



A report by the partners of:



Map of Remanufacturing Business Model Landscape

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- Siemens ITAB
- Stone Computers
- Storebro Industrier
- Ståthöga MA Teknik
- Toyota MHS
- UBD Cleantech
- Vector Aerospace

Glossary

CR	Contracted Remanufacturer
EEE	Electrical and Electronic Equipment
ERN	European Remanufacturing Network
HDOR	Heavy-Duty and Off-Road equipment
IR	Independent Remanufacturer
KPI	Key Performance Index
OEM	Original Equipment Manufacturer
OER	Original Equipment Remanufacturer
WP	Work Package

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1 Executive summary

Within the ERN project there are three different themes investigated in relation to remanufacturing in Europe. These are Business Models, Product Design and Remanufacturing Processes. In the first part of these investigations, the different remanufacturing landscapes are described. This report (Deliverable 3.1) describes the landscape of remanufacturing business models by summarising how 30 remanufacturing companies are operating their business models. The areas that were chosen to be investigated within the company business models were: **core sourcing, value chains, remanufacturing process, customer benefits, economic benefits, economic challenges, key resources, environmental benefits, social benefits** and **advanced material recovery**.

Most remanufacturers combine different **ways of sourcing cores**. However, the most common ways of sourcing cores are to buy cores from the end users, core dealers or scrap yards (**buy-back**), or to retrieve cores that the company already owns through rental or leasing agreements (**ownership-based**). The third most common way to source cores is by **voluntary-based schemes**, where remanufacturers collect cores voluntarily from e.g. end users.

Looking at **customer values**, the remanufacturing companies gave many different answers but mainly they were covered by **lower price** in comparison to new parts, **high quality** although being used, relatively **long warranty** periods, **higher up-time** in comparison to repairs with new spare parts, and a **good option to discard used products**.

The **economic benefits** of remanufacturing mainly deal with the **lower cost** of performing remanufacturing in comparison to new product/part manufacturing. This, in turn, also makes it possible to offer the customer a **lower price** for the remanufactured products/parts in comparison to newly produced products and parts. The remanufacturers claim that their prices are from 10% to 90% lower than for newly produced products/parts, where most of them are above 50%.

The 22 remanufacturing companies who mention their **economic challenges** stated that the most common challenge is to **stay competitive and profitable**. **Access to** and **management of cores** were also mentioned as problematic, as well as the **lack of customer awareness** of the benefits of remanufactured products. Some companies further mentioned having difficulties maintaining high **process efficiency** as well dealing with **product design** issues.

Staff was the most stated **key resource** at the remanufacturers. Here, the **staff** needed to have good know-how to perform remanufacturing and to manage the inventory levels. Companies also mentioned unique **access to cores** or unique remanufacturing **machinery and equipment** to perform remanufacturing as their key resources.

Most companies stated that their business had many **environmental benefits**, e.g. **reduced material** and **energy consumption** as well as **reduced CO₂ emissions**. **Job creation** and possibilities for more users to get **access to products** were mentioned as **social benefits** of remanufacturing.

2 Introduction

Remanufacturing is an important component of a resource-efficient manufacturing industry. Remanufacture involves dismantling a product, restoration and replacement of components, and testing of the individual parts and whole product to ensure that it is within its original design specifications. The performance after remanufacture is expected to be the same as the original performance specification, and the remanufactured product generally offers a warranty.

By keeping components and their embodied material in use for longer, significant environmental benefits can be realised. Remanufacturing also provides opportunities for the creation of highly skilled jobs and economic growth. Despite these accolades, remanufacturing is an undervalued part of the industrial landscape and an under-recognised industry.

In order to encourage greater remanufacturing activities, the European Commission has funded a project to form, coordinate and support a European Remanufacturing Network (ERN). This Horizon2020 project takes place over a period of two years, with the ambition to:

- encourage new businesses to take up remanufacturing
- help existing remanufacturers improve their operations
- improve competitiveness of remanufacturers domestically and internationally
- create greater awareness of remanufacturing to increase demand and address barriers

Work Package 3 (WP3) aims to map *best practices* and *challenges* with respect to business models for remanufacturing, design for remanufacturing and remanufacturing processes. This report focuses on the outputs of Task and Deliverable 3.1. In this body of work, we approach this by defining the distinctive thematic threads and activities, within the sphere of business models for remanufacturing. In particular, this includes the way cores are retrieved, the value chain of cores and remanufactured products, economic benefits and challenges, environmental and social benefits, and if there are any advanced materials recovered within remanufacturing.

This report summarises the current status of business models for remanufacturing in Europe, through company case studies from key sectors relevant to remanufacturing. In particular, the cases describe core sourcing, value chain, economic and environmental challenges and benefits, social benefits and possible advanced material recovery.

3 Research Questions and Objectives

The aim of this work is to map the remanufacturing business model landscape. The specific objectives of D3.1, which will build knowledge on business models, are:

- To describe how companies include remanufacturing in their business models, and how this in turn changes product design to facilitate remanufacturing and what remanufacturing processes are used.
- To review in which ways the cores being remanufactured are retrieved, e.g. by traditional product sales and/or through selling a service/function that the product fulfils, e.g. through leasehold contracts.
- To examine the pros and cons of business models that includes remanufacturing from economic and environmental perspectives.
- To describe which business model challenges the remanufacturing companies experience, including longer product life and materials requirements for critical materials security.
- To deliver an innovative, robust and dynamic map of the remanufacturing business model landscape.

Task description: The business model survey aims at identifying how the remanufacturing companies in our Member States make their businesses work. This requires knowledge about how they make money and how their business models are realized with all their main stakeholder involvement. A survey will be devised to meet the business model objectives stated for this work package, and will be sent out to the remanufacturing companies within the Member States. It will include questions on how cores are retrieved. The survey results will be collected and analyzed in order to find the answers to the above-stated business model objectives.

4 Methodology

The ERN project seeks to map current best practices in remanufacturing in Europe. Hence, interviews with companies operating in this space were found to be the most appropriate methodology. Multiple qualitative semi-structured interviews were conducted over the phone and/or face-to-face with senior members at the chosen case companies, as summarised in Table 1. The companies were selected from the ERN Market Study report (D2.1) and from the researchers' own network contacts within remanufacturing. Most often, company managers having the best view of their business model were interviewed. All interviews were checked by the interviewees to assure that the correct information was gathered. The interviewees were told to focus on a specific product when giving answers to the questions. The cases are structured around the following themes:

1. General information about the company
2. Business model (e.g. core sourcing, value chain, remanufacturing process steps, customer benefits, economic challenges, economic benefits, key resources)
3. Environmental and social benefits (e.g. job creation)
4. Advanced material recovery (when applicable)

A list totalling around 100 remanufacturing companies was identified through the ERN Market Study report (D2.1) and from the researchers own network of remanufacturers. The first 30 cases analysed and approved by the companies are analysed within this report (see Table 1).

Table 1 Overview of Case Companies

No.	Company	Sector / product	Type	Exp.	Country
1	ACES	Machinery / Compressors	CR / IR	2000	UK
2	ARP Suppliers	EEE / Toner cartridges	IR	2000	NED
3	ATP Industries	Automotive / Transmissions	OEM/OER	1970	UK
4	Autoelectro	Automotive / Alternators	IR	1986	UK
5	Borg Automotive	Automotive / Steering racks	CR / IR	1985	DEN
6	Büroservice Hübner	EEE / Printers and copiers	IR	2006	GER
7	Carwood	Automotive / Pumps & Injectors	OEM/OER	1968	UK
8	Desko	Furniture / Office desks	OEM/OER	1950	NED
9	ES Power	Machinery / Wind turbines	CR / IR	2012	SWE
10	Hitachi CME	Machinery / Pumps	OEM/OER	2009	NED
11	Inrego	EEE / Computers & smart phones	IR	1995	SWE
12	IT-Lyftet	EEE / Computers	IR	2010	SWE
13	Leapp	EEE / Laptops	IR	2011	NED
14	Linde	HDOR / Forklift trucks	OEM/OER	1996	GER
15	Oerlikon LV	Machinery / Vacuum solutions	OEM/OER	2006	GER
16	Polyplank	Machinery / Core plugs	OEM/OER	1994	SWE
17	PSS	Automotive / Power steering boxes	IR	1971	UK
18	RDC	EEE / IT equipment	IR	1991	UK
19	robotiF	Machinery / Industrial robots	IR	2009	GER
20	Scandi-Toner	EEE / Toner cartridges	IR	1993	SWE
21	Schmitz+Krieger	Automotive / Engines	CR	1911	GER
22	SCM Turbo	Automotive / Turbo chargers	IR	1980	UK
23	Siemens Industrial Turbomachinery	Machinery / Gas turbines	OEM/OER	1955	SWE
24	Stone Computers	EEE / IT equipment	IR	2009	UK
25	Storebro Industrier	Machinery / Machines	CR	1991	SWE
26	Ståthöga MA Teknik	Machinery / Pumps	CR	1988	SWE
27	Toyota MHS	HDOR / Forklift trucks	OEM/OER	2003	SWE
28	UBD Cleantech	Automotive / Brake calipers	CR / IR	1980	SWE
29	UBD Cleantech	Automotive / Diesel particle filters	CR	1980	SWE
30	Vector Aerospace	Aerospace / Engine components	IR	1940	UK

The interviews contained the following set of questions developed by the authors of this report and with guidance from all other ERN researchers:

1. Please describe your product selected for this survey

there could be several products surveyed if they have widely different business models.

2. What are the main sources for getting back used products (to retrieve cores)?

examples of how to collect cores are (from Östlin et al, 2008):

- **Ownership-based:** *The product is owned by the manufacturer and operated by the customer, as for example in a rental, lease or product-service offer,*
- **Service contract:** *This type of relationship is based on a service contract between a manufacturer and a customer that includes remanufacturing,*
- **Direct-order:** *The customer returns the used product to the remanufacturer, the product is remanufactured and the customer gets the same product back (if it is possible to perform a remanufacturing operation),*
- **Deposit-based:** *When the customers buy a remanufactured product, they are obligated to return a similar used product, thus also acting as a supplier to the remanufacturer,*
- **Credit-based:** *When the customers return a used product they receive a specific number of credits for the returned product. These credits are then used as a discount when buying a remanufactured product,*
- **Buy-back:** *The remanufacturer simply buys the wanted used products from a supplier that can be the end user, a scrap yard or similar, or a core dealer, and*
- **Voluntary-based:** *The supplier gives the used products to the remanufacturer. The supplier can also be a customer but do not have to be.*

3. Briefly, explain the value chain back to market and actors involved?

If possible, with a flowchart with the material flow between the actors.

4. Briefly, explain your steps in your remanufacturing process.

5. Please, describe the business model (how your remanufacturing business works including profit generation) used for the selected product. When doing so, please consider the sub questions:

- 5.1 What are the main drivers/rational behind this business model?
- 5.2 What are the main challenges by having this business model?
- 5.3 Are there different customers or customer groups you target for remanufactured products from buying newly manufactured products?
- 5.4 Is there a different value proposition for the customer (what's the value for the customer) from buying newly manufactured products?
- 5.5 Do you use different pricing strategies for remanufactured products compared to 'new' products? (e.g. reduced price, 50%, 75% of newly manufactured products, E-bay) If so, what do they look like?
- 5.6 What do you think customers see as the benefits and/or downsides of remanufactured products?
- 5.7 Do you have any different selling channels or selling techniques for remanufactured products compared to 'new' products? (e.g. E-bay, retailers, internet) If so, how do they differ?
- 5.8 Do you have partnerships or collaborations to facilitate remanufacturing (e.g. logistics providers, collaboration with end-customers)? If so, what do they look like?
- 5.9 What are key resources (e.g. remanufacturing personnel, facility, and product information)?

6. Please describe the main economic pros and cons with your business model?

- 6.1 Are you using any methods for developing/measuring your business model economic performance?

7. Please describe the main environmental pros and cons with your business model?

- 7.1 Are you using any methods for developing/measuring your environmental performance? (Environmental standards, Environmental labels, Ecodesign methods?)

- 8. What other pros and cons does your business model have, e.g. social benefits, jobs?**
- 9. Are there any advanced materials (such as advanced composites and alloys) recovered in your remanufacturing process?**
- 10. What are your main challenges to improve your remanufacturing business?**

5 Case study results

This section presents the summarised results from the case study of the 30 companies listed in Table 1 (Section 3). The results described in the different subsection are correlated to the business model case study descriptions (Deliverable 4.1): **Location, Type, Experience in remanufacturing, Sector/product, Business model, Core sourcing, Economic benefits, Social benefits,** and **Advanced materials recovery**. The first characteristics investigated are described under the heading “5.1 Company background information” while the rest are described under the heading “5.2 Business model information”.

5.1 Company background information

In this section the company background information concerning the companies’ location, experience in remanufacturing and industrial sector is described.

5.1.1 Location

The locations of the company remanufacturing facility or headquarters were asked for during the interview. Figure 1 shows the distribution of locations within this task.

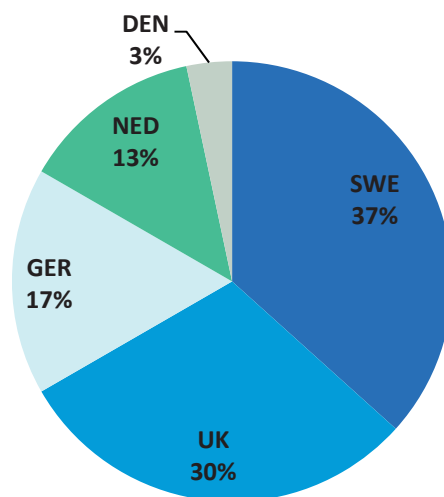


Fig 1. The location of the remanufacturing company facility/headquarters analysed in the business model case study.

The country origins of the companies were not so surprising, since the *ERN Market Study report* showed many remanufacturing companies being present in Germany and the United Kingdom. In addition, since the investigators came from Sweden, the Netherlands and the United Kingdom, these countries were also where the investigators had the closest industry contacts, which are crucial when investigating business models. Some additional companies were added after they contacted the research investigators to join the business model study. Hence, some representation from Denmark was included.

5.1.2 Type of remanufacturer

There are different types of companies that perform remanufacturing. These companies can be divided according to their relationship to the product manufacturer, i.e. the Original Equipment Manufacturer (OEM). According to Lund (1983), Jacobsson (2000) and Sundin (2004), remanufacturers can be categorised into:

- **Original Equipment Manufacturers/Remanufacturers (OEM/OERs)** – OEMs who remanufacture their own products; these companies are also called Original Equipment Remanufacturers (OERs). In this case, it is the OEM/OER who remanufactures its own products arriving from service centres, trade-ins from retailers or end-of-lease contracts. Furthermore, OEMs/OERs have all the needed information concerning product design, availability of spare parts and service knowledge. The remanufacturing process could be integrated with the ordinary manufacturing process or be separated from it. Also, the parts from the remanufactured products could be used in manufacturing, or the products could be entirely remanufactured; see e.g. the case of FUJI Film (Sundin, 2004). An OER can be seen in this study as the business unit in the OEM that performs the remanufacturing.
- **Contracted Remanufacturers (CR)** – remanufacturing companies that are contracted to remanufacture products on behalf of other companies. This means that the OEM normally owns the products, but does not need to perform the actual remanufacturing of them. Still, the OEMs have their products remanufactured and can offer them to their customers once again for a lower price. For the remanufacturer, there is likely to be a fairly consistent stream of business with fewer working capital requirements (e.g. work in progress) and risks, and the company can expect to obtain assistance from the OEM in terms of replacement parts, design and testing specifications, and even tooling (Lund, 1983).
- **Independent Remanufacturers (IR)** – these are independent remanufacturers who remanufacture products with little or no contact with the OEM, and who need to buy or collect cores for their process. Sometimes, these companies are paid by the last owner or distributor to pick up discarded products (Jacobsson, 2000). These independent remanufacturers also often need to buy spare parts for their products that are to be remanufactured. The typical independent remanufacturer is a private corporation with closely held ownership (Lund, 1983). Generally, exchange of experience between these remanufacturers concerning reprocessing to the OEM is minimal (Jacobsson, 2000).

In this investigation we have categorised the case companies into the above categories and labelled them OEM/OER, CR and IR respectively. For some cases, the remanufacturing companies act as both CR and IR (Cases 1, 5, 9 and 28). This means that for some product brands they have collaboration with the OEMs, and for others not. The distribution of the different types of remanufacturers investigated in this task is illustrated in Figure 2.

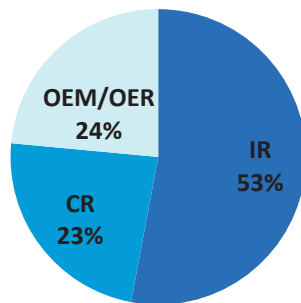


Fig 2. The type of remanufacturing company analysed in the business model case study.

As also shown in the ERN Market Study, most remanufacturers are independent. For this task, a large share of the OEM/OERs and CRs were also investigated.

5.1.3 Experience in remanufacturing

The companies' experience in remanufacturing was also investigated (Figure 3).

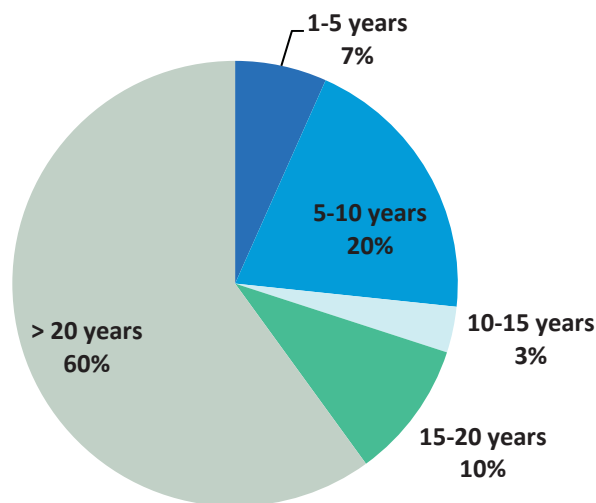


Fig 3. The amount of experience the analysed companies have in remanufacturing in the business model case study.

Most of the companies had extensive experience in remanufacturing. A reason why the older companies have a large focus in this investigation is because the investigators used their industrial networks and have been collaborating with these companies for a long period of time, and thus have a good relationship with them. However, some younger companies were also investigated, mainly from the EEE sector.

5.1.4 Industry sectors

As with all three themes within this project (Business Model, Product Design and Remanufacturing Process) the companies investigated were categorised into the following nine categories: **aerospace, automotive, heavy-duty and off-road (HDOR) equipment,**

electronic and electrical equipment (EEE), machinery and medical equipment, and into smaller sectors such as (office) **furniture, rail** (rolling stock) and **marine**. These sectors were chosen to be able to compare our ERN studies with previous studies performed in the United States and China (see ERN Market Study). A shorter description of the industrial sectors is presented below in order to understand which products are used for each sector:

Aerospace sector

The European aerospace industry encompasses activities including the design, development and production of civil and military aircraft, aero engines, helicopters, unmanned aerial vehicles and their associated systems, parts and equipment¹. The sector is characterised by some of the most durable, long-lived products. Civil aircraft typically have a lifespan of 25 years or more and can have their life prolonged further by conversion to a freight aircraft. Military aircraft have longer life cycles; military transport aircraft, for example, may have a life span of 30 years or longer.² The physical life-limiting factor for aircraft is the number of cycles of pressurization and depressurization of the fuselage (one cycle per flight), which affects the durability of the fuselage structure. Hence, long-haul aircraft have a longer life span than short-haul, which make more cycles/flights per day. Operating costs are another factor that can affect the in-use life of an aircraft.

Automotive sector

The automotive sector encompasses motorised road vehicles, motorbikes and vans. HGVs and lorries are not considered here to avoid an overlap with the HDOR sector. Remanufacturing in this sector is focused around automotive components but also includes tyre retreading.

Electrical and electronic equipment (EEE)

For the purposes of this report, the EEE sector will be defined as consisting of: information and communication technologies (ICT) and consumer electronics; ink and toner printer cartridges; and white goods. These three sub-sectors, as described in Table 2, will be addressed individually throughout this chapter.

Table 2 Sub-sectors of the EEE sector

Category	Description
ICT and consumer electronics	ICT infrastructure including server machines and network switches. Office imaging equipment. Consumer electronics (also known as “brown goods”) encompasses laptops, desktops and mobile phones.
Ink and toner cartridges	As in inkjet and laser printers
White goods	Washing machines, refrigerators/freezers and dishwashers

Furniture

The furniture sector can be divided into furniture for personal use and furniture for business use, including offices. In this study, we consider the furniture sector to include companies

¹ European Commission, Annual Analyses of the EU Air Transport Market 2011, Final Report 2013: http://ec.europa.eu/transport/modes/air/internal_market/observatory_market/doc/annual-2011.pdf

² A national aviation organisation in Germany

that produce free-standing or built-in furniture units, to be used for storage, seating, sleeping, working on/at and eating on/at. Thus furniture, as defined for the purpose of this project, includes chairs, tables, wardrobes, shelves, cupboards, etc. used for business purposes, e.g. in offices and schools, as well as for domestic purposes. It excludes building products (e.g. steps, walls, mouldings and panels), sanitary equipment, carpets, fabrics, office supplies, and other products, the primary purpose of which is not to function as furniture. Office furniture generally includes seating, desks and pedestals, steel or wooden storage units, and a small percentage (2.5% of sales) of miscellaneous items such as partitions. Furniture is a “workhorse” item, built for durability and a long lifetime.

Heavy-duty and off-road equipment (HDOR)

The heavy-duty and off-road (HDOR) equipment category encompasses the manufacture, installation, maintenance and repair of a wide variety of equipment including: engines and turbines, except those used in light vehicles and aircraft; forestry and agricultural equipment; mining and quarrying equipment; lifting and handling equipment; and the equipment used in the manufacture of cars and other vehicles.

This chapter focuses on lifting and handling equipment, off-road machinery, and HDOR tyre retreading as a representation of this sector, as described in more detail in Table 3.

