

Literature Review of Remanufacturing

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Abstract: Remanufacturing is the exemplification of the awareness of environmental protection, and is one kind of manufacturing method that governments and enterprises attach great importance under the situation that the resource cost improves continuously. In the beginning of the paper, the concept of remanufacturing and remanufacturing enterprise are introduced, and through some related literature, remanufacturing is analyzed from three aspects: influence factors of the development of the remanufacturing industry, promoting factors of the development of remanufacturing, and baffling factors of the development of remanufacturing. In the end, a certain summary about the remanufacturing is made.

Keywords: Remanufacturing; Resource cost; Related literature

1. Introduction

Reform and opening is the epoch-making event of China, which promotes the development of China, the economy, society, culture have been greatly improved, especially in the economic aspect, and at present, China has become the world's second economic powers. But with the rapid economy development, a lot of non renewable energy and natural resources have been consumed. The pollution from industrial waste and emission of waste gas is also becoming more and more serious. In such a case, the research of the remanufacturing and the development of the remanufacturing industry are of great significances, which is conducive to the health of the people's life, sustainable development and the construction of a harmonious and circular economy.

2. The Concept of Remanufacturing and Remanufacturing Industry

2.1. The concept of remanufacturing

Compared with manufacturing, there is not a unified concept about remanufacturing. William Hauser and Robert. T. Lund, who are the remanufacturing experts of Boston University, have expounded the names of the remanufacturing in various industries in their management observation report of the remanufacturing industry "Remanufacturing - business methods and strategies", for instance, remanufacturing is usually called rebuilding by the automotive parts sector, retreaders by the automobile tire manufacturers, and reconditioning is also used frequently nowadays[1]. At present, remanufacturing has been used as the general academic noun, which is used widely.

1) William Hauser and Robert. T. Lund defined remanufacturing as the process that recovers old, waste or non functional products to new ones[2].

2) Rolf Steinhilper, who works in the Germany Remanufacturing Engineering Center, defines that the remanufacturing is one recycling process which recovers old or waste products like new ones[3].

3) The Design for Manufacture, Assembly, Disassembly and End-of-Life Processing (MADE). Part 2: Terms and Definitions, which is the British standard, has defined remanufacturing as returning a used product to at least its original performance with a warranty that is equivalent or better than that of the newly manufactured product[4].

4) Binshi Xu, who is a remanufacturing advocator in China, says that the remanufacturing is the general term of a series of technical measures and engineering activities which restore or reform the used mechanical and electrical products, taking Total-Life-Cycle design and management of the mechanical and electrical products as the guidance, taking the achievement of great-leap-forward promotion as the purpose, taking high quality, high efficiency, energy saving, material saving, environmental protection as the principle, and taking high technology and industrial manufacture as the means[5].

5) "Remanufacturing term" (item number: 20091292-T-469) which is the Chinese national standards program project, says that remanufacturing is the manufacturing process that specialized repairs or upgrades old products to make the quality characteristics reach or function better than the new ones(note: quality characteristics include product function, technical performance, green Character, safety and economy, etc.).

The key word in these definitions is "the same as the new ones", which, from the perspective of the remanufacturers, has indicated the purpose of remanufacturers, the requirements of the products and the ability to fulfill these requirements. As to remanufacturing blank, there may be various kinds of defects, but the remanufacturers must produce the products that meet the standard of "the

same as the new ones". Standing in the customer's point of view, customers want the remanufacturing products to have the same quality as the new ones, remanufacturing products must meet the specifications of similar new ones, at least from the performance and appearance.

2.2. The Concept of Remanufacturing Industry

Remanufacturing industry is a new and environmental friendly industry, which considers the Total-Life-Cycle theory according to the requirements of circular economy. On the basement of the production of similar products and treating the improvement of the waste and old products as the goal, remanufacturing industry repairs or upgrades the waste and old products using the remanufacturing technology to make the quality characteristics close to the level of the new ones.

