

Chapter 19

Remanufacturing Services in the Construction Machinery Value Chain

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19.1. Firm Overview

19.1.1. History of the Firm

The firm central to this study began in 1925 as a tractor company based in San Leandro, California, and moved its headquarters to East Peoria, Illinois in 1930. In the 1950s, while its competitors focused on agricultural equipment for the domestic market, the case study firm focused its manufacturing on earth-moving construction equipment and was open to trading internationally. Its remanufacturing production began in 1972, making the company among the first major original equipment manufacturers (OEMs) in the heavy-duty truck and off-roading (HDOR) equipment sector to become involved in remanufacturing. By the late 1980s, the company offered a broad range of earth-moving construction equipment, which included highway trucks, power generation equipment including gas and diesel turbines, as well as engine manufacturing.

19.1.2. Situation within Construction Machinery Industry

Today, the firm is the global leader in the manufacture of construction and mining equipment, diesel and natural gas engines, industrial gas turbines, diesel-electric locomotives, and mobile electricity generating equipment including drilling rigs and electricity for cruise ships. Its 2014 sales and revenues totaled \$55.2 billion (SEC 2014: Filings 10K).³ The company is structured into seven segments: Construction Industries; Resource Industries; Energy and Transportation; Financial Products; Corporate Services; Customer & Dealer Support; and the Enterprise System Group (Company sources, 2014a; 2015f).⁴ The company currently employs 114,233 full-time employees globally (Company sources, 2015b; SEC 2014: Filing 10K).

The case study firm is among the three largest remanufacturers of HDOR equipment in the United States.⁵ The company describes its current business model with the expression “Seed, Grow, Harvest,” which refers to its aims of delivering equipment to clients in the field (“seed”), expanding its market share (“grow”), and maintaining its end-products through on-going client service and the production of remanufactured goods (“harvest”). The latter point is important for this study of manufacturing-related services because the goal of “harvesting” refers to the firm ethic of producing high quality, high value capital goods, which can be maintained through extensive service and maintenance options (Company source, 2015e).⁶

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³ The firm is ranked first in its industry and in the top 100 overall in the 2015 *Fortune 500* list (Fortune 2015).

⁴ Its three main product segments are: Construction; Resource and Energy; and Transportation. Additional key segments include Customer & Dealer Support, Corporate Services, the Enterprise System Group and Law & Public Policy (Company source, 2015f). Remanufacturing, Components and Work Tools falls under the Customer and Dealer Support segment, and its remanufacturing division emerged as a distinct division in 2005.

⁵ HDOR equipment includes “trucks, bulldozers, excavators, backhoes, asphalt pavers and rollers, farm tractors and combines, rock cutters and tunneling machinery, and oil and gas drilling machinery” (USITC 2012: 83).

⁶ The firm continues to carry parts for any of its own equipment that is still in operation in the world.

19.1.3 Remanufacturing at the Firm

The industrial process of remanufacturing restores end-of-life manufactured goods to OEM specifications. Remanufacturing involves high levels of design, engineering and technical skill, and its sophistication distinguishes it from refurbishment, rebuilding, recycling and reuse. According to a 2012 study by the U.S. International Trade Commission (USITC), the United States is the largest remanufacturer globally, and the value of this type of production is steadily increasing, having reached at least \$43 billion and supporting over 180,000 full-time jobs by 2011 (USITC 2012: i). Heavy-duty and off-road equipment is a major remanufacturing sector in the United States.⁷

Remanufacturing is particularly important for manufacturers of large and expensive construction and mining equipment. By closing the loop on the manufacturing process and introducing reverse logistics, remanufacturing enables the firm to integrate all of the manufacturing-related services along the value chain. It also enables the firm to retain the value of its products, stabilize demand for replacement components, and leverage its exclusive dealer network to provide information and after-sales services to customers. The company is a leader in remanufacturing for the earth-moving equipment industry (Stahel 1995).

The Remanufacturing Process

The dedicated remanufacturing line of the case study firm, which emerged as its own division in 2005, is consistent with the “Seed, Grow, Harvest” business model (Company source, 2015e; Fiksel 2006). As shown in Figure 19.1, the remanufacturing division employs over 4,000 workers across 17 dedicated remanufacturing facilities (Company source, 2015g). Located in China, France, Mexico, Singapore, the United Kingdom, and the United States, these facilities are specifically outfitted to receive, inspect and remanufacture core components (APEC and USAID 2013; Fiksel 2012). Remanufacturing earned \$1 billion in sales in 2005 and earnings have steadily increased each year since (Fiksel 2006; Hindo and Arndt 2006).⁸ The case study firm has steadily expanded its remanufacturing capacity to allow for the restoration of components across its product line of over 7,200 products (Company source, 2015g).

⁷ The majority of U.S. remanufacturing occurs in “aerospace, consumer products, electrical apparatus, heavy-duty and off-road equipment, information technology products, locomotives, machinery, medical devices, motor vehicle parts, office furniture, restaurant equipment, and retreaded tires” (USITC 2012: i).

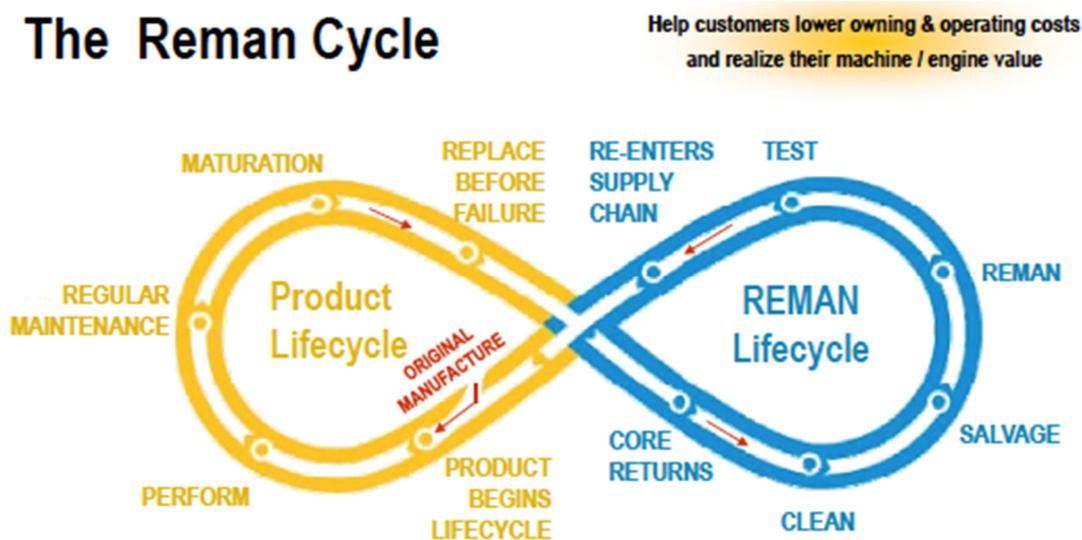
⁸ Financial accounting at the firm is performed on an end-to-end basis. As a result, data are not available detailing the percentage of overall business that remanufactured products comprise (Company source, 2015e).

Figure 19.1. Dedicated Remanufacturing Facility Locations



Source: Company source, 2015g

Figure 19.2. Product Life Cycle: Integrating Manufacturing and Reman



Source: Company source, 2015g

Figure 19.2 shows how manufacturing operations at the firm are fully integrated and linked to the remanufacturing program for its entire product line. For clients, purchasing a remanufactured product means receiving the same form, fit, function and warranty as a new product at about half the cost (Company source, 2015e). As depicted in Figure 19.2, the firm describes this as the “lowest-cost life cycle” available for their high quality goods: remanufactured products are expected to perform as well as new products, and also be equally reliable and durable. The remanufacturing process at the firm is centered on core components of finished products, such as engines.

