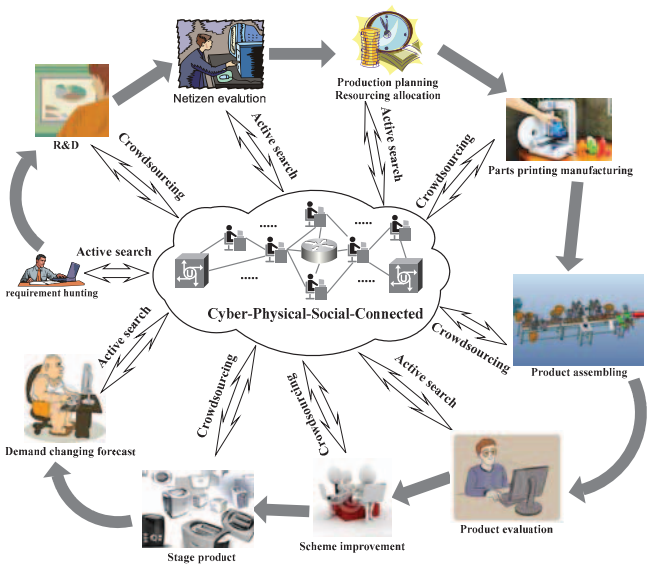

Fig. 1. Process of social manufacturing

Some authors present similar but narrower and more practical concepts. They define social manufacturing as a system that uses information technology, additive processes, and organizational structures to deliver a wide range of products and services that meet specific needs of prosumers (*i.e.*, integration of producer and consumer), at a cost near that of mass production [18, 19]. In any case, social manufacturing is seen to be a systemic idea involving all aspects of conceptual design, development, production, product sale, and delivery, full-circle from the customer option up to receiving the final "finished" product [20, 21]. Generally the subsequent processes to the discarded products losing their functions after application will be included [19, 22].

The justification and evaluation for the development of social manufacturing mode is based on the following six main ideas [11]:

1) New ideas, innovative knowledge and socialized manufacturing resources etc. are available abundantly [23].

2) New flexible manufacturing process and new materials enable production systems to transform from operating at mass scale to more individualized and higher customized production at lower cost [24].

3) Prosumers pay more attention to outsourcing and crowdsourcing for the systematic processing of huge information and resources to create better service for customers.

4) There is an increasing demand for product and service variety and customization [4, 25].

5) The shortening of product life cycles has led to the breakdown of many mass industries, increasing the need for production strategies focused on individual customers and expanding industrial competition ranges [26].

6) The intensive integrations of the manufacturing and service greatly enhance the complexity and unpredictability of the manufacturing system due to the dynamic, distributed, and invisible characteristics of production service among prosumers.

III. SOCIALIZED NETWORK

Fombrum [27] proposed a relatively comprehensive definition to the social network: It is the interrelationship between the entrepreneurs and their contacts for business purposes. But now, with the fast development of network technologies and applications, such as cloud computing and social media etc., perhaps strictly distinguishing the designer, consumer and manufacturer is not so important. In social manufacturing mode, consumers are sometimes also producers and all of them, including consumers and producers, are defined as prosumers. That's to say, in a social manufacturing system, a manufacturing community is composed of large number of prosumers who have shared interests and tasks [11]. Social network is one of the cores for the development the social manufacturing system.

The main disadvantage of the traditional design and manufacturing processes is lack of interaction with stakeholders and crowds outside organizations. Nowadays, entrepreneurs have embraced social networks by using social media, such as Facebook, LinkedIn etc., for interaction and communication with users and customers. Wu et al. formulate a social network analysis approach to analyze the cloud-based design and manufacturing (CBDM) system to facilitate design and manufacturing knowledge sharing between actors [28]. In this research, two questions are answered: a) What measures can be used to analyze the socio-technical network generated by CBDM? b) How to detect communities/clusters and key actors in the socio-technical network? These results provide a way to coordinate the product suppliers and consumers. Evmorfia [29] developed an application system, FITMAN Anlzer, to facilitate social media monitoring for enterprises.

This system is cloud-based, domain-independent and allows any manufacturer to effectively train it based on production and management needs and creates personalized reports to timely capture the right information.

Not only in product design and manufacturing, social manufacturing network is also playing a key role in product selling and buying. Xiong et al. [30] propose a new method and frame to analyze the features of network B2B (Business to Business) software of electric commerce, which is based on the new network technologies, such as complex network [31] and cloud computing [32]. The new software frame has been proved to promote software maintaining efficiency, decrease software and business handling cost and time. Surin and Wahab investigate the impact of social network on business performance in the Malaysian established manufacturing small and medium enterprises [33].

Generally speaking, knowledge is recognized to be the only resource that increases in value. And the sharing of knowledge can enhance innovation through facilitating the free flow of ideas [34], which in turn will build valuable knowledge. Said explore the relationship between face-to-face social networks and knowledge sharing. They advised many ways to share knowledge, such as the use of multiple communication styles, brainstorming and problem-solving, learning and teaching, training, consultations and employee rotation. It means that potential cost savings and improved work practices can be achieved [35]. Recently Leng and Jiang proposed a deep learning model and put it in web-based implementation in social manufacturing interaction context. This gives us another theoretical guidance to facilitate knowledge transferring and sharing based on the context of enterprise social interaction [36]. Ding et al., build a social manufacturing-oriented enterprise relationship network to well organize plenty of distributed enterprises [37]. Thus manufacturers and organizations can break the walls and share information and develop their products or services [38, 39].