In the remanufacturing process of the mechanical and electrical products, the cost is of half of the new products, saving both energy and material, what's more, the degree of harm to the environment is far less than that of manufacturing new products. Therefore, the development of remanufacturing industry plays an important role to solve the problem of resource shortage and waste of resources, reduce the environment harm of the waste products. Recycling economy and sustainable development can be realized by the re manufacturing industry.

3. Domestic and International Literature Review

In recent years, special research about remanufacturing at home and abroad continues to increase, and has gradually become a hot topic. In the remanufacturing theory research aspect, previous studies were mostly focused on engineering technology[6-7], in recent years there not only has the research on remanufacturing technology[8-12], but also expands to research on the design of remanufacturing logistics network[13], remanufacturing mode[14], production plan of remanufacturing[15], inventory management of the remanufacturing production[16], product pricing of remanufacturing[17], etc. In order to describe the trend more comprehensively and intuitively, the main influence factors for the industry development, the promotion factors of remanufacturing development and the baffling to the development of remanufacturing are deeply studied in this paper.

3.1. The Main Influence Factors for the Remanufacturing Industry Development

1) The Development of Remanufacturing Industry in Foreign Countries

The end of 1970s, Research on the development of remanufacturing industry had been studied in Massachusetts institute of Technology. In the 1980s, the World Bank supported Lund to complete the summary report of "remanufacturing: the U.S. experience and the Enlighten-

ment on the developing countries", which has promoted the vigorous development of the re manufacturing industry, and the United States is the most representative country on the remanufacturing development and research[18]. In the 1920's, mass production and assembly lines began to dominate the American industry[19], which created the conditions for the development of a comprehensive remanufacturing, and Automotive Engine Rebuilders Association (AERA) was established in 1922, the Remanufacturing Industries Council International (RICI) was also established in 1997. Legislature in Texas, Connecticut and California pass the laws that promotes the development of remanufacturing industry in 1999, and New York enacted two laws to promote remanufacturing in 2000.

Take automobile parts remanufacturing as an example, during the Great Depression of the United States in the last century, because of the lack of funds and resources, the repair business began to try to repair the car parts in the way of remanufacturing. The parts remanufacturing industry has been further developed in World War II. during World War II, all domestic automobile manufacturers and parts manufacturing of America only produced military products to meet the needs of the war, which has caused the serious shortage of auto parts needed by the American people. In this case, repair business were forced to repair and use some abandoned parts, thus gradually formed a new industry. At the same time, the damage rate of the U. S. military vehicle for combat was very high, and were eager to be repaired, in this case, car spare parts repaired at home were tried to be used to quickly replace in the battlefield, which has greatly improved the maintenance speed of the vehicle, becoming the direct beneficiaries of the remanufacturing of auto parts. The demand of war has promoted the development of auto parts remanufacturing industry[20].

Although the war is over, the parts remanufacturing enterprises still survive, and have developed quickly in a period of time because of the very nice profits brought by remanufacturing industry. In the whole production process of auto parts remanufacturing, both the old product collectors and the remanufactured products users have gained considerable economic benefits, which has made the rapid development of the auto parts remanufacturing industry, and made it sweep the North American continent quickly. Thus the auto parts remanufacturing industry has become the industrial giants after the steel industry in America.

In recent years, Japan has strengthened the re manufacture of construction machinery. To 2008, Japan's domestic users accounted for 58%, exports to foreign countries accounted for 34%, and the rest of the 8% were for sale after dismantling, in the construction machinery remanufacturing in Japan. Germany's Volkswagen also has used remanufacturing for a long time. By 2004, Volkswagen

has used produced 7.48 million engines and 2.4 million transmissions, using the remanufacturing, and the remanufacturing engine and its accessories to the new machine ratio is 9:1.

Different countries have different emphasis on remanufacturing. In the design of Remanufacturing of Europe and America, important design elements in remanufacturing process are mainly studied, Such as the material types, dismantling performance, design structure and fastening methods of parts, etc.; in remanufacturing processing, parts of mechanical products are mainly repaired through size changing repair method and piece repair method[21].