The firm describes its remanufacturing process as follows:

Our remanufacturing operations are primarily focused on the remanufacture of engines and components and rail-related products. In this business, used engines and related components (core) are inspected, cleaned and remanufactured. In connection with the sale of most of our remanufactured product, we collect a deposit from the dealer that is repaid if the dealer returns an acceptable core within a specified time period. [The firm] owns and has title to the cores when they are returned from dealers. The rebuilt engine or component (the core plus any new content) is then sold as a remanufactured product to dealers and customers (SEC Company Form10-K 2014: A-12).

The core deposit thus renders end-of-life or worn components to be valuable if dealers find them eligible for remanufacture. This, in turn, gives customers financial incentive to return products that need to be replaced. Once the dealer inspects and accepts the old product, the dealer ships the core to a core-receiving facility, which confirms the dealer's inspection and reimburses the dealer for the deposit. Next, the core is shipped to a remanufacturing facility, where it is disassembled into its individual components, down to each nut and bolt. Qualifying components are then restored in the remanufacturing process, while components that fail inspections are recycled.

Later stages of the process include reassembly, product testing, and preparation for re-sale and after-sales services. The use of its own core components for remanufacturing enables the firm to be vertically integrated throughout its reproduction processes. The role of each phase of this circuit in the value chain will be discussed in the next section.

19.2. Manufacturing Services Value Chain

19.2.1. Global Value Chain Analysis of Services Value Chain at the Firm

The global value chain (GVC) framework is an analytical tool used to examine the global expansion and organization of supply chains. GVC analysis is particularly useful for better understanding how value creation and capture take place within supply chains, and also for identifying the causes and effects of the reconfiguration taking place among organizations in global industries (Gereffi 2015: 1, 5). Through its emphasis on how “new patterns of international trade, production, and employment shape prospects for development and competitiveness,” the GVC framework highlights the international expansion and geographic fragmentation of contemporary supply chains, and focuses on issues of industry (re)organization, coordination, governance and power in the chain (Gereffi 2015:1; Gereffi and Lee 2012). In addition, the framework employs the central concepts of ‘governance’ and ‘upgrading’ to demonstrate these dynamics (Gereffi 2015:1; Gereffi and Lee 2012).⁹ The concept of governance is particularly relevant when applying GVC analysis to lead firms, given that the closed-loop production process that remanufacturing introduces carries with it important opportunities for economic, social and environmental upgrading.

Manufacturing- and remanufacturing-related services are not segmented or discrete; both cut across the entire value chain. Equipment manufacturers typically conduct substantial and highly successful business through services, which can generate up to half of total company revenues (BCG 2014: 3). A recent analysis of service performance within the machinery sector has shown that services perform better than machinery sales by having faster growth rates, higher profitability, greater predictability and more resilience during economic downturns (BCG 2014: 3-4). The degree of value that services provide

⁹ Governance and upgrading represent two converse but complementary ways to view the global expansion of supply chains. *Governance* represents the “top-down” perspective that concerns lead firms, the organization of global industries and how power influences the distribution of both risk and profits in an industry (Gereffi 2015: 5). *Upgrading*, by contrast, represents the “bottom-up” perspective and concerns local, regional and national actors interested in strengthening linkages and enhancing access to markets in order to move up to higher value activities in the chain, ultimately in order to improve their positions in the global economy (Gereffi 2015: 5; 2011: 39 – 40).

to these manufacturers varies by equipment, competition in the sector, and the regulatory conditions affecting trade, but generally a higher investment in manufacturing-related services correlates with competitive advantage for machinery companies (BCG 2014: 3).

The company is a vertically integrated lead firm positioned at the apex of the construction machinery value chain, and, with the exception of its network of certified dealers, it is vertically integrated through ownership across all of its affiliates. Its production process encompasses the full scope of backward and forward linkages to manufacturing, from mining and extracting raw materials through to the point of retail sale. The value chain, however, extends well beyond the point of sale, through manufacturing-related services that offer financing for leasing and purchasing equipment, monitoring support for equipment, technical and information services for equipment use, as well as maintenance, repair and replacement services.

In addition to enhancing value and lowering costs for products used by its customers, remanufacturing also has a significant environmental impact through savings in materials, energy and deferring transportation costs. This can be understood in terms of the closed-loop life cycle as depicted in Figure 19.2. The remanufacturing process is particularly relevant to value chain analysis not only because remanufacturing is a relatively new mode of industrial production, but also because the majority of remanufactured goods require services in order to be exported (UNCTAD 2013: 22). All of the services integral to remanufacturing add value to the remanufacturing product line, and the majority of these services involve significant training and skills.

19.2.2. Value Chain Diagram of Firm Services

A value chain diagram of manufacturing-related services identifies the value adding stages in the manufacturing process in which services are both integral and add value to the finished product. The value chain diagram in Figure 19.3, on the following page, outlines the services associated with both manufacturing and remanufacturing at the firm, and emphasizes (in yellow) those phases that add particularly high value.¹⁰ Figure 19.3 also demonstrates how remanufacturing-related services are superimposed on the manufacturing value chain.

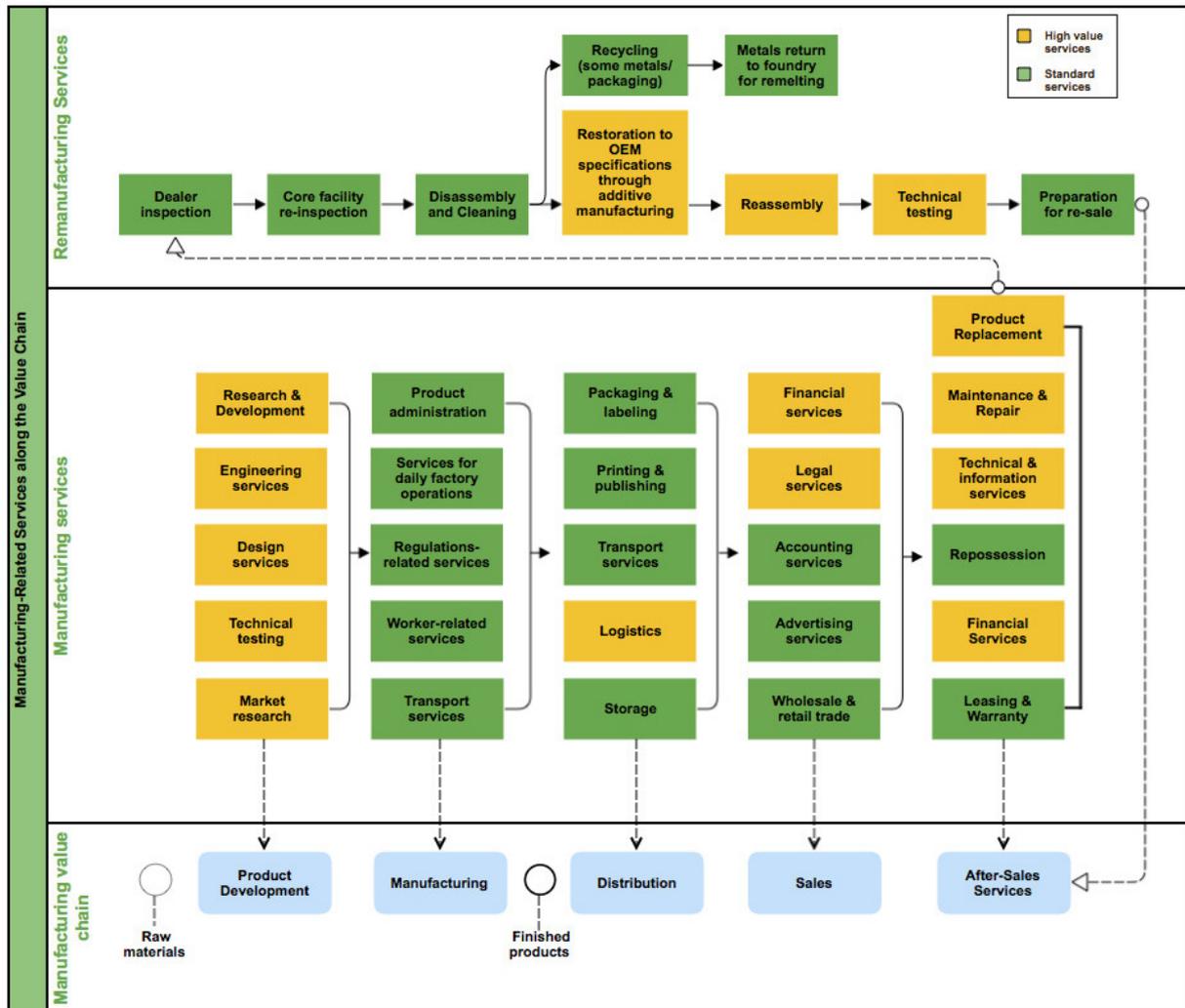
19.2.2.1. Value Addition of Manufacturing-Related Services