Table 3 Sub-sectors of the HDOR sector

Category	Description
Lifting/handling equipment	Cranes and hoists, industrial handling equipment including forklift trucks and lifts and escalators.
Off-road	Mining, quarrying, forestry and agricultural vehicles and equipment, both motorised and unpowered.
Tyre retreading	Tyres used on equipment in this sector as described above.

Machinery

The machinery sector encompasses the manufacturing, installation, maintenance and repair of a wide variety of equipment including: machinery for food and beverage processing, machine tools, pumps and compressors, engines and turbines (excluding aircraft, vehicle and cycle engines), alongside the installation and repair of machinery and equipment. In this report, three categories of machinery (Table 4) and the remanufacturing opportunities they present are considered.

Table 4 Categories of machinery

Category	Description
Industrial food processing equipment	Packaging and sealing equipment, liquid and powder filling machines, slicing and mixing equipment, along with ovens, moulders, batch cooking and line processing equipment.
Pumps and compressors	Pumps are a core component of a vast array of equipment. Compressors are used in applications including heating, ventilation and air conditioning (HVAC) systems, transporting natural gas and equipment which requires compressed air to function.
Industrial tools	Industrial tooling comprises machine and cutting tools, such as those used to work and shape metal or other materials into the correct form before product assembly occurs.

Marine

The marine industries manufacture and provide support services in the leisure, naval, commercial, offshore renewable energy and other sub-sectors.³ Almost 90% of global trade is waterborne. Dry bulk and containerized cargoes constitute 70% of the global seaborne trade, while oil and gas tankers account for the other 30%.

Medical devices

Medical devices and equipment are items used on patients to carry out medical care, including testing, diagnosis, surgery and after-care. Thousands of products fall into this category, from simple disposable supplies to highly capital-intensive devices (Table 5).⁴ The products manufactured by the medical technology industry range from spectacle lenses to cardiac implants, from blood-glucose monitors to hospital beds and MRI scanners.⁵ In Europe, what is considered to be a medical device or a piece of medical equipment is clearly outlined in the European Union Medical Devices Directive (93/42/ECC).⁶

“Remanufacturing” or “refurbishing” in the medical device sector favours medical equipment that is designed to have a long lifespan, is non-invasive, requires significant R&D investment and is capital-intensive to build and buy. Devices that fall into this category include magnetic resonance imaging (MRI), ultrasound and computed tomography (CT) scanners, X-ray and cardiology equipment as well as precision and optical devices. In general, this equipment is well made resulting in a long useable life. Remanufacture and servicing plays an important role in keeping a piece of equipment functioning for as long as it is needed, or until it becomes obsolete because of technological advancements or due to functional redundancy.

Table 5 Examples of medical devices and equipment

Medical division	Type of equipment
Anaesthesia	Face masks, patient monitoring equipment
Endoscopy/laparoscopy	Range of implements and equipment
Hearing aids and audiometry	Instruments to aid hearing and diagnose hearing loss
Hospital capital fixed plant	Body scanners, linear accelerators to x-ray apparatus
Hospital supplies and disposables	Sterilisers, gloves, needles, syringes to sample holders
Implantable devices	Miniaturised instruments such as pacemakers
In-vitro diagnostics and kits	“Lab-in-a-box” kits
Infusion and inhalation therapies	Instruments to dispense drugs or nutrients
Invasive surgery	Surgical tools and disposables
Prosthetics and artificial joints	Implants or limb replacements
Ultrasound	Imaging, diagnostic and treatment devices

³ [www.zerowastescotland.org.uk/sites/files/zws/Remanufacturing Study - Full Report - March 2015_0.pdf](http://www.zerowastescotland.org.uk/sites/files/zws/Remanufacturing%20Study%20-%20Full%20Report%20-%20March%202015_0.pdf)

⁴ PRIME Faraday Partnership: Medical Devices: The UK Industry and its Technology Development, 2003

⁵ PRIME Faraday Partnership: Medical Devices: The UK Industry and its Technology Development, 2003

⁶ UK: Department for Business, Innovation and Skills (DBIS), UK Trade and Investment (UKTI), Department of Health (DH): The landscape of the medical technology, medical biotechnology and industrial biotechnology sectors in the UK.

Rail

For the purpose of this report, only rolling stock remanufacturing will be considered in the rail sector. Rolling stock are the vehicles used in the rail industry and include: traction units (providing motive power to pull passenger and freight trains), passenger carriages, self-propelled passenger vehicles, freight wagons and infrastructure maintenance vehicles. Their manufacture is lengthy and capital-intensive; thus, rail systems need huge investments.

The rail sector encompasses inter-city passenger and freight rail services as well as urban rail services, including light rail systems, trams and street cars, automatic people movers (APMs) e.g. driverless trains often used in large airports, metro train systems monorail and personal rapid transit (PRT) systems, also called podcars.

The outcome of the categorisation within this task is shown in Figure 4.

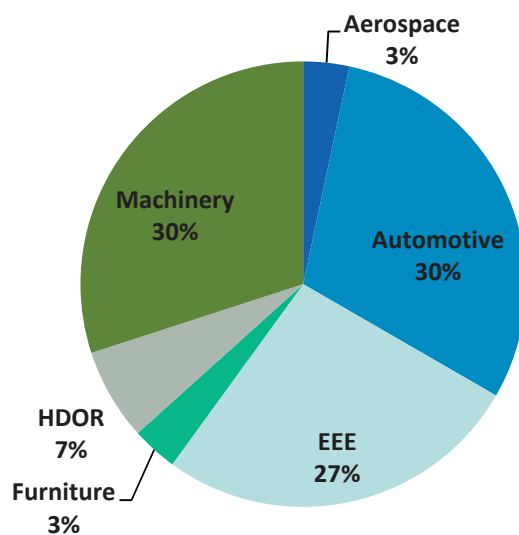


Fig 4. The industrial sectors from which the analysed companies have of remanufacturing in the business model case study.

The *Automotive* industry sector is often shown as the largest in Europe, and this is also the case in this investigation. There are also large shares of companies from the *Machinery* and *Electronics (EEE)* sectors present in the study. Table 1 show what products the case companies are performing remanufacturing on, which in some cases are more useful to look at than which industrial sector they belong to.

5.2 Business model information

Company business models can be mapped and investigated in many ways. A popular method used is the Business Model Canvas provided by Business Model Foundry AG (2016), consisting of: key partners, key activities, key resources, value propositions, customer relationships, channels, customer segments, cost structure and revenue streams. In our investigation, which is adapted to remanufacturing companies, we have used the interview questions stated in *Section 4 Methodology* to provide us with information on; **core sourcing, value chain, remanufacturing process, customer benefits, economic benefits, economic challenges, key resources, environmental benefits, social benefits** and **advanced material recovery**. These areas are further explored in the following sections.

5.2.1 Core sourcing

Regarding the way cores are being sourced the categories from Östlin et al (2008) were used as examples of how to collect cores:

- **Ownership-based:** The product is owned by the manufacturer and operated by the customer, as for example in a rental, lease or product-service offer,
- **Service contract-based:** This type of relationship is based on a service contract between a manufacturer and a customer that includes remanufacturing,
- **Direct-order-based:** The customer returns the used product to the remanufacturer, the product is remanufactured and the customer gets the same product back (if it is possible to perform a remanufacturing operation),
- **Deposit-based:** When the customers buy a remanufactured product, they are obligated to return a similar used product, thus also acting as a supplier to the remanufacturer,
- **Credit-based:** When the customers return a used product they receive a specific number of credits for the returned product. These credits are then used as a discount when buying a remanufactured product,
- **Buy-back-based:** The remanufacturer simply buys the wanted used products from a supplier that can be the end user, a scrap yard or similar, or a core dealer, and
- **Voluntary-based:** The supplier gives the used products to the remanufacturer. The supplier can also be a customer but do not have to be.

Since the investigators and interviewees used different terms and descriptions for how they are retrieving cores, this summary had to consider all the cases to understand and match which of the core sourcing strategies were used. It was found that the most common way is **Buy-back-based** (15 cases) followed by **Ownership-based** (6 cases) and **Voluntary-based** (6 cases). In many cases, the main way of sourcing cores is complimented with the **Buy-back** and **Voluntary-based** options. Figure 5 shows the distribution of which sources of cores that the companies are using.

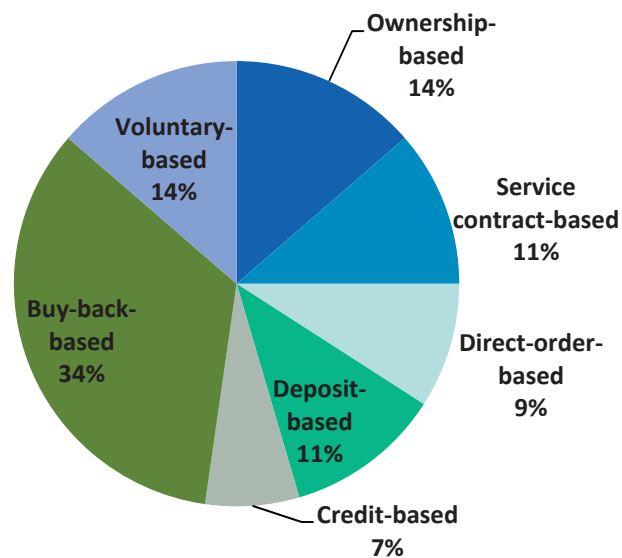


Fig 5. The sources of cores for the analysed companies within the business model case study.

It is common that the companies are using several ways of sourcing cores. Table 6 below shows more details on what methods of core sources being used by the companies within this task where the main sources shown in bold figures:

Table 6 Detailed summary of core sourcing methods (figures in bold = main source)

Source method (# of cases)	Company cases
Ownership-based (6)	6, 8, 11, 14 , 16, 27
Service contract-based (5)	1 , 3 , 7, 24, 30
Direct-order-based (4)	1, 17, 22, 30
Deposit-based (5)	4 , 5 , 7 , 17 , 22
Credit-based (3)	7, 13, 17
Buy-back-based (15)	1, 2 , 5, 6 , 8 , 10 , 11 , 13 , 15 , 16 , 19, 20, 22, 27, 28
Voluntary-based (6)	1, 12, 18 , 20 , 22, 24

One goal of this investigation was to review in which ways the cores being remanufactured are retrieved, e.g. through traditional product sales and/or through selling a service/function that the product fulfils, e.g. through leasehold contracts. The reason why this was investigated is that a common challenge for remanufacturers is the uncertainty of time and quality of the cores coming to the remanufacturing companies. Using a product-service system model, e.g. rental agreements for core providing, is a way that these uncertainties can be reduced. An OEM could use product-service systems to collect cores, but independent remanufacturers could also lease their remanufactured products in order to get them back for another remanufacturing round (as in case 11). Going through the cases it was found that in six of them, some kind of leasing model is being used as a way of collecting cores (Cases 6, 8, 11, 14, 16 and 27).

5.2.2 Value chain

Each company's value chain is described, with actors involved and how cores and remanufactured products are transported between these, e.g. garages, distributors, core suppliers, dealers, OEM, remanufacturers, retailers and customers. Figures 6-8 show three examples of how the value chains can be illustrated in the cases of Borg Automotive (Case 5), Vector Aerospace (Case 30) and UBD Cleantech (Case 29). All value chain descriptions can be studied in more detail for each company in Annexe A.

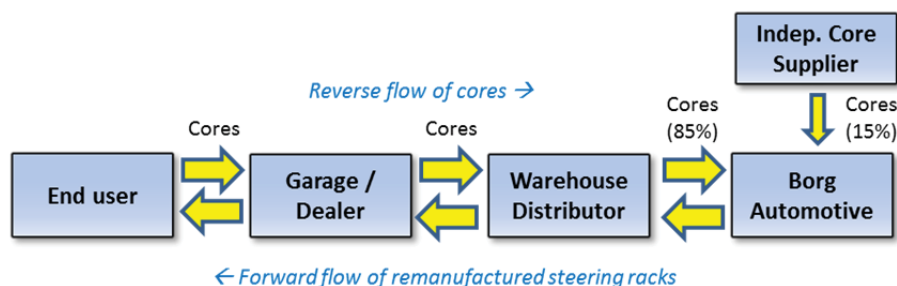


Fig 6. The value chain of Borg Automotive (Case 5).

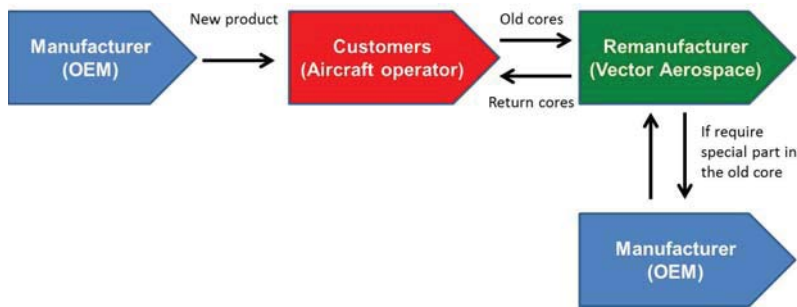


Fig 7. The value chain of Vector Aerospace (Case 30).

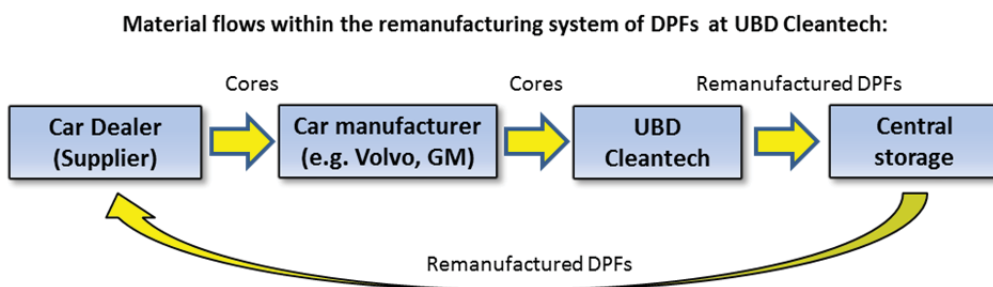


Fig 8. The value chain for UBD Cleantech (Case 29).

5.2.3 Remanufacturing process

All studied companies were able to describe their remanufacturing processes. Most of them described the process steps in text and bullet points. Two illustrative examples from Borg Automotive (Case 5) and Toyota Material Handling Sweden (Case 27) are shown in Figure 9 and 10.

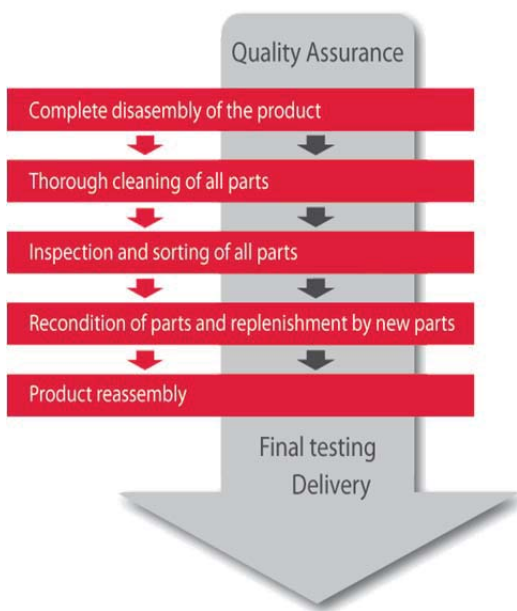


Fig 9. The remanufacturing process at Borg Automotive (Case 5).



Fig 10. The remanufacturing process at Toyota Material Handling Sweden (Case 27).

Within this study each company’s remanufacturing processes are described, which can be studied within the case descriptions in Annexe A. In addition, the ERN third research theme “Remanufacturing processes” brings up issues about remanufacturing process landscape in more detail, see the Remanufacturing Process Landscape report (D3.3).

5.2.4 Customer benefits

The customer benefits of remanufacturing companies vary a lot and all answers are unique, as can be read in the case descriptions in Annexe A. When trying to summarize, the main customer benefits are **lower price, high quality, long warranty and higher up-time**.

The companies offer a lower price but with same or better quality (Cases 5, 11, 12, 14, 15, 16, 17, 27, 28, 29). One company (Case 4) said they have better quality than the cloned products they compete with.

Most companies say it is a price-worthy option in comparison to new products/parts. In another case (Case 5) remanufactured products are the only option since new products are not manufactured any longer. In addition, the remanufactured products provide a faster solution (Cases 14, 17, 21, 22, 26) than ordering new parts meaning that up-time is higher and the out-of-service times are lower. Remanufacturing is also seen as a good option to get rid of used products (Cases 8, 11, 12, 16, 24). Figure 11 illustrates these most common answers from the companies.

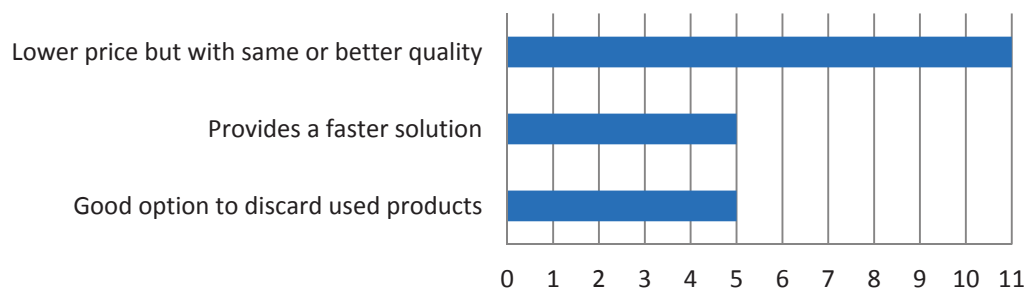


Fig 11. The most common answers regarding the remanufacturing company customer values.

Listed below are the benefits the customer has according to the remanufacturing companies studied within this task (case numbers in brackets):

- Possibilities to return products (8)
- Used equipment can result in net economic income instead of just taking space (11)
- Used equipment can be used by others instead of just taking space (12)
- Buy-back => no tied-up capital and no scrapping costs (14)
- Free-of-charge recycling of products (24)
- Good warranty (4 years) and at least 20% cheaper price (2)

- Longer warranty (2 years) (4)
- Better quality than cloned products (4)
- Cheap and sometimes the only solution (5)
- Eliminating weaknesses in original products (5)
- Lower price and availability of older models and good environmental performance (6)
- Good functionality of remanufactured products and equivalent warranty to new products, but with lower price (7)
- Reman company keeps a stock of remanufactured products to be able to replace breakdowns fast (10)
- Lower price, same warranty (1, 10)
- Lower price, high quality (5, 11, 12, 14-17, 27-29)
- Lower price, 2-year warranty (13)
- Fast access to products (14)
- Faster product repairs than without remanufacturing (17)
- Minimise “out-of-service” (off-the-road) times for products (trucks and buses) (17)
- Keeping low lead times and repair times for their customers (17)
- Lower price and increased availability of products (21)
- Reman products in stock -> Immediate service to customers (22)
- Prolong the use of their equipment and reduce down-time in comparison to buying new products (26)
- Increase up-time and less use of electricity (26)
- Reduced risk of product failure (27)
- Price-worthy products to a lower price, same quality, with a 2-year warranty (20)
- Avoid leaks of confidential data by secure erasing (18)
- Affordable access to computer technology and the Internet provided to those unable to buy new products (18)
- Keep their products (robots) working (19)
- Avoid emergency repairs – good from an economic perspective (19)
- Product life extension (19)
- Better environmental image (16, 21)
- Longer warranty than new products (22)
- Cost-effective solution (22)
- Realizing optimal operational performance from their assets by product life extension (23)
- Lower costs and extended lifecycles including latest OEM technologies (23)
- Price-worthy machines delivered with a complete measurement report and supporting documentation, e.g. risk assessment (25)
- Manual of how to maintain the products to make them last longer (25)
- Significantly lower cost (26)
- Increased product efficiency (26)
- Better relationship with the product provider (27)
- Price-worthy and high-quality products being maintained by the OEM (27)
- Lower price but good quality (28)
- Possibility to offer remanufactured products to their customers (29)
- Saves time and cost (30)
- Improved product quality (e.g. reduced turnaround times) (30)

5.2.5 Economic benefits

On the question about economic benefits, various answers were given. For example, the economic benefits are lower costs to remanufacture a product in comparison to new manufacturing. This means that the prices can also be set to a lower level and thus are a customer benefit. Of course, it is the market which decides the price of the remanufactured products, so therefore price over time is not certain. However, most of the remanufacturing companies claim more than 50% lower prices than new products. Even in the cases the remanufacturers' costs/prices are not mentioned, having revenues is an obvious economic benefit for the remanufacturers. Figure 12 illustrates examples of how 21 companies answered regarding the reduction in price of remanufactured products.

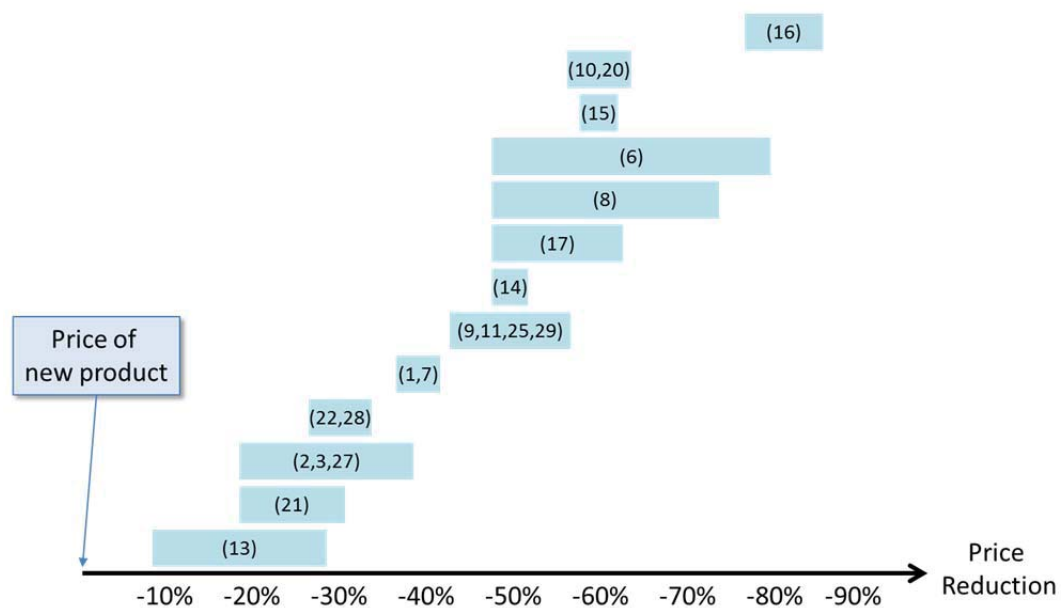


Fig 12. Reductions in costs or prices when comparing remanufacturing with manufacturing. The length of the bars illustrate the price reduction range while the number in brackets responds to the case numbers.