In Europe and America, the quality control of remanufacturing is very strict. The product quality, performance and after-sales service of the remanufacturing products are required to maintain the same as the new ones. The management of remanufacturing products is the same as the new ones, such as the quality standards, enterprise access threshold or tax policy, etc.[23]. There are special provisions for advertising, labeling, and intellectual property of remanufacturing products because of the particularity of remanufacturing products. The legislation of many organizations has promoted the development of remanufacturing industry. In 2015, the EU legislation stipulated that the waste of a vehicle must not exceed 5%. As can be seen from the collection of the above information, the concept of remanufacturing appeared early in the foreign countries. So far, the support system matching with the re manufacturing industry has been basically completed, including the relevant laws and regulations, process technology, production and operation mode, etc.[24]. However, due to the particularity of remanufacturing, there are still a lot of problems need to be resolved in the future development process[25].

2) *The Development of Remanufacturing Industry in China*

The remanufacturing industry in China is developed on the basis of surface engineering and maintenance engineering, which has its own characteristic. Remanufacturing process in China is mainly based on surface engineering, nano surface engineering, and automatic surface engineering technology to improve the performance of the product significantly, which has reached the international advanced level, the remanufacturing technology path with the Chinese characteristics has been formed.

Remanufacturing in China started late from the perspective of industrial development, the development model is from the concept to the technology research and development, then to the enterprise pilot. From the concept in the end of 1990s to today's remanufacturing getting into China's 12th Five-Year development plan, relevant state departments and enterprises have given full attention, and the development policies and measures are being conti-

nuously improved, so development model of remanufacturing industry in China is from "top to bottom".

In China, the key development areas of remanufacturing industry are reuse of waste electronic products, remanufacturing of auto parts, machine tool remanufacturing and manufacturing of major technical equipment, etc. The current situation of remanufacturing is that more attention has been got, but with less use. According to the actual situation of the investigation, with the limitation of various conditions, there are not too much enterprises having the real large-scale remanufacturing development. The development of China's remanufacturing industry is still facing many challenges, mainly in four aspects.

various aspects are lack of adequate understanding to the remanufacture and its products. First, the relevant government departments does not form a unified understanding to the remanufacturing. Pilot work of the remanufacturing has laid the foundation for the development of remanufacturing industry, but the long-term sustainable development can not be valued by only one or a few sectors, business, public security, finance, taxation, transportation, commerce, environmental protection, technical supervision and other departments are required to participate in the development of remanufacturing industry, introducing relevant support policies and measures.

Second, Consumers are lack of correct understanding on remanufacturing products. Influenced by media publicity, the vast number of ordinary consumers often connect regular remanufacturing products with the fake and inferior commodities and old parts renovation. The United States government has done a lot of useful work in this area, such as the every year "recycling day", media vigorously publicize the benefits brought from the use of remanufacturing products, and publicize the same performance between remanufacturing products and the new ones, in the form of popular science. All of these have played a positive role in spreading remanufacturing products.

Policy environment which is conducive to the healthy development of the manufacturing industry is not formed. Firstly, "Circular Economy Promotion Law" published in 2009, "Some Opinions on Accelerating the Development of Circular Economy" published by the state council in 2005, and "Pilot Scheme for Remanufacturing of Auto Parts and Components" published by The National Development and Reform Commission(NDRC) in 2008 all put forward to accelerate the development of remanufacturing industry, which have established a reliable basis for the development of the remanufacturing industry. But in the actual operation process, departments are lack of policy measures that fit the policy, which has made it difficult to develop enterprises.

Second, as to the issue of tax remissions to the remanufacturing industry, "Notice about the Comprehensive utilization of resources and the value-added tax policy of

other products”, published by the Ministry of Finance and the State Administration of Taxation in 2008, still does not make clear relief policy that should be enjoyed by remanufacturing products. But the "tire renovation" which is also the first batch of circular economy pilot project can enjoy the exemption from value-added tax policy.

The key technology of remanufacturing has less extensive promotion. The mature key technology of remanufacturing which are urgent to be promoted are: high efficiency and green cleaning technology of waste mechanical and electrical products, rapid and nondestructive life evaluation technology, high efficiency and automation technology on size recovery and performance improvement for key components of waste mechanical and electrical products and the situ self-healing technology, etc. All these technologies are an important symbol to improve the level of recycling utilization of renewable resources and the recycling utilization rate of waste mechanical and electrical products in China, which have been applied in practice in national pilot car engine remanufacturing enterprise, and the effect of resource saving, energy saving and emission reduction is remarkable. However, some key technologies have strong pertinence, and have not or can not be widely used.