Product Development

The manufacturing-related services value chain shown in Figure 19.3 begins with several product development services required before manufacturing can take place. Of these services, the product development phase of the value chain, which includes research and development (R&D), engineering, and design services, generates important value addition for both manufacturing and remanufacturing. Through innovating new products and technologies, these phases have the capacity for eventual additive remanufacturing, enabling the extension of the traditional after-sales life cycle of products. Continued investment in R&D, equipment design and engineering will enable the company to sustain its competitive advantage, allowing it to “offer clients better and more competitive machine features and performance and also to differentiate their service capabilities from other competitors” (BCG 2014: 10)

¹⁰ GVC diagrams illustrate the relationship between lead firms and all of the economic activities and companies in a supply chain, and therefore provide both the “top-down” and “bottom-up” views of an industry. By showing how the governance and upgrading sides of an industry interrelate, both lead firms and key local, regional and national actors can focus upon those leverage points needed to facilitate trade and/or improve one’s position within the sector.

Figure 19.3. Value Chain of Manufacturing and Remanufacturing Services



Source: Manufacturing-related services stages adapted for the firm

Distribution

Logistics services, during the distribution phase of the services value chain, also deliver crucial value-addition for the firm. These services include streamlining the transportation of products to the dealer network, as well as the timely delivery of replacement parts (as well as maintenance and repair services). Well-implemented logistics processes enable lead OEMs like the case study firm to “both reduce the capital invested in spare parts and speed up delivery,” and increasing the flow of components helps the parts to maintain value while also supporting machine performance and efficiency (BCG 2014: 5, 10).

Sales

Sales services in the manufacturing phase of the firm value chain that provide relatively high value include financial and legal services. Financial services in the sale phase include the arrangement of financing for product leasing and sales. Legal services include patent protection for proprietary designs, technologies and products, as well as the preparation and provision of contracts for leasing and sales.

After-Sales

The after-sales services phase of the value chain is crucial for the firm. Because of the large scale and substantial expense of heavy-duty construction equipment, warranties are essential for customers. Financial services in the after-sales phase pertain to refinancing, which can be especially relevant when clients purchase remanufactured products as replacements. Information and technical services are high-

value-adding after-sales services as well. These include the acquisition of information on condition and performance of core components already in the field, as well as the development of equipment manuals, training clients to use equipment, managing equipment fleets and other on-going client support.

Maintenance and Repair

Maintenance and repair include on-going equipment support services so that clients reduce equipment downtime and prolong the life and efficiency of equipment. Customer service agreements typically offer customers predictable operation costs, fewer unexpected operating problems and reduced down time for servicing, and better service levels; all of these contribute to long-term relationships between the firm, dealers and customers (BCG 2014: 6, 9). By investing in remanufacturing, the case study firm has demonstrated an innovative maintenance strategy that simultaneously enables to firm to retain the value of its worn components, maintain demand for restored components and continue on-going relationships with customers.

Product Replacement

Product replacement is the crucial link to remanufacturing, and this phase closes the loop and reverses the logistics for manufacturing at the company. By offering remanufactured components to fulfill product replacement needs, the firm reduces cost and downtime for customers while maintaining high service levels through dealer familiarity with OEM specifications, inspections, and the product line more broadly.

19.2.2.2. Value Addition of Remanufacturing-Related Services

Remanufacturing is a much more refined, sophisticated and developed process than recycling, refurbishment and rebuilding. As such, it is the highest level of re-use for industrial goods. Expert knowledge of firm specifications is integral to the remanufacturing process (Company source, 2015e). Remanufacturing-related services add value to every stage of the production process, and many of the services are inherently high-value. Most services involve a high degree of technical, engineering and design skill, a deep understanding of proprietary specifications, extensive training, as well as technological development. Since the exchange of remanufactured products involves core components, the company is able to re-capture the value of its previously manufactured goods at the very beginning of the Reman value chain. Thus, the firm has reduced the resource and material intensity of the remanufacturing process. The retrieval of core components also enables the firm to offer customers lower prices on replacement components.

Disassembly, Cleaning and Inspections

Both dealers and dedicated remanufacturing specialists conduct inspections of retrieved core components to determine whether they qualify for remanufacturing. This stage eliminates wait time that would otherwise be required if only the core receiving facility conducted inspections. Once dealers have approved core components for remanufacturing, they are shipped to the remanufacturing facility for re-inspection, where the components are completely disassembled and cleaned using a patented cleaning process. The second inspection then takes place using detailed remanufacturing criteria to determine if the components can be remanufactured to meet original design and engineering specifications.

Restoration to OEM Specifications

The high-value adding engineering and design phase of the remanufacturing process involves the application of advanced additive-manufacturing technology that restores components to original specifications and good-as-new quality. Many of the technologies applied during this phase are developed by the dedicated remanufacturing division of the firm.

Reassembly, Technical Testing and Preparation for Re-sale

Reassembly involves a combination of remanufactured and new parts, and includes engineering updates. Reassembled products are then tested to meet manufacturer specifications.¹¹ Finally, in preparation for re-sale, new serial numbers (where applicable) are issued to the products, which are painted and prepared for sale as remanufactured products. The preparation for re-sale phase also creates value for remanufacturing through innovations such as metal spray, laser welding and other technologies that can restore tolerances to products, rendering them identical or even superior to original parts.

After-Sales Services

After-sales services are as essential for remanufacturing products as for new products, because the firm assumes responsibility for the core components.

19.2.2.3. Service Inputs Across Production Phases

The value chain analysis in this case study encompasses a minimum of 66 manufacturing-related services pertaining to the establishment, pre-production, manufacturing, post-manufacturing, back-office and post-sales phases of production, as shown in Appendix A Tables A.1 through A.6.¹² The tables provide detailed descriptions of 66 services that enter into the services value chain across each of these manufacturing phases. The third column of the tables refers to the Central Product Classification (CPC) codes associated with each service. Where 3-digit group codes and 4-digit class codes are listed, the service can be further disaggregated into approximately 80 categories, demonstrating that no fewer than 66 services are involved in the services value chain for this firm. The fourth column of the tables indicates whether the service is provided in-house by the firm, by an in-group company or is outsourced to a third-party provider. Approximately 38% of the services in Appendix A Tables A.1 through A.6 are provided in-house, 8% in-group, 18% are outsourced, and 36% are provided by a combination of in-house, in-group or third-party agents.¹³

Of the 66 services, manufacturing services (Table A.3) comprise 29% of the total, while raw materials, input and pre-production services (Table A.2) comprise 20%. Delivery, sales and post-manufacturing services (Table A.4) and back-office, utilities and general services (Table A.5) each comprise 15% of the total services in the value chain. Establishment (Table A.1) and post-sales services (Table A.6) each comprise 10% of the total. While these proportions do not represent costs or value, our analysis of the services value chain suggests that design, R&D, and engineering services, as well as the remanufacturing-related inspections of core components, are the services that add the most value to the pre-production phase. Remanufacturing services, including disassembly and restoration of core components through remanufacturing, re-assembly and technical testing, also add significant value to the manufacturing phase. In addition, our research showed that the IT services in the back-office phase are particularly crucial for the firm, as these facilitate product ordering and core processing required for the remanufacturing business model.