Below more details on what the economic benefits are at the remanufacturing companies studied within this task (case numbers in brackets):

Reduction in price:

- 10-30% lower price (13)
- 20-30% lower price (21)
- 20-40% lower price (2, 3, 27)
- 30% lower price (22, 28)
- 40% lower price (1, 7)
- 50% lower price (9, 11, 25, 29)
- 50% lower price (14)
- 50-80% lower price (6)
- 60% lower price (15)
- 50-65% lower price (17)
- 50-75% lower price (8)
- 60% lower price (10, 20)

- 80-90% lower price (16)
- Much lower price (12, 18)
- Affordable price (24)

Other:

- Using correct pricing strategy => good for remanufacturer and customer (6)
- High demand for remanufactured products (9)
- Enhancing the after-sales business to third parties (15)
- Keep products running longer – saves money (19, 26)
- Cheaper and shorter out-of-service time for aircrafts (30)
- Lower cost of ownership (23)
- Increased product knowledge (23)

5.2.6 Economic challenges

Eight of the companies did not state they had any economic challenges (Cases 1, 2, 8, 11, 12, 23, 24, 26). However, most (22) of the companies said that they have economic challenges.

The main economic challenges are **core access/management**, **lack of customer awareness**, **design issues**, **process inefficiency** and **staying competitive and profitable**. Figure 13 illustrates the most common answers from the companies.

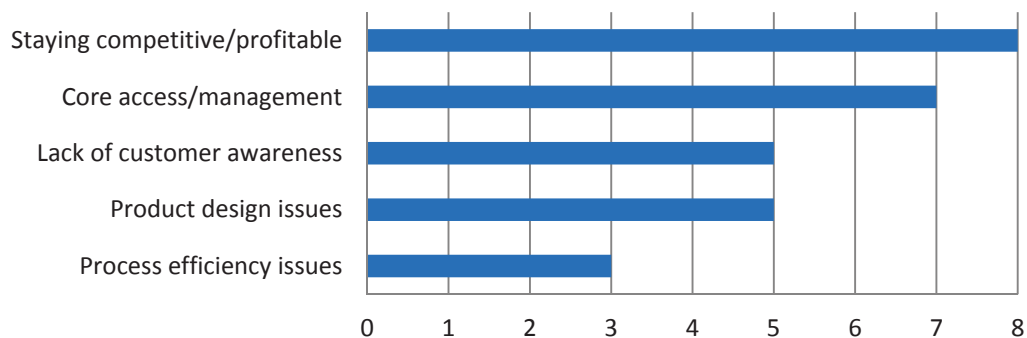


Fig 13. The most common answers regarding the economic challenges.

Listed below are the economic challenges at the remanufacturing companies studied within this task (case numbers in brackets):

- Six companies stated that they have problems **staying competitive** (Cases 4, 14, 17, 20, 22, 28), while two others mentioned **staying profitable** is a challenge for them (Cases 3, 7).
- Another seven of the companies stated that they had challenges within **core access and/or management** (Cases 3, 5, 14, 17, 21, 25, 27)
- Five of the companies mentioned a **lack of customer awareness** of the benefits of remanufactured products (Cases 4, 6, 10, 13, 20).
- Five of the companies have **design issues** that make their remanufacturing business troublesome (Cases 3, 9, 19, 21, 28)
- Three of the companies said they have challenges to improve their **process efficiency** (Cases 3, 6, 29)

Listed below are the economic challenges stated by the remanufacturing companies within this task (case numbers in brackets):

No economic challenges mentioned (Cases 1, 2, 8, 11, 12, 23, 24, 26)

Core:

- Core collection (3)
- Core handling (5)
- Receiving and sorting cores (5)
- Access to cores (14, 17, 25)
- Core management, e.g. stock levels (21)
- Uneven amount of cores arriving at the remanufacturing facility (27)

Staying competitive and profitable:

- Maintaining price competitiveness (14)
- Competition with cloned products with inferior quality from the Far East (4)
- Compete with cheaper cloned products (17, 20)
- Stay competitive by capturing as much business as possible (22)
- Competition with new products produced in low labour markets, e.g. Asia (28)
- Maintain and grow profitability (3)
- Keep business profitable while investing in equipment and facilities (7)

Lack of customer awareness:

- Customer needs to understand the benefits of remanufactured products (4)
- Customer awareness of remanufactured products (6, 13, 20)
- Customer awareness of remanufactured products high quality since often price equals quality (10)

Design:

- Product phase changes (3)
- Parts are welded together (9)
- Computerization of parts -> harder to change if broken (19)
- Access to data about product and processes (21)
- Introduction of electronics in products (21)
- Technical challenges to renovate the electric functions, e.g. newer brake caliper designs (28)

Process efficiency:

- Improve process efficiency (3)
- Improve processes (6)
- Develop a more efficient process (29)

Other:

- Coping with regulations (6)
- Better knowledge sharing (6)
- Labour costs (6, 27)
- Sustain availability of cores in stock (7)

- Training and acquisition of skilled personnel to expand business (7)
- Problems meeting the demand for remanufactured products (13)
- Better preventive maintenance before breakdown (14)
- To optimize the offerings to specific markets and set correct prices (15)
- Hard or impossible to buy spare parts during a recession (production is zero) (19)
- Remanufacturing of cloned products is illegal (20)
- Too small a market (20)
- Low quality of products with cheaper price from other competitors -> influences the perception of remanufactured products in the market (22)
- Being able to plan the remanufacturing process, e.g. reprocessing times (25)
- Knowing the product value for the remanufacturing market and how much time to put on it (27)
- Sales companies still focus on new sales rather than remanufactured product sales (27)
- Maintaining airworthiness control standards for aircraft and product innovation (30)

5.2.7 Key resources

Many companies mentioned their **staff**, **access to cores**, **remanufacturing know-how**, and **equipment and facilities** as their key resources for their remanufacturing business. Figure 14 illustrates the most common answers from the companies.

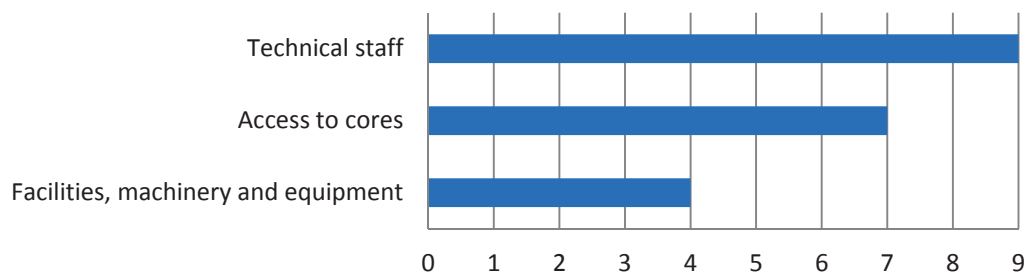


Fig 14. The most common answers regarding the remanufacturing companies' key resources.

Listed below is how the companies responded about their key resources (case numbers in brackets):

- Facilities, machinery and equipment (1, 3, 17, 28)
- Technical staff (3, 6, 14, 15, 17, 19, 20, 24, 29)
- Access to cores (3, 5, 6, 13, 20, 24, 29)
- Remanufacturing know-how, sales channels and supply of cores (6)
- OEM partnerships (7)
- Certified data erasing process (11)
- Certified (ISO27001) data erasing technology (18)
- An international and standardized remanufacturing process (14)
- Know-how and dedicated staff (15)
- Sophisticated facilities, e.g. cleaning and assembly tools (17)
- The reverse logistics system, technologies, right staff competence (20)
- Product knowledge and facilities (23)
- Extensive experience and good collaboration partners (25)
- Product knowledge (27)
- Knowing which cores that are valuable at which price (28)

- Cheap electricity (29)
- Unique process (29)
- KPIs to ensure profitability (30)

5.2.8 Environmental benefits

Most companies claim that there are environmental benefits of their business in comparison to new manufacturing. Not all, but many of the companies have also made their own environmental assessments. The most common answers from the companies are listed below and illustrated in Figure 15.

- Reduced energy consumption (Cases 3, 5, 7, 10, 16, 17, 21, 22, 26)
- Reduced CO₂ emissions (Cases 3, 5, 8, 11, 16, 18, 20, 22, 23, 27-29)
- Reduced material consumption (Cases 1, 3, 6, 7, 10, 12, 14-17, 20, 21, 26, 27)

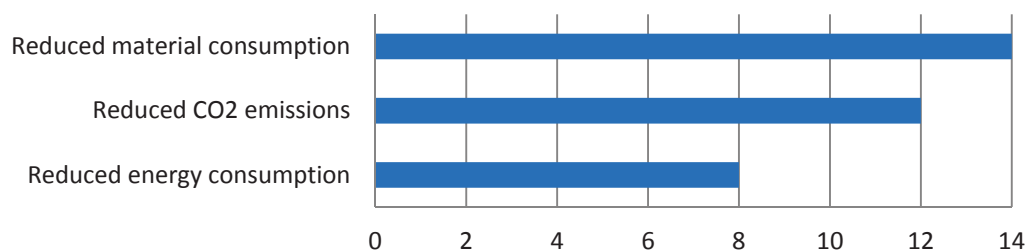


Fig 15. The most common answers regarding the environmental benefits.

Listed below is how the companies responded (case numbers in brackets):

- ISO14001 (1, 4, 7, 11, 18, 20, 30)
- Use of waste oil and recycled material (1, 3)
- Product-life extension (2, 6, 10, 13)

Energy:

- Energy savings (21, 22, 26)
- Energy savings by 75% (3, 5)
- Energy savings by 85% (7, 10, 17)
- Use of more renewable energy (9)

CO₂:

- Reduced CO₂ emissions (11, 16, 18, 20, 22, 23, 27)
- Reduced CO₂ emissions by 70-80% (3, 5)
- Reduced CO₂ emissions by 90% (28, 29)
- Reduced CO₂ emissions by 94% (8)

Raw materials:

- Reuse of raw materials (6, 7, 10, 12, 14-16, 26, 27)

Other:

- 80-90% less environmental impact than new (16)
- Antimon-eq reduction: 91% (8)
- 90% less use of raw materials (17)
- There are environmental benefits but not calculated (19, 24, 25)
- Environmental awards (4, 18, 24)
- Nordic Swan (20)
- 80% less oil used (20)
- Prolonged lifetimes (6)
- Zero waste to landfill (30)

5.2.9 Social benefits

All remanufacturing companies (Cases 1-30) create job opportunities both at the remanufacturing company and with the surrounding partners in the reverse supply chain. Seven companies (Cases 11-13, 15, 18, 24) claim that their remanufacturing business makes it possible for those unable to buy new products being able to buy and use those products. Some also arrange social activities and/or work with charity (Cases 3, 18, 22, 24). The most common answers from the companies are compiled in Figure 16.

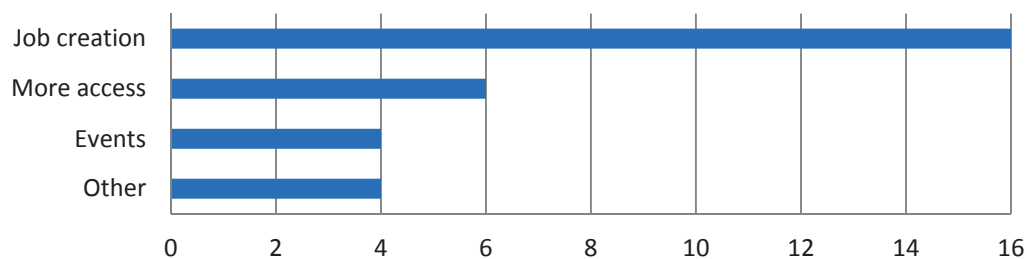


Fig 16. The most common answers regarding the social benefits.

Listed below is how the companies responded (case numbers in brackets):

Number of jobs created (16 cases):

- 10 jobs (20, 25)
- 15 jobs (3)
- 20 jobs (19, 28)
- 40 jobs (29)
- 50 jobs (8, 24)
- 80 jobs + more (11)
- 100 jobs (13)
- 380 new jobs (18)
- 600 jobs (10)
- 800 jobs (30)
- Around 25 x 35 jobs in Europe = 875 jobs (27)
- 1200 jobs (5)
- High-skilled job (30)

More access (6 cases):

- More students get access to digital tools (11)
- Reman products donated to charity e.g. refugee camps (11)
- More people can afford to use the products (12)
- More people get access to newer products (13)
- Make the product available for low-income buyers e.g. in emerging countries (15)
- Affordable access to computer technology and the Internet provided to those unable to buy new products (18)

Events (4 cases):

- Social activities – dinners for elderly people at Christmas (3)
- Working with charities and social enterprises (18)
- Encouraging all employees to participate with local community activities and allow employees to take paid time off to take part in these events every year (22)
- Regular donations to charities and to local community organisations (22)
- Providing matched funding for any employee donations to charity (22)
- Members of the Calderdale and Kirklees Manufacturing Association and regularly support local events (22)
- The companies also have numbers of associated charity activities such as: donating numbers of refurbished PCs every month to IT School Africa, supporting social scheme “Get on-line” run by Microsoft, and donations to local organisations (schools, nurseries) (24)

Other (4 cases):

- Social awards (3)
- Teach people about remanufacturing (12)
- Increased childhood cancer research (12)
- Economic efficiencies that reduce out-of-service (off-the-road) time for trucks and buses (17)
- Employees learn about product’s use (23)

5.2.10 Advance materials recovery

For some of the companies, this question was hard to answer depending on if they had knowledge about exactly what materials are included in the products and/or if they knew what advance materials are. Knowledge is more on a product and part level. Some companies have responded with what is recovered advanced or not. Listed below is how the companies responded (case numbers in brackets):

No AMR mentioned (10 cases): (Cases 1, 2, 6, 7, 9, 10, 13-15, 19)

Metals (15 cases):

- Alloys (3, 22)
- Aluminum (3-5, 20, 22, 28)
- Copper (4, 5, 11)
- Iron (4, 5, 22, 28)
- Other metals (4)
- Rare earth metals (5, 11)
- Steel alloys (8, 20)

- Precious metal (11)
- Tin (11)
- Metals (17, 24, 25)
- 100% recycling and recovery of materials (18)
- Titanium (22, 30)
- Advanced materials, such as low-maintenance materials, high-temperature resistance materials, super alloys, and coated materials (23)
- Platina, Palladium or Rhodium is recovered as well stainless steel (29)

Other (4 cases):

- Plastics (11)
- Electronics (3)
- Reduced need for advanced materials (12)
- Advance composites (30)

6 Discussion and concluding remarks

6.1 Method discussion

A delimitation associated with this case study as a method is that what is reported in this document is not always the case with every remanufacturer. For instance, a lower price is raised as an economic benefit of a remanufactured product in many of the 30 cases, but prices equal to or even higher (e.g. due to shorter delivery time) than new products do exist on the market. However, in comparison to the prices of new spare parts and costs for down time, the price for the remanufactured product can still be lower. It is most often the market which decides the price for both remanufactured and newly manufactured products.

The questions asked during the investigation were used by several authors of this report, and the answers could be quite different depending on how the respondents interpreted the questions to their operation. Therefore, the answers were sometimes hard to compare.

In addition, since asking questions about companies' business models could be sensitive to find answers to due to its confidential nature, some companies could have accidentally left out information during the interviews since they did not want to reveal classified information.

6.2 Concluding remarks

This report is summarising a business model study at 30 remanufacturing companies. It reveals that the remanufacturing companies face different challenges while having different drivers for their business, depending on what products are being remanufactured and at what volumes, different legislations and market demands, competition, etc. Therefore, in order to grasp the landscape of business models one needs to go through the descriptions of the 30 cases found in the annexe of this report. There, one can read about how each company's business model works in more detail. The summary of the case descriptions made in this report and the 30 case descriptions in Annexe A forms the landscape of remanufacturing business models for the 30 companies studied.

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Annexe A *Business model case descriptions*

Annexe A describes the business model cases as indexed in the table below.

Table 1 Overview of Case Companies

No.	Company	Sector / product	Type	Exp.	Country
1	ACES	Machinery / Compressors	CR / IR	2000	UK
2	ARP Suppliers	EEE / Toner cartridges	IR	2000	NED
3	ATP Industries	Automotive / Transmissions	OEM/OER	1970	UK
4	Autoelectro	Automotive / Alternators	IR	1986	UK
5	Borg Automotive	Automotive / Steering racks	CR / IR	1985	DEN
6	Büroservice Hübner	EEE / Printers and copiers	IR	2006	GER
7	Carwood	Automotive / Pumps & Injectors	OEM/OER	1968	UK
8	Desko	Furniture / Office desks	OEM/OER	1950	NED
9	ES Power	Machinery / Wind turbines	CR / IR	2012	SWE
10	Hitachi CME	Machinery / Pumps	OEM/OER	2009	NED
11	Inrego	EEE / Computers & smart phones	IR	1995	SWE
12	IT-Lyftet	EEE / Computers	IR	2010	SWE
13	Leapp	EEE / Laptops	IR	2011	NED
14	Linde	HDOR / Forklift trucks	OEM/OER	1996	GER
15	Oerlikon LV	Machinery / Vacuum solutions	OEM/OER	2006	GER
16	Polyplank	Machinery / Core plugs	OEM/OER	1994	SWE
17	PSS	Automotive / Power steering boxes	IR	1971	UK
18	RDC	EEE / IT equipment	IR	1991	UK
19	robotIF	Machinery / Industrial robots	IR	2009	GER
20	Scandi-Toner	EEE / Toner cartridges	IR	1993	SWE
21	Schmitz+Krieger	Automotive / Engines	CR	1911	GER
22	SCM Turbo	Automotive / Turbo chargers	IR	1980	UK
23	Siemens Industrial Turbomachinery	Machinery / Gas turbines	OEM/OER	1955	SWE
24	Stone Computers	EEE / IT equipment	IR	2009	UK
25	Storebro Industrier	Machinery / Machines	CR	1991	SWE
26	Ståthöga MA Teknik	Machinery / Pumps	CR	1988	SWE
27	Toyota MHS	HDOR / Forklift trucks	OEM/OER	2003	SWE
28	UBD Cleantech	Automotive / Brake calipers	CR / IR	1980	SWE
29	UBD Cleantech	Automotive / Diesel particle filters	CR	1980	SWE
30	Vector Aerospace	Aerospace / Engine components	IR	1940	UK

Company: Advanced Compressor Engineering Services Ltd (ACES)
Location: Chalgrove, UK
Type: Contracted / Independent remanufacturer
In reman: Since 2000
Contact: Eileen Wade (Marketing)
Phone: +44 (0) 1865 891522
E-mail: eileenwade@acescomp.co.uk
Web: <http://acescomp.co.uk/index.html>



Product

Refrigeration and air conditioning compressors

Core Sourcing

Cores are retrieved from several methods (see below) depending on the requests from contractors:

Service contract (main method): Mainly deal with contractors, not manufacturers

Direct-order: Only if contractors want their own compressor returned or a direct replacement is not available from stock will it necessitate the customer/contractor sending his own compressor in for remanufacture.

Deposit-based: All compressors supplied from stock are sold on an exchange basis and ACES need the old (broken) compressor returned in exchange.

Buy-back: It happens occasionally – defunct plant, surplus comps etc.

Voluntary-based: Not usually but defunct compressors are often offered and purchased to boost stocks. i.e. when a plant room has become obsolete and the equipment is sold off.



Business Model

Value Chain: ACES is one of the largest compressor remanufacturing companies in the UK. The company supplies remanufactured compressors to Contractors in the refrigeration and air conditioning industry. These contractors work directly for the end user (i.e. Supermarkets, shops, offices, railways, marine vessels, wherever compressors are used to provide refrigeration and or air conditioning). On very rare occasions the company will deal with the end user. In most instances all remanufactured compressors are supplied on an exchange basis. The company supplies a compressor from stock and the old (broken/defunct) compressor is returned in exchange, or a surcharge is made. In cases where the company does not have a specific compressor in stock the contractor will return the broken compressor for ACES to remanufacture. In some instances ACES can carry out the remanufacture on site.

Remanufacturing Process: 1) Complete strip down, 2) Inspection of parts, 3) Replace and recycle, 4) Re-winding, 5) Cleaning, 6) Reassembly, 7) Testing. In addition, please see the attachment after this one-pager for details.

Business Model: The main challenge of this business is to source parts for compressors that are no longer manufactured and source specific compressor bodies to replace those that are found to be beyond economical repair/or scrapped. Since the company provides remanufacturing services, the customer group targeted is all refrigeration & air conditioning contractors both in the UK and sometimes overseas. As the company is utilizing the actual body casting in the remanufacturing process there are enormous savings. Roughly, it depends on the size/value of the compressor, the bigger the compressor body casting the bigger the value. Sometimes more than 60% of the cost of the new compressor can be achieved in the remanufacturing process. For customers' point of view, the benefit of the remanufactured compressor is financial (cost saving). Customers get the remanufactured products as good as newly manufactured products with the same warranty. The company sees their remanufacturing personnel and facilities as their key resources; such as quality fitters for compressor remanufacturing, qualified electrical rewinders, heavy duty plant and machinery in their facility, heavy duty lifting equipment, i.e. forklifts, overhead crane.