The orderly competition developing environment of remanufacturing industry has not been formed. As a big industry, many small and medium enterprises could be contained. However, the development of remanufacturing makes it difficult for small and medium enterprises to survive. The main reason is that their technology is limited, and will encounter a lot of difficulties faced with old part source and marketing. Small and medium enterprises could seldom be supported by the original manufacturers, and even worse, threatened by them. A lot of the original manufacturers treat the remanufacturers as competitors. This kind of situation happens not only in China, but also in foreign countries. The original manufacturers threaten the remanufacture industry using unfair competition strategy, they use professional and copyright laws to prevent remanufacturing their products.

As can be seen from the above description, it has been more than ten years since the development of remanufacturing in China, and the development process is relatively short. Although the development of the situation is good, the foundation of the industry itself is relatively weak. So far, the main research focus is on the basic theory and technology of remanufacturing, such as residual life assessment technology for used spare parts, automated surface engineering technology, surface engineering processing technology, quality inspection technology for remanufacture products, nano surface engineering technology, quality inspection technology for the used mechanical and electrical products, etc. A number of academic organizations have been formed aimed to reman-

ufacturing, such as the Key Laboratory of National Science and Technology for Equipment Remanufacturing Technology in the Academy of Armored Forces Engineering, Dalian University of Technology, Shandong University, etc. According to the literature, the research on remanufacturing management is mainly about the inventory control system simulation, the construction of reverse logistics, the scheduling of production planning, and the establishment of closed loop supply chain, etc. Some researchers have studied the selection of quality level and the optimal pricing strategy of remanufacturing products, which still belongs to preliminary study, without forming a theoretical system. Compared to the concerns of the theoretical studies, domestic remanufacturing enterprises pay more attention to the introduction and implementation of the related policy of the remanufacturing, the establishment and operation of the quality management system, specification and implementation of the certification and accreditation system, however, the content of the research is still relatively blank.

It can be seen through the above studies, economic, strategic, environmental policy factors and technical factors can promote the development of remanufacturing industry. Policy, technical, economic, social consciousness factors and industrial environmental factors will hinder the development of remanufacturing industry.

3.2. Research on the promotion factors of remanufacturing development

In terms of economic factor, remanufacturing products has the advantage of helping consumers save expenditure. Because the cost and price are lower than the new product when the quality and performance are nearly the same as the new ones. In the study of AndelT, Schendler, etc., closed loop supply chain, including product regeneration, remanufacturing, etc., can bring win-win situation on the economic and environmental two aspects. Moreover, it is more economical to produce remanufacturing products than to make new ones, which can save 50% of the cost, 60% of the energy, and 70% of the raw material. Remanufacturing industry can reduce the use of public goods and imports, such as iron and steel, copper, plastic particles, which has a very attractive prospect[26]. In addition, the development situation of remanufacturing industry in China is excellent, the car market implies the value of hundreds of billions in the field of remanufacturing.

In terms of environmental policy, Caimcross, Den Hond F, and Handfield RB have studied the relationship between environmental regulations and business activities about remanufacturing. And some scholars in China believe with the promulgation of “Opinions on Promoting the Development of Remanufacturing Industry” and the introduction of the relevant policies and regulations to support enterprises to carry out motor vehicle parts, con-

struction machinery, machine tools and other products of remanufacturing and tire renovation in "Circular Economy Promotion Law", the Chinese government attaches great importance to the development of remanufacturing industry, relied on which the remanufacturing industry in China could develop quickly. In addition, due to the accelerated process of industrialization, a lot of waste mechanical and electrical products occurs, which provides a wealth of raw materials to remanufacturing industry.