19.2.2.4. Key Role of Firm Dealer Network

A notable aspect of the remanufacturing reproduction process at the company, and a key contributor to its success, is the extent to which it is driven by strong personal relationships between the company, its dealers and their shared clients. The strong and exclusive relationships between the firm and its dealers have enabled the company to secure an extremely high core-return rate of 93%. This translates into a

¹¹ These specifications include knowledge of the exact capacity for a part, heat treatment, and the internal dimensions of a part (Company source, 2015e).

¹² Author approximations based on analysis of case study firm.

¹³ Over two-thirds (70.8%) of services involving coordination of more than one party have an in-house component.

high level of customer loyalty through on-going relationships established in channels such as equipment rental, new product and parts sales, preventive maintenance monitoring and the provision of warranties for a range of firm equipment including construction machinery, trucks, engines and electric power generation equipment (Company sources, 2015e and 2015g; RER Magazine 2015: 1).

Dealers are crucial to its business because they exclusively sell and support company products and do not distribute competitive products. This means that dealers recommend the firm-brand replacement components and create a stable flow of demand for these components.¹⁴ Their understanding of the import and export restrictions relevant to exchange and international trade is another way dealers contribute to the remanufacturing business model (Company source, 2015e).¹⁵ Dealers can be particularly useful when trade policy for remanufactured goods and core components lacks clarity.

Dealers occupy a crucial role in the remanufacturing circuit by providing irreplaceable liaison services between clients and the firm. Their client-facing services include detailed knowledge of products and permission to carry the brand exclusively, their ability to conduct inspections, as well as the authorization to conduct certified re-builds, which can be highly profitable for dealers. Dealers also provide firm-facing services, such as fluency in the local language of economies where dealerships are based, understanding how to represent the brand to clients, as well as familiarity with the exchange process for core components and international trade restrictions (Company source, 2015e).

19.2.2.5. Environmental Impact of Remanufacturing

Remanufacturing and its related services generate important and far-reaching environmental benefits, including reduced waste from industrial production, decreased demand for raw materials, and the creation of a “closed-loop reverse logistics process” that recovers end-of-life products (Company source, 2013; Fiksel 2012; Opresnik and Taisch 2015).¹⁶ As shown in Figure 19.2, the remanufacturing cycle helps the firm to meet its sustainability goals through extending the time those resource-intensive goods are in use and reducing the materials and energy used in the production process.

The remanufacturing process at the company delivers many benefits of dematerialization that Fiksel has outlined in his research on sustainable industrial processes, including “increasing material efficiency in operations; designing products with reduced mass, packaging, or life cycle energy requirements; reducing transportation requirements in the supply chain, thus reducing fuel and vehicle utilization; and substitution of electronic services for material-intensive services” (2012: 140). These issues are discussed in more depth in the Triple Value (3V) Model developed by Joseph Fiksel, as well as in the Circular Economy literature. Both the 3V and the Circular Economy models are “closed-loop” models that understand the conservation of capital to positively affect the economic, social and environmental systems over time. An example of how the sustainable practices implemented through remanufacturing fit into the Circular Economy model is available in Figure 19.4.

¹⁴ Dealers can independently provide “certified rebuild” services to specific firm products, which are distinct from remanufacturing because they involve the complete machine. These certified machine rebuilds will generally use remanufactured products and components in the process, enabling the customer to benefit from the value added engineering updates, technological and design inputs inherent in the firm’s remanufacturing process. These dealer provided certified rebuilds offer service revenue for the dealer and extended life of machines for the customer.

¹⁵ The company’s network of local dealers is also noteworthy because it is highly stable: the firm requires dealers to have a succession plan, and dealerships and client bases rarely change. As a result, dealers have two to three generations of experience representing the brand and have established strong client relationships.

¹⁶ For more information, see the Ellen MacArthur Foundation 2012 and Fiksel 2012.

19.3. The Impact of Trade Policy and the Regulatory Environment on the Firm's Services Value Chain

Trade policy and the regulatory environment affect the majority of services along the manufacturing and remanufacturing value chains. Based on the current regulatory environment affecting remanufacturing, the firm has highlighted specific policy priorities that support its overarching goal of strengthening regional economic integration. Currently, its highest priorities are to establish a shared legal definition of “remanufactured,” support movement toward the Trans Pacific Partnership (TPP), and practice sustainable industrial production. These priorities shape the policy discussion below.

19.3.1. Trade Facilitation of Remanufactured Goods

The most important issue for the remanufacturing division of the case study firm is the establishment of a shared international definition of remanufactured products. Currently, the absence of such a definition contributes to regulatory bans, import restrictions and confusion among customs officials about the origins and content of remanufactured goods. Without this clarification, economies such as China, Indonesia and Turkey can maintain their existing importation restrictions on remanufactured goods while simultaneously supporting initiatives to bolster domestic remanufacturing, for example through inviting foreign direct investment in the establishment of remanufacturing facilities at home. If such facilities are established, there are not restrictions for foreign firms in hiring local labor. In addition, the lack of clarity about the content of remanufactured goods means that customs officials in many markets will continue to categorize the goods as used or waste. This complicates international trade by limiting both the importation of remanufactured goods and the exchange of core components.

A related issue is that the definition of “core” also needs to be established legally in order to help remanufacturers obtain exception and permission to export non-functioning mechanical devices. Core components have financial value, involve a regulated chain of command, and are properly packaged for re-sale on the market. Extant trade barriers rooted in these definitional issues constrain growth of the remanufacturing industry, for example by preventing the firm from providing equipment for large-scale infrastructural projects, many of which are currently underway in China.¹⁷

The APEC Pathfinder Initiative

The Asia-Pacific Economic Cooperation (APEC) Pathfinder initiative, launched in 2011, advocates the facilitation of trade in remanufactured goods (APEC 2011). The initiative notes that exported manufactured goods often face “trade-restrictive non-tariff measures” including documentation requirements, import licensing requirements or prohibitions against importing used goods. Many economies already treat remanufactured goods as new, including Australia, Canada, Chile, Chinese Taipei, Japan, Korea, Mexico, New Zealand, Papua New Guinea, Singapore and the United States (APEC 2011). Still, APEC continues to work toward increasing economy participation.