Economic Benefits

ACES strives to improve the efficiency of their remanufacturing. They recycle as many components as possible whilst conforming to the original manufactures specified tolerances. They also strive to increase company growth and use advertising to source new customers and make people more aware of the advantages of remanufactured compressors.

Environmental Benefits

The company has ISO14001 accreditation. Within the remanufacturing process, the waste oil from the broken compressors is burnt to provide heat in the factory using a special burner. The refrigerant usage is recorded and monitored in accordance with F Gas regulations. The company also uses recycled packaging to protect the remanufactured compressors in transit

Social Benefits

The social benefit is the job opportunities created.

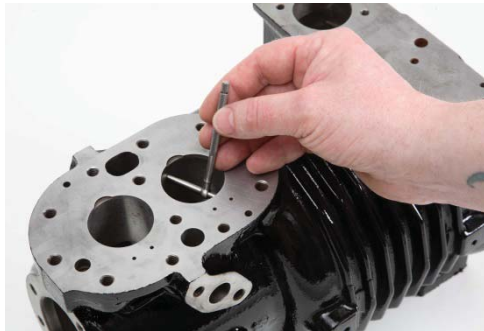
Advanced Materials Recovery

No advanced materials are recovered.

Attachment: THE REMANUFACTURING PROCESS

Every compressor that arrives in our factory follows an exact procedure;

- Each compressor is given a unique number stamped on the body casting – this number stays with the compressor for its life and is recorded on all relative correspondence. This number also goes into our computer database where the history of the compressor can be recalled at the push of a button.
- The first process is to drain the oil and completely strip down the compressor.
- All components are inspected and measured for size and tolerance using micrometers. Under certain circumstances it may be possible to re-grind the crankshaft and re-bore the cylinder bores which are carried out in-house.



- Components within the manufacturer's specified tolerances are recycled; all other components are replaced - unless contract requirements exist dictating replacement of specific parts.
- Valve reeds and piston rings are discarded regardless of condition. All valve plates are surface ground.
- The stator windings are removed, identified with the compressor and sent to our electrical re-wind department for testing or re-wind.

Each winding is subjected to 2000V-to-earth flash test, ohms readings are taken with a multi-meter and recorded, and then the winding is subjected to a full load test on a transformer. Any winding that fails these tests is rewound.

Rewind Process; prior to stripping out any winding, the coils are lifted and measured using a micrometer, and the amount of turns are counted. The coils of the stator winding are stripped out and the stator and rotor are cleaned. The details of the coil size and turns are entered into our specialist coil winding machine which winds the coils ready for installation. The stator windings are then wound by hand incorporating Class 'F' insulation, and impregnated with Freon-proof varnish. Each winding is then subjected to 2000V-to-earth flash test, ohms readings are taken with a multi-meter and recorded, and then the winding is subjected to a full load test on a transformer.



Each winding is then subjected to 2000V-to-earth flash test, ohms readings are taken with a multi-meter and recorded, and then the winding is subjected to a full load test on a transformer.



■ All cast components, ie body, heads, end covers, are then thoroughly cleaned using a Vaqua wet blaster or degreaser tank.



■ The compressor is then reassembled by one of our experienced personnel and checks are made at every stage of the assembly.

■ Once assembled the compressor is bench-tested electrically with a flash tester again and ohms readings are recorded.



■ The compressor is then transferred to our Test Centre where it is subject to the most rigorous testing procedure on our unique, purpose-built test rig both open and under load. At this stage the compressor performance is recorded on the Rebuild & Test Certificate;

- Amp readings are taken to ensure that the three phases are balanced
- Oil pressure is taken whilst the compressor is run clockwise and again when the compressor is run counter clock-wise
- Oil return is checked via the sight glass
- Any unloading is checked for correct operation
- When the compressor has reached a minimum of 7bar head pressure, it is stopped and then restarted.
- A pump down test is carried out to ensure there is no let back across the discharge valve reeds.



- The test oil will be drained from the compressor and new oil charged in at the correct level.
- The compressor is then charged with 30bar Oxygen-free Dry Nitrogen and submerged under water to ensure that it is leak tight before being dehydrated and evacuated to 2torr or below.
- The compressor is then given a 2bar holding charge of OFN before being spray-painted in manufacturers original colour, unless otherwise specified.



Company: ARP suppliers
Locations: Maastricht, Netherlands
Type: Independent Remanufacturer
In reman: Since 2000
Contact: Ben Brouns (Director)
Phone: +31- 043-855-0961
E-mail: ben.brouns@arp.com
Web: www.arp.com



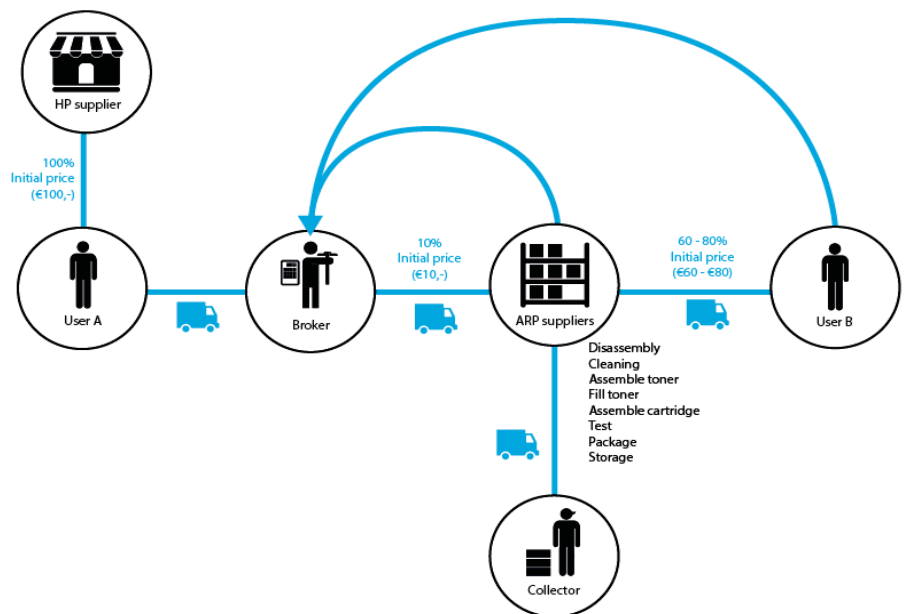
HP Laser Toner - Refurbishment of HP laser toners cartridges.

Core Sourcing

Retrieving toners from toner brokers.

Business Model

An empty laser toner does have some value. Brokers collect these empty laser toners, ARP buys these empty toners and disassemble them. Components that can be reused are cleaned like screws. Key components will be replaced to guarantee quality. Aluminium and iron parts are collected and brought to a metal and iron trader who will recycle the material. Besides this 99% of all the plastics cannot be reused and becomes a waste stream. After cleaning, the toner is assembled, then the toner is filled with ink again and reassemble with the cleaned reused and new components to a cartridge. The cartridge can be bought by the (often business to business) consumer. Toners are recycled



maximal two times, this is to guarantee the quality, through the process 80-99% of the original quality can be reached. After two times of reuse the cartridge is disassembled and all components become a waste stream. The cartridges are sold online in Germany, Austria, the Netherlands, France and Belgium. When a new type of toner is launched, it takes two years after the launch of a new toner to build a buffer of toners. With the current business model, remanufactured cartridges can be sold for 60%-80% of the initial price. This percentage depends per type of cartridge, which on the demand. So if an original cartridge is sold for €100, ARP can sell remanufactured cartridges for a price between €60,- and 80,-. To differentiate themselves from competitors, ARP ensures a guarantee of 4 years.

Economic Benefits

For the customer, the price is at least 20% lower compared to an original toner. The collaboration with brokers create some jobs which can be seen as an economic benefit.

Environmental Benefits

Instead of make, take, waste the service life of a cartridge is extended (two times of reuse max.).

Social Benefits

Jobs are created at ARP and at the core brokers.

Advanced Materials Recovery

There are no advanced material recovered in ARP's remanufacturing business.

Company: ATP Industries Group Ltd.
Location: Cannock, UK
Type: Original Equipment Manufacturer / Remanufacturer (OEM/OER)
In reman: Since 1970
Contact: Malcolm Morris (OEM Sales Manager)
Phone: +44-1543-870354
E-mail: malcolmmorris@atp-group.com
Web: www.atp-group.com



The Home of Remanufacturing



Product

Automatic, Dual clutch transmissions

Core Sourcing

Cores are retrieved from vehicle OEM or dealers through service contract.

Business Model

ATP is the major remanufacturing partner to a world-wide portfolio of Original Equipment Manufacturers (OEM's). ATP wins ReMaTec Remanufacturer of the Year 2013 which recognises the company's achievements in the remanufacturing field. ATP currently has

contracts with most of the OEMs: Chrysler, Ford Motor Company, Ford Turkey, General Motors, Mitsubishi, Colt Cars, Unipart Jaguar and Unipart, London Taxi International, Aston Martin, Proton, Mobis Hyundai and Mobis Kia.

The value chain operates through 3 main actors: the remanufacturer (ATP), OEM and/or local dealers (the customers for ATP), and the end-users (the customers for OEM or local dealers). OEM collects the cores from the end-users and sends them to ATP for remanufacturing. The remanufactured products will send back to OEM and the OEM will give them back to the end-users with surcharge to ensure the cores returning for remanufacturing in future. The remanufacturing process details in attachment.

The challenges ATP encountered are cores collection and phase change of the transmission. "Core is king!" Without cores, there is no programme for remanufacturing. Some product designs are not inherently suited to remanufacturing processes which can impact the feasibility of a project or the core yield, which is a critical measure. Over past years, more regulations were established so the specification of transmission changes rapidly. These changes lead to some components no longer being used for remanufacturing new module cores which affect the existing program being set up by the company for remanufacturing. The main benefit of the ATP remanufactured product is to reduce their customers' (OEM) warranty costs. For example, if the transmission has a known failure mode and hasn't been corrected for new transmission before inserting into the vehicle, the vehicle will fail again within warranty period where add cost on their customers again to repair the vehicle for their end-user. In contrast, the remanufactured products give their customers the benefits to limit the failure mode and to update the product to the latest specifications so reduce any chance and resulting costs that the end-users return the vehicles in the warranty period.

ATP thinks everybody is the key resources e.g. personnel, facility etc. Technical staff is the most important among the resources. ATP have 5 year business plan regarding selling strategy, what product should look at etc. The economic performance will be assessed by annual forecast, profitability of the products, and business operation system (BOS) reviews where performance versus various parameters is measured.

The main challenges to improve ATP business are: to maintain and grow the profitability of the business; to improve the efficiency of the remanufacturing process. By improving the process efficiency, ATP will be able to utilise the resources well to support fluctuating demands from their customers and the market.

Economic Benefits

The price depends on the type of the remanufactured products and the costs for remanufacturing. Roughly, the company aims their remanufactured products' price is 60-80% to that of the newly manufactured products.



Environmental Benefits

The remanufacturing stops raw materials being scrapped. The process in general will have benefits of energy saving (~75%), less CO2 emission (70 – 80%). The company will also recycle the waste oil for heating oil, and reuse packaging to save environment. The company also has ISO1400; the first remanufacturer achieves this accreditation.

Social Benefits

With the business growth, ATP creates about 15 jobs for local community from 2014 – 2015. ATP also supports social activities such as sponsor of local business award, providing dinner for elder people around Christmas time etc.

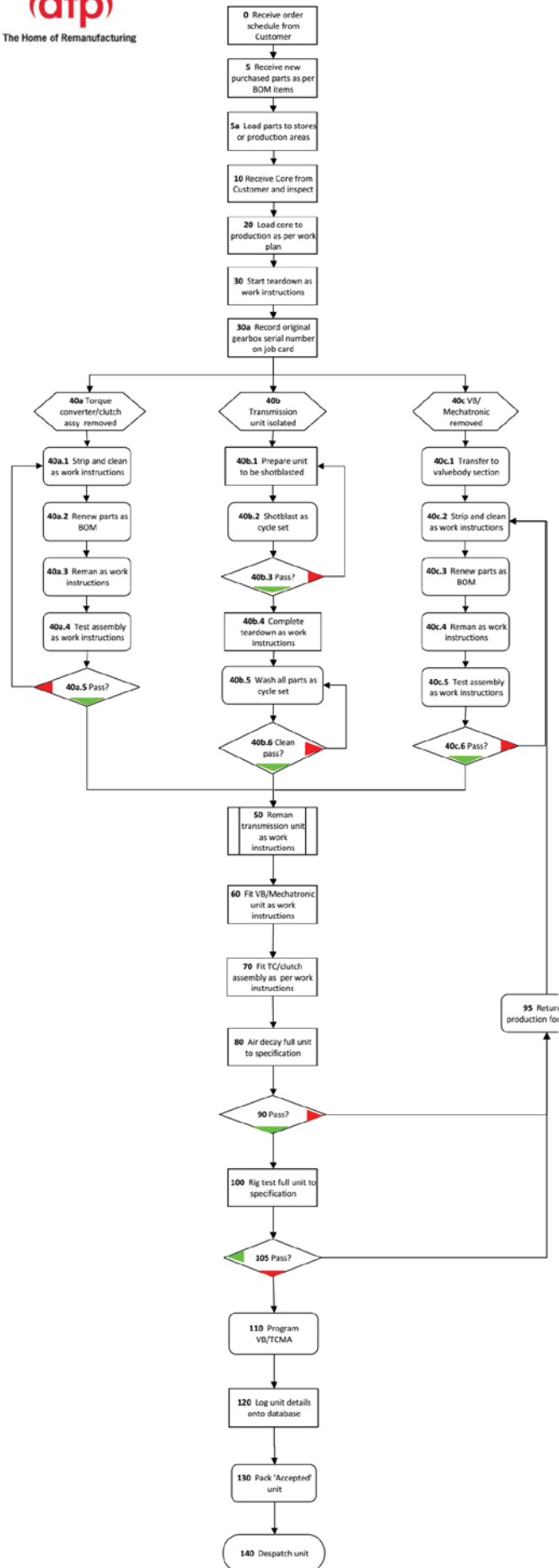
Advanced Materials Recovery

During the remanufacturing process, the electronics inside transmission is recovered. In addition, many components in transmission are made of alloys and aluminium and are reused in remanufacturing process so these materials are accountable for materials recovery.

Attachment: Remanufacturing Process



TYPICAL TRANSMISSION PROCESS FLOW



Company: Autoelectro
Location: Bradford, UK
Type: Independent Remanufacturer
In reman: Since 1986
Contact: Tony Bhogal (Director)
Phone: +44-1274-656101
E-mail: tony@autoelectro.co.uk
Web: www.autoelectro.co.uk



Product

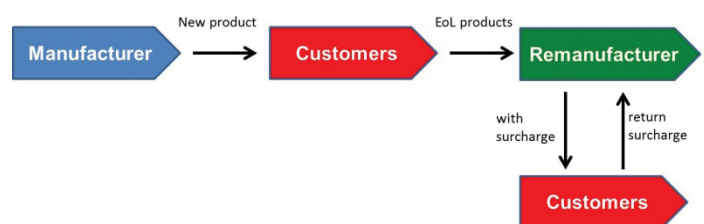
Starter motors and alternators

Core Sourcing

The cores are retrieved from automotive part wholesalers across UK through service exchange scheme where surcharge is involved.

Business Model

Autoelectro is a remanufacturer of starter motors and alternators for cars and light commercial vehicles. The Autoelectro remanufactures a large variety of starter motors and alternators which can fit various automotive brands such as Audi, BMW, etc. and is now the largest independent remanufacturer and supplier of Rotating Electrics in the UK.



The starter motors and alternators are retrieved via the service (service exchange) between direct order and deposit-based system where the remanufactured products are sold with surcharge to customers and the customers will get the surcharge back once they returned the remanufactured products. The remanufacturing processes for the cores involves full strip down, cleaning, internal component checking, replacement of wear components and faulty parts, re-assembly and testing to original equipment (OE) specifications on computerised test benches. The remanufactured products were issued with 2 years warranty which is longer than the OE equipment. The customers targeted are mainly UK aftermarket and the price of the remanufactured product varies significantly depending on the market. The main challenge for this business nowadays is the cloned products with inferior quality from Far East. The remanufactured products also have to compete with the price of these cloned products in the market although the remanufactured products possess higher quality contributed from strict remanufacturing and testing processes. The interviewee addresses that market needs to understand the difference between the remanufactured products and cloned products in order to promote remanufacturing business.

Economic Benefits

Autoelectro has an internal management system on financial and accounting to monitor business performance on daily, monthly and/or annually basis in order to set correct pricing strategy. The economic benefits for publics are customers get high quality (equivalent to OE) of remanufactured products with cheaper price. So customers has additional option to purchase: the new product from original equipment manufacturer (OEM) with higher price; the remanufactured products in equivalent OE quality with cheaper price; or the cheaper cloned products from Far East with inferior quality and potentially with shorter life span.

Environmental Benefits

Remanufacturing starter motors and alternators have definite energy saving compared to manufacture new ones. The amount of energy saving is unknown. The company has ISO14001 accredited and has recently won Green Apple Environmental Award, an international environment award for the greenest companies, councils and communities.

Social Benefits

The remanufacturing business is labour-intensive so the business creates a lot of job opportunities and also the remanufactured products have pricing benefit for general public compared to new manufactured products.

Advanced Materials Recovery

In remanufacturing process, the starter motors and alternators were first diagnosed with economically remanufacturable and un-remanufacturable. The ones without economic benefit for remanufacturing were scrapped off and sold to recycling company. So the aluminium, copper, iron and other metals in the components will be separated for reuse and/or recycling.

Company: Borg Automotive A/S
Location: Silkeborg, Denmark
Type: Contracted / Independent Remanufacturer
In reman: Since 1985
Contact: Sören Toft-Jensen (President)
Phone: +45-40-608777
E-mail: stj@borgautomotive.com
Web: www.borgautomotive.com



Product

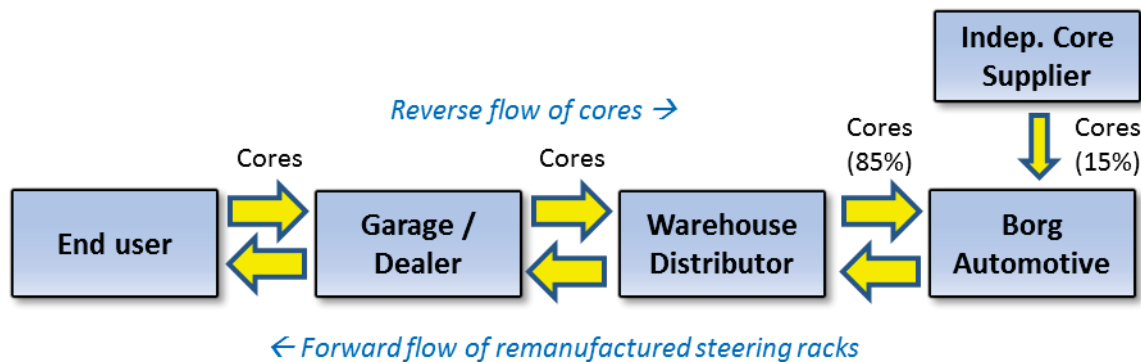
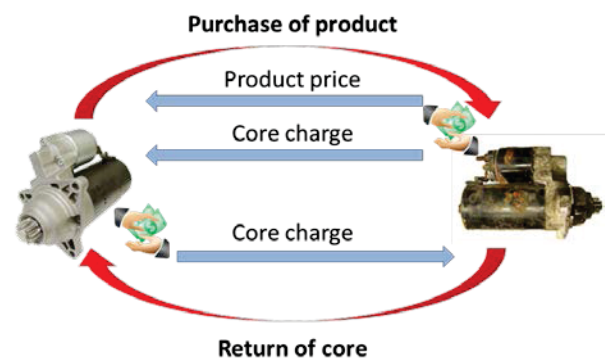
Hydraulic and electric steering racks

Core Sourcing

The main source for getting cores for the production is a surcharge model, where customers are charged a deposit, which are credited when the customer return the same type of unit. On average, the surcharge model brings 85% of the cores back. The other 15% are purchased from independent core suppliers to cover for growing demand, lost cores in the trade, and cores being scrapped in the remanufacturing process.

Business Model

Borg Automotive (BA) is primarily serving the European aftermarket through the major Warehouse Distributors (WD) and buying groups, but has also some OES contracts with major OEM suppliers. The value chain and material flows of used and remanufactured steering racks:



Drivers for BA: Remanufacturing in general gives a number of advantages and solves a lot of socioeconomic problems (irrespective of what product line), but the main driver for this business model is to create value out of worn out products.

Challenges for BA: The main challenge for Borg Automotive (and all companies in remanufacturing) is the core handling issue, and the costs around that. Receiving and sorting the huge volume and variety of cores returned to BAs factories (> 1.3 mio units annually) is a major challenge, which requires a very dedicated set-up. Cores that are lost in the supply chain must be sourced outside of the standard supply chain, and that is also the case for cores needed for sales growth. Not always are certain cores available on the market and therefore it are needed to buy certain cores no matter if they are currently required. That is a major cash drain to the operation, and is increasing the total balance of the business. Because without cores which is the raw material, there can be no remanufacturing.

Also the huge variety of reference numbers not only for each car, but sometimes various OEM producers for the same car, requires an unseen volume of OEM and cross reference numbers to be dealt with on a daily bases.

As previously described BA is partly marketing its products via Warehouse Distributors (WDs), and partly through OES agreements with OEM producers. WDs will stock a selected range of the steering racks in question, in order to be able to answer market demand with a same day delivery for most popular numbers. The competition in this market on fast moving units is mainly units produced in Asia since they are sold without a core charge. Fortunately for BA, most WDs prefer one supplier with a full coverage program, which remanufacturing companies, like BA, can offer.