In the technical factor, China mainly uses the method of reference to improve remanufacturing technology system. With the gradual maturation of foreign remanufacturing technology, remanufacturing enterprises in China continue to introduce, digest, absorb, and innovate, which gives the development of China's remanufacturing industry a strong technical support[27]. And, China has made great efforts on the remanufacturing technology research, a great number of remanufacturing technology with Chinese characteristics have been created, through years of research and practice, such as the automatic high velocity arc spraying technology, nano anti friction intelligent self repairing additive technology, automation of nano particle composite brush key technology, automated micro-plasma cladding technology, Nondestructive testing and evaluation technology of remanufacturing, etc.[22], which have provided a large number of technical support for the production of Chinese remanufacturing products. In terms of the strategic factor, Margarete A. Seitz, a foreign scholar, has found that remanufacturing engine provides a valuable source for the automotive aftermarket warranty engine because the raw materials of remanufacture are not only cheap but also saving production time. In addition, brand protection of OEM enterprise and market share have also contributed to the recovery operation of the enterprise and remanufacturing[28].

3.3. Research on the baffling to the development of remanufacturing

In China, relevant policies and legislation for the development of remanufacturing industry is still incomplete, some part of the policy is still the main obstacle to the development of remanufacturing industry. Recycling rate in China is very low, thus a lot of remanufacturing enterprises have no blank source. According to statistics, the number of scrapped vehicles of China is 1 million per year, but the recovery rate is less than 40%, nearly 60% of scrapped vehicles are free from government regulation. Zhang Yanli pointed out in the "Remanufacturing Supplies" that two big problems must be solved to develop remanufacturing industry. And the two problems are the difficulty of obtaining raw materials and the lack of tax system. A lot of people were lack of adequate understanding of the remanufacturing industry before. Many companies, such as Weichai Power Manufacturing Co.

Ltd., still only allowed the company to create products of their own brand. There are many companies that have this rule according to the survey, and the whole remanufacturing industry is facing the same problem[29]. This restriction has brought great obstacles to the expansion of remanufacturing production.

In terms of technical factors, Chu Jiangwei pointed out in the study, that research on the prediction of the remaining life of remanufacturing products in China and the control of product quality just start. There are some technical limitations in recycling and remanufacturing process, because the remanufacturing theory and technology of China are still in the primary stage, thus the quality of remanufacturing products and social reputation will be affected[30]. In addition, the legislation about remanufacturing technology standards, raw materials recycling, product sales, and after-sales service is not complete. Especially on the technical standards, there is not unified national standard about technical standard and other aspects, which has seriously affected the development of remanufacture business[22].

In terms of economic factor, Lan Chaozhen, Sun Congying, and Wang Wenbo pointed out that remanufacturing industry is difficult to have healthy development because of the lack of backbone enterprises and the overall lack of competitiveness. Zhang Jinping and Xu Jianzhong put forward in their research that remanufacturing industry started relatively late and has not formed a scale economy so far, which leads the low economic efficiency of the remanufacturing industry. Most of the remanufacturing enterprises are faced with the problem of insufficient investment and financing difficulties, the development of remanufacturing enterprises of China need to be supported by all sectors of society. There is also a more realistic situation, it is difficult for the remanufacturing TV to achieve the indicators of the new home appliances due to the technical problems, and maybe it takes more cost to achieve reuse than to manufacture new ones, which is also the cause of the difficulty of manufacturing industry. Zhang Yanli mentioned in the research that the heavy tax burden of enterprises is also one of the important issues affecting the enthusiasm of enterprises to participate in the remanufacturing.

In terms of social consciousness factor, the development of remanufacturing industry in China has been seriously affected. As early as 1994, Paton pointed out that one of the important factors affecting the development of remanufacturing industry is the market demand. Foreign remanufacturing industry can be developed rapidly, which is largely because of the public's high participation. Many consumers in America, the European Union and other developed countries take the initiative choice to have remanufacturing of products, because the manufacturing industry in their countries has been developing for decades, with a sound remanufacturing product sales

system. And coupled with the price advantage and the perfect after-sales, remanufactured products have been recognized by the public. In contrast, the situation in China is very different, people's public awareness of remanufacturing products is not right, doubt the cost-effective, and threat the remanufacturing as the renovation of old products. People don't know remanufacturing very well because of the lack of social propaganda[22]. In conclusion, in order to develop remanufacturing industry, strengthening the publicity of remanufacturing products and improving the public recognition of the product are essential. Rick Hammond and Tony Amezquita fund in the investigation of American remanufacturing enterprises that more than 60% enterprises have communication and interview with consumers, and there are more than 80% enterprises which have done those more than once a week[31].