The Pathfinder initiative supports arguments set forth by the firm that “the treatment of these high-quality, lower-cost goods as used goods can impede their trade, limit the opportunities for remanufacturing industries to grow in developing and developed economies, and cause the APEC

¹⁷ In the past, the corporation has faced obstacles to participation in large-scale foreign infrastructure projects. A key example is the Three Gorges Dam Project on the Yangtze River in Hubei Province, China, whose construction began in December 1994. While the firm had secured the required export credit insurance and deal financing from ExIm Bank to become the equipment provider for this project, the largest earth-moving project of that decade globally, it lost the business when ExIm Bank coverage was withdrawn by the U.S. government. In turn, a key competitor gained the advantage of providing the equipment (Company source, 2015e).

region to miss out on the significant environmental benefits from more robust trade in remanufactured goods” (APEC 2011).¹⁸ As a result, the Pathfinder initiative recommends:

- **The application of import-related measures only to used goods, as remanufactured goods are *not* used goods - remanufactured goods should not face import limitations**
- **The release of import prohibitions against remanufactured goods, in specific sectors and across sectors**
- **Tariff measures and border charges should treat remanufactured goods as new goods**
- **The same technical regulations, conformity assessment procedures, documentation and import licensing requirements that apply to new goods should also apply to remanufactured goods.**

Trade facilitation measures are needed to lift tariff measures, border charges, assessment procedures and licensing requirements that currently treat remanufactured goods as used goods. A recent joint report by the World Trade Organization (WTO) and the United Nations Conference on Trade and Development (UNCTAD) has underscored the importance of trade facilitation measures, asserting that they are crucial to the successful participation in GVCs (WTO / UNCTAD 2013: 5).

Trade Policy and the Location of Remanufacturing Facilities

Restrictive trade policies on both the export and import of remanufactured goods can limit the scope of locations in which remanufacturing facilities and industries can establish themselves. The location of remanufacturing facilities is relevant to GVC analysis for several reasons. First, facilities are located in markets where firms have permission to export their goods. Second, they are often located near markets with increasing demand for remanufactured goods. Third, remanufacturing facilities can be located near emerging markets and developing economies; this proximity enables linkages for that economy to the manufacturing-related services value chain in the corresponding industry. Such linkages are crucial for industrial clustering, the development of regional value chains, and eventual regional integration. Fourth, as mentioned by the USITC report on remanufacturing, “Some of the largest U.S.-based HDOR equipment remanufacturers, have remanufacturing operations located in or near markets experiencing growth in demand for aftermarket parts, including in Brazil, China, and India” (USITC 2012: 2 – 24).

Dedicated remanufacturing facilities may strategically locate near major infrastructural development projects, or near other lead firms in order to provide exclusive remanufacturing services for third parties. For example, the company’s remanufacturing division is the exclusive remanufacturing partner with Honeywell Garret for turbochargers and Weir Minerals for industrial pumps & components (PR Newswire 2005, 2011; Bloomberg 2011). Thus, in terms of policy, remanufacturing industries need trade partnerships and new markets in order to expand their sales. Without this access, the linkages between small and medium size firms are constrained.¹⁹

¹⁸ This is a key point because even subsequent trade conventions such as the Basel Convention in 2014, organized to promote the control of the trans-boundary movement of hazardous wastes and their disposal, explicitly explore the concept of remanufactured goods as waste. While the Basel Convention states that business and industry “contribute to support and promote environmentally sound management of hazardous wastes and other wastes,” the twelfth meeting of the convention in 2014 considered including remanufactured goods (Secretariat of the Basel Convention 2011). This would be damaging to the firm and other remanufacturers (Company source, 2015e). Many economies already treat remanufactured goods as new, as recommended above, including Australia, Canada, Chile, Chinese Taipei, Japan, Korea, Mexico, New Zealand, Papua New Guinea, Singapore and the United States (APEC 2011). APEC continues to work toward increasing economy participation in the Pathfinder initiative.

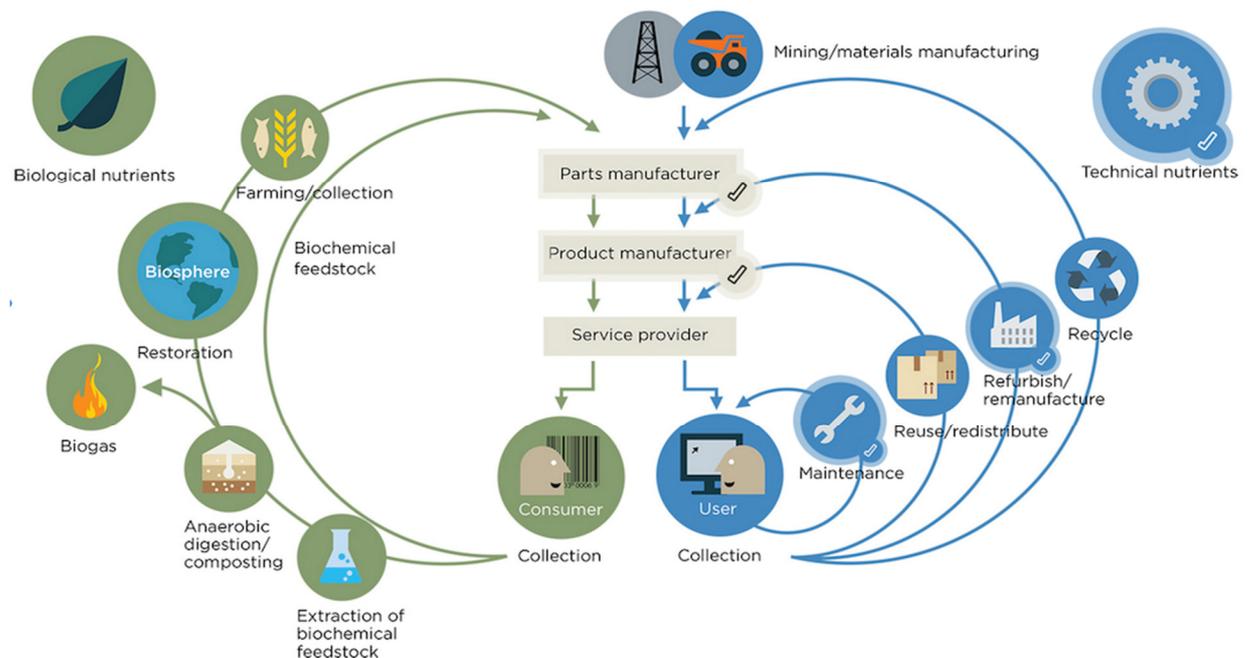
¹⁹ For instance, the firm may face obstacles to providing equipment and services for major infrastructural projects taking place in developing and emerging economies. With an expanded definition of remanufactured goods, government policymakers can also support the domestic establishment and growth of the remanufacturing industry in their own economies. This, in turn, can help to provide the long-term environmental benefits and the growth of skilled professions that accompany remanufacturing in their economies.

19.3.2. Sustainable Development

In its recent 2014 Sustainability Report, the firm communicated its sustainability goals and outlines the metrics it uses to measure its environmental impact. By 2020, the firm aims to reduce energy intensity, greenhouse gas emissions, water consumption intensity and by-product materials intensity by half, relative to its previous 2006 levels (Company source, 2014b: 2). Additional Operations goals include using alternative or renewable sources to meet twenty percent of energy needs, designing new construction to meet green building criteria, and reducing both workplace injuries and lost-time case rates (2014b: 2).

In their analysis of the long-term economic and environmental benefits of the closed-loop supply chain, Li and colleagues emphasize the importance of government policy intervention in supporting the development of the remanufacturing industry (Li et al. 2014: 6314). Specifically, they suggest that government subsidies are one useful intervention that can promote domestic remanufacturing (Li et al. 2014: 6322).²⁰ Beyond the clear environmental benefits of sustainable industrial practices, however, by having advanced logistical and technological capabilities to remanufacture, the firm is well-positioned to further regional integration and enhance its access to new markets globally.

Figure 19.4. Case Study Firm in the Circular Economy



Source: Ellen MacArthur Foundation 2012.