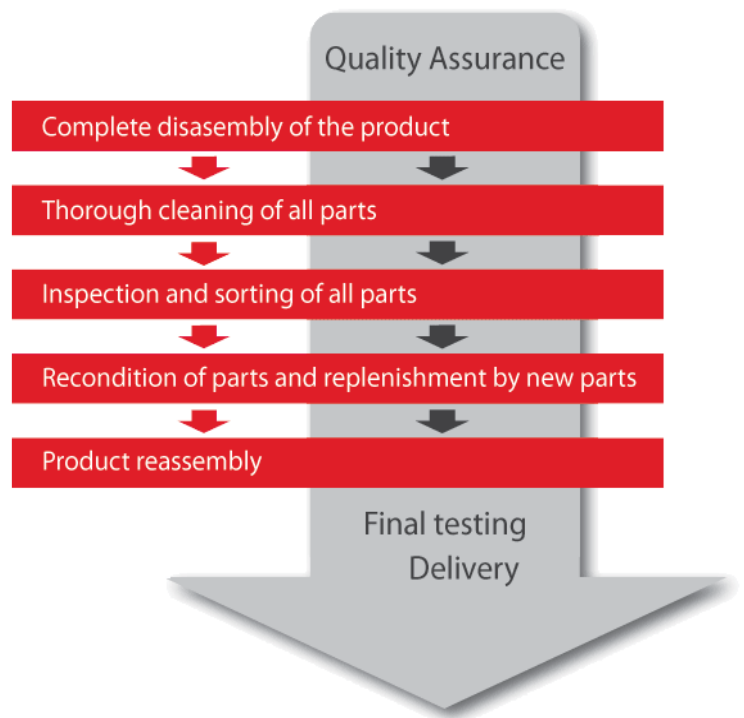
As the car manufacturers cover the warranty period for the vehicle, BA is mainly meeting a demand from 3-15 year old cars. For these cars new original spare parts are often not available (or very expensive) meaning that the main competition is between various remanufacturing companies. Therefore the remanufactured part is not only a cheaper solution, but it is in many cases also the only solution available on a day to day bases. Furthermore the Remanufacturing process is often revealing weaknesses in the original product, which then, in many cases, can be eliminated during the remanufacturing process. Most customers are not even asked if they want a new spare part or a remanufactured part, because that alternative is often not available or not economic for the customer. In addition, the appearance of the Remanufactured units is very much like a brand new unit.

Key resources for BA: access to cores. That is why there with the sale of a remanufactured part, is also invoiced a surcharge to motivate the customer(s) (garage, dealership and DW) to return the old worn out core.

Remanufacturing process at BA: The steering racks are remanufactured according to the following process:

- 1) Disassembly, 2) Cleaning, 3) Inspection and sorting,
- 4) Reconditioning and replenishment of parts, 5) Reassembly,
- 6) Final testing (see figure to the right).

Bringing old cores a new lease of life

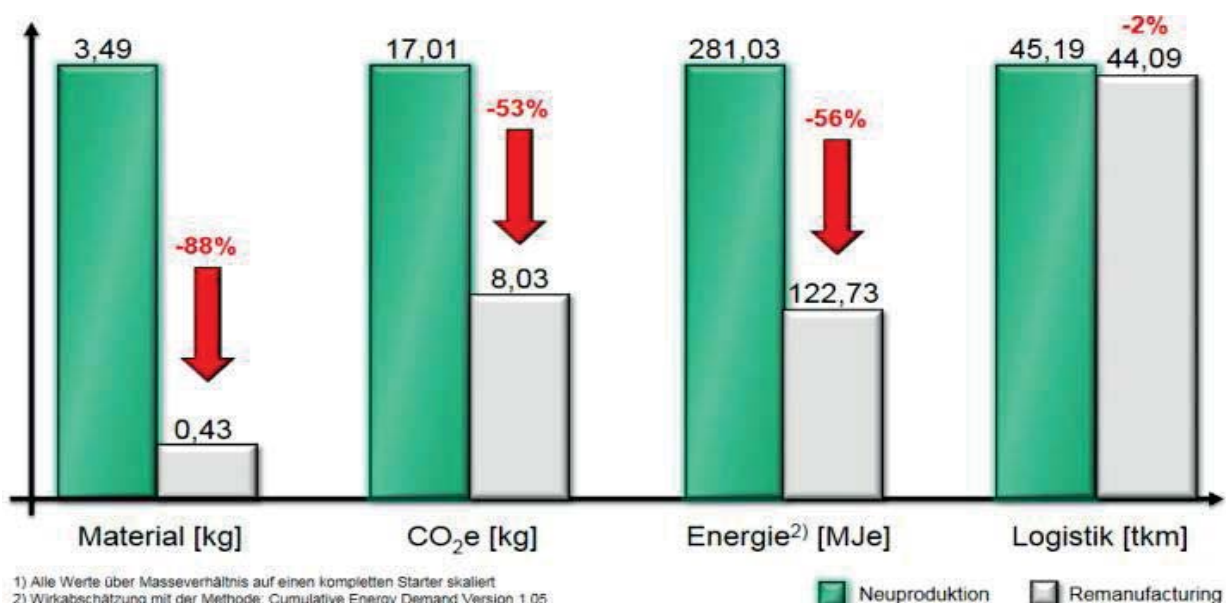


Environmental and Social Benefits

BA is the 3rd largest remanufacturing group in Europe, producing 1.3 mio units annually (of various products), from 3 factories, employing a total of 1200 people. Today Remanufacturing has gained a lot of steam and awareness as one of the key players in the circular economy trend. Remanufacturing is not only requiring a lot of hands, as it is very labor intensive, due to the short series and huge variety, but is also saving very substantial amounts of metal like aluminum, copper, iron and rare earth metals, energy and CO₂, and this is contributing big time to a sustainable industrial growth (see figure below).

Advanced Materials Recovery

The materials recovered by the steering rack remanufacturing process are aluminum, copper, iron and rare earth metals. The rare earth metals are deriving from the permanent magnets used in the steering racks.



Company: Büroservice Hübner GmbH
Location: Tübingen, Germany
Type: Independent remanufacturer
In reman: Since 2006
Contact: Michael Hübner
Phone: +49 (0) 7071 966 900
E-mail: info@druckerboerse.com
Web: www.druckerboerse.com



Product

Printers and copiers

Core Sourcing

Buy-back: Büroservice Hübner GmbH buys used products from a supplier, which can either be an end user or a leasing firm.

Business Model

In the information technology (IT) industry, the product lifecycles are short (between 2 and 5 years in general). As a result, a large number of products are renewed regularly. They are mostly recycled (after being scrapped) or remanufactured (after being transported to low-wage countries in some cases). Remanufacturing is actually a part of the IT industry's activities. Büroservice Hübner GmbH gets used IT products such as printers and copiers for remarketing, usually with compensation for the products depending on their condition, and focuses on selling used products. Büroservice Hübner GmbH has several strategic partners in logistics, leasing, and IT companies (the IT industry is well connected in this sense). Further, the remarketing in some cases involves remanufacturing, which is carried out by a service provider collaborating with Büroservice Hübner GmbH.

The benefits of remanufactured products for the customers are lower prices and the availability of older models, as well as environmental performance. The motivations of Büroservice Hübner GmbH, on the other hand, are environmental sustainability and the profit.

The remanufacturing process consists of: 1.) basic functionality test (all the product functions), 2.) thorough cleaning (outside and inside), 3.) exchange of consumable components (e.g. drums), and 4.) quick test. The key resources of Büroservice Hübner GmbH are remanufacturing know-how, sales channels, and supply of used products.

The main challenges of Büroservice Hübner GmbH are: 1.) enhancing awareness, images and acceptance of remanufactured products by end users; 2.) coping with regulations (e.g. warranty to end customers (12-month), protection of the data in used products, and environmental-regulations); 3.) improving the involved processes; 4.) getting more support for knowledge sharing and knowledge dissemination; and 5.) labour cost. Regarding awareness, those who buy new products sometimes simply do not know the availability of remanufactured products.

Economic Benefits

For customers, lower prices are an economic benefit: remanufactured products are 50%-80% cheaper than new ones.

Environmental Benefits

The environmental benefits are less scrap and prolonged lifetimes.

Social Benefits

Job creation (sometimes for disabled persons) is the major benefit to society.

Advanced Materials Recovery

No such materials are recovered.

Company: Carwood Motor Units Ltd
Location: Coventry, UK
Type: OEM/OEM Remanufacturer
In reman: Since 1968
Contact: Gary Carter (Chairman)
Phone: +44-24-76446590
E-mail: garycarter@carwood.org
Web: www.carwood.co.uk



Product

Diesel Fuel Injection Pumps and Injectors

Core Sourcing

Cores are retrieved from a wide range of customers/suppliers through service exchange and credit-based schemes.

Business Model

Carwood Motor Units Ltd was established as a local automotive parts business based in Coventry in August 1966, since then it has grown steadily both organically and by strategic acquisition into one of the European leaders in its specialised fields. The company's expertise areas are remanufacturing, technical services and logistics. The company focuses on diesel fuel injection, electrical, electronic, HVAC

(heating, ventilation, air conditioning) and turbocharger systems for all types of vehicles, ranging from passenger cars to cable cars, from trucks to trains, from earth movers to people carriers and from battle tanks to buses.

The Company sells the remanufactured products with surcharge. When customers return the old units, the customers are credited or refunded with the surcharge. Through this service exchange scheme, Carwood receive more than 90% old units compared to the remanufactured products sold. The Company's customer base is diverse, including end-users, vehicle engine manufacturers and independent aftermarket, such as motor factors who sell their remanufactured products.

In the remanufacturing process, the cores are firstly stripped down to components. The components are then inspected. The Company has its diagnosis system to classify the components into green, amber and red. Green means 100% replacement. Amber means the component has the possibility to be remanufactured, the parts will be checked via various testing processes before a decision is made. Red means the components are beyond economical repair. After the inspection, the unit will be remanufactured with reclaimed and new parts from the OEM with 100% bench testing, using the latest equipment and test data, before being packed to store or sold directly.

The driver of the business is to provide continued supply of units to vehicle and engine remanufacturers, users and resellers, while generating profit to sustain the Company's business growth. The main challenges of the business are: sustaining availability of cores in stock, training and acquisition of skilled personnel to expand business, keeping the business profitable enough for the continued need of capital investment for new facilities and technologies. Carwood has different selling channels for remanufactured products and has partnerships with OEMs such as Denso, Delphi, Bosch, VDO etc., to facilitate remanufacturing.

Economic Benefits

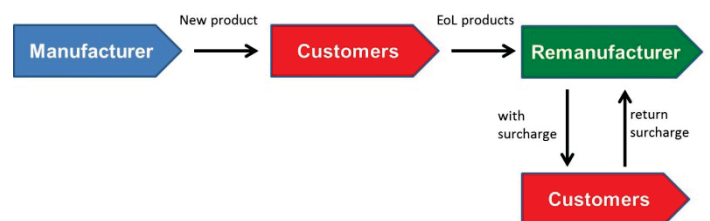
The price of the remanufactured product is market driven. Roughly, the price is 40% cheaper than new product. Customers can choose a product that has equivalent functionality and warranty equivalent to new product, but with cheaper purchasing price.

Environmental and Social Benefits

The company has ISO9001-2008, ISO14001-2004 and clean room technology ISO 14644-1 class 7 accreditations. The remanufacturing process involves reuse of raw materials and uses up to 85% less energy than production of new products. With the business growth, the company creates more employment in the local community.

Advanced Materials Recovery

No advanced materials are recovered.



Company: Desko
Locations: Amsterdam, The Netherlands
Type: OEM/OER
In reman: Since 1950
Contact: Michael Kuipers (Managing director)
Phone: +31-204801020
E-mail: michael@decorum.nl
Web: www.desko.nl



Product

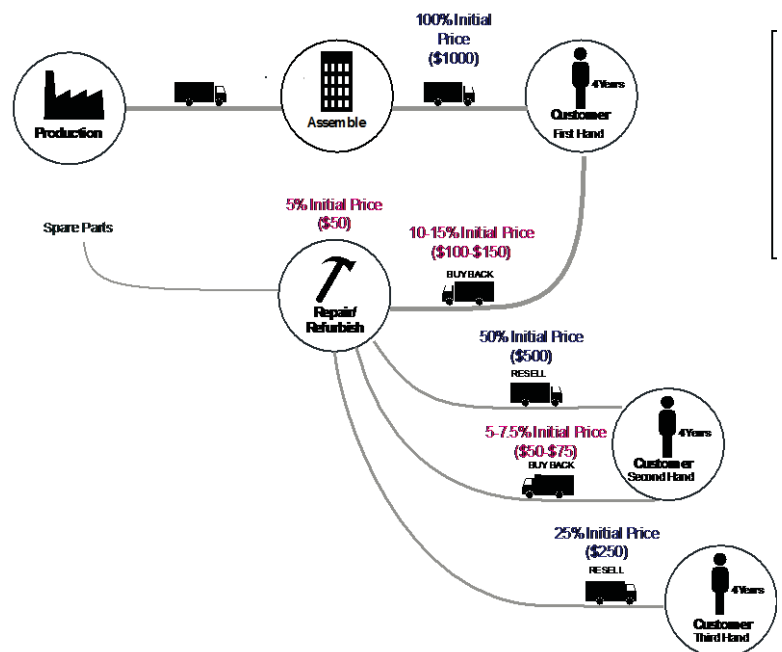
In-house remanufacturing of office desks: Duo Slinger Table.

Core Sourcing

The majority of desks are retrieved from customers through a buy-back scheme.

Business Model

Desko is an office furniture provider, selling and renting both their own and other brands. For their own Duo Slinger table, Desko employs a three-tier buy-back scheme and usually remanufacture cores twice during their life-time. Desko buys newly manufactured products back from customers at roughly 10% of the product’s initial price. After in-house remanufacturing at Desko’s headquarters, desks are sold to a different market segment at roughly 50% of the initial product price. The customers of these remanufactured products are able to sell the desks back to Desko after use. These already once remanufactured are bought back by Desko at roughly 5% of the product’s initial price. Desko remanufactures the desks once more and resells the product for the last time to a third customer segment at 25% of the original price. Desko offers a free take-back for these customers and scraps the desks for parts.



Economic Benefits

With these services, Desko offers three price points for customers – newly manufactured at approximately €920, remanufactured once at around €460, and remanufactured twice at approximately €230. The buy-back scheme also provides economic incentive for the customer to return the product. Due to the structure of their finances, many customers are unable to rent or lease office furniture. The buy-back structure allows customers to return products after use, gain some economic benefit, and not interfere with company cash flow.

Environmental Benefits

Manufacturing a Duo Slinger table generates 127 kg-CO₂-eq and consumes 0.935 kg antimony-eq. Remanufacturing the same table contributes a much lower climate change global warming potential and depletion of abiotic resources at 8.255 kg-CO₂-eq and 0.08 kg antimony-eq. This means a CO₂ reduction with 94% and antimony reduction of 91%.

Social Benefits

Currently 50 employees work on Desko’s remanufacturing practices. This is expected to grow significantly over coming years.

Advanced Materials Recovery

Steel alloys are recovered.

Company: ES Power AB
Location: Örebro, Sweden
Type: Contracted / Independent Remanufacturer
In reman: Since 2012
Contact: Erik Josefsson (Manager)
Phone: +46-70-2664212
E-mail: erik@espower.se
Web: www.espower.se



Product

Wind Turbines

Core Sourcing

ES Power is specialized in dismantling wind turbines, and supports Swedish owners to contact and mediate purchases with the new owner.

Business Model

Value chain

ES Power contacts or is contacted by Swedish wind turbine owners with turbines that are 15 years or older. The first step is to contact a new owner and negotiate. This step is followed by, or is in parallel with, inspection and planning for the remanufacturing of the wind turbine structure, disassembly and transport to the new owner.

Remanufacturing process

The first step is a visual inspection of wear (e.g. regarding the physical status like rust and affected components) as well as examining existing documentation for the specific windmill. Examples of data checked are e.g. when components have been maintained or exchanged and the number of operation hours.

The next step is to take down the rotor (normally done with the blades still mounted) and place it on the ground. Once on the ground, the blades are dismantled and checked. In the following step, the nacelle is lifted off and placed on the ground. The nacelle consists of many components, e.g. the gearbox and generator. Normally, before assembly the windmill, gearbox and generator are checked and refurbished. If needed, ES Power sends those components to an appropriate sub supplier.

The following step is to take down the tower. Modern towers are normally made in sections with bolted connections, but old ones are normally welded and therefore require some extra work in order to disassemble them.

After taking down and checking the tower it is organized in an order to ease further transportation. Sometimes, smaller parts are put into larger parts of the tower. A problem when taking down old wind turbine towers is that they quite often are welded onto the foundation, i.e. the bottom ring is not possible to detach from the foundation. If the bottom ring is welded off, later on, when rebuilding the tower, it is replaced with a new bottom ring.

Economic Benefits

After approximately 20 years a windmill, especially an older one, still holds a high value and the second-hand market is huge, especially in Ireland and Italy. There, energy prices are much higher than in Sweden or any Nordic country. For a windmill owner, this implies an opportunity to get back approximately 50% of the initial investment after 20 years. This is especially the case for some of the old Vestas models, e.g. V27 and V29. These models are oversized and very robust, and this implies a long use phase.

Environmental and Social Benefits

Fewer windmills need to be produced, and more renewable energy can be produced from existing windmills. Remanufacturing of old windmills opens up new work opportunities.

Advanced Materials Recovery

No advanced material recovered.



Company: Hitachi Construction Machinery Europe (HCME)
Location: Amsterdam, The Netherlands
Type: OEM/OER
In reman: Since 2009
Contact: Marten Bootsma (Manager Remanufacturing)
Phone: +31651560711
E-mail: marten.bootsma@hcme.com
Web: www.hcme.com



Product

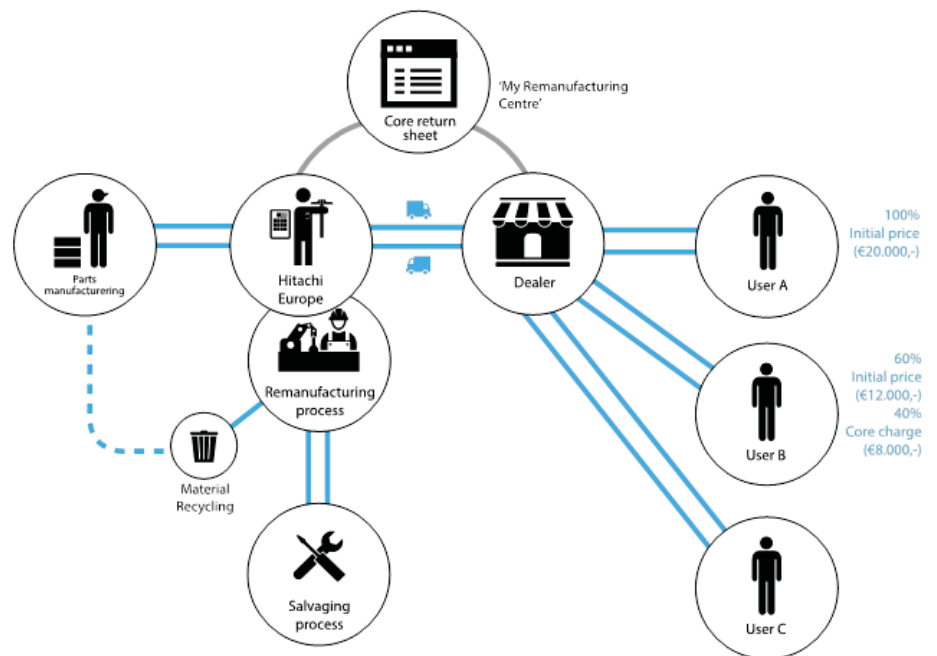
Hydraulic main pumps of construction machines

Core Sourcing

Cores are sourced via the dealers who sell Hitachi machinery to customers in Europe. HCME uses a core charge at the time of sale of a remanufactured component, to make sure the core is returned.

Business Model

HCME’s remanufacturing business model is based on the knowledge and craftsmanship of its employees, the economic and environmental advantage of remanufacturing cores, and the availability of used cores. This case focuses on hydraulic main pumps of construction machinery. The performance of a hydraulic main pump decreases after a certain amount of severe usages, while also failures may occur. HCME has decided to offer their customer the option of replacing their pump with a remanufactured one and take back the used core. To facilitate core returns, the return transportation from a dealer location anywhere in Europe to the Netherlands comes at no additional charge. HCME has developed



dedicated online systems that keep track of the sold machines and components via dealers. The ‘My Remanufacturing Centre’ system is used to keep control over the inflow and outflow of cores, while also the return transportation can be booked here. Hitachi dealers collect cores and send them to the Netherlands, where employees are trained to assess the conditions of (used) main pump. The remanufacturing process of a main pump starts with the disassembly of the core. A main pump consists for 15% of critical components, like bearings that are exposed to wear. To guarantee an ‘as good as new’ main pump these components are replaced at all time. The remaining 85% components are cleaned and assessed on specifications, determined by the engineering department at the head office in Japan. This assessment is a critical step in the remanufacturing process, since inner parts in remanufactured components should have the same specifications as inner parts in new components. Inner parts that meet these standards can be reused; inner parts that do not meet the specifications will run through a salvaging process or are replaced with a new one. After reassembly, the main pump is tested. The remanufactured main pump should perform on ‘as good as new’ standards during the test. The cores that are remanufactured are stored to be available at the time there is a demand from the market. For high-pressure components this process can be repeated multiple times, before the material will be recycled. Hitachi actively shares and improves knowledge and expertise about the remanufacturing process through a network of remanufacturing centres all over the world. As a result of HCME’s remanufacturing process, they have stock of remanufactured components to quickly react on the demand of the customer. This reaction is critical, to avoid machine down time which is expensive for the customer.

Challenges for HCME: The HCME's main challenge is the customer awareness of the quality of remanufactured components. Customers may easily assume that the price of the product reflects its quality. Even though remanufactured products have a lower price than new, HCME ensures an 'as good as new' product with a warranty that is the same as the new component.

Economic Benefits

A remanufactured component has a better price than a new one because inner parts can be reused or salvaged. Consequently, the remanufactured product can be sold for 60% of the initial price.