In addition to the above factors, industrial environmental factor also affects the development of remanufacturing industry. Xu Jianzhong and Chen Haiwei showed in the study that the industrial base of remanufacturing industry of China is weak, and has a late start, which leads to low economic benefit. In addition, the incomplete industrial system and the industry chain are major obstacles to the further development of the manufacturing industry. Li Yulin put forward in "The Confusion of Parts Remanufacturing Industry" that there are many problems need to be solved in the development of spare parts remanufacturing industry, for example, the market acceptance of remanufacturing products is limited; the circulation channel of remanufactured products is not smooth; remanufacturing industry of China is weak, small scale, and develops slowly[32].

After studying the literature that analyzes the factors influencing the development of remanufacturing industry, it could be found that not too much literature study the remanufacturing from an empirical point of view in quantitative terms, and mostly of them are based on qualitative aspects, although there are lots of research directions about the promotion and obstruction factors of the development of remanufacturing industry. What's more, the research on the development of remanufacturing industry is lack of relevant theoretical support, and is lack of overall summary about promotion and obstruction factors.

4. Summary

Sustained rapid development has improved people's living standards, which brings great harm to the human survival at the same time. In recent years, people's environmental awareness surge has increased, protecting the environment, saving the resources, and developing remanufacturing actively have become a new growth point of the economy of all countries. The characteristics of remanufacturing industry can not only save resources and energy input, but also make the enterprise have more

competitive advantage. The labour price of China is also rising, it has become difficult to get a competitive advantage in the international competition only based on cheap labour. As a manufacturing power with large population, China is faced with the lack of natural resources, and in this case, developing environmental protection and sustainable remanufacturing, changing the current state of disorderly competition, would be the inevitable choice to control environmental pollution and achieve sustainable economic development.

References

- [1] Hauser W, Lund R. Remanufacturing: Operating practices and strategies[J]. Boston, MA, Boston University, 2008.
- [2] Lund R T, Hauser W M. Remanufacturing-an American perspective[J]. 2010.
- [3] Steinhilper R, Zhu Sheng, Yao Jukun. Remanufacturing—Best form of recycling[J]. 2006.
- [4] Design for manufacture, assembly, disassembly and end-of-life processing (MADE). Part 2: Terms and definitions [S]. BS 8887-2:2009.
- [5] Theory and technology of Equipment Remanufacturing Engineering [M]. National Defence Industry Press, 2007.
- [6] Speranza, M. Grazia, and Paul Stähly, eds. New trends in distribution logistics. Vol. 480. Springer, 1999.
- [7] Xu Binshi, Ma Shining, Liu Shican, et al. Remanufacturing engineering in 21st Century [J]. China Mechanical Engineering, 2010 (2).
- [8] Cui Peizhi, Zhu Sheng, Yao Jukun. Study of Flexible Remanufacturing System[J]. Machinery, 2004, 41(11): 7-9.
- [9] Teng Jiaxu, Hu Zhongxiang, Shi Xiaojun, et al. Development and key technique of virtual remanufacturing engineering [J]. China Surface Engineering, 2008, 21(3): 7-11.
- [10] Pu Qiulin, Huang Xiaodiao, Hong Rongjing. The stiffness analysis of guides joint surface in numerical remanufacturing of machine tool [J]. Modular Machine Tool & Automatic Manufacturing technique, 2010 (10): 16-19.
- [11] Wang Zhijian, Zhai Haibo, Liu Yu, et al. Laser remanufacturing technology and its application [J]. laser journal, 2010 (5): 35-37.
- [12] Liang Xiubing, Chen Yongxiong, Bai Jinyuan, et al. Automatic high speed arc spraying technology to remanufacturing engine crankshaft [J]. China Surface Engineering, 2010, 23(2): 112-116.
- [13] Dai Ying, Ma Zujun, Liu Fei. Optimal design of integrated logistics networks for manufacturing/remanufacturing systems based on hybrid genetic algorithm [J]. Computer Integrated Manufacturing Systems, 2007, 12(11): 1853-1859.
- [14] Du Yanbin, Cao Huajun, Liu Fei, et al. Process model of machine tool remanufacturing oriented to lifecycle [J]. Computer Integrated Manufacturing Systems, 2010, 16(10): 2073-2077.
- [15] Chen Xinlin, Zhang Shuangwu. A closed-loop supply chain robust production planning under multi-vender competition[J]. Systems Engineering, 2010 (4): 41-47.
- [16] Wang Meijie, Di Weimin. Production inventory optimization model for returned logistics system [J]. Computer Integrated Manufacturing Systems, 2010, 16(7): 1539-1544.
- [17] Ding Xue-feng, Dan Bin, Zhang Xu-mei. Optimal pricing policies for remanufactured products under changing market scale[J]. Computer Integrated Manufacturing Systems, 2011, 17(4): 888-895.