19.4. Conclusions

The company at the center of this study is the lead firm in the construction machinery industry. With the exception of its network of dealers, it is vertically integrated through the ownership of its entire corporate supply chain. Its production process encompasses the full scope of backward and forward linkages to manufacturing, from the use of raw materials from mining and extraction through to the point of retail sale. The firm's services value chain is not segmented; rather, its services span the entire

²⁰ Since technological innovation and the skill levels of workers are integral to the development of this industry, these aspects of the remanufacturing industry are also policy priorities.

value chain. The 66 services spanning the production and reproduction processes at the company contribute significant value to its services value chain. Of the 66 total services, manufacturing services comprise 29%, while raw materials, input and pre-production services comprise 20%. Post-manufacturing and back-office services each comprise 15% of total services in the value chain, while establishment and post-sales services each comprise 10% of the total.

Manufacturing-related services support equipment from the initial purchase of equipment through its life cycle. Financing and leasing agreements support client purchases. Business, financial and consulting services also support customers over the duration of their relationship with the firm. These services are integral to the industrial process of remanufacturing. In addition to enhancing the value and lowering costs for customers, remanufactured products offered through the dedicated remanufacturing division introduce significant positive environmental benefits through savings in materials, energy and deferred transportation costs.

Construction and mining equipment manufacturers generate a large share of their business through offering services. In fact, sales of services typically perform better than machinery sales by having faster growth rates, higher profitability, greater predictability and more resilience during economic downturns (BCG 2014: 3-4). Although the value of these services varies by sector, type of machinery, and the regulatory conditions affecting trade, a higher investment in manufacturing-related services typically correlates with competitive advantage for machinery companies (BCG 2014: 3).

The remanufacturing process is particularly relevant to value chain analysis because the majority of remanufactured goods require services in order to be exported (UNCTAD 2013: 22). The key policy issue that the case study firm currently faces is the need for a shared international understanding and definition of remanufactured products as having the same quality, durability and performance guarantees as newly manufactured products. A revised definition will facilitate lifting restrictions on imports and exports of remanufactured goods, particularly core components. In turn, this will loosen constraints on the expansion of the remanufacturing industry. By supporting a clear definition of remanufactured goods, government policymakers can also support the establishment and growth of the remanufacturing industry in their own economies.

Appendix A

Manufacturing-Related Services Relevant to the Construction Machinery Value Chain at the Firm

Table A.1. Establishment stage

<i>Stage / Category</i>	<i>Service</i>	<i>Central Product Classification (CPC) Ver.2 Code</i>	<i>Service provided in-house, by an in-group company, or outsourced</i>
1. Government services (licensing etc.)	1. Business liaison services (for example, services from trade development centres or SME centres)	Class of 9113 - Public administrative services related to the more efficient operation of business	Outsourced.
	2. Company registration and licensing services	91138 - Public administrative services related to general economic, commercial and labour affairs	Outsourced (government).
	3. Information and statistical services	Class of 9113 - Public administrative services related to the more efficient operation of business	Outsourced.
	4. Visa and immigration services for foreign investors/employees	91290 - Public administrative services related to other public order and safety affairs	In-house in coordination with outsourced local agents.
2. Other services (professional etc.)	5. Business consultant services	Class of 8311 - Management consulting and management services	Outsourced.
	6. Banking and finance services	71135 - Non-mortgage loan services for business purposes	In-house and outsourced.
	7. Legal services	82130 - Legal documentation and certification services	In-house and outsourced.

Table A.2. Raw-materials, input / pre-production stage

Stage / Category	Service	Central Product Classification (CPC) Ver.2 Code	Service provided in-house, by an in-group company, or outsourced
1. Procurement of raw materials	8. Procurement agent for raw material sourcing	85999 - Other support services n.e.c.	In-house and outsourced.
	9. Customs-related services for raw materials imported	85999 - Other support services n.e.c.	Outsourced.
	10. Quality assurance services (of raw materials)	83441 - Composition and purity testing and analysis services	Likely in-group.
2. Logistics	11. Freight transportation services (of raw materials) by road, rail, sea or air	Division: 65 - Freight transport services	Likely in-group, coordinated with a third party.
3. Storage	12. Storage of raw materials – general storage	67290 - Other storage and warehousing services	In-house.
4. Product Design	13. Conception and design of product	83920 Design originals	In-house.
	14. Industrial design	83912 Industrial design services	In-house.
	15. Patent acquisition ²¹	83960 Trademarks and franchises	In-house.

²¹ The value chain diagram for this firm categorizes patent acquisition under “Legal Services” in both the Sales & Preparation for Resale phases; patent acquisition is important for both manufactured and remanufactured goods.

<p>5. Product Development – R&D</p>	<p>16. – 17. Conception and design of product</p> <p>18. Engineering Services</p>	<p>81129 - Research and experimental development services in other engineering and technology</p> <p>81400 - Research and development originals - Innovation of new products & technologies, including those used for additive reman.</p> <p>83310 - Engineering advisory services - Development of Original Equipment Manufacturer (OEM) specifications and fabrication of prototypes</p>	<p>In-house.</p> <p>In-house.</p> <p>In-house.</p>
<p>6. Other services: Core Component Inspections</p>	<p>19. Dealer inspection</p> <p>20. Core facility re-inspection</p>	<p>End-of-life components inspected for remanufacture eligibility</p> <p>End-of-life components inspected for remanufacture eligibility</p>	<p>In-house.</p> <p>In-house.</p>

Table A.3. Manufacturing stage

Stage / Category	Service	Central Product Classification (CPC) Ver.2 Code	Service provided in-house, by an in-group company, or outsourced
1. Production administration	21. Production Administration – Production Management	83115 - Operations management consulting services	In-house.
	22. Production Administration - Repair and maintenance of factory equipment	87156 - Maintenance and repair services of commercial and industrial machinery	In-house.
2. Services supporting factory daily operations	23. Cleaning services of factory	85330 - General cleaning services	In-house.
	24. Engineering Services	Class: 8332 - Engineering services for specific projects	In-house.
	25. Specialized cleaning services for machines and equipment	85340 - Specialized cleaning services	In-house.
	26. Repair and maintenance services of machines and equipment	87156 - Maintenance and repair services of commercial and industrial machinery	In-house.
	27. – 28. Waste collection and recycling services	9421 – Collection services of hazardous waste	Outsourced.
94229 - Collection services of non-hazardous recyclable materials, other		Outsourced.	
3. Services from government regulation requirements	29. – 30. Government inspections on fire prevention, health hazards, environmental protection and other aspects.	91133 - Public administrative services related to mining and mineral resources, manufacturing and construction	Outsourced (government).
		91290 - Public administrative services related to other public order and safety affairs	Outsourced (government).

4. Worker- related services	31. Catering services for workers	63393 - Other contract food services	In-group company.
	32. Medical services	93121 - General medical services	In-group company.
	33. – 34. Social insurance for factory workers	91320 -Administrative services related to government employee pension schemes; old-age disability or survivors' benefit schemes, other than for government employees 91330 - Administrative services related to unemployment compensation benefit schemes	In-house and outsourced. In-house and outsourced.
5. Others (please specify): Worker-related	35. Wellness services		In-group company.
6. Others: Core Disassembly	36. Core disassembled into individual core components using advanced qualification technology		In-house.
7. Others: Restoration to Original Equipment Manufacturer (OEM) Specifications	37. Remanufacture core components using advanced salvaging and additive manufacturing technology		In-house.
8. Others: Re-assembly	38. Recombination of new and remanufactured components, with addition of engineering updates, for eventual sale as remanufactured product		In-house.
9. Others: Technical testing	39. Validation that reassembled, remanufactured product meets		In-house.

	standards for reliability, durability and quality, to OEM specifications		
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Table A.4. Delivery and sales / post-manufacturing stage

Stage / Category	Service	Central Product Classification (CPC) Ver.2 Code	Service provided in-house, by an in-group company, or outsourced
Packaging and labeling	40. Design of Packages	83919 - Other specialty design services	In-house.
	41. Packaging Services	85400 - Packaging services	In-house.
Delivery to wholesaler / retailer	42. Customs-related services ²²	85999 - Other support services n.e.c.	Outsourced – customs brokers.
	43. Land transport of goods (from warehouse to domestic port)	65112 – Road transport services of freight by tank trucks or semi-trailers	In-group and outsourced.
Sales services	44. Retail trade services - by distributors	Group of 621 – Non-specialized store retail trade services ²³	In-group company (dealer network) and outsourced.
	45. Retail services on a fee or contract bases	Group of 625 - Retail trade services on a fee or contract basis	In-group company (dealer network) and outsourced.
	46. – 47. Retail Administration - Operations management	83115 - Operations management consulting services 83116 - Supply chain and other management consulting services	In-group company and outsourced. In-group company and outsourced.