IV. SUPPLY/VALUE CHAIN

Social manufacturing demands manufacturers and enterprises to response to customized needs quickly and low-costly, in order to maximize economic benefits. Establishing a customer-centric supply chain can make enterprises better suit the dynamic and uncertain competitive environment and simultaneously enhance the flexibility and agility of the supply chain [9]. Under social manufacturing model and social network environment, Xiong et al. [9] enumerate several characteristics of selecting supply enterprises:

1) Social manufacturing requires "Every people and enterprise involved in the design, manufacture and enjoyment". And it is necessary for the enterprise to take an effective and scientific management model or strategies for various suppliers.

2) Suppliers are usually final retailers, and sometimes the disorganization of these distributed suppliers has obstructed the collaboration decision making and led them to inferior positions [37].

3) Many social media network platforms, such as Facebook and Twitter etc., can gain many new users in a daily basis. So internet suppliers and online procurement will be the mainly selling and buying mode.

As the outsourced manufacturing services more and more flourish in social manufacturing, the manufacturing service providers trend to collaborate to finish product development. Ding and Jiang [40] build a graphical formalized deduction method, called RFID driven state block model, to investigate the integrated production and logistic service flow monitoring problem. Based on the social firm network, Fu and Shuai build the structure model of manufacturing enterprise's logistics operational costs. And the simulated results show that system dynamics, which is used to research the supplier's logistics cost control, can be applied to optimize the relation factors in the manufacturing system [41].

Carnovale [42] explores the role that various network constructs play in exploring partner selection in the formation of new supply chain manufacturing joint ventures. The hypotheses regarding joint venture formations of domestic and international partners are also investigated. Two discrete time event history analyses, with time-varying independent variables are used to estimate the effects of the ego network and structural network. Results provide empirical support for the role of network structure, at multiple levels, in mitigating the uncertainties of new equity based partnership decisions in global supply chain networks. Mahmoudzadeh and Laleh [43] survey the efficient of supply network based on the social network analysis method. The supply network of Tractor Motor Manufacturing Company is analyzed and some structural ruptures are found.

V. KEY POINTS AND APPLICATION

The success of social manufacturing paradigm relies on a series of external and internal factors [44, 45]. The existence of these factors justifies the use of social manufacturing as an adaptive and competitive strategy and boosts the development of social manufacturing systems. The following are five main factors most commonly emphasized in the literature.

1) Personal demand for products and services must exist. The needs to deal with increasing personalized demand for innovative and customized products and service is the fundamental justification for social manufacturing [10, 25, 46]. The success of social manufacturing depends on the balance between the potential sacrifice that prosumers make for social manufacturing products and service (i.e. how much they will pay and wait for the delivery of personalized products) and the networked company's ability to produce and release individualized products within an acceptable period, quality and cost frame.

2) Value chain network should be ready. Social manufacturing is a kind of value chain-based manufacturing mode. Now the firm competition justifies toward the delivery of value to customers [47]. The supply network must be at close proximity to the organizations to deliver products and service efficiently and low-costly. Most important, manufacturers, communities, retailers, and other value chain

entities must be part of an efficiently linked information network [4].

3) Open architecture production must be available: Personalized products need an open production platform that accommodates all kinds of modules, including user himself designed modules to be integrated together. A personalized product will typically have an open architecture and will include personalized modules that allow customers to create and design [46]. Product architecting is to determine the modules that will be common, customizable and personalizable depending on cost and manufacturability [48].

4) On-demand manufacturing mode must come into being [49, 50]. To ensure rapid response to the consumer demand, the networked manufacturing system must provide agility and flexibility in fabricating personalized and modular products, and assembling these modules from other manufacturers [48]. Additive manufacturing, 3D printing, is considered as enabling technologies towards personalization. In addition, the manufacturing system should be configured and reconfigured cost-effectively.

5) Cyber-physical-social-connected network should be established for knowledge sharing. Social manufacturing is a dynamic system [51] and relies on the ability to translate new personalized customer demands into new products and services timely. To achieve that, entrepreneurs must pursue a culture that emphasizes knowledge creation and distribution across the value chain. That requires the development of dynamic networks to support the distributed personalization design, collaboration and on-demand manufacturing.

These factors have direct practical implications. A successful and typical example is Haier, a household electrical appliance manufacturer in China, which has flattened its original pyramid-shaped organization into an open platform organization in resent years. That means the social individuals and its employees are mobilized as independent social micro-entrepreneurs to compete for its crowdsourcing orders [14]. Of course, many other entrepreneurs in other countries also achieve great benefits by meanings of social manufacturing [52-56].

VI. CONCLUSIONS

With the rapid development of manufacturing technologies, management and information, social manufacturing has become an important manufacturing strategy for the need to the personalized products and production. Agile and quick responses to varying manufacturing and competition environments have become mandatory to most companies and organizations in view of current levels of market globalization, rapid technological innovations. Cloud computing will be a powerful technology and mean to distributed and integrated innovation knowledge.

This paper presents a literature review on social manufacturing. The objective is to identify required conditions and situations where social manufacturing implementation is suitable. Additionally basic principles, frames and concepts in social manufacturing paradigm are discussed in detail.

ACKNOWLEDGMENT

The correspondence author would like to acknowledge support in part from the National Natural Science Foundation of China under Grants: 71232006, 61233001; Finnish TEKES's Project "SoMa2020: Social Manufacturing" (2015-2017); Chinese Guangdong's S&T Project (2014B010118001, 2014A050503004); Chinese Dongguan's S&T Project (2013508102018), and Dongguan's Innovation Talents Project (Gang Xiong).

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