Environmental Benefits

Due to the remanufacturing process a component can have several service lives, rather than only one. Therefore the requirement for new components is reduced significantly. Besides this the inner parts are salvaged wherever possible, reducing the requirement for new inner parts. Together this extends the usage of already manufactured material and consumed energy, resulting in an overall reduction of the company's requirement for raw materials and energy consumption.

Social Benefits

Currently 600 people are employed by Hitachi Construction Machinery Europe.

Advanced Materials Recovery

It is unknown whether Hitachi recovers advanced materials through its operations.

Company: Inrego AB
Locations: Sweden
Type: Independent remanufacturer
In reman: Since 1995
Contact: Erik Pettersson
Phone: +46-8 50 10 90 28
E-mail: erik.pettersson@inrego.se
Web: www.inrego.se




Product

Computers and smart phones

Core Sourcing

Inrego buys used professional IT-equipment from private and public organisations for reuse purposes.

Business Model

Inrego buys used professional IT-equipment from private and public organisations, reconditions it, data wipes all information and resells or leases it to the next user. Inrego pays the seller for the product value and charges for the asset disposition services handling, data wiping and transportation.

Value chain

This way the seller, the buyer and society benefits as well as creating a profitable business for Inrego. The seller can be reassured all data on discarded equipment is permanently erased while at the same time easily getting unwanted IT-equipment fetched, payed for and inventoried in a controlled and transparent manner. The vast majority of IT-users do not need the latest and greatest hardware for operating their needs in business, home use, administration etc. A three year old reconditioned computer or smart phone by far fulfills these needs for the buyer, who can hereby buy or lease a fully functioning high end IT-product including one year warranty. Inrego's leasing or "Product as a service" is increasing and is an important area to promote, as products this way comes back for another life extension when no more needed and can fulfill IT hardware needs in other parts of the society. As every unit is tested thoroughly, Inrego experiences an even lower customer complaint percentage than suppliers of new manufactured equipment.

Remanufacturing process

All equipment is received and sorted for potential reuses at Inrego's ISO 14001, 9001, 27001 and OHSAS 18001 certified recondition facility. Around 90% of all received equipment is reused; the remaining is recycled downstream at an external recycling partner. At reception, all core units are bar code labeled with a unique ID tied to its serial number, which is scanned to track and register specifications and test results throughout the reconditioning process. The hardware functionality is tested and cosmetic damages inspected. Appropriate upgrades and repairs are performed based on standard cost/benefit analysis. Data is wiped using professional software that renders a data wiping certificate. The inventory list, data wiping certificate and environmental savings are reported back to the seller in a web portal, and payment is done for the product value. Products are resold online at www.inrego.se and can be customized to fit the customer's need of technical specifications and software.

Economic Benefits

- The used IT-equipment can result in a net economic income instead of taking up valuable space in a seller's storage room
- Municipalities, businesses and private persons can buy professional IT-equipment at half the price of new products.
- Inrego has annual turnover of 230 MSEK with good profitability, all related to the IT-equipment reuse business model.

Environmental Benefits

Manufacturing of a computer requires approximate 22 kg chemicals, 240 kg fossil fuels and 1 500 liters of water according to UNEP. Furthermore, reuse of a computer saves the atmosphere 109 kg CO₂-equivalent emissions and a smart phone 27 kg CO₂-equivalent emission. These environmental savings share is reported to both the seller and buyer. In 2014 Inrego reconditioned 260 000 units which saved 2 800 tons CO₂-equivalent emissions.

Social Benefits – Jobs, Upscaling, etc.

- As schools can obtain approximately the double quantity of fully functioning reconditioned computers compared to new products within their fixed spending budget, more students get access to digital tools in education. In 2014, around 700 schools utilized reconditioned computers through Inrego.
- Directly employs 80 people at Inrego (which is steadily increasing) as well as numerous suppliers within e.g. transportation.
- Some of the computers and smart phones are donated by Inrego and their customers to charity where it is needed, e.g. Stadsmissionen in Stockholm needs computers and smart phones for their refugee centers.

Advanced Materials Recovery

As reuse makes use of all embedded materials in the product, materials such as precious metals, plastics, copper, tin, rare earth metals et c, are avoided to end up too early in the waste stream and replaces corresponding materials in a not needed newly manufactured computer or smart phone.

Company: Distanssupport i Väst / IT-Lyftet
Location: Göteborg, Sweden
Type: Independent remanufacturer
In reman: Since 2010
Contact: Ruben Linton
Phone: +46-733 822 609
E-mail: ruben.linton@itlyftet.se
Web: www.itlyftet.se



Product

Computers

Core Sourcing

Distanssupport i Väst / IT-Lyftet collects used computer-equipment from private and public organisations for reuse purposes.

Business Model

Value chain

The company collects used computer-equipment from private and public organisations, reconditions it, data wipes all information and resells it to new customers. As part of its business, the company also teaches people how to remanufacture computer-equipment. All profits are donated to Barncancerfonden – The Swedish Childhood Cancer Foundation – a non-profit organisation dedicated to preventing and combating cancer in children. In this way, Distanssupport i Väst / IT-Lyftet encourages their customers to transform what they consider “scrap” into refurbished products and donations to promote childhood cancer research.

Remanufacturing process

The first step in Distanssupport i Väst / IT-Lyftet’s equipment remanufacturing is an ocular inspection to reveal potential damages to the frame. If okay, this is followed by an external cleaning process, e.g. cleaning the frame and removing identification stickers. This is followed by an internal inspection process that includes removing dust and a visual inspection of the hardware in order to locate potential damages and to check vital components, e.g. capacitors.

The next step is to delete information on the hard drive, which is done with a secure wiping program followed by a functionality test. The previous owner of the hard drive can, if wanted, follow up the information deletion process. Each machine’s or hard drive’s serial number is traceable along with the results of the reconditioning.

This step is followed by tests of memory, graphics, USB functionality, and network connectivity. If needed, components are replaced. Following this process, complete computers are assembled from the refurbished equipment, software may be installed, and documentation for the remanufactured computer is assembled. The latter is connected to the computer's unique serial number.

Economic Benefits

- Used computer-equipment is no longer taking up space in the previous user’s storage room.
- Municipalities, businesses and private persons can buy computer-equipment for a much lower price as compared to new products.
- Money is raised to finance childhood cancer research.
- Distanssupport i Väst / IT-Lyftet earns money by educating people about how to remanufacture computers.

Environmental Benefits

Fewer computers need to be produced, conserving natural resources.

Social Benefits

- More people can afford and access computers, e.g. people with low incomes.
- Via Distanssupport i Väst / IT-Lyftet, people receive practical remanufacturing training and work experience, which may lead to future job opportunities.

Advanced Materials Recovery

Lesser computer production has a positive effect on needed use of advanced materials.

Company: Leapp
Locations: Amsterdam, the Netherlands
Type: Independent Remanufacturer
In reman: Since 2011
Contact: Marcus van Elk (Chief Marketing Officer)
Phone: +31-88-100-5105
E-mail: marcus@leapp.com
Web: www.leapp.nl

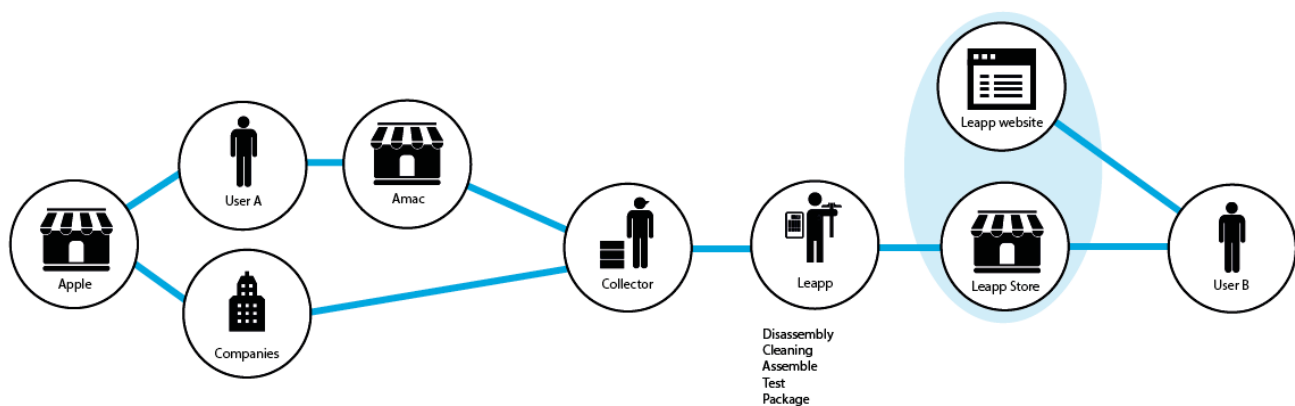


Product

Leapp recovers all types of Apple products, in this business case Apple Macbook will be used as an example.

Core Sourcing

Leapp has two types of core sourcing streams. 80% of the used Macbooks comes from business users, besides this 20% comes from Apple resellers. For the customer segment, by returning an old Macbook a discount is applied to the new product which can be seen as a **credit-based** way to collect cores.



Business Model

Leapp's business model is based on the difference between economic redemption and technical redemption of a Macbook. The biggest sourcing stream comes from collector companies that focus on businesses customers in Europe. Most of the Macbooks are collected in Germany and the United Kingdom. Leapp has a long-term contract with these collector companies to buy Macbooks after three years of usage, then the economic value is written off while the lifetime of a Macbook is much longer. Because of this Leapp can use this value. After collecting Macbooks, the used products arrive at Leapp where they are screened on quality. After screening and classification of the Macbooks, they are decomposed and all hardware pieces are checked and repaired or replaced if needed. Afterwards, the original user data is wiped and the software is being updated. Finally, the products go through a thorough cleaning procedure. Employees are trained by Apple to be able to guarantee quality of the remanufactured products. Around 8% of components cannot be re-used, these once will be recycled at a waste disposal. The iron parts are brought to a metal scrap collector. After cleaning, the Macbooks are packed and ready to be sold to a new customer. The remanufactured products are sold on the website and in the offline shops with a warranty of 24 months. This remanufacturing process is possible because to the quality of the materials used in a Macbook and the timeless design. A recent model is sold for 90% of the initial price of a new Macbook, an older version is sold for 70% of the initial price.

Challenges for LEAPP: at an early stage the biggest challenge for Leapp was that people were unfamiliar with remanufactured Macbook, besides this people did not know the brand. A big of effort was invested in marketing of the concept and the brand. Now the main challenge is to find enough used Macbook to be able to cope with the demand.

Economic Benefits

The economic benefit for customers is clear, people can buy a recovered Macbook which is less expensive compared to a new one. For Apple the remanufactured business is interesting as it broadens their market. Customers who were not able to buy Apple products, now are enabled.

Environmental Benefits

Leapp creates a second life for the Macbooks that would otherwise be disposed, but there are no clear numbers on the environmental benefits.

Social Benefits

The business model is scalable, Leapp started in 2011 with four employees now they have over 100 employees in three countries.

Advanced Materials Recovery

No advanced materials are recovered.

Company: Linde Material Handling GmbH
Locations: Aschaffenburg, Germany
Type: OEM/OER
In reman: Since 1996
Contact: Philippe Mulot
Phone: +49 (0) 6021 99 1685
E-mail: Philippe.Mulot@linde-mh.de
Web: www.linde-mh.com



Product

Forklift trucks

Core Sourcing

Cores are typically retrieved directly from customers (i.e. forklift truck users) under rental contracts both in a long term (3-6 years) and a short term, where Linde keeps ownership of the forklift trucks.

Business Model

Linde Material Handling GmbH carries out thorough refurbishment and provides Approved Used Trucks to meet market demands, especially from users with a medium or low utilization level. The main advantage of the Approved Used Trucks is Linde quality at lower prices (approximately half of the price of new forklift trucks), while the main disadvantage is shorter remaining lifetimes. During the refurbishment process only genuine Linde parts are fitted. The company utilizes its own sales channels for both refurbished and new forklift trucks.

The rental contracts utilized with the refurbishment are provided in order to meet the market demands for quick, simple and easy access with cost-effectiveness, and with the widest choice of materials handling equipment available on the market today.

Linde provides three standards for the refurbished forklift trucks so that a customer can choose the alternative that best fits their needs such as individual utilisation and budgetary needs. A safety certificate is provided for all Linde Approved Trucks, along with a warranty and CE certificate. All of Linde's forklift trucks meet the latest health safety legislation requirements and EU directives. The highest standard includes, e.g., an overhauled engine, a battery with over 80% potential and less than 3 years old or new, a new set of tires or over 90% potential, and transparent forklift truck history available.

The refurbishment process includes: 1.) control of forklift truck conditions, 2.) Check and, if needed, replacement of components (e.g. batteries), 3.) repaint, and 4.) quality control.

Key resources are the company's personnel (technicians' quality) and the process of refurbishment (internationally standardized). On the other hand, the main challenges are maintaining price competitiveness, keeping a high enough number of returning forklift trucks, and better preventive maintenance carried out before returning to Linde.

Economic Benefits

For customers, lower cost with the same quality are the major benefits, i.e., "the best value for money" according to Linde. For Linde, utilizing residual value in the used forklift trucks is regarded as the main economic benefit. Linde utilizes LCC (life-cycle costing) to evaluate the cost of a life-cycle of a forklift truck.

Environmental Benefits

The obvious environmental benefit is the resources saved, and no major negative environmental impact is recognized.

Social Benefits

Job creation is the major benefit to society.

Advanced Materials Recovery

No such materials are recovered.

Company: Oerlikon Leybold Vacuum GmbH
Locations: Cologne, Germany
Type: OEM/OER
In reman: Since 2006
Contact: Matthias Mester
Phone: +49 (0) 221 347 1774
E-mail: matthias.mester@oerlikon.com
Web: www.oerlikon.com/leyboldvacuum

oerlikon
 leybold vacuum



Product

Vacuum solutions

Core Sourcing

Buy-back: Oerlikon Leybold Vacuum buys used products from customers. The company offers an on-line buyback request template, which can be used to submit a buyback request to Oerlikon Leybold Vacuum. The template includes such items as material number, serial number, year of production, general condition (not used, normal usage marks, severely damaged, or total loss), and price expectation (not all of the items must be filled in).

Business Model

Oerlikon Leybold Vacuum is a manufacturer and full-line supplier of vacuum solutions including repair and remanufacturing. Its main driver for remanufacturing is a profitable contribution to sustainability. The major benefits for customers are lower prices for the same quality as newly manufactured products (a 12-month warranty is always granted and 3-year warranty is optional). The benefits of buyback for customers include no tied-up capital and no scrapping costs. Customer groups buying remanufactured products (e.g. research laboratories) are different from those who always buy newly manufactured products (e.g. large system integrating firms).

The remanufacturing process is the same as normal repair and consists of: 1.) quality check by eyesight, 2.) decision to refurbish (if not, going to scrap), 3.) repair, 4.) pack like new, and 5.) shipping. The key resource is the company's extensive know-how and a dedicated staff, as the variety of products requires complex techniques.

The company's main challenges are to optimize the offering to the specifics of the respective markets and set appropriate prices.

Economic Benefits

For customers, an economic benefit is lower prices: remanufactured products are in general 60% cheaper than new ones.

For Oerlikon Leybold Vacuum, remanufacturing means reinforcing environmental aspects and enhancing the after-sales business to third parties. This is seen as a major economic and economical benefit.

Environmental Benefits

An environmental benefit is seen as saved resources and sustainability.

Social Benefits

Making the company's products affordable to low-income buyers, especially those in emerging countries.

Advanced Materials Recovery

Special surfaces are disposed of, if worn out, because they are hard to recover.

Company: Polyplank AB
Location: Mörbylånga, Sweden
Type: OEM/OER
In reman: Since 1994
Contact: Bengt Nilsson (Managing Director)
Phone: +46-485 66 4480
E-mail: info@polyplank.se
Web: www.polyplank.se

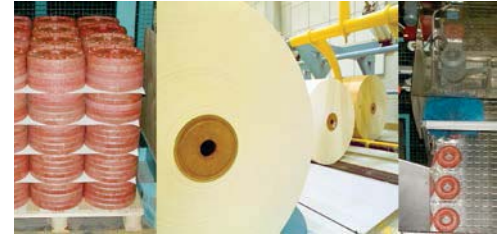


Product

Core plugs for paper industry

Core Sourcing

Cores are retrieved from customers and their customers.



Polyplank ↔ Paper mill ↔ Paper mill's customers

Business Model

Polyplank were founded on a process technology for the production of its own unique composite. The recipe for the composite, used in their products, includes two main ingredients. The first is recycled wood fibres, a waste material from sawmills. But wood requires painting, maintenance and must sometimes be replaced when used outdoors, for instance when in contact with the ground. For wood to last outdoors it must be saturated with toxins and heavy metals – in other words, pressure impregnation. The second ingredient is thermoplastics, more specifically recycled packages and other plastic waste products collected in the society. Today, much of the plastic that is collected gets incinerated in thermal power stations. True, heat is produced but an excellent resource is going up in smoke. The combination of wood and plastic in the form of Polyplank enjoys the best qualities of both materials: attractive and durable, resistant to rot and good for the environment.

Based on this composite material, which in itself is 100% recyclable within their process, Polyplank produce extrusion and injection moulded and extruded products that, based on life cycle and systems thinking, are integrated into offerings. All production waste as well as returned, used products are reused in new products. The resulting material, e.g. boards, has the feeling of wood and can be worked as if it were wood: it can be sawn, drilled and screwed. In addition, since the material is colored during production, painting is never required.

Polyplank use their boards in different system solutions, one of which are the core plugs used by paper mills. Paper mills use them to plug the cores on which paper is rolled up, and which follows the roll out to the customer. Through selling through the concept of functional sales, Polyplank collaborates closely with their customer, the paper mill, and can thus take advantage of the core plugs when the paper mill's customers send them back to the paper mill. Normally, the core plugs go back and forth three times between the paper mill and their customers before the plugs return to Polyplank. Described below are the three potential scenarios for used core plugs.

Handling of used plugs – There are three main scenarios for the paper mill's customers' used core plugs:

- Disposal by the paper mill's customer – In some cases, used core plugs at the paper mill customer disappear or are discarded. This quantity is very small.
- Reuse by the paper mill (sent out to new customers) – The most common scenario is when core plugs, after a period out at the paper mill customer, are returned to the paper mill; after washing and quality control, operated by Polyplank, these core plugs can be reused for new customers. If the core plug is worn-out it is sent to Polyplank where it is recycled. Normally, the core plug is reused several times. Because of the business model, Polyplank aims to achieve a level of quality that will enable their core plugs to be reused several times. Even the paper mill's customers benefit from this approach; instead of the handling and the cost of discarding core plugs, they can easily send them back.
- Recycling by Polyplank – When core plugs are finally discarded, they are returned to Polyplank where they are grinded down and sent to injection moulding in order to become new core plugs. In practice, almost 100% of all incoming used core plugs become new core plugs.

Economic Benefits

The main economic benefit for Polyplank is that they get back their material and do not need to produce new raw material. The use of recycled instead of virgin plastic reduces the life cycle cost. Without the economic benefits of using recycled plastic, the question is whether or not core plugs would be made of recycled plastic, and it is therefore not surprising that the results

demonstrate this. When the paper mill does not need to consume as many core plugs, the life cycle cost per core plug is lower each time it is reused. The results show that recycling is more cost-effective than the use of virgin core plugs.

Environmental Benefits

As partly described above, the Polyplank material has several general environmental benefits, e.g. that the material requires no coating and is moisture resistant. In order to verify their claims, Polyplank have conducted a life cycle assessment (LCA) and a life cycle cost (LCC) study together with Linköping University. In comparison with a single-use core plug of virgin plastic, Polyplank's business model/solution results in approximately 80 to 90% less environmental impact, and their cost for providing the core plug is also approximately 80 to 90% less. The largest gain with core plugs based on Polyplank material is the use of recycled compared to virgin plastics, resulting in a significantly reduced overall environmental impact. The more times the plug's material can be reused, the less the environmental impact. Polyplank's business model has increased their ability to take full advantage of their material. Since the Polyplank core plug can be reused, the overall environmental impact per use is decreased; however, reusability puts higher requirements on quality with regards to durability. It has been confirmed that the core plug that Polyplank manufactures has sufficient quality to withstand at least five reuses, which helps reduce the overall environmental impact.

Social Benefits

It is hard to make any statements about this issue.

Advanced Materials Recovery

No advanced materials are used in this product.

Company: PSS - Steering & Hydraulics Division
Location: Norfolk, UK
Type: Independent Remanufacturer
In reman: Since 1971
Contact: Andrew Brammer (Commercial Director)
Phone: +44-1692-406017
E-mail: andrew.brammer@pss.co.uk
Web: www.pss.co.uk



Product

Power steering boxes (gears) for trucks and buses

Core Sourcing

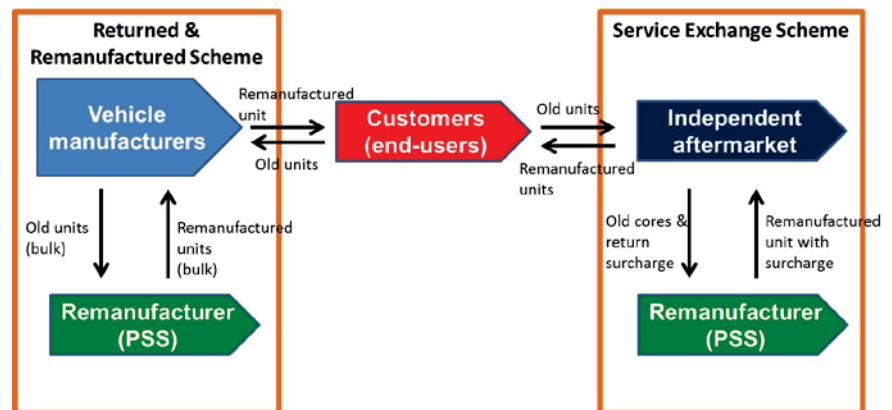
Core units are retrieved from independent aftermarket customers such as truck parts distributors and also from vehicle manufacturers.