²² The firm considers customs authorizations from third party customs-broker services to belong in “Other Professional Services” during the Back-Office phase.

²³ The network of dealers is key for this phase.

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Leasing/Hire purchase services	48. Hire purchase services of machinery	71140 Financial leasing services	In-house, in-group and outsourced.
Others (please specify): Printing & Publishing	49. Production of equipment manuals for training and equipment use		In-house.

Table A.5. Back-office, utilities and general services

Stage / Category	Service	Central Product Classification (CPC) Ver.2 Code	Service provided in-house, by an in-group company, or outsourced
1. Finance	50. Auditing on financial accounts	Group of 822 - Accounting, auditing and bookkeeping services	Outsourced, with assistance from in-house finance division.
	51. – 52. Financial services	71121 - Deposit services to corporate and institutional depositors	In-group.
		71313 - Group pension services	Outsourced.
	53. Internal auditing (including audits of financial accounts and corporate governance)	Group of 822 - Accounting, auditing and bookkeeping services	In-house and in-group.
	54. Insurance services for machinery	71334 – Other property insurance services	In-group and outsourced.
2. General Management	55. – 57. I.T. and information system management, consulting and support, with webpage development	Class of 8313 - Information technology (IT) consulting and support services	In-house and outsourced.
		Class of 8314 - Information technology (IT) design and development services	In-house and outsourced.
		Class of 8316 - IT infrastructure and network management services	In-house and outsourced.

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3. Legal	58. – 59. Legal services ²⁴	82120 - Legal advisory and representation services concerning other fields of law 82130 - Legal documentation and certification	In-house and outsourced. In-house and outsourced.
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²⁴ The global value chain analysis presented in the above discussion considers Legal Services to belong in the Sales phase of the value chain for manufacturing and remanufacturing.

Table A.6. Post-sales services

Stage / Category	Service	Central Product Classification (CPC) Ver.2 Code	Service provided in-house, by an in-group company, or outsourced
1. Sales/After-sales Customer services	60. Customer services – Loyalty Program	95999 - Other services provided by membership organizations n.e.c.	In-house.
	61. Customer services – Technical support	85931 - Telephone call centre services	Outsourced.
	62. Customer services – warranty and repair services	Group of 872 - Repair services of other goods	In-house.
	63. Replacement / re-possession services for leased equipment	Group of 731 - Leasing or rental services concerning machinery and equipment without operator	In-house.
Group of 732 - Leasing or rental services concerning other goods		In-house.	
71140 Financial leasing services		In-house.	
2. Repair and Maintenance	64. Repair and maintenance of machines for customers	87156 Maintenance and repair services of commercial and industrial machinery	In-house and in-group (dealer network).
3. Remanufacturing services	65. Recovery of core components: buy-back services	62587 - Retail trade services on a fee or contract basis, of mining, construction and civil engineering equipment and components	In-house, in-group and outsourced (in cooperation with customs regulations and trade policy).

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	66. Remanufacturing services <i>(Note: for related services, see rows 6 – 9 in Table A.3.)</i>	Class of 4446 - Parts for the goods of classes 4441 to 4444 (Machinery and equipment for special purposes)	In-house and in-group (dealer network).
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References

- Adler, D.P. (2004). "Comparing Energy and Other Measures of Environmental Performance in the Manufacturing and Remanufacturing of Engine Components." M.S. Thesis, Department of Mechanical Engineering, Michigan Technological University.
- Asia-Pacific Economic Cooperation (APEC) (2011). "Annex D: Pathfinder on Facilitating Trade in Remanufactured Goods." Appendix 12 from The 23rd APEC Ministers Meeting, Honolulu, HI, November 11, 2011. Retrieved June 8, 2015. Electronic access: http://www.apec.org/Meeting-Papers/Ministerial-Statements/Annual/2011/2011_amm/annex-d.aspx.
- _____(2013). "Annex D: Pathfinder on Facilitating Trade in Remanufactured Goods." June 24, 2013.
- _____(2014). "Manufacturing Related Services in Supply Chains/Value Chains." Dec. 12, 2014. Electronic access: <http://goo.gl/P1Jkpu>.
- Asia-Pacific Economic Cooperation (APEC) and United States Agency for International Development (USAID) (2013). *Remanufacturing Resource Guide*. Prepared for APEC Technical Assistance Training Faculty (TATF) Program, managed by USAID. Retrieved May 10, 2015. Electronic access: http://www.apec.org/~media/Files/Groups/MAG/20131120_APEC-RemanResourceGuide_Sep2013.pdf.
- Barrientos, S., G. Gereffi, and A. Rossi (2011). "Economic and social upgrading in global production networks: A new paradigm for a changing world." *International Labour Review* 150(3-4): 319-340.
- Bernard, S. (2011). "Remanufacturing." *Journal of Environmental Economics and Management*. 62(3). 2011: 337-351.
- Bloomberg (2011). "[Remanufacturing] Reaches Commercial Agreement With Weir Minerals-North America." May 25, 2011. Accessed June 7, 2015. Electronic access: <http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aIZ7MHdOrg8Q>.
- Boston Consulting Group (BCG) (2001). "E-Services: Redefining the After-Market Opportunity." BCG Report on Industrial Products & Processes and Automotive Sector by Tom Erixon and Dan Johnson. Accessed June 7, 2015. Electronic access: <https://goo.gl/9oSWEL>.
- _____(2014). "Creating Value for Machinery Companies through Services." BCG Perspectives Report on Industrial Products & Processes and Operations by Victor Du, Kelly Howe, Rahul Jain, Rafael Rilo, Patrick Staudacher, Pekka Vanne and Francisco Salmerón. May 26, 2014. Accessed June 7, 2015. Electronic access: <https://goo.gl/xclj7F>.
- _____(2015). "Battling for Global Leadership in Construction Equipment." BCG Perspectives Report on Globalization and Automotive Sector by Nikolaus Lang, Bob Zhai, Brian Collie, and Peter Ullrich. June 24, 2015. Accessed July 18, 2015. Electronic access: <https://goo.gl/LF3SFd>.
- Company source (2008). Remanufacturing Worldwide Locations. Retrieved June 23, 2015.
- _____(2010a). [Firm] Remanufacturing Process. Nov. 17. 2010. Video. Retrieved June 3, 2015.
- _____(2010b). [Firm] Values in Action: Worldwide Code of Conduct. Retrieved June 23, 2015.
- _____(2012). "History of Remanufacturing at [the Firm]." Retrieved May 2015.