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- [18] Lund R. T. Remanufacturing. *Technology Review* [J], 984,87: 18-23.
- [19] Lund R T. Remanufacturing, United States experience and implications for developing nations[M]. Center for Policy Alternatives, Massachusetts Institute of Technology, 1983.
- [20] Xu Binshi. Auto engine remanufacturing engineering based on advanced surface engineering technology and its industrial pattern[J]. *Digital Manufacture Science*, 2008, 6(2): 19-34.
- [21] Giutini R, Gaudette K. Remanufacturing: The next great opportunity for boosting US productivity[J]. *Business Horizons*, 2003, 46(6): 41-48.
- [22] Xu Binshi. Remanufacture Engineering and Its Development in China [J]. *China Surface Engineering*, 2010, 23(2): 1-6.
- [23] Hammond R, Amezcuita T, Bras B. Issues in the automotive parts remanufacturing industry: a discussion of results from surveys performed among remanufacturers[J]. *Engineering Design and Automation*, 1998, 4: 27-46.
- [24] Lund R T, Skeels F D. Guidelines for an original equipment manufacturer starting a remanufacturing operation[R]. Massachusetts Inst. of Tech., Cambridge (USA). Center for Policy Alternatives, 1983.
- [25] Guide V D R. Production planning and control for remanufacturing: industry practice and research needs[J]. *Journal of Operations Management*, 2000, 18(4): 467-483.
- [26] Lan Zhaohui, Sun Congying. Uncover the veil of remanufacturing industry: Temptation and technology, Financial constraints coexistence [J]. *Mechanical Engineer*, 2010 (7): I0005-I0007.
- [27] Xu Jianzhong, Zhang Jinping, Na Baoguo. Research on the Current Situation and Model of the Development of Chinese Remanufacturing Industry in the Perspective of Circular Economy[J]. *Science & Technology Progress and Policy*, 2009, 26(24): 64-66.
- [28] Seitz M A. A critical assessment of motives for product recovery: the case of engine remanufacturing[J]. *Journal of Cleaner Production*, 2007, 15(11): 1147-1157.
- [29] Chu Jiangwei, Zhang Tongzhu, Cui Pengfei, Jin Xiaohong. Analysis of the Development Patterns of Chinese Automobile Remanufacturing Industry[J]. *Forum on Science and Technology in China*, 2010 (1): 33-37.
- [30] Shang Huiliang. Remanufacturing Industry still needs to Cross a few Thresholds [J]. *The Chinese Journal of Nonferrous Metals*, 2010, 16: 010.
- [31] Hammond R, Amezcuita T, Bras B. Issues in the automotive parts remanufacturing industry: a discussion of results from surveys performed among remanufacturers[J]. *Engineering Design and Automation*, 1998, 4: 27-46.
- [32] Li Yuling. Problems of the Industrialization of Parts Remanufacturing[J]. *Automobile & Parts*, 2010 (33): 16-19.