Business Model

PSS - Steering & Hydraulics Division is a leading supplier (remanufacturer and manufacturer) of power steering and hydraulic products and is the UK's largest independent remanufacturer of truck and bus power steering products. The applications of PSS products cover trucks, buses, off-highway vehicles, military vehicles, tractors, forklifts and more.

PSS remanufactured products are supplied through service exchange and return & remanufacture schemes. The schemes used

depend on the type of customers involved. Most sales in PSS are made through service exchange schemes and the main customer group is the independent aftermarket. Under these schemes, PSS will supply a customer a remanufactured product from stock with a surcharge applied that is normally higher than the price of the product. The customer replaces the worn unit in the truck or bus with this PSS product, and returns the worn unit to PSS as an old core unit. PSS then gives the surcharge credit back, using the old unit to replenish the service exchange scheme stock. On the other hand, the return & remanufacture scheme is primarily applied to vehicle manufacturers. The manufacturers collect the old units from their end-users and send the bulk units to PSS for remanufacturing. PSS sends the bulk units back to the manufacturers once the remanufacturing is completed.



In terms of the remanufacturing process, when an old core unit arrives, it will initially go through identification as to which type of truck or bus steering box it is. Technicians then clean the unit using highly sophisticated cleaning equipment, shot-blasting it and then disassembling using dedicated tooling. At this stage, any parts that require mandatory replacement are discarded, and all other components are measured, analysed and checked to ensure they are within required specifications and tolerances. Any hard components that require re-work are re-engineered accordingly, and those that need replacing are infilled with replacement parts. The unit's recovered hard parts are then cleaned again using specialised equipment, and are kitted with the appropriate repair kits and replacement parts ready for assembly. The unit is then assembled against its assembly process plan in a clean room environment, and is fully tested to specifications and conditions that simulate vehicle operating conditions. Once the unit has passed these extensive testing criteria, it is spray painted, individually hard stamped with a unique identification code for full traceability, labelled, packed and dispatched.

The driver behind this business is that PSS spots the profitability potentials of power steering boxes and provides the remanufacturing service that significantly reduces the time length for getting back the product to the customer, minimising the out-of-service (off-the-road) time for trucks and buses. The challenges of the business are availability of the old cores, and for certain products (not power steering boxes yet) PSS has to compete with cheaper cloned new products in the market place. The key resources in the remanufacturing business are personnel and labour where PSS could provide training for remanufacturing and also the sophisticated facilities such as cleaning and assembly tools to perform remanufacturing activities. The main

challenge to improve the remanufacturing business is how to get old core units from the new model trucks in advance and store these for future service exchange schemes when the demands of the remanufactured units start to hit the market place.

Economic Benefits

The price of the remanufactured product is driven by market. Roughly, the remanufactured product is 50-65% cheaper than new product. The economic benefits are that PSS provides an option for their customers to choose a product that is cheaper with equivalent quality to newly manufactured, and to keep lead times of the product and repair times of the trucks and buses to a minimum.

Environmental Benefits

The remanufactured units only use 10% of raw materials and save 85% energy compared to newly manufactured product.

Social Benefits

As the business grows, PSS provides job opportunities in the local community and also economic efficiencies that reduces out-of-service (off-the-road) time for trucks and buses.

Advanced Materials Recovery

All the metals in the power steering box are recovered, unless there has been catastrophic damage. The only materials automatically being discarded are rubber and plastic seals for safety reasons of the product. Another advantage in the company is that PSS has a dedicated manufacturing site so that unremanufacturable power steering box components can be re-engineered and re-worked in order to be recoverable.

Company: R D Trading Limited, trading as RDC
Location: Essex, UK
Type: Independent remanufacturer
In reman: Since 1991
Contact: Gary Griffiths (International Partner)
Phone: +44-1376-336-415
E-mail: ggriffiths@rdc.co.uk
Web: www.rdc.co.uk

Product

IT equipment

Core Sourcing

The laptops are retrieved from mainly business customers.

Business Model

RDC was formed in 1991, sourcing second hand computer equipment for sale at auctions just as used computers first became available in numbers. A new IT asset management services business model developed for used and unwanted IT equipment. The driver for this business model is to mitigate customers' risks associated with value recovery from sales of used

IT equipment with secure deletion of data and responsible recycling of unusable and obsolete items. RDC sanitises confidential data held in computers and tests to verify that equipment is safe and fit for reuse. After servicing, the IT equipment may be sold worldwide, recycled or redeployed for customers to reuse, avoiding costs of buying new equipment. Customers are mostly business computers users from a wide range of sectors including finance, retail, computer manufacturers and resellers, universities and the public sector – among others.

Services are provided at customer sites or at RDC's site in Braintree, Essex – at 350,000 sq ft possibly the largest facility of its kind in the world. Processes start with asset tracking of each IT equipment device, data is sanitized using Security Services' approved software and hardware tools; electrical safety testing verifies it is safe to use; components function is tested; licensed software added. Scuffed but working equipment is sold at lower prices compared to items in an 'as new' condition. For data media destruction, hard drives are shredded to fragments of less than 20mm. To many customers, RDC's quality assured reused products possess better quality and reliability (with warranties issued) than cloned new products.

With global business growing, RDC has formed an international partners' network that provides uniform best practice IT reuse and recycling services worldwide. In 2014, IT asset disposition services were provided by RDC and approved partners in more than 120 countries around the world.

International concerns exist about illegal exports of waste computers and the damage to human health and the natural environment from poor recycling practices and hazardous materials used in computer components. As a result, RDC uses independent certification to international standards to reassure customers that RDC manages in environmentally responsible ways that protect the reputation of RDC and customers as socially responsible and legally compliant enterprises. RDC is certified to ISO 9001 (Quality), ISO 14001 (Environment) and ISO 27001 (Information Security).

Economic Benefits

Money from reuse benefits former users – and reuse is seen as environmentally preferable to recycling. Customers avoid leaks of confidential data and personal injury liability claims arising from faulty used electrical equipment. Affordable access to computer technology and the Internet is provided to those unable to buy new.

Environmental Benefits

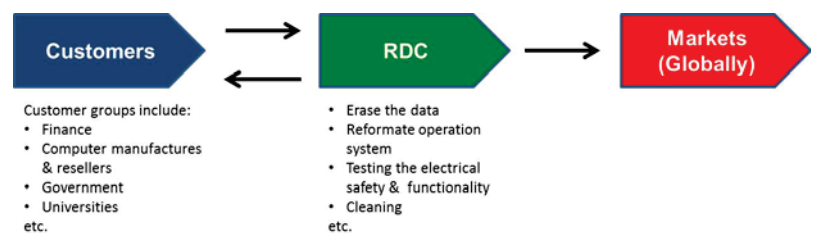
By reusing IT equipment, several hundred tonnes of carbon emission is saved compared to production of new items. RDC's success was recognised by the UK Queen's Award for Enterprise for Sustainable Development. Further to this, RDC recently won a Gold Zero Waste Award from letrecycle.com.

Social Benefits

From the formation of RDC, this company has grown from 1 to 380+ staff members. RDC has worked with a number of charities and social enterprises in the UK, using computer refurbishment as training skills for people with special needs.

Advanced Materials Recovery

RDC reports 100% recycling and recovery by weight, with a mass balance of materials diverted from landfill or incineration.



Company: robotif GmbH
Locations: Harsdorf, Germany
Type: Independent remanufacturer
In reman: Since 2009
Contact: Ingo Förster (Executive Director)
Phone: +49 9203 973909-0
E-mail: i.foerster@robotif.de
Web: www.robotif.de



Product

Industrial robots from Adept, Bosch, Denso and Staubli.

Core Sourcing

Most industrial robots (around 90%) that come in for remanufacturing are remanufactured on-demand of an industrial robot user who is in need of remanufacturing. The rest (10%), is bought from the market through E-bay, customers etc.



Business Model

The best way for the customers of robotif to keep their industrial robots working is to have them remanufactured. If the industrial robots are not remanufactured emergency repairs are needed and this is not economic over time. Another option would be to buy a new industrial robot with all new installation costs that comes with it. Therefore, having the industrial robots remanufactured by robotif. The customer value is to have their manufacturing machines in business fast. By remanufacturing the industrial robots can run longer time than specified from the OEMs. In order to have the industrial robots remanufactured over time the customers need to tell robotif that they have the industrial robots so that robotif can be prepared to perform emergency repairs and/or remanufacturing on them when needed.

The remanufacturing process consist of the following steps: After robotif receives a robot for repair, a visual inspection of the robot for external damage is made. Thereafter, a technical inspection is accomplished, consisting of individual test of all components to function and durability. If there are any defective components, it will be checked which components need to be repaired or replaced, to find the best economical solution for the customer. The result is an individual, customized offer. After receiving the order, robotif starts with the disassembly, cleaning and overhaul or repair of the robot and defective components. The robot will be assembled, measured and a 24h test run is made. After the successful completion of the test run, a final inspection takes place. At last, robotif organizes the packaging in special robotif safety-boxes and freight, so your robot arrives fast and safely at your company again.

The key resource is the staff. The staff is being trained from easy repairs until being able to do advance remanufacturing. It is important for the staff to understand how to remanufacture an industrial robot to make into a reliable machine.

The most important driver for robotif is to fulfil customer value. The customers understand the value and pay for it. Some customers ask for environmental calculations but to get that they have to pay for the calculations so then they avoid it.

Economic risks are few – it has happen one time that a company have gone bankrupt so that was a small loss but not much overall. A challenge could be in recession time when there could be hard or even impossible to buy new spare parts sine the spare part suppliers having shut down their manufacturing. This means that spare parts needs to be found in already existing industrial robots.

The biggest challenge for robotif is to get the small amount of spare parts that are needed for their business. Another problem is the computerisation of parts. For example, previous industrial robot had amplifiers easily changed but current design has the amplifiers integrated in the computer systems. Therefore, they are much harder to change if broken.

Economic Benefits

The customers pay well to achieve their value of having their industrial robots working longer time.

Environmental Benefits

There are environmental benefits but they have not been calculated.

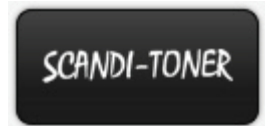
Social Benefits

The business keeps around 20 people at work in a smaller city, Harsdorf, in Germany.

Advanced Materials Recovery

The wiring is containing advanced materials from the Aerospace industry such as PTFE Kapton or PTFE with glass fibre braid.

Company: Scandi-Toner AB
Location: Karlstad, Sweden
Type: Independent remanufacturer
In reman: Since 1993
Contact: Björn Hultström (CEO, plant manager)
Phone: +46-54-217820
E-mail: bjorn.h@scandi-toner.se
Web: www.scandi-toner.se



Product

Toner cartridges

Core Sourcing

Around 90% of the used toner cartridges are collected through Scandi-Toner's own return system and the rest (10%) is bought from partners in Europe.

Business Model

The remanufactured toner cartridges are sold through retailers (around 300) who also retrieve empty cartridges from the market. Return-boxes are distributed by Scandi-Toner. Upon arrival to the remanufacturing facility the empty cartridges are sorted, disassembled, cleaned, refilled, reassembled, and tested. Different toner cartridge remanufacturers collaborate in Europe about technology improvements but also when buying and selling cores to each other. Also, technical information about products are shared in order to be able to remanufacture the toner cartridges in a good manner. Scandi-Toner is also a member of ETIRA, European toner and inkjet remanufacturers association.

A driver for conducting remanufacturing is that it is possible to remanufacture the products used on the market. The cores work as raw material for the remanufacturing process. The 300 retailers sell both new and remanufactured toner cartridges in the same store for the same customers. The parts of the remanufacturing system which is crucial and important are:

- the reverse logistics system,
- the technologies used within the remanufacturing process, and
- the right staff competence.

The value for the customers is that they get price-worthy remanufactured toner cartridges to a lower price than a new one. In general the toner cartridges are sold to 40% of a new toner cartridge with a 24 month warranty, which is equal as for newly manufactured toner cartridges. The quality of the remanufactured toner cartridges should be the same as the newly manufactured toner cartridges have. The warranty given on the remanufactured toner cartridges is important since it needs to be the same or better than newly manufactured toner cartridges. However, the actual length of the warranty period (24 months) is not such a big deal since almost all toner cartridges have been used within the warranty time.

Economic Benefits and Challenges

The biggest challenge is the newly produced compatible cartridges manufactured in China. These cheaper versions of the OEM toner cartridges knock out the price view on the market. Some of these are remanufacturable and some are not. Some of the compatible toner cartridges are violating existing patents. To remanufacture these would be illegal in some countries. From an environmental point of view it is not preferable to use the compatible toner cartridges since they are illegal to perform remanufacturing on and can only be used once in comparison to OEM toner cartridges. Another challenge is that the market for the Scandi-Toner, which is the Nordic countries, is the smallest in Europe which is much smaller than for example the markets in Germany and or Italy. Finally, the biggest challenge is get customers – therefore more investments in marketing are needed.

Environmental Benefits

The company holds an ISO14001 certificate and use Nordic Swan labels. Several environmental calculations have been made. One says that 80% less oil is used when using remanufactured toner cartridges in comparison to a new produced toner cartridge which uses 3-5 litres of oil per cartridge. In comparison with both OEM and imported cartridges, the total CO₂ impact is also lower since the whole process is locally conducted within a region/country.

Social Benefits

Today there are 10 employees and 80% of the process is manual. The products are too complex and different to each other which makes automation hard to make.

Advanced Materials Recovery

The materials recovered by the toner cartridge remanufacturing process are aluminium and steel.

Company: Schmitz + Krieger GmbH
Locations: Cologne, Germany
Type: Contracted Remanufacturer
In reman: Since 1911
Contact: Robert Casper (Manager)
Phone: +49 (0) 172 34 32 827
E-mail: robert.casper@schmitz-krieger.de
Web: www.schmitz-krieger.de



Product

Engines, transmissions, and other components for automotive assemblers. Injection equipment and high-pressure pumps.

Core Sourcing

Service exchange: the customer returns the used product to the remanufacturer, the product is remanufactured and the customer gets the same quality of the same product model back (if it is possible to perform a remanufacturing operation).

Business Model

Benefits for customers are a lower price, increased availability of products (although some remanufactured products are not always available), and an image about environmental sustainability. The main driver for Schmitz + Krieger is economic, which is followed by environmental sustainability and customer demands. There are neither customer groups nor sales channels specifically for remanufactured products. Schmitz + Krieger directly deals with its customers in most cases, and collaborates with logistics providers and spare part providers.

The remanufacturing process consists of: 1.) reception of cores, 2.) visual check of the cores' quality, 3.) stock, 4.) disassembly, 5.) cleaning, 6.) check of quality, 7.) machining (e.g. grinding), 8.) mounting, 9.) testing, and 10.) shipment. Key resources are the company's remanufacturing personnel.

The main challenges of Schmitz + Krieger are: 1) access to measurable data and information about products and processes, 2) core management (e.g. how to optimize the level of stock), and 3) dealing with electronic products in general (not addressed at present).

Economic Benefits

For customers, an economic benefit is lower prices: remanufactured products are 20-30% cheaper than new ones.

In general, using existing raw materials and less inputs for the process (e.g. staff, information, machines) is perceived as a source of economic benefit. "Full production costing" is used as a cost calculation method including labour time, material, and investment. This differs from a method for new products.

Environmental Benefits

From the environmental viewpoint, advantages are fewer materials and reduced energy input, while a disadvantage is dirt from cleaning parts (this can be hazardous).

Social Benefits

Job creation is the major benefit to society.

Advanced Materials Recovery

No such materials are recovered.



Company: SCM Turbomotive Ltd
Location: Huddersfield, UK
Type: Independent Remanufacturer
In reman: Since 1980s
Contact: Duncan Troughton (Commercial Manager)
Phone: +44-1484345383
E-mail: duncan.troughton@scmturbo.com
Web: www.scmturbo.com



Product

Full range of turbochargers and the spare parts

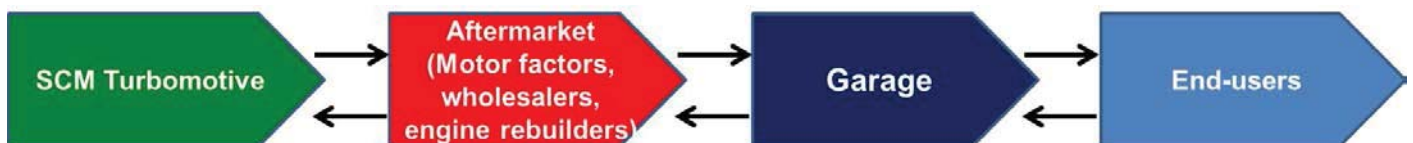
Core Sourcing

The cores are retrieved from their customers through four schemes: Direct-order, Deposit-based, Buy-back and Voluntary-based. Most of the remanufactured products are sold with surcharges to help control the units back.



Business Model

SCM Turbomotive is a major distributor, remanufacturer and repairer of turbochargers to the independent aftermarket. SCM supplies all makes and model of new and remanufactured turbochargers for service passenger car, CV, bus, marine and industrial applications. The main customer of SCM remanufactured product is the motor factors which supply spare parts to garage. In value chain, the remanufactured units will go to motor factors that sell to garage and then to end-users. The old units will flow back to the chain through garage, motor factors. SCM will have small amount of business with wholesalers and engine rebuilders.



In terms of remanufacturing process, the cores will firstly be stripped down to small components and cleaned using different methods such as sand blasting etc. depending on the components being made of. The components will then be checked individually if they are within tolerance before going through machining including honing, grinding etc. The subsequent process is rebuilding which includes the activities of replacing discarded components, core balancing and actuator before going through 19 inspection points to confirm the OE specifications. After the aforementioned steps, the remanufactured products will be packed for storage or sold directly to the customers.

SCM deals with vehicle off the road (VOR) business so that the driver behind the business mode is the efficiency of delivery service to their customers. The company therefore has a wide range of remanufactured turbochargers in stock in order to provide immediate service to their customers (motor factors). The challenges of the business model are:

- Ensuring the company's service can capture as much business as possible in the market and stay competitiveness with other turbocharger providers.
- Some competitors (small operations) will by-pass motor factor route to garage which will influence SCM business in some ways.
- Low quality of products (such as the core is not through balancing test) with cheaper price from other competitors influences the perception of remanufactured products in the market thus affects the sales of SCM remanufactured products.

SCM has internal developed tools to measure the economic performance such as availability of turbochargers, cost savings, pricing, stock etc. With this performance measurement, SCM would be able to set up a strategic plan to react the market. The main challenge to improve the company's remanufacturing business is keep up-to-date technology for turbochargers.

Economic Benefits

In general, SCM remanufactured products are 70% priced compared to newly manufactured products. The warranty issued with remanufactured product is longer than new product (24 months warranty with 12 months no quibble guarantee). The customers see the benefits of SCM remanufactured products are: cost effective and also easy sell to their customers (i.e. the garage and end-users).

Environmental Benefits

The remanufacturing includes reusing parts in turbocharger so that it brings energy saving and impacts to environment.

Social Benefits

The growth of remanufacturing business in SCM will create more job opportunities in local community. SCM also have other activities to the social benefits:

- Encouraging all employees to participate with local community activities and allow employees to take paid time off to take part in these events every year.
- Regular donations to charities and to local community organisations.
- Providing matched funding for any employee donations to charity.
- Members of the Calderdale and Kirklees Manufacturing Association and regularly support local events.

Advanced Materials Recovery

Yes, from remanufacturing turbocharger, the alloys, aluminium, cast iron, titanium can be recovered.

Company: Siemens Industrial Turbomachinery AB
Location: Finspång, Sweden
Type: OEM/OER
In reman: Since 61 years
Contact: Malin Hazard (overhaul), Olov Andersson (repair)
Phone: Malin: +46-122-887454, Olov: +46-122-82119
E-mail: malin.hazard@siemens.com, olov.andersson@siemens.com
Web: www.sit-ab.se



Product

Gas turbines

Core Sourcing

Cores are retrieved from customers (i.e. turbine users), and cores with the same quality (or the same entities) are returned to the customers after overhaul/repair. The overhaul/repair is often a planned activity (e.g. after a predefined length of operation).

Business Model

Siemens Industrial Turbomachinery AB carries out overhaul and repair of gas turbines for its customers (i.e. users) by using new, repaired or refurbished parts in sectors such as power generation and oil & gas, contributing to extending the lifetime of existing equipment. Overhaul options focus on operational demands through in-situ or factory-based overhauls, and/or by service exchange or leased engines (for the duration of the overhaul period). For its customers, the cost (lowest cost of ownership) is a major driver to pay for this service. Siemens overhaul and repairs, which can also incorporate modernizations and upgrades in certain cases, are designed to help customers realize optimal operational performance from their assets, by providing the turbines with a long lifetime, such as 20 years.

The company's key resources are its product knowledge and facility. In particular, the company utilizes its OEM (Original Equipment Manufacturer) knowledge of operating parameters (ambient conditions, operating mode, operated fuel, etc.) and of component design, manufacturing parameters and tolerances. In addition, fact-finding in close cooperation with the Siemens design department is a strong asset. Regarding the facility, Siemens uses a global network of company-approved workshops to meet exacting quality and safety standards and guarantee the performance of its engines. Furthermore, guaranteed OEM parts for the turbines and access to the latest OEM-proven technology for extended economic viability of the asset are also important.

The process includes transport of the core (if needed), inspection, refurbishment, reassembly, test, transport (if needed), commission, and test.

Economic Benefits

For customers, lower costs and extended lifecycles are important benefits as overhauls provide customers with the latest OEM proven technology for extended economic viability of their asset. For Siemens, increased product knowledge obtained during overhaul/repair operations, and through the ongoing collection and analysis of fleet data, affords Siemens as opportunity to apply that knowledge to new turbine design and new service concepts.

Environmental Benefits

On-site overhaul/repair is acknowledged to reduce the environmental impacts from logistics and overhauls provide technology improvements that can result in lower emissions.

Social Benefits

From the job viewpoint, working on overhaul/repair could be seen as a good component for his/her career.