- _____(2013). “[Firm] Celebrates Five Years in West Fargo with Grand Opening of Facility Expansion.” July 2013. Retrieved June 25, 2015.
- _____(2014a). Corporate Overview Presentation. Retrieved June 23, 2015.
- _____(2014b). Sustainability Report Fact Sheet. Retrieved June 5, 2015.
- _____(2014c). Year in Review - Annual Report. Retrieved June 5, 2015.
- _____(2015a). Employment Site. Retrieved June 10, 2015.
- _____(2015b). First Quarter (1Q) Fact Sheet. Retrieved June 23, 2015.
- _____(2015c). Global Footprint – China. Retrieved July 18, 2015.
- _____(2015d). Governmental Affairs News. “U.S. Ambassador Visits [Remanufacturing] Facility in Singapore.” Retrieved July 7, 2015.
- _____(2015e). Executive interview at firm headquarters, June 12, 2015.
- _____(2015f). Organizational Chart. May 1, 2015. Retrieved June 23, 2015.
- _____(2015g). Presentation on Firm Remanufacturing at the 2015 World Remanufacturing Summit, June 16, 2015, Amsterdam, NL.
- _____(2015h). Remanufacturing page – corporate site. Retrieved June 3, 2015.
- Cheung, D. and A. Wirjo (2015). “Production of Precision Die and Machine Parts in Thailand”, Chapter 11 in *Services in Global Value Chains: Manufacturing-Related Services*, APEC Policy Support Unit, Singapore.
- Colvin, G. (2011). “[Firm] is Absolutely Crushing It.” *Fortune*. 163.7 (2011): 54. Retrieved June 8, 2015.
- Ellen MacArthur Foundation (2012). “[Firm] Case Study.” Retrieved June 9, 2015.
- Elliott, S. (2014). “[Remanufacturing]: Hungry for More.” *Duxes (Shanghai) Business Consulting, Inc.* Retrieved June 8, 2015.
- Fabick Cat (2015). “[Dealers] Have Joined Forces” Press Release, July 1, 2015. Retrieved July 18, 2015.
- Fiksel, J. (2012). "A systems view of sustainability: The triple value model." *Environmental Development* (2): 138-141.
- Fortune 500 (2015). Retrieved July 19, 2015.
- Fuller, K. (2012). “RIT’s Nabil Nasr Touts Remanufacturing in Testimony to U.S. International Trade Commission.” March 5, 2012. *Rochester Institute of Technology University News*. Retrieved June 10, 2015. Electronic access: <http://www.rit.edu/news/story.php?id=48934>.
- Gereffi, G. (2005). “The Global Economy: Organization, Governance and Development.” In *Handbook of Economic Sociology*, edited by Neil J. Smelser and Richard Swedberg, Second edition, 160–82. Princeton, NJ: Princeton University Press/Russel Sage Foundation.

- _____(2011). "Global Value Chains and International Competition." *Antitrust Bulletin*. 56 (1): 37-56.
- _____(2015). "Global Value Chains and Development." Report written for the United Nations Industrial Development Organization (UNIDO), April 6.
- Gereffi, G., A. Goger, A. Abdulsamad, D. Hamrick, G. Ahmed, A. Guinn, J. Daly, and J. Morgan (2014). "Shifting Sources of Wheat Supply for MENA Countries: the Rise of the Black Sea." Duke Center on Globalization, Governance & Competitiveness, Durham, NC.
- Gereffi, G. and J. Lee (2012). "Why the World Suddenly Cares About Global Supply Chains." *Journal of Supply Chain Management* 48(3): 24-32.
- Hauser, W. and R.T. Lund (2003). "The remanufacturing industry: anatomy of a giant." Department of Manufacturing Engineering, Boston, MA: Boston University.
- _____(2008). "Remanufacturing: Operating Practices and Strategies." Boston, MA: Boston University.
- Hindo, B. and M. Arndt. (2006). "Everything Old Is New Again." *Bloomberg.com*. Retrieved June 8, 2015.
- Japke, O. (2009). "Practice Guidelines: Development of a framework for assessing the economic benefits of remanufacturing." MA Thesis. Cranfield University: Cranfield UK. Retrieved June 9, 2015. Electronic access: www.remanufacturing.org.uk.
- Low, P. (2013). "The Role of Services in Global Value Chains." Dec. 4, 2013. Working Paper. Fung Global Institute. Retrieved May 10, 2015. Electronic access: <http://www.funglobalinstitute.org/en/working-paper-the-role-of-services-in-global-value-chains/>.
- _____(2014). "A Loaf of Bread's Well-serviced Journey." Aug. 20, 2014. *South China Morning Post*. Retrieved June 22, 2015. Electronic access: <http://www.scmp.com/comment/insight-opinion/article/1577631/loaf-breads-well-serviced-journey>.
- Lund, R.T. (1984). "Remanufacturing." *Technology Review*. 87(2): 18.
- _____(2012). "The Database of Remanufacturers." Boston, MA: Boston University.
- Lund, R.T. and F.D. Skeels (1983). *Guidelines for an original equipment manufacturer starting a remanufacturing operation*. No. DOE/CS/40192-T2. Massachusetts Inst. of Tech., Cambridge (USA). Center for Policy Alternatives.
- Nasr, N. and M. Thurston (2006). "Remanufacturing: A key enabler to sustainable product systems." Rochester Institute of Technology.
- Opresnik D., C. Zanetti, and M. Taisch (2013). "Servitization of the Manufacturer's Value Chain." pp. 234-241 in *Advances in Production Management Systems (APMS 2013: PART II, IFIP AICT 415)*. IFIP Advances in Information and Communication Technology. Prabhu V, Taisch M, Kiritsis D, Editors. Springer: Berlin, Heidelberg.
- Opresnik, D. and M. Taisch (2015). "The manufacturer's value chain as a service - the case of remanufacturing." *Journal of Remanufacturing* 5(1): 1 – 23.
- Parker, D. and P. Butler (2007). "An Introduction to Remanufacturing." Aylesbury, UK: Centre for Remanufacturing and Reuse.

PR Newswire (2005). “[Firm] Remanufacturing Services and Honeywell Announce North American Turbocharger Remanufacturing Alliance.” Oct. 5, 2005. Retrieved June 7, 2015.

_____(2011). “[Firm] and Vestas Wind Systems Reach Agreement on Remanufacturing Wind Turbine Components.” Nov. 7, 2011. Retrieved June 7, 2015.

Remanufacturing Industries Council. Definition and Importance of Remanufacturing. Retrieved June 5, 2015. Electronic access: <http://remancouncil.org/>.

Rental Equipment Register Magazine (2015). “[Firm] Dealers to Merge.” Feb. 18, 2015. Retrieved July 18, 2015.

Stahel, W. (1995). “[Firm] Remanufactured Products Group.” The Product-Life Institute, Geneva. Research for the Geneva Environment Meetings in 1995. Retrieved June 9, 2015.

Trefis T. (2014). “[Firm] Intensifies Focus on Dealer Performance to Drive Results in a Tough Macro.” March 11, 2014. Retrieved July 9, 2015.

United Nations Conference on Trade and Development (UNCTAD) (2013). *World Investment Report 2013 - Global Value Chains: Investment and Trade for Development*. New York and Geneva.

United States International Trade Commission (USITC) (2012). "Remanufactured goods: An Overview of the U.S. and Global Industries, Markets and Trade." *USITC Publication* 4356: pp. 332-525.

United States Securities and Exchange Commission (SEC) (2014). Company Form 10-K. Retrieved June 22, 2015.

Wirjo, A. and G.Pasadilla (2015). “Manufacturing of Oil and Gas Industry Equipment in Singapore”, Chapter 8 in *Services in Global Value Chains: Manufacturing-Related Services*, APEC Policy Support Unit, Singapore.

World Trade Organization (WTO) (2014). World Trade Report 2014. Chapter 3: “The Rise of Global Value Chains,” pp. 78 – 127. Retrieved June 25, 2015. Electronic access: <https://goo.gl/s3Y18c>.