Advanced Materials Recovery

Advanced materials, such as low-maintenance materials, high-temperature resistance materials, super alloys, and coated materials, are recovered.



Company: Stone Group (Stone Computers Ltd)
Location: Stafford, UK
Type: IR
In reman: Since 2009
Contact: Martin Ruston (Risk & Compliance Manager)
Phone: +44-1785-786-735
E-mail: martin.ruston@stonecomputers.com
Web: www.stonegroup.co.uk



Product

Refurbished IT equipment

Core Sourcing

Cores are retrieved from any companies, public sectors, organisations with waste IT equipment.

Business Model

Stone Group is established in 1991 and is a leading provider of Information and Communication Technology (ICT) solutions to education and the public sectors. They are one of the only UK IT hardware configurators to operate its own in-house IT recycling and refurbishment facility (fully licensed by the Environment Agency). The company also follows and maintains a zero landfill policy.



In the recycling scheme, the company retrieves the cores via several methods:

- The main one: old cores will be collected when the company refreshes the IT equipment for their customers.
- In some cases: The company will collect the cores from other companies, public sectors, organisations that did not have previous business with Stone and have waste IT equipment.
- The company also have numbers of partners to find the sources of waste equipment to recycle.

After cores are collected, the refurbishment processes are: Safety & function tests → Clean & data erased → Minor repairs → Cleaning which is undertook to render the IT equipment suitable for re-use at different grades.

The driver of the business model is the ethical and legal propagation. As a manufacture of electronic equipment, Stone Group feels to have obligation to maximise the uses of IT equipment and recycle the un-reusable ones properly. So the company has their own facilities to recycle the end-of-life equipment to achieve zero wastes. The challenge for Stone Group is second remarket where the equipment can be reused. For older equipment, it is more difficult to find second reuses. The company has different customer group to sell the refurbished equipment: to private consumers in UK through their own Encore website, EBay, Amazon; to brokerage which sells the products in developing countries. To facilitate this business, the key resources are IT technician skill, facilities and space for the IT refurbishment operation, technology support such software for easing data, and mechanical shredding equipment to facilitate recycling and segregating materials for un-reusable equipment.

From this business model and recycling scheme, the pros are customers get free of charge recycling service including waste collection and the recycling process. Stone group cover the cost of the recycling service through sales of reusable equipment or recycled materials such as metals.

Economic Benefits

The refurbished products' price varies significantly depending on the age, specifications, capability, and also brand of the products. As this service, customers see the benefit of usable IT equipment with affordable price. However, the downside of the product is the specifications that are behind up-to-date technology.

Environmental Benefits

Refurbishing equipment for reuses helps to reduce electronic waste and save energy used at the manufacturing stage. The company has environmentally regulated process and facilities to recover waste equipment in the market and ensure the equipment get to reuse instead of scrapped. From the recycling activities, the company ensures there is no landfill.

Stone Group has awarded Electrical and Electronic Recycler of the Year at the National Recycling Awards in 2014 which recognises the activities of recycling and waste management in the company.

Social Benefits

The recycling facilities expand a lot since the company started in 2009 and there are 40 – 50 people associated with the recycling service now.

The companies also have numbers of associated charity activities such as: donating numbers of refurbished PCs every month to IT School Africa, supporting social scheme “Get on-line” run by Microsoft, donations to local organisations (schools, nursery).

Advanced Materials Recovery

From IT refurbishment process, the advanced materials in the IT equipment such as metal can be recovered and reused.

Company: Storebro Industrier AB
Location: Storebro, Sweden
Type: Contracted remanufacturer
In reman: Since 1991
Contact: Hans Åhsgren (Managing Director)
Phone: +46 492 308 00
E-mail: info@storebro-service.se
Web: www.storebro-service.se

Storebro Industrier AB
 Industri



Product

Lathes, milling and grinding machines.

Core Sourcing

Storebro Industrier (Storebro) is performing remanufacturing on lathes, milling and grinding machines as a service for their customers. This means that the customers own the machine during remanufacturing and placed back when remanufacturing is finished.

Business Model

Storebro has a close collaboration with their customers in order to provide them with a good remanufacturing service of their customers' machines. In general the remanufacturing process is including the steps; 1) Inspection and test run at customer; 2) Transport to Storebro; 3) Disassembly; 4) Cleaning of parts; 5) Part reprocessing or replacing; 7) Reassembly; 8) Testing; 9) Transport to customer; 10) Installation at customer.

During the first step, the machine goes through a status review, a test run and a final check. Secondly, the machine is disassembled. All parts will be washed and thoroughly cleansed. The machine bed and chest will be reground as well as saddles, cross slides etc. Milling machine tables will be planed. Gibbs, headstocks, tailstocks and slides will be scraped. Teflon or Turcite linings will be relined and scraped. Headstocks, Norton gearboxes and aprons will be overhauled and equipped with new bearings, bushings and gaskets. Damaged gear wheels or axles as well as worn out ball bearings will be replaced. Table, cross and tailstock screws will also be replaced. The hydraulic and lubrication system will be overhauled. The tailstock will be provided with a new barrel and screws. New spindle bearings will be mounted. Clutches and brakes will be replaced. The machine may be filled and primed prior to a two pack finishing paint being applied. The electrical equipment will be replaced or upgraded. Digital measuring systems (DRO) will be attached. On CNC machines, outdated control systems can be replaced if requested. Finally, the machine will be reassembled, gauged and a measuring protocol will be issued. The whole procedure will be carried out meticulously, so that no stage or component will be overlooked.

The customer's value is that they get price-worthy machine delivered with a complete measurement report and supporting documentation. Within the documentation often a risk assessment is conducted and manuals of how to maintain the remanufactured machine to make it last longer. As the aging process may improve the properties of the machine bed, by increasing its firmness and stability, there are a number of advantages in remanufacturing a machine. By comparing the purchase cost of a new machine against the cost of remanufacturing an old one, there is an estimated cost saving of 50% or more should you choose to remanufacture.

The key resources for Storebro are their long experience in machine remanufacturing and good collaboration partners that could help them to remanufacture machines for their customers.

The drivers for Storebro are to make money and to satisfy the needs of their customers.

The challenges are e.g. to be able to plan their remanufacturing process better. It is not easy to foresee how long time the reprocessing of parts will take. Getting access to cores is also a challenge that recently has become stronger.

Economic Benefits

By comparing the purchase cost of a new machine against the cost of remanufacturing an old one, there is an estimated cost saving of 50% or more should you choose to remanufacture.

Environmental Benefits

There are resources saved in their remanufacturing process but no calculations made.

Social Benefits

The business keeps around 10 people at work in, Storebro, in Sweden.

Advanced Materials Recovery

There are much metals being recovered but usually no advanced materials.

Company: Ståthöga MA Teknik AB
Location: Sweden, Norrköping
Type: Contracted
In reman: Since 1988
Contact: Henrik Fältmars (Managing Director)
Phone: +46-11 31 49 50
E-mail: info@stathoga.se
Web: www.stathoga.se

STÅTHÖGA
MA TEKNIK



Product

Pumps and smoke channels

Core Sourcing

Cores are retrieved from customers.

Business Model

The business concept is to find and upgrade existing pumps at their customers. The value for the customer is that they can prolong the use of their old equipment and also reduce the down time period since the remanufacturing time is quite short in comparison with replacing it with new pumps. The cost for remanufacturing is also significantly lower than the option of replacing with a new pump.

The normal procedure is that the used pump is transported to their workshop. In some cases, the work is done at the customer site. The first step is to assess the condition of the pump in order to plan the work. The next step is to clean the pump and this step is followed by repairing the pump. This could imply additive measures, e.g. removing roost and add new materials. Replace worn out components with newly produced ones. In order to prolong the life time, improve accessibility and to improve the efficiency of the pumps, they normally add a surface treatment with modern composite coating and sealing technology. Modern sealing composites have lower coefficient of friction as well as the composite coat inside of the pump this together can improve the pumps efficiency between 5-15%. While industrial pumps consume only about 25% of the installed electrical motor power, their potential for energy savings is one of the largest.

Economic Benefits

The main economic benefit for upgrading pumps is that they use less power after the upgrade and their up time increase.

Environmental Benefits

Less power use also means reduced their electric energy consumption, i.e. in general a reduction of fuel and CO₂ emissions. Material resources are also salvaged.

Social Benefits

The social benefits would mainly mean more job opportunities at Ståthöga MA Teknik.

Advanced Materials Recovery

No advanced materials are used in this product.

Company: Toyota Material Handling Sweden
Location: Mjölby, Sweden
Type: Original Equipment Remanufacturer (OER)
In reman: Since 2003
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E-mail: anders.nielsen@se.toyota-industries.eu
Web: www.toyota-forklifts.se/Sv/Services-and-Solutions

TOYOTA

TOYOTA MATERIAL HANDLING SWEDEN



Product

Forklift trucks

Core Sourcing

Around 90% of the used fork lift truck comes from rental agreements and the rest is bought from the market.

Business Model

Most of the forklift trucks are deriving from the market from different kinds of rental models. These rental contracts run from one month up till 10 years. Usually the newly manufactured forklift trucks are sold on a long-term rental contract and then sold several times on short-term rental until sold as used forklift truck or for being scrapped and then only the material value is returned. The advantage of having this kind of business model is mainly that the company keeps the control of the forklift trucks while being used and reused several times. It keeps a good relation to the customers. A challenge is though is that the company takes more risks than in normal traditional sales. This is e.g. the case when companies using their forklift trucks are get bankrupt. By providing the market remanufactured forklift trucks the company reaches new customer segments i.e. those who are not willing to buy new forklift trucks. These kinds of companies could for example be new started companies that are not willing to invest much in equipment.

The forklift trucks are being remanufacturing according to the following five process steps:

- 1) **Inspection** at the gate to determine which class the used forklift is going to achieve from 1 to 5 depending on e.g. age, wornness, and ability to be sold to a new customer.
- 2) **Cleaning** the forklift trucks in an environmentally controlled manner,
- 3) **Repairing** parts that needs to be repaired, changing parts that needs to be changed, changing wear and tear parts. The new spare parts are ordered from the Toyota parts company that is located a few kilometers from the remanufacturing facility which makes the lead time fairly short.
- 4) **Repainting** to meet the new customer demands, and
- 5) **Testing** the remanufactured forklift truck to ensure it meets the new customer requirements.

The value for the customers is that they get price-worthy forklift trucks that have been treated well during their previous usages under the control of Toyota. New forklift trucks come with a 12 months warranty while the remanufactured forklift trucks come with a warranty between 3 and 9 months. The remanufactured forklift trucks that are given a warranty of 3 months are sold at a price of 60% of a newly manufactured forklift truck while a remanufactured forklift truck sold with 9 months warranty is sold at a price of 80% of a newly manufactured forklift truck. Usually the same sales channels are used for selling both new and remanufactured forklift trucks but in some cases the remanufacturing customer are more knowledgeable and ask more questions over phone about their remanufactured forklifts before buying it.

Economic Benefits and Challenges

The economic benefits for the remanufacturing operations are to retrieve good cores that are easily remanufactured and also more important easily sold to a next customer. It is also important for the business that the remanufacturing staff have the knowledge of knowing what value the forklift truck have in order to put down the right amount of time on their manual remanufacturing work.

A main challenge for the remanufacturing operation in Mjölby, Sweden is that the manual work creates high costs which need to be balanced with the actual profit made on each and every forklift truck that enters the remanufacturing facility for being remanufactured, sold as is, and being scrapped for material recycling. Another challenge is how to deal with the uneven amount of used forklift truck entering the remanufacturing facility. Another challenge is that the sales companies are traditionally mostly still measured in how many new forklift trucks being sold but maybe this is about to change in the future.

Environmental Benefits

By having the forklift trucks remanufactured several times environmental benefits are achieved. This concerns for example material resources used and reduced greenhouse gas emissions.

Social Benefits

Social benefits of the remanufacturing operation is that it creates much work since all processes in the remanufacturing process is done manually. The forklift trucks are too complicated to perform automation on. Currently there are 25 people working within the remanufacturing facility in Mjölby, Sweden. In each European country has a sales company who is in charge of approximately one remanufacturing facility (FMC). This means that there are around 35 remanufacturing facilities within Europe.

Company: UBD Cleantech AB
Locations: Höör (Sweden) and Stettin (Poland)
Type: Independent/Contracted Remanufacturer
In reman: Since 1980
Contact: Sanny Runesson (Marketing manager)
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Product

Brake calipers

Core Sourcing

Cores are retrieved from car workshops, car dismantlers and core traders.

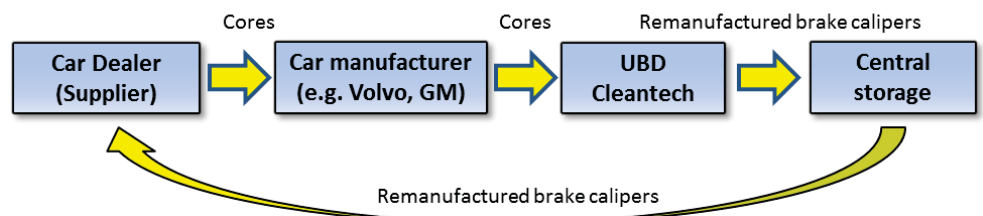
Business Model

UBD Cleantech AB is performing remanufacturing on brake calipers on many different models. The brake calipers are bought from different sources e.g. car workshops, car dismantlers and core traders. The used brake calipers come in different conditions and volumes depending on how easy they are to retrieve from the market. Upon arrival the used brake calipers are sorted. When a customer order a specific number of brake calipers are found the actual remanufacturing process starts with cleaning and disassembling necessary parts. Some wear and tear parts e.g. gaskets are always replaced with new parts. The brake calipers are reassembled and tested again to ensure it meets the customer needs. The customers (retailors e.g. Mekonomen or even OES) retrieves the remanufactured brake calipers to a lower price than newly manufactured brake calipers which allows them to sell them to a cheaper price to the end users (usually car owners) while still making good profit. The warranty time given on the remanufactured brake calipers are two years which is the same or same as given for newly manufactured brake calipers.

Material flows within the remanufacturing system of brake calipers at UBD Cleantech:

The remanufacturing process for remanufacturing brake caliper is:

- 1) Inspection, 2) Disassembly, 3) Cleaning, 4) Reassembly, 5) Testing



The drivers for UBD are to earn money and at the same time environmentally friendly. The value for the car dealer (customer) is that get better utilization of the casted bodies. The end-user (car drivers) gets a cheaper spare part than a new spare part.

The challenges for UBD are wide e.g. the competition from new produced brake calipers from low labor markets e.g. in Asia. A technical challenge is to renovate the electric function of the newer brake caliper designs. The key resource is the staff. They need to be skilled enough to be able to buy the right cores to the right quality.

Economic Benefits

At these services the customer can get the question if he or she wants to have a new brake caliper or a remanufactured brake caliper, the price is usually around 30% lower.

Environmental Benefits

At 9,8 kg of carbon emissions, the manufacture of a brake caliper comes with a heavy environmental impact. However, remanufacturing the same filter leaves a much lighter 0,53 kg carbon footprint.

Social Benefits

The amount of people working with the brake caliper remanufacturing at UBD is around 20.

Advanced Materials Recovery

90% of the cast iron brake calipers can be remanufactured. For aluminium housing the yield is lower: 50% due to galvanic corrosion.

Company: UBD Cleantech AB
Location: Höör, Sweden
Type: Contracted Remanufacturer
In reman: Since 1980
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Product

Diesel Particle Filters (DPF)

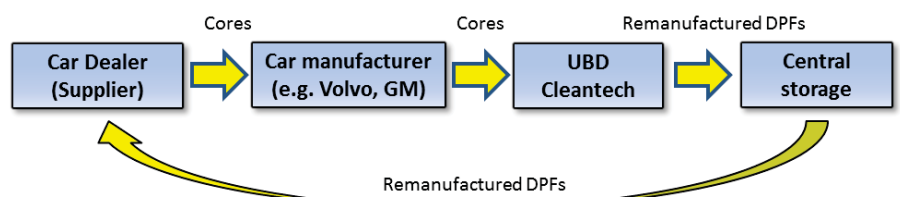
Core Sourcing

Cores are retrieved from workshops without prior knowledge about volumes.

Business Model

UBD Cleantech AB is performing a remanufacturing service for European car manufacturers aftermarket who are conducting supply to the dealer network. In order to keep diesel cars running in a safe and comfortable manner they need to be maintained after a certain number of mileages or after a certain time. The diesel particle filters clean themselves if the car is running longer distances but still they need to be changed and cleaned properly in a remanufacturing process in order to be safely used again. UBD Cleantech has developed a patented method to remanufacture the filter and restore it to at least 95% of its original performance capacity. Even small volumes will boost your bottom line and soften environmental impact. Therefore, the car users need to change their DPFs at some of the service intervals decided by the car manufacturer e.g. Volvo or Renault. At these services the customer can get the question if he or she wants to have a new DPF for e.g. €800 or a remanufactured DPF for €400. UBD makes it possible for the car workshops to ask this question to their customers.

Material flows within the remanufacturing system of DPFs at UBD Cleantech:



The remanufacturing process for remanufacturing diesel particle filters is:

1) Inspection, 2) Disassembly, 3) Cleaning, 4) Reassembly, 5) Testing

The value for the car dealers is that they can keep a high margin on the remanufactured DPFs compared to a new one. The end-user (car drivers) value is that they get a lower price of the spare part but still with good or equal quality.

The drivers for UBD are e.g. improved economy and environmental performance.

Key resources are here the staff, electricity and also that they have a unique remanufacturing process give that access to O.E.S. customers. Another key resource is the ability UBD have to bring back cores that are remanufacturable.

The challenges for UBD is to develop the remanufacturing process that enable even higher utilisation of incoming cores

Economic Benefits

At these services the customer can get the question if he or she wants to have a new DPF for e.g. €800 or a remanufactured DPF for €400.

Environmental Benefits

At 25.6 kg of carbon emissions, the manufacture of a Diesel Particle Filter comes with a heavy environmental impact. However, remanufacturing the same filter leaves a much lighter 3.3 kg carbon footprint.

Social Benefits

Around 45 people work with the remanufacturing of diesel particle filters at UBD.

Advanced Materials Recovery

Platina, Palladium or Rhodium is recovered as well stainless steel.

Company: Vector Aerospace - UK
Location: Fleetlands, UK
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In reman: Since 1940s
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Product

Engine components and piece parts of fixed-wing aircraft

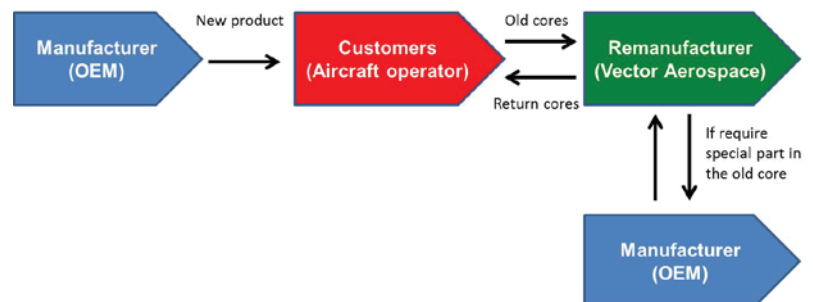
Core Sourcing

The company's ethos is to repair rather than replace. Cores are retrieved from aircraft operators through service contract and direct order to offer life prolonging maintenance from the company.

Business Model

Vector Aerospace is a global leader in aerospace maintenance, repair and overhaul (MRO), providing responsive, quality support for turbine engines, helicopters, fixed-wing aircraft and components. The company have 21 sites across Canada, the United States, the United Kingdom, France, Kenya, South Africa, Australia and Singapore. The business model survey is done with the one in Fleetlands, UK which provides MRO services for a range of civil and military helicopters and engines for fixed-wing aircraft.

The cores were obtained from aircraft operators and returned to the same customer after repaired. If there is a special parts need to be replaced in the core, Vector Aerospace will acquire from the OEM to keep the reliability of the parts and the engine.



The repairing (remanufacturing) process is divided into 3 cycles:

- Cycle 1: The engines will be stripped down, cleaned and assessed for repairability.
- Cycle 2: The repairable engines will have NDT process to diagnose the repairing point and then repairing the components using chemical electro plating, welding etc.
- Cycle 3: The repaired component will be reintroduced back to main engine (reassembly) before series of tests (embedded, engine, performance indicator tests) is proceeded to meet OE performance.

The driver and rational behind this business model is that the company provides the time and cost saving compared to manufacture new parts for the legacy engine. Keeping the balance between airworthiness and cost-effective business is a main challenge for this company. Vectors USP is identified in the company's strapline of 'setting the standard of customer service', as with many MRO company's it is selling a service that must meet customer requirements. The service is what the customer needs, the repair rather than replace ethos ensures that the remanufacture of the product is more cost effective than purchasing new and in many cases (dependant on scarcity of raw materials) ensures that the product is returned in much reduced turnaround times. Vector Aerospace does not have specific partnership to facilitate remanufacturing unless the parts require speciality that the company could not carry out (e.g. special welding process). The skilled personnel are the key resource for the company in order to keep MRO services at high standard. The company have internal estimation and calculation system and methodology to measure the key performance index (KPI) to ensure the profitability. The main challenge to improve the business is the keeping of airworthiness control standard for aircraft and the innovation through remanufacturing business.

Economic Benefits

The benefit of the company's product is that customers have an option to choose much cheaper and shorter out-of-service time of their aircraft from MRO service.

Environmental Benefits

The company have ISO 14001 and ISO 1800 for measurement of the performance. The remanufacturing site in Almondbank, Scotland has achieved zero waste to landfill.

Social Benefits

In order to reuse more materials rather than scrapped, the number and level of higher skilled personnel need to maintained and then elevated. The company keeps increasing the job opportunities to local communities (e.g. maintenance site in Fleetlands has 800 employees).

Advanced Materials Recovery

During the remanufacturing (repairing) process, titanium and advanced composite materials are recovered, such as from the components in engine. Vector Aerospace has the plastic media strip (PMS) facility to remove painting of aircraft and the materials used in the process are recycled to plastic bricks for construction materials